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Prey, perception, and the visual psychology of early figurative art

Multidisciplinary approaches to the composition, context, visibility and perception of Upper Palaeolithic rock art in the Côa Valley, Portugal.

Palaeolithic (Old Stone Age) archaeology provides the only evidence for the origins of art, but its record is notoriously difficult to interrogate in testable ways. Even multidisciplinary approaches to understanding some of the earliest archaeologically recognisable art are still very rare. This project bridges the disciplines of Archaeology and Psychology to arrive at an unprecedented understanding of early art in Europe. Approaches from Visual Psychology offer new methodologies for understanding the perceptual basis of the art. Unlike the well-studied caves of southern France and northern Spain, this study focuses on the lesser-known open-air locations of engraved rocks in the landscapes surrounding the Côa Valley in Portugal.

The rock carvings, primarily featuring the depiction of prey animals, are analysed by deploying traditional archaeological methods such as typological surveying and distribution mapping, and are combined with insights from the psychology of perception in the form of six perception-based experiments. These experiments illuminate underlying mechanisms behind (1) the drawing of animals; (2) identifying salient animal features; (3) panel compositioning; (4) motif superimpositioning; (5) rock art viewing distances and pigmentation and (6) the art's landscape setting. The structure of this thesis is guided by the sequential, scalar concept of *Prey Perception Landscapes*, three key components, holistically bringing together prey identification and visibility, human vision, and landscape topography into a new model of the arts' function.

Results, on all scalar levels, show that the artists, most likely the hunters themselves, used their visuality to create marks in as perceptually accommodating ways as possible. Major aspects of motif shapes, panel compositions and location choices are found to be cognitively-derived. This thesis advocates the fruitfulness of taking advances from vision science and applying them to patterns found within some of the earliest forms of art in Europe, as it interrogates its creation and use in previously unconceived ways.

Lisa-Elen Meyering

Prey, perception, and the visual psychology of early figurative art

Multidisciplinary approaches to the composition, context, visibility and perception of Upper Palaeolithic rock art in the Côa Valley, Portugal (~ 24,000–15,000 years Before Present).



Photograph taken by author during fieldwork on rock art visibility ranges in the Côa Valley, 2018

Lisa-Elen Meyering

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List of Abbreviations

Recurring Terms throughout this Thesis:

cal BP – Calibrated Years Before Present

CI – Classification Image

EDP – Energias de Portugal

GIS – Geographic Information Systems

Ka BP – Kilo Annum Before Present

mas – Metres Above Sea Level

ms – Milliseconds

SPSS – Statistical Package for the Social Sciences

TL – Thermoluminescence

UP – Upper Palaeolithic

Pixel Calculations:

Pixel Count (PC) Then – Pixel Counts based on Upper Palaeolithic Bedrock Colouration

Pixel Count (PC) Now – Pixel Counts based on Modern Bedrock Colouration

PD – Pixel Difference

Visibility Parameters:

ResPe – Resolution Distances of Pecked Engravings

ResIn – Resolution Distances of Incised Engravings

ResAz – Resolution Distances of Azilian-Style Engravings

LegPe – Legibility Distances of Pecked Engravings

LegIn – Legibility Distances of Incised Engraving

LegAz – Legibility Distances of Azilian-Style Engravings

Statement of Copyright

The copyright of this thesis rests with the author. No quotation from it should be published without the author's prior written consent and information derived from it should be acknowledged.

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Dedication: I would like to dedicate this work to my grandmother, Theodora, who sadly passed away, whilst I was writing this thesis.

Chapter 1 - Introduction and Objectives

1.1. Introducing the Research

The following anecdote about the encounter between João Zilhão[1] and an Uluru elder visiting the Côa Valley rock art roughly 20 years ago serves as the preamble to this research. The latter had been sitting at the banks of the River Côa observing and thinking about the Penascosa rock art site for quite a while and, without being prompted, said:

"One can tell this is a great place for hunting kangaroo."[2]

These very observations offer a fitting starting point for a study that combines investigations on the perception of landscapes, the perceptions of prey within those landscapes and the perception and production of prey-specific art. Studies adopting such multidisciplinary approaches, to understand the earliest archaeologically recognisable art, are still very exceptional. Recent advances in scientific dating techniques have established a broad evolutionary scheme for Palaeolithic rock art and portable art (cf. Pike *et al.* 2017). Pigment analysis, 3D recording techniques, image manipulation and contextual studies of 'cave art' continue to refine a nuanced understanding of art from its non-figurative inception recently dated to at least 64,000 years BP (Hoffmann *et al.* 2018), until the end of the Palaeolithic ('Ice Age') around 12,000 years ago. However, there remains much to be learned from the integration of 'traditional' Palaeolithic approaches to art, GIS-based contextual analysis of art landscapes, and in particular, the psychology of perception. This is where this study comes into play, encompassing an entirely novel multidisciplinary investigation of some of the earliest known figurative art found in the open-air landscapes of the Côa Valley, Portugal.

In this introductory chapter, a focus will be placed on the importance of studying open-air rock art in a multidisciplinary way, as is conducted here. Emphasis will be on the newly developed subfield called **Visual Palaeopsychology** that addresses how psychology can inform archaeologically significant assemblages and vice versa. Overall, this thesis questions many aspects of rock art that have been debated for some time, yet have never been empirically tested or interrogated on a larger scale. The prime concern of this research is the visual nature of the rock art which sets out to test rock art specific features, such as their basic forms, their potential pigmentation and their deliberate (?) artistic placements.

[1] First director of the UNESCO World Heritage archaeology park in the Côa Valley, Portugal (Parque Arqueológico do Vale do Côa) housing thousands of rock art engravings and material culture from the Upper Palaeolithic.
[2] Uluru aboriginal elder to João Zilhão, pers. comm. to Prof. Paul Pettitt, May 2016.

An initial thought experiment

As a baseline for all investigations in this study, the following thought-experiment serves as an introduction to the different concepts and contained methodologies:



Figure 1.1.1.: Rock art panel *Penascosa 5* in the Côa Valley (Photograph by author, 2018).

Bearing the photograph above (Fig. 1.1.1) in mind, imagine stepping back from the rock surface and start to visualise the rock before the art was created.

Start off by thinking about your desired motifs.

What will you depict? Do you have a specific type of depiction in mind that you want to convey? If it is an animal, which one do you want to portray and why? Will it be the last animal you have encountered or something you see in your vicinity right now? Will you depict all parts of the animal or will its most salient features suffice for you to convey your message? How big will you make your depiction? What will your engraving style be? Will you engrave it and colour it in with distinct types of pigments afterwards? Or will you leave your trace without any additions with full knowledge that it will fade away in a couple of years' time?

Now, think about the motif's embeddedness in its wider panel.

Will your motif be placed in isolation or will you situate it near others? Will your motif only be accompanied by similar motifs or are you not fazed by a multitude of motif types? Would you overlap your depictions? Do you have a 'composition' in mind or are you just free-handing things?

***Lastly, think about its place*.**

Does this rock evoke particular memories? Does it trigger any kinds of visual experiences? Why would you take this rock over another rock to create your 'art' on? Is the structure, positioning and angle of the rock as important to you as the image itself? Is this location meant for a private or public audience? In other words, do you want your depiction to be seen by a bigger audience or should it be a private spot?

Exactly these types of questions form the basis of this investigation. Reasons for selecting a particular motif (including its size and style), reasons for selecting a particular rock and rock surface and reasons for selecting a particular rock location, will be interrogated in this thesis. At large, the overall aim of this research is to assess various aspects of the Côa Valley rock art through a visual lens. That is, assessing the engravings in close relation to the human visual system and to interrogate the relationship between the depicted motifs and their corresponding visible reality in its embedded landscapes. Of particular interest is the connection between rock art placement and its visible significance within the wider landscapes of the Côa Valley. Contrasting to traditional rock art studies that focus on either style, dating or context, this project assesses the engravings in their entirety, from its simplest formal analysis to its wider reaching environmental components. Therefore, the following schema (Fig. 1.1.2) is brought to the reader's attention at this point, which shows the interconnectedness between rock art process, practice (i.e. consumption/engagement) and product, a trio used in conjunction with each other throughout this thesis:



Figure 1.1.2.: The three 'P's for investigating the life cycle of material culture. (Photographs courtesy of Fundação Côa Parque).

1.2. The Importance of the Research

1.2.1. Original contribution to knowledge

This PhDs' original contribution to the body of knowledge is governed by its unique combination of interdisciplinary studies and experiments. Below is an introduction to the four principle areas of original contribution:

1) <u>The research area</u>

Much to the neglect of other areas producing artistic expressions in Europe, a lot of scholarly attention has been dedicated to prominent places of discovery, in particular cave structures and their motifs, their inherent meanings, and their public dissemination. This PhD thesis seeks to create awareness of Palaeolithic art outside the realms of the well-known and frequently written about caves in France and on the Iberian Peninsula. Whilst the land and riverscapes of the Douro river and its surrounding tributaries like the Côa have received great attention during the time of the uproar about a hydro-electric dam construction, threatening to submerge all rock art in the region, only a handful of studies and researchers have since surfaced that systematically assess the wealth of its artistic material. This neglect is targeted here. Furthermore, this study aims to generate a corpus of work written in English rather than in Portuguese or Spanish making it more accessible to a wider academic audience. For further insights into the discovery of the art, refer to section 2.2.

2) <u>The research methodologies</u>

This thesis aims to open new avenues of interdisciplinary study. It builds bridges between the disciplines of archaeology and visual psychology within a new interdisciplinary sub-field entitled **Visual Palaeopsychology**. This project approaches rock art from an unprecedented perspective. Up until now, typical rock art studies have been informed by methodologies from within archaeology, yet multidisciplinary approaches are rare. Many rock art studies do not go beyond the mere documentation and visualisation phases and are being left with a large quantity of motifs in catalogue formats. However, there is no further engagement as to how they interrelate and/or tell us more about the societies that produced them. This neglect is combatted here by taking one under-studied and infrequently published-upon region and subjecting its rock art motifs to a series of experimental tests, specifically devised for this thesis. To the author's knowledge, rock art imagery has never been subjected to rigorous psychological testing as such before. These methodologies have the potential to influence and transform future rock art studies (with similar as well as different geographical and temporal factors) and their associated interpretative trends whilst also pioneering the development of multidisciplinary approaches to

investigate the earliest human art. It is anticipated that this entirely novel approach results in new perspectives on processes prior to and during the creation of ancient mark making that previously were thought to be untestable and hence uninterpretable.

3) The research approach

This project aims at coming closer to an understanding of the rock art from an experimental and empirical data generating approach rather than basing it on purely theoretical or subjectively interpretative frameworks. The original contribution lies within the holistic approach of assessing the rock art from a variety of scales (cf. Fig. 1.3) starting with the depicted motifs and ending within its situated landscapes. This visual culture approach will be of significant archaeological and psychological value, enhancing our understanding of how hunter-gatherers linked real-life phenomena with visual cues in the landscape.

4) The wider research outcome

As will become apparent throughout this study, a wider understanding of Palaeolithic selection processes in rock art creation, Palaeolithic structural organisation as well as importance of links to their own landscapes will be obtained here. Additionally, in thinking about the conceptual differences between cave art versus its open-air 'equivalent' of landscape art, it might highlight several factors informing us about further aspects of Palaeolithic life. The public versus private debate of rock art audience will be addressed, as will be the fact whether rock artists saw their acts as *art* in the first place and whether these can be classified as extraordinary or mundane acts of creation. In other words, was rock art making a mere activity to pass time or were there particular underlying intentions with accompanying implications and meanings? Additionally, the findings are relevant to academic circles beyond the rock art community, for the employed methodologies and resulting interpretations can be adopted, adapted and applied to different areas of academic enquiry. These observations will be outlined in more detail in the conclusion and evaluation sections of this thesis (cf. Ch. 8).

5) The research impact

Aside from the impact illustrated in the four previous sections, this research will contribute to the wider collaborative work the Côa archaeological team are carrying out. This study will further complement certain objectives within the project PALÆCOA: Neanderthal to Anatomically Modern Human transition in the Côa Valley: Environments, Symbolism and Social networks, funded by Fundação Ciência e Tecnologia (FCT) and the Europe 2020 Programme (http://paleocoa.wixsite.com/paleocoa).

1.2.2. Why study open-air art?

The certainty of open-air rock art

Studying rock art, as its own scholarly discipline within the field of archaeology, has many advantages over the study of other archaeological materials. Rock art is fixed. Emplaced. Immovable. It is situated in the same location nowadays, as it will have been when the art was created.[3] Hence, the original birthplace of the art is preserved. The place of production equals the place of consumption, both now and during the Upper Palaeolithic. It is exactly that fixed nature that plays into the hand of the modern-day researcher of the art in trying to conduct emplaced structural and locational analyses. For many other archaeological artefacts, such as portable figurines or engraved plaquettes, it is harder to determine their place of origin and place of use because of its portable nature. For immovable rock art in a landscape setting this uncertainty falls away.

A glimpse into the mind-set of the artists

The beauty of this certainty in place is therefore ideally suited for a study of perception of art in its original setting. One does not have to search for long to discover that rock art, the direct manifestation of human presence, mark making and human thoughts on their worlds surrounding them, is the example par excellence for such cognitive analysis of material remains. Taçon and Chippindale (1998: 2) agree that engravings made by our human ancestors are "direct material expressions of human concepts, of human thought". Rock art gives a direct record of how people in the past saw their world and what they saw and experienced within their surroundings. It illustrates direct decision making of what rock artists deemed worthy of depiction at the time. Rock art provides us with a glimpse into their own mind-sets. It reveals the results of direct decision-making on which locations were important for a specific set of depictions.

A glimpse into the perception of their landscapes

The most important aspect in the study of rock art and its occurrence or absence in certain landscapes, is the availability and suitability of rocks for engravings in the first place. Rocks must be present for rock art to occur. Rock art is *arguably* created from people for people. From people who saw the need to depict their world around them. For people to see that others have

[3] This, of course, does not include the rock art slabs that have been transported to elsewhere, e.g. museums, in order to protect and curate them for future generations. This however occurs on a very miniscule scale.

already been there and to understand what has previously happened or has been witnessed and perceived at the site: Thus, deliberate landscape positioning of rock art would have been of the utmost importance.

The quick detectability of rock art from certain points in the landscape will have been key to those who were creating their art for the 'masses', for the public. For the artists, who were creating their depictions for smaller, more private audiences, it would seem most logical for them to position their creations away from well-travelled paths and on less conspicuous rocks.

1.3. Archaeology and Psychology Symbiosis

1.3.1. What can archaeologists learn from psychologists and vice versa?

Palaeolithic archaeology provides the only evidence for the origins of art, but its record is notoriously difficult to interrogate in testable ways. However, it will become apparent throughout this section that visual psychology can offer new methodologies for understanding the psychological and, in particular, perceptual basis of some of the earliest art in Europe. The aim of this section, therefore, is to introduce the interdisciplinary nature of this project which combines archaeology with psychology and vice versa. It aims to bridge and open up a symbiosis between these two, seemingly opposing, disciplines. This section is then followed by separate discussions of the histories of research of both disciplinary fields.

Archaeology, the study of ancient material culture, provides the methodological tools to access past material evidence. Through this, researchers can study cognitive processes right from the onset of human cognition. Per contra, psychology, the study of behaviour and mind, offers archaeology the toolkit for deeper investigations of this material record. Although this connection is still highly underrepresented and understudied in current scholarship and trends within either discipline, the mid 1980s were shaped by archaeologists investigating the connection between material remains and their creators' minds. Psychologists, in return, have, with a few exceptions, rarely been keen to learn about what archaeological procedures can contribute to their own discipline (Gonzalez-Ruibal, 2012).

Since the aim is to find out the rationale behind the Palaeolithic marks on the schist in Portugal, several theoretical strands come to mind on how to tackle their 'theoretical' existence. Indeed, the theoretical turn towards the incorporation of psychological scholarship into archaeology summited in the late 1990s. Under the umbrella term 'cognitive' or 'cognitive-processual' archaeology, this new influx of ideas from psychology was welcomed by researchers who concerned themselves with evolutionary processes of humanity. *Cognitive archaeology* as termed by Colin Renfrew is the "study of past ways of thought, as inferred from material remains" (1994: 3). As per this definition, archaeologists have used the cognitive, rather than the cultural aspect of psychology to be able to broaden their knowledge on the developmental stages of cognitive decision making in humans. Due to this psychological backing, it became common place to expand on questions like: when did abstract thought, aesthetics or the use of material culture as external symbolic storage appear for the first time? (cf. Zeki, 2001; Morriss-Kay, 2010; Gonzalez-Ruibal, 2012).

By following Renfrew's guidance that "the task for the cognitive archaeologist is to devise methods of study (...) which will, in practice, allow the archaeological evidence to be used to make contributions to the discussion which goes beyond more general speculation" (1994: 5), the aim for the following investigation will be to devise a number of experiments through which perceptual processes can be linked to the reasoning behind specific rock art compositions and engravings.

However, for the purposes of this study the term cognitive archaeology poses theoretical as well as conceptual difficulties. It comes to no surprise that the sub-field of cognitive archaeology has attracted much opposition over its analytical course of existence. Amongst others, Lewis Binford (2002) negated the possibility that archaeological material could convey human *thought* but instead could only demonstrate *actions*. Nonetheless, to counter-argue this position, *actions* are commonly seen as a direct manifestation of someone's prior *thought* processes. Yet, a problem with the cognitive archaeological school of thought, and incidentally its processual critique, is that it does not leave much room for testable hypotheses, something that Binford understood as his ultimate goal as an archaeologist. This, in turn, neither allows for empirical, nor reproducible ways of testing rock art occurrences in ancient landscapes.

Moreover, another big criticism that can be brought forward against the practice of cognitive archaeologists is that of extrapolating modern, 'euro'-centric views onto past material. Garofoli and Haidle (2014: 7) concur: "The coupling between extinct minds, brains and behaviours cannot be investigated in a laboratory. Without direct testability, there is a risk that theories in cognitive archaeology will remain merely subjective opinions in which 'anything goes'". Hence, we ought to refrain from looking at the past solely through the prism of the present.

1.3.2. Introducing Visual Palaeopsychology

It is for these negative connotations within the sub-field of cognitive archaeology that this thesis pioneers the introduction of the term **Visual Palaeopsychology** to come to a more nuanced symbiosis of archaeology and psychology. This is achieved by applying empirical, testable and reproducible methodologies from both disciplines onto the medium of rock art. To illustrate this point further, the following example reveals the distinction that is to be drawn between these two schools of thought (Cognitive Archaeology vs. Visual Palaeopsychology) concerning themselves with the study of the mind in relation to ancient artefacts. Consider the following example (Fig. 1.2) of a rock art depiction in the Côa Valley. The following questions spring to mind:

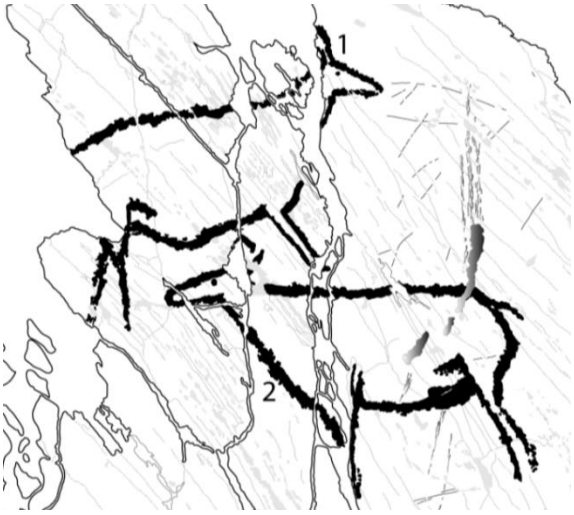


Figure 1.2.: Rock 2 at Vermelhosa (drawing courtesy of Fundação Côa Parque).

- What is depicted?
- How were the marks produced?
- Why is it this pattern?
- Why is it here?
- Who produced them?
- What exactly do these depictions mean? I.e. Why do these depictions exist?

This is how a **cognitive archaeologist** would 'subjectively' approach the following image in a 'laboratory' environment, with the agenda to figure out the thoughts behind these creations: They might argue that from the standpoint of the history of the people who created these depictions, the 'artists' have been culturally exposed to the sightings of these animals on previous occasions, resulting in their portrayal of them on the rocks. The artists will also have been historically subjected to mark making on rock, resulting in their rather 'professional' and effortless portrayal of animals without the need to eradicate engraving inaccuracies/mistakes. This is the 'mental' or rather 'cognitive' extent to which a cognitive archaeologist would go into the matter, neglecting any 'physical' investigative enquiry in the field.

Contrastingly, this is how a **Visual Palaeopsychologist** would 'empirically' approach the following example in its 'original' environment, with the agenda to figure out the thoughts behind these creations: A comprehensive set of visual experiments is lined up to investigate the engraved marks empirically. The shape is tested against a psychologically repeatable backdrop asking whether the most memorable parts of the animal in real life stimulated the shape and engraving technique on the subsequent surface. The site is being visited in person to attest several eventualities (location, originator, intention) bearing in mind changes in landscapes and

in societal memory between Palaeolithic and modern spectators of the art. A 'euro'-centric etic approach is strictly to be avoided. The status of the emic *perceptual* observer is able to be assumed and investigated since we know that no perceptual dissonance between our modern visual system and that of the Palaeolithic inhabitant exists. In other words, all experiments apply empirical, testable and reproducible methodologies to prevent the pitfalls of the long-outdated cognitive archaeologist.

Fundamentally, there are a plethora of concepts that visual psychologists can bring to the table when trying to investigate poorly understood archaeological material. The same can be said for archaeologists who can give their material evidence and corresponding analysis to develop the psychological realms of visual cognition and early visual perception in under-studied regions. Hence, this thesis commences this new field by studying how human cognitive processes can inform us about the reasoning behind assemblages of material culture. This entirely novel approach will result in new perspectives on processes prior to and during the creation of ancient artefacts that previously were thought to be untestable and hence uninterpretable. More detailed research contexts into which this research fall are further explored in the next chapters, yet it is important to acknowledge previous research approaches that specifically deal with sensorial as well as 'cognitive' dimensions of rock art early on here. The entailed research presented here, in its broadest sense (approaching rock art from the senses) is not completely novel. Scholars such as Waller (1993 - on sound creation of rock art making); Tilley (1994 – on phenomenological consumption and production of rock art); Ouzman (2001 - on non-visual rock art approaches); Lewis-Williams (2002 - on the mind and consciousness) amongst many more have previously tackled to illuminate rock art from and with a sensorial approach in mind. What differentiates this research, as will become apparent in the succession of chapters, is not necessarily the fact that the rock art's visual culture is attested for, but that new methodological contributions enable the investigation of rock art specificities with a data-driven and replicable end goal. Eventually, this chapter will be revisited and reviewed in the conclusion chapter to reflect upon the results of the experiment contained within and the resulting impact on both disciplines and the newly rising sub-field of **Visual Palaeopsychology.**

1.4. Research Aims and Objectives

This study has as its core aim the visual palaeopsychological assessment of Côa Valley rock art sites, including its composition, context, position as well as its inter and intra-visibility. The main research question that systematically structures this thesis is as follows: Why are exactly these motifs on these panels placed in these landscapes? The psychology of perception will be deployed to understand the specific nature of art perception and prey recognition; a new, multidisciplinary concept that can link art, landscape and human perception.

1.4.1. Which main research question does this research address?

To accomplish this, a scalar model of investigation is being deployed so that every aspect of rock art will be considered; from the zoomed-in motif-perspective to the zoomed-out situatedness-in-the-landscape perspective. This approach will offer readers of this thesis a novel way to track rock art from its places of inception to its wider situatedness, in order to understand (from a visual psychological point of view) the full cycle of creation, use, re-use and our modern way of researching it nowadays. Here are the identified levels that are being considered as part of this research:

1. **Motif Level/The Graphic or Gestaltian Rockscape**
2. **Panel Level/ The Compositional Rockscape**
3. **Environmental Level/ The Contextual Rockscape**

This allows for the engravings to be assessed in their entirety and not in isolation, from its simplest formal analysis to its wider reaching environmental components. The following chart illustrates these scalar investigative levels:

Identified rock art scales - Studying rock art through a series of different spatial considerations

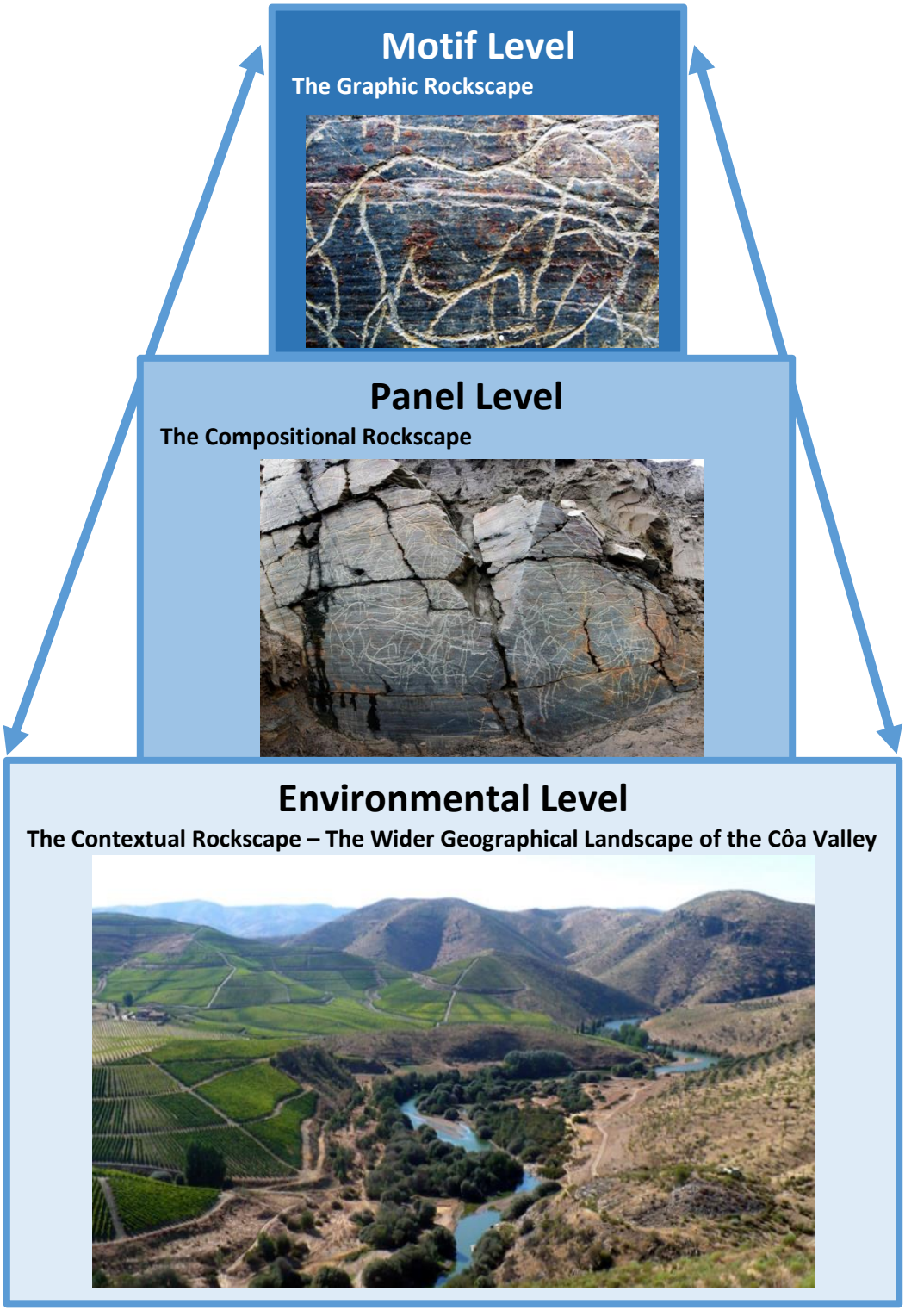


Figure 1.3: Scalar rock art model applied in this thesis (photographs courtesy of Fundação Côa Parque).

For each of these three scalar levels, one broad research question can be identified:

Motif Level: Why are the engravings depicted in the way they are?

Panel Level: Why are specific panels and panel compositions chosen?

Landscape Level: Why are the engravings placed in specific locations?

In short, this can be simplified into the following question:

Why are exactly these motifs on these panels placed in these landscapes?

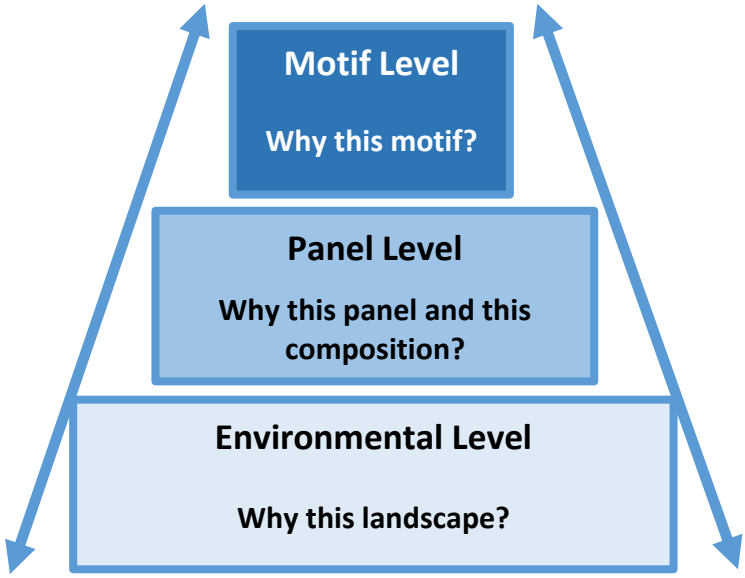


Figure 1.4: Scalar rock art model linking the three main research questions.

To reiterate, this study will investigate why specific images were deliberately placed in certain positions in chosen landscapes. The null hypothesis here would be that rock engravings were randomly scattered around the landscape with an arbitrary assortment of motifs, in this case animal depictions. As will become apparent in the next section, there are three objectives that will be satisfied in the fulfilment of this overarching aim.

1.4.2. The three main objectives

To fulfil the three main research questions, the project builds upon a trio of concepts that will be explored throughout the various sections of this thesis by integrating them into the scalar rock art model: Prey → Motif Level; Perception → Panel Level; and Landscape → Landscape Level. For all three aspects, specific experiments will be conducted and evaluated that explicitly explore how psychological frameworks for visual categorisation can be applied to further our understanding of the Palaeolithic archaeological record. Each section in turn bears its own individual research questions aiding in answering the main goal of this thesis.

1) Motif level – prey

The motif level concerns itself with single prey depictions only. Here, individual species will be analysed on their own merit and not with regard to what surrounds them. Yet, what must be caveated here right at the start of this thesis is the use of the word '*prey*' which will be reoccurring throughout. Of course, its use presupposes that the species presented herein are related to activities of hunting for purposes of resource procurement, which also implicates further nuances of modern interpretation extrapolated onto the workings of the hunter-gatherers and the status of species of the past. Even though there is no faunal evidence to present an argument for or against the correct use of such a term, the broader understanding that the species of the Côa were used as such (cf. also Hodgson and Pettitt, 2018) prevails and readers are advised of these thoughts when presented with the word 'prey' throughout. The following research questions will be addressed, bearing in mind that the original aim for this level investigates the question: **Why this motif?**

Archaeological analysis

- What motif types; frequencies; forms (full bodies or other); features (details such as eyes, nostrils or other); facing directions exist in the rock art of the Côa Valley?

Psychological (experimental) analysis

<u>Experiment 1: Drawing Animals</u>

- What is the general shape of the animals drawn by modern participants?
    - How do participants deal with familiar and unfamiliar drawing prompts? Does visual priming influence the way participants draw?
- What drawing order is noticeable?
- How are animals drawn in their contextual environment?
- What constitutes a minimally presented animal?
- Is there a difference between left and right-handed artists?

<u>Experiment 2: *Bubbles* Experiments</u>

- Can visual psychological processes explain why animals are depicted in the way they are?

  → In other words, do elements critical to the resolution of particular animals correspond to clues known to be critical to human perception?
- Which are the most diagnostic features on (1) a horse and (2) a bison, that actively aid our identification of these particular species?
- Does the minimal amount of information needed for detection or discrimination of an animal, as revealed by the *Bubbles* method, correspond to features depicted in rock art?
- If rock art features do resemble the diagnostic information established through *Bubbles,* are we therefore able to make inferences on the hunter as the artist?

2) Panel level – perception

The panel level denotes the composition of all images on a rock art panel and regards the area immediately surrounding the panel. The interrelatedness between certain animal depictions will be explored, a study on superimposed images will be conducted and topographical panel features will be assessed and compared. The following research questions will be addressed, bearing in mind that the overall aim here is to question: **Why in particular was this panel chosen?**

Archaeological analysis

(1) What types of …

- engraving techniques
- base colouration of the schist
- panel orientations

… exist in the rock art of the Côa Valley?

Psychological (experimental) analysis

<u>Experiment 3: Gestaltian Analysis</u>

- Do the rock art compositions adopt Gestaltian principles?
- What does this tell us about the rock art making process and about the stylistic choices of the carvers?

<u>Experiment 4: Superimposition Study</u>

- Why might artists superimpose their creations?
- Which motifs overlap each other and what are their related frequencies?
  - Why do certain animal types overlap? Is there a visual strategy behind this? If so, which?
- Are there different degrees of superimpositions?
- How visible are engravings within different degrees of superimpositions and rock types?
- Where do superimpositions occur on the panel?
- Can superimposed images provide insights into the mind-sets of carvers at the time?

3) Landscape level – position and visibility of the rock art

The environmental level is concerned with the relationship between rock art panels in the landscape and the wider impact of the depictions for example in relation to its possible function as markers of migratory routes. The following research questions will be addressed, bearing in mind the overall aim that queries: Why exactly this landscape location?

Archaeological analysis – topographical GIS analysis

- Do human occupation sites equate to rock art sites?
- What can the palynological and palaeo-environmental record reveal about rock art visibility?
- Were animals, depicted on specific rocks, killed at these corresponding spots?
    - I.e. does the faunal assemblage match the rock art assemblage?

Psychological (experimental) analysis

Experiment 5: Rock Art Visibility – Distance Perception

- At what distances can viewers resolve the rock art?
- Did the addition of coloured pigments affect perception of these images?
- Do different engraving techniques influence visibility levels of rock art?
- Do the visibility levels from pilot study withstand in real rock art terrain?
- Does sun exposure (i.e. lighting levels) influence visibility levels of rock art?

These questions will be complemented and tied together within a landscape framework by the following enquiries that will be tackled using GIS and landscape surveys in the field:

Experiment 6: Integrated Rock Art Visibility – Distance Perception

GIS-specific analysis: Integrating all data: rock art features in the landscape

- What does the **distribution pattern** across the Côa Valley look like for:
    a) Individual Motifs?
    b) Incomplete/Complete Motifs?
    c) Engraving Techniques?
    d) Superimposed Imagery?

  I.e. Do these depictions appear in particular areas, or do they appear randomly distributed across the Côa Valley?
    - How **visible** are different rock art panels?
    - From which specific points in the landscape are individual panels visible?
    - Can an inter-visibility between panels be noted?
    - Which kinds of viewsheds do panels create, with regard to
        - Resolution (ease to acknowledge rock art presence) distances towards pecking/incision/Azilian depictions?
        - Legibility distances towards pecking/incision/Azilian-style depictions?
- What do visibility and locality tell us about the artists' **intentions**?

  I.e. Was every panel containing rock art to be seen by everyone in the community?

1.4.3. Research overview

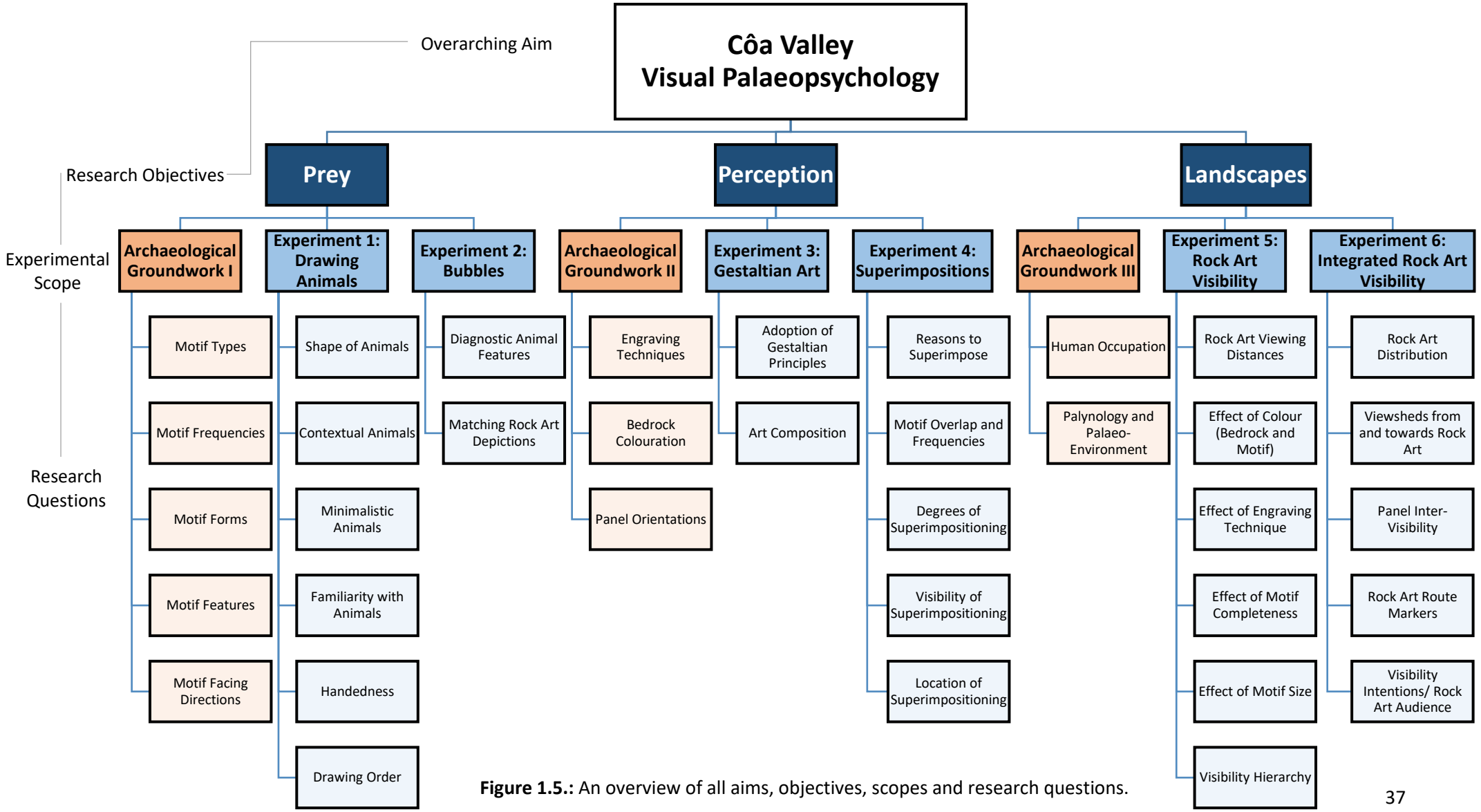


Figure 1.5.: An overview of all aims, objectives, scopes and research questions.

1.5. The Importance of these Research Objectives

The engravings under study, created during the Upper Palaeolithic of continental Europe (24,000-15,000 years BP), lack the advantage of contemporary written or oral sources that could shed light on their intrinsic functions and meanings. Even though we only have access to purely visual, non-textual material from the period, it is all the more important to approach these early images through a multi-disciplinary lens. For, if we regard all engraved animal motifs as archaeological artefacts, their vast frequency within the Côa Valley easily outnumbers the existing number of physical, often portable, artefacts (including faunal assemblages, material culture and settlement sites) providing us with information about its corresponding culture.

Therefore, to learn as much as possible about an illiterate society within the Portuguese[4] Palaeolithic, we can use this abundance of rock art evidence as pictorial 'writing' and investigate what aspects were clearly important for them and worthy of depiction. We can scrutinise what they might have wanted to convey about their lifestyle, their way of conducting tasks and about their marks left for next generations including ourselves. In fact, we can question their overarching reasons for devoting time to rock carving, which could have equally been expended in other domains of their lives. This question is especially pertinent to depictions that have been made with much attention to detail, with carvers spending substantial amounts of time to perfect their creations.

The research questions have been specifically devised with this in mind, trying to shed light on a society that has left marks for us to decipher. Instead of focusing much attention on the mere recording[5], cataloguing or small-scale analysis of the art, the novel and original approach to the art in this thesis comprises the incorporation of perceptual experiments to question whether neuro-visual processes can explain the reasoning behind compositions of rock art images, overall art perception and prey recognition.

[4] Whilst modern boundary markers/notions such as 'continental Europe' or 'Portugal' are deliberately chosen to situate the reader in the correct geographical contexts, it is important to remember that any demarcations of such lands will not have existed as such during the Upper Palaeolithic.

[5] The recording, description and cataloguing of the rock art continues to be carried out by the archaeology team at the Fundação Côa Parque and its results will be integrated into the data sections of this thesis.

1.6. Thesis Overview

This thesis comprises of eight chapters. Following this introduction and statement of objectives, **the second chapter** is dedicated to the 'housekeeping' side of this work. The research areas will be introduced as will the history of discovery of the rock art itself. What makes a study in this region so unique, is that one can encounter the Palaeolithic mind 'outside' the realms of the better-known and written about caves. We are able to meet the creations of the artists in their very birthplace and are thus able to link choice of motif with choice of location, place of creation with place of reception. Relevant rock art related terminology is introduced, with emphasis on the use of the notion *art* in 'rock art', and the definition of *landscape* as well as *space* and *place*. Once someone selects a space for their own artistic traces, one could argue that they turn this space into a place. A place of cultural memory, a place that alters over time due to anthropogenic investment and natural processes, and a place that can be returned to just like we do nowadays to get into the minds of our early ancestors.

The third chapter then guides the reader through the historiographies of rock art research with a focus on animal imagery and open-air landscape studies. Whilst the history of Palaeolithic rock art is addressed, a stronger focus is being placed on introducing the reader to concepts within the study of psychological perception, perception of works of art and the perception of moving animals/things.

The fourth chapter is dedicated to the explanation of methodological choices throughout this work. A general overview is given as to why this research functions in the way it does and how each individual methodology for each psychological experiment will follow in subsequent chapters so as to keep, in the interest of the reader's understanding, a flow of argument and cohesion at all times. This project deploys and develops approaches from archaeology, psychology and Geographic Information Systems to understand the nature and function of Upper Palaeolithic rock art in the valleys in and around Portugal's Côa Valley. More specifically, a blend of conventional archaeological investigation is coupled with experimental procedures from the field of psychology. This will give this investigation an unprecedented look at some of the earliest marks of humanity.

The subsequent chapters that follow engage with the subject matter from a scalar methodological approach. Each chapter entails an introductory archaeological investigation which is then followed and corroborated by two psychological experiments.

Chapter five, entitled *prey,* concerns itself with the motif level, in other words, the individual depictions as they appear in front of us. The archaeological groundwork introduces matters such as the general composure of the art, in other words the types of motifs, their quantities, shapes, sizes and carving techniques. After that has been established, two psychological experimentations follow, one that assesses animal drawings of participants who have been exposed/primed to diverse kinds of visual stimuli throughout the experimental process. The other experiment is the use of a psychological software, named *Bubbles*, to identify body parts of animals that are visually salient.

Chapter six, called *perception*, provides the reader with a closer look at the panel level. After an assessment of the 'archaeological groundwork', i.e. general factors relating to the choice of panels, their specific characteristics such as sizes, location and colouration, the next two psychological experiments follow. Here, the chapter splits into two aspects that consider the panel environment. First, art features that are repeatedly found in connection to each other are tested for their adherence to the visual psychological principles of *Gestalt*, i.e. the conglomeration of motifs and their specific characteristics coming together to create scenes and compositions. The fourth experiment considers the occurrence of superimpositioning of motifs and questions why they occur.

The seventh chapter, named *landscapes*, situates the motifs and panels into their respective landscapes. The archaeological groundwork here assesses the existence of human occupation sites and evaluates the available palaeo-environmental and palynological data for the Côa Valley. After this, the last two experimental tests assess the visibility of the engravings in their embedded contexts. Hence, the fifth experiment within this thesis establishes a framework for testing for the possible use of colour in their artwork and their respective viewing distances. The last, sixth experiment re-examines the visibility study in its embedded geographical context. GIS is used to create a general overview of where the rock art and specific motif types are situated. Findings from the visibility study are incorporated into a larger view of the region's inter-visibility and rock art interconnectivity to gain insights into larger patterns of rock art creation and consumption.

The conclusion chapter, **chapter eight**, brings together and evaluates all findings from across the scalar levels.

Chapter 2 – The Research Area, Rock Art Terminology and Practices

This chapter focuses on the research area, the initial definitions of rock 'art' and related terminology, the main aims and objectives of the study and on the significance and its applied uses of this undertaking.

2.1. The Region, its Geology and Climate

This study focuses on the open-air rock art of the Iberian Upper Palaeolithic found in the Côa Valley (Portugal). The Côa Valley is situated in the North East of Portugal through which the Douro and its left-bank tributary, the river Côa, runs. The Douro is one of the longest rivers in Iberia and largest by water volume (Zilhão, 1998). The source of the Côa lies in the Malcata mountains which geologically aligns with the western most limit of the so-called Iberian Meseta, known to be the biggest geomorphological formation within central Iberia (Luís, 2009). The course of the river runs in a clearly defined north-south direction (Meireles, 1997). A tributary river of the Douro further to the south east across the border into Spain is the river Agueda, alongside which the so-called Siega Verde panels can be found. The landscape is characterised by granite river bedrock but the last 15km of the valley houses many of the engraved *schists* near the banks of the river Côa and its aforementioned tributaries (Zilhão *et al.* 1997). The following map indicates the location of the art, first in its wider context, and secondly, in its riverine environment:

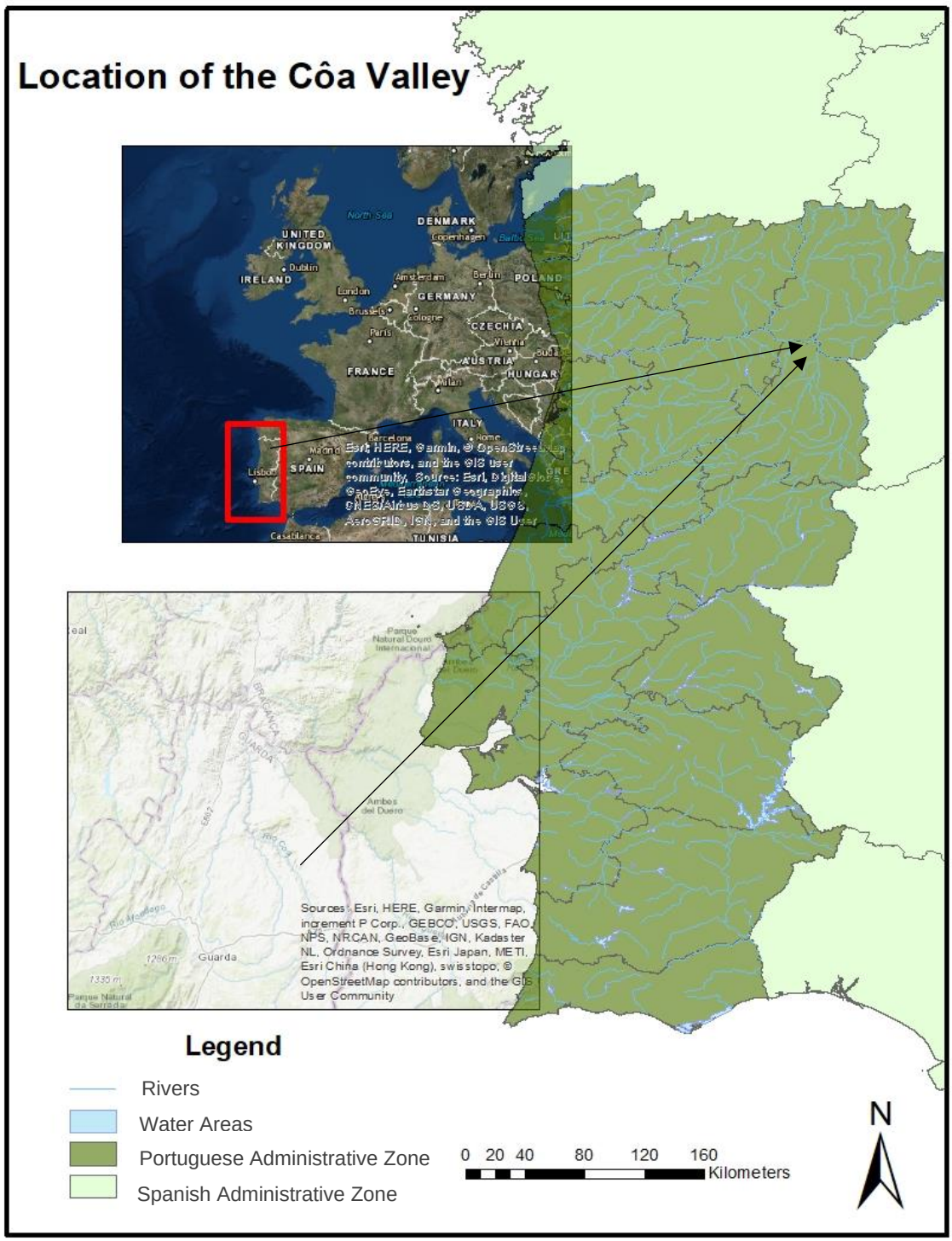


Figure 2.1.: Location map showing the Côa Valley in its riverine environments (map created by author in GIS).

It seems the location of rock art is of particular significance to the research community. Why does rock art appear in some areas, while others are completely left blank? It is often postulated that there must have been an ideological reason for the artists to have chosen these exact locations. Yet, rock art occurrence can also be dependent on geological as well as taphonomic and anthropogenic factors that can impose biases on surviving assemblages.

There are several geological and taphonomic bias factors determining rock art occurrence in certain regions[6]:

1) Geological formation, i.e. rock availability
2) Geological composition, i.e. rock type and preferential use of specific types of rock that are easily engravable
3) Geographical location, i.e. rock accessibility
4) Preservation levels, i.e. level of rock art preservation and conservation → Rock art loss due to erosion, terracing, quarrying, damming, vandalism and agricultural activities

By actively choosing rocks as the preferred medium for artistic representations, the creators likely deliberately chose the most persistent natural material available to them at the time (although softer materials could have also been embellished, of course), perhaps to preserve their creations for the future. A choice which, in itself and with all its attached connotations, such as thinking about the past, present and future, is a stimulating act.

As for the case of the Côa Valley rock art, geological constraints and the distribution and location of specific rock formations bear patterns of rock availability for engraving. The location of the engraved schists is typically along the banks of the river Côa and its tributaries. Indeed, Zilhão (1997) has pointed out that the pattern in engraving location in close vicinity to the water of the river systems can also be attributed to their preserving nature in these environments. Nevertheless, the large-scale occurrence of remaining engravings in specific art clusters might indicate, "it would be unlikely that preservation factors alone would have erased any type of evidence from specifically defined areas in their vicinity" (Ferreira, 1993: 75). The following paragraphs will elucidate these rock configurations further.

[6] Refer to chapter 2.5. for a discussion of limitation and selection bias in rock art studies.

Geologically, granite outcrops that formed approximately 300 million years ago, when the Permian transitioned to the Carboniferous, frame a 130 km stretch of the course of the Côa (Meireles, 1997; Luís, 2000; Aubry, 2001; Aubry *et al*. 2002). The last stretches of the Côa River correspond to the western most limit of the so-called Iberian Meseta, known to be the biggest geomorphological formation within central Iberia. About 20 km closer to the junction between the Côa and the Douro, a drastic geological change can be observed, noticeable by the existence of large Cambrian schist outcrops that geologically form part of the Desejosa formation (Meireles, 1997). The occurrence of schist in this region is further characterised by its flat vertical structures, owing its shape to a vertical fracturing system, in other words the progressive exposure to tilting and traction during the early formation of the river system (Aubry *et al.* 2002; Luís, 2009). The fracturing patterns are responsible for the well-known vertical schist structures, called "testas" or "foreheads", observable throughout the region, presenting ideal conditions for rock art engravings (Luís, 2009). The southernmost Côa Valley site of Faia, which features engraved granite surfaces and is a site at which the rock art is situated within shade (Santos *et al.* 2019). Incidentally, this is also the only rock art site in the region at which traces of red pigments have been recovered, posing several interesting questions for debate (cf. Ch. 6 and 7).

Vertical schists are easily engravable with low amounts of body rotation or bending and thus require relatively (depending on rock accessibility of course) low amounts of artistic athleticism (cf. Boivin, 2004; Gittins and Pettitt, 2017). Verticality, of course, also lends itself to lower amounts of weathering as schists are more protected from winds and (acid) rain than horizontally sloped rock art panels. In fact, the only engraved horizontal panels that have been recorded in the region are found at Vale da Casa, on a river terrace formed by erosions. That is not to say, however, that not more horizontally aligned panels could have existed in the past and that we are only seeing a partial picture nowadays.

This incision to its current level has been dated by Zilhão *et al.* (1997) according to Cl36 testing and points to a minimum age of 100,000 years ago. On either side of the river, the landscape is shaped by varyingly high plateaux. The altitude corresponding to the right bank of the Côa ranges between 400-800 mas (metres above sea level), while the relief of the left bank of the Côa ranges from 100-500 mas (Carvalho *et al.* 1996; Luís, 2000; Aubry, 2001). Abrupt incisions in the northern and eastern plateau follow a south-north divide, hence creating steep valleys, now housing the valleys of Ribeira de Piscos towards the north ending in the Douro gorge and the valleys of Massueime and Côa on the left bank of the Côa River.

The fact that this area is marked by such steep incisions into the landscape, with a special focus on the river passages that run through them, can lead to speculations as to why exactly these spaces have been utilised in the creation of artistic expressions and in the making of place. Baptista and Diez (2002) and Carvalho *et al.* (1996) have highlighted the riverine proximity of the engravings. This distribution points to the importance placed on watercourses. Indeed, water is a hugely important resource for humans and animals alike, and it is a fool's errand to be away from fresh drinking water for extended periods of time. Moreover, the entire study area is marked by naturally occurring formations and phenomena that will have attracted a profound sense of wonder and awe in the people roaming those lands, both in the past and nowadays. It therefore does not seem surprising that evidence of previous occupation of these lands and artistic creations are still to be found there nowadays (cf. Baptista, 1999; Aubry *et al*. 2002; Luís, 2009).

The high acidity of the soils within the Côa Valley results in poor preservation of organic material and thus limiting the ability to reconstruct the ancient climate. However, a possibility that allows us to come to a closer understanding of climatic conditions during the Upper Palaeolithic is to revert back to large scale models applying measurements from ice cores (Johnson *et al.* 1992), isotopic marine cores (Bond *et al.* 1993) and isotopic pollen data (Peyron *et al*. 1998) dating to the last glacial maximum in Europe. These collective measurements suggest that climates at the height of art creation in the region involved 30-50% lower precipitation levels and temperatures of 10°C (+/- 5°C) colder than present conditions (Aubry *et al.* 2002). This in turn suggests that temperatures within the winter periods would have repeatedly fallen below 0°C, likely turning rain into snow during these periods. Considering this data, resulting vegetal covering of the soils would mirror that of a continental steppe-environment above altitudes of 700m and an alpine, sub-alpine, boreal and temperate-like environment below 700m altitude (Aubry *et al.* 2002).

Zilhão *et al.* (1997) suggest that due to such climatic conditions, merely larger rivers such as the Douro and associated Côa would be able to move all year around being fed by melting snow and glaciers situated in the Estrela mountain ranges to the South of the rivers and the Central Iberian mountains situated to the East. Drainage from the higher altitudinal plateaux towards the lower lying rivers (which measures about 110 mas) will have been and is through incised streams in the bedrock, termed locally as small "canadas" (Luís, 2009). These riverine conditions would hence attract large migratory herds of herbivores and would have formed the basis of human occupational structures within the region.

Several excavated and well-preserved human occupation sites affirm Palaeolithic presence in the area, at sites in close vicinity to the river. Excavations in 1996 and 1997 at Quinta da Granja and Quinta do Monte Meão unearthed Acheulian material datable to the end of the Lower Palaeolithic (approximately 90,000 years BP). Upper Palaeolithic presences can be observed at sites such as Fonto do Olmo, Quinta da Barca Sul, Olga Grande 4 and 6 and Cardina I and II (Zilhão *et al.* 1997; Aubry and Carvalho, 1998), where its associated layers, dating from the Gravettian (circa 25.000 BP) to the Late Magdalenian (circa 10.000 BP), offer an abundancy of stone tools, primarily made out of quartzite and quartz and more rarely out of rock crystals and flint (Aubry *et al.* 2002). Hence, human presence in the valley in this time range has been independently confirmed by well- preserved and characteristic settlement sites.

It is important to note here that during the Upper Palaeolithic, such administrative and socio-economic boundaries between two countries for instance as we perceive and label them nowadays will have conceptually not existed then. Although there might have been territorial distinctions, the river system on the Iberian Peninsula will have formed a unity in itself. Both art clusters of the Côa and within the Siega Verde region are geographically close, and as will be seen throughout this research, the style and content of their art indicates that they formed a unitary whole over some 10,000 years of the Late Pleistocene.

2.2. The Discovery and Dating of the Côa Valley Rock Art

The discovery of the art in the Côa Valley dates to 1994, which coincided with the onset of a huge dam building project in the Côa Valley area. A few months earlier, Nelson Rabanda, a local archaeologist, had uncovered a couple of rock incisions, initially guarding his finds from the public eye. However, since the dam, initiated and funded by the EDP (Energias de Portugal), would have eventually submerged many of the rock carvings, due to their proximity to the water's edge, he decided to make his discoveries public. This move resulted in great media coverage and public interest, with members of the public, having formed the "Movimento para a Salvação das Gravuras do Côa" demonstrating on local streets holding banners with the words (see Ribeiro, 1995: 40; Baptista, 2002):

"As gravuras não sabem nadar"

"Petroglyphs can't swim"

The media coverage coupled with the authenticity endorsement by internationally renowned archaeologists and UNESCO put a temporary halt on EDPs' plans. However, the persistency of the EDP to actively disprove the age of the engravings continued, since a more contemporaneous date for the engravings would allow them to continue with their project[7]. In what would later be known as the "Côa controversy" (see also Arcà *et al.* 2001), the EDP was assisted by scholars Robert Bednarik and Alan Watchman (1995) as well as Ronald Dorn and Fred Philipps (1997), who applied an unproven methodology in order to confirm that the engravings were not to be situated within the Palaeolithic corpus. It had to take a shift in political government to resolve the existential battle between advocates of its authenticity, notably Bahn (1995) and Zilhão *et al.* (1995) and the aforementioned opponents and the construction of the dam was eventually stopped in November 1995.

In 1999, the Douro River Dam located downstream of the Côa, was emptied leaving previously unknown rock carvings exposed. This event coincides with the discovery of the rock art site of Fariseu 1. The water drainage revealed the lower parts of the rock art panel, which had previously been covered by thick layers of sediment. Shortly after its discovery, an excavation team revealed a 2.5m deep stratigraphy holding rich deposits of schist fragments, lithic artefacts as well as layers of alluvium (Aubry *et al*. 2002).

[7] However, are more contemporaneous engravings by 19th century farmers and millers for instance not worth saving for future generations and studies?

Yet, what finally proved the age of the Côa engravings, was the fact that stratigraphic layers containing archaeological material were discovered in direct contact with the 82 animal engravings filling a 3.2m rock surface:

> "Until now the dating of the stylistically Palaeolithic Côa Valley rock art to the Palaeolithic was supported only by indirect evidence. This was very strong evidence, but, in the language of the courts, only circumstantial. Now we have the strongest possible evidence: stratigraphy. After the Fariseu finds, no one in good faith can question the Palaeolithic chronology of the Côa Valley rock art.' (J. Zilhão, quoted in Himelfarb 2000)"



Figure 2.2.: Engravings found at Fariseu 9, conveniently covered by archaeologically datable chronological layers. The colouration of the engravings was done in an editing software to understand possible sequencing of lines (Photograph courtesy of Fundação Côa Parque).

The most recent rock art discovery within the Côa Valley dates to March 2020, with a 6m wide panel (Fariseu 9) unearthed in close vicinity to Fariseu 1 (Aubry *et al.* 2020). Similar to the panel of Fariseu 1, this newly discovered rock is also covered by archaeological layers which are useful in the reconstruction of the art's age (cf. Fig. 2.2 and Fig 2.3 for the layer exposure during excavations). What makes this new panel so unique, however, is that one of its contained depictions boasts the largest prey animal depiction in open-air environments (to date) around the world. Figure 2.4 shows the depiction of an aurochs, spanning 3.5m, whose dorsal line and other bodily features also nicely assimilate to the curvature of the panel layout, akin to the visual phenomenon called pareidolia (more on this in Chapter 3.2.3).



Figure 2.3.: Excavation in progress at Fariseu 9 in early 2020. (Photograph courtesy of Fundação Côa Parque).



Figure 2.4.: The pecked outline of the 3.5m wide aurochs pointing to the left with some smaller depictions towards its ventral line (Photograph courtesy of Fundação Côa Parque).

Aside from direct contact between archaeological layer and engraved surface, several flint tools bearing heated quartzite fragments could be dated through thermoluminescence dating (TL). Additionally, to gain more insight into the chronological sequencing at the site, several samples of sediment were dated through optic luminescence dating (OSL) since layers had been directly exposed to sunlight before eventually getting covered by the next stratigraphic layer. These dating efforts revealed a date range from c. 18.500 for the lowest datable layer of deposit, a date of 14.500 for layer 6 and 7 which coincide with the lowest laying petroglyph in the sequence and dates of 11.000 attributable to layer 4 which is located near the top of the archaeological level above which only recent fluvial sediment can be found (Mercier *et al*. 2001). This establishes a *terminus ante quem* of 14.500 for this particular example of art.

It is now commonly agreed upon, that chronologically the art spans the period ~24,000 – 14,500 Before Present at Côa (culturally from the Late Gravettian/Solutrean to the Late Magdalenian) supplemented by Late Magdalenian images at Siega Verde (Valladas *et al.* 2001; Luís *et al.* 2015). This offers an exceptional dataset of art in its original geographical context, with archaeological associations. A large majority of the rock art figures date from the Upper Palaeolithic; stylistic comparison suggests that the oldest may be of the Late Gravettian Age, i.e. more than 20,000 years old, and that this first artistic cycle lasted until the end of the Magdalenian, some 10,000 years ago. Human presence in the valley during this time range is independently confirmed by well-preserved and characteristic settlement sites (Zilhão *et al.* 1997; Aubry and Carvalho, 1998).[8]

[8] More on human occupation in the regions are found in the landscape section of this thesis – chapter 7.2.2.

2.3. Rock Art Terminology

To begin with, a basic definition of rock art will aid in contextualising this study. A definition for *rock* seems very straight forward, yet when it comes to *art*, the definitions become more varied and disputable. Everyone's conception of art nowadays differs from the next, let alone comparing the concept of art as understood by Upper Palaeolithic hunter-gatherers to the one by a 21st century inhabitant. One must therefore question: Are we qualified to call such engravings art? Conversely, does rock art qualify as art altogether? What constitutes art? Although these questions are interesting to ponder about, the search for a definition of art itself is not the subject of this study. The intersecting meanings for art such as "representational images", "skilled craftwork" and "indicating a world of symbolism" (Chippindale and Nash, 2004: 22) all coincide with what can be found on the rocks of the Côa Valley. Thus, the term art as such can be accepted for this project and will be used hereafter.

The International Federation of Rock Art Organisations (IFRAO) names rock art as "everything inscribed or painted on rock surfaces possessing no utilitarian use" (2008: 130). Although this is a widely accepted definition amongst researchers in the field (see also Clottes, 2002 and Chippindale, 2004), it seems adequate to question whether in fact rock art is able to possess utilitarian functions, such as the portrayal of identity (Batarda Fernandes, 2012) or as signposts in the landscape. Rock art might have also functioned as an educational tool, perhaps in the form of targets for practicing projectile hunting. Specific motifs might have signalled power, wealth and/or hunting prowess. These possibilities will be further discussed at a later stage of this thesis. Within this study, rock art will simply be considered as anthropogenic markings (either as petroglyphs (engraved in the rock) or as pictographs (painted onto the rock)) on natural rock surfaces. The uncertainty of the inherent function of rock art therefore makes it too ambiguous to be included in the definition itself.

Within the field of rock art research, there exists a considerable discrepancy of what constitutes a rock art panel, a rock art site, a rock art region and so forth. Although scholars have tried to unite some of these definitions and set precedence for future rock art studies at their time of writing, their proposed frameworks have failed and have not been taken up by contemporary scholars writing on the subject (Chippindale, 2004). This seems to be the result of the highly individualised inspections of what and how much rock art scholars believe to be belonging to a panel and site. Thus, it is inherently biased by individual scholarly judgments and mandated by locational infrastructure of clusters of sites (Chippindale, 2004). Yet, for the purpose of this study, the following definitions will be utilised throughout:

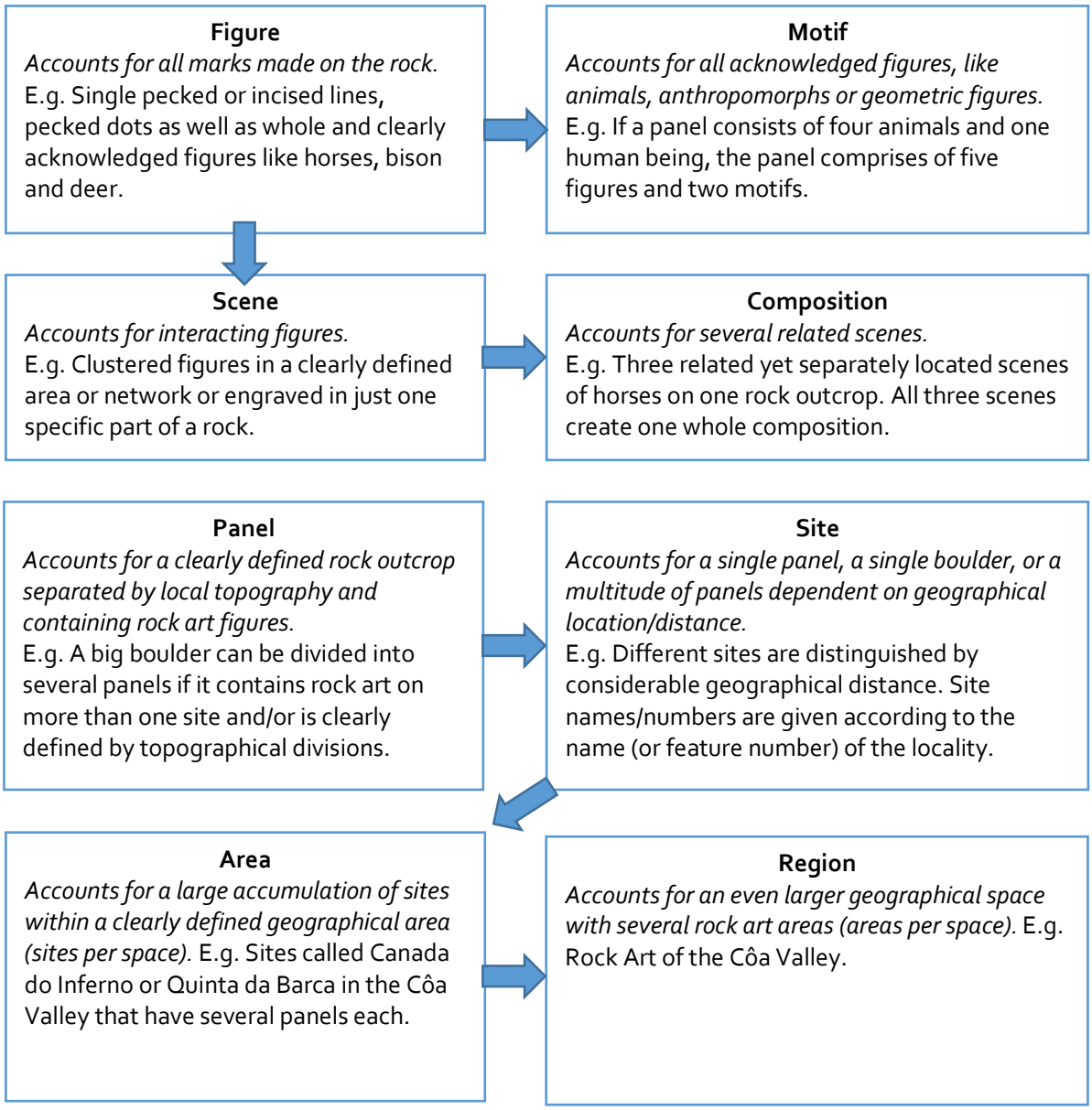


Table 2.1.: Rock art terminology chart. Adapted from Gjerde's (2010) doctoral thesis on *Rock art from northern Fennoscandia*.

2.3.1. Defining art

What does 'art' mean in this context?

The terminology of 'rock art' and especially the incorporation of the word 'art' in its notion has been contentious amongst rock art researchers and in the wider academic realms ever since the emergence of the field. Whilst 'rock' attracts no obvious ambiguity, the word or rather the concept of 'art' has been put through many debates by many schools of thought. It is common for rock art scholars to simply use the term rock art without really delving too much into the implications that this use of terminology causes. However, art can mean many things to different people and thus is inherently based on subjective observations. Here, one can question how the term 'rock art' first came into academic circulation, since it already assumes certain aspects about the past itself. Who determines what art is and what it is not? Which categories fall under this umbrella, which ones are omitted? If the term 'art' is to be used, one must proceed with caution as to what this notion entails. Two previous definitions shed some light on the difficult endeavour of defining art:

> "There are two approaches to the definition of art which are applicable across cultural boundaries, even if neither seems to have quite universal application. One deals in terms of **aesthetics**, the other treats art as communication distinguished by a particularly apt use of images."
>
> (Robert Layton, 1991: 4, *The Anthropology of Art; boldness altered by author*)

> "Art objects are ones with **aesthetic** and/or sematic attributes (but in most cases both), that are used for representational or presentational purposes."
>
> (Howard Morphy, 1994: 655*; boldness altered by author*)

What becomes apparent in both definitions is the inclusion of *aesthetics*, which Morphy further defines as "the human capacity to assign qualitative values to properties of the material world" (1994: 631). In fact, when discussing art in an anthropological context, Morphy rejects the heavily institutionalised definition of art to mean art as art once its recognised by members of the 'art world' (Morphy, 1994). Yet, as Alfred Gell rightly points out, in many anthropologically studied societies the 'art world' as we (as Westerners) know it today, does not exist as such, even though these societies produce 'art' that would be recognised as 'art' by our 'art world' today. The so-called "institutional theory of art" deems indigenous art as 'art' because we label it as such and not merely because 'they' say their works are 'art' (Gell, 1998).

Since we do not know whether Palaeolithic rock 'artists' considered their works worthy of being art, and whether they so strictly divided their creations into categories of art or something else, the term art seems a little far-fetched for the purposes of this study. However, since so much care and consideration of detail has flown into their creations, a modern viewing based on the opinion of this thesis' author, regards their designs as highly artistic and aesthetically pleasing after having assigned Morphy's "qualitative values". Yet, from here on onwards, instead of using an alternative word for "art" which would only add unnecessary confusion within the field, the term *rock art* will be used throughout this work and should be associated with invisible inverted commas (see also Bradley, 2009).

2.3.2. Defining landscapes

What does 'landscape' mean in this context?

What would a study of open-air rock art be without the study of the surrounding and incorporating landscapes? A large corpus of past studies has primarily focused on the classification and dating of rock art motifs and their styles. Thus, individual engravings have been taken out of their original context, onto paper and into categories attached with columns and numeric values. By omitting the considerations of landscapes, one is taking away a considerable part of the 'thinking' behind the art's creation. The landscape locations give rise to the embeddedness of the art in its frame and places the artist at exactly that point in the landscape giving rise to their thoughts of where, when, and how they placed their marks on the surfaces. Arguably, the landscape aspect of the rock art is as important as the engravings themselves and both cannot be considered in an adequate way without one another.

Since the concept of landscapes can be variously defined and utilised depending on one's specific research needs and contexts, one universal definition of what a landscape is, is difficult to obtain and adhere by. The landscape concept can be used in a plethora of ways such as ecologically, wildlife-related, or even silviculturally. Here we examine the relationship between anthropomorphic marks in open-air environments. For the purposes of this study, landscapes will be defined as a social construct of human imagination:

> "landscapes everywhere in the world is a construct of human beings – whether through human ascription to it of mythological creation, or through physical action by the humans themselves. … Whatever the difficulties of recognizing such special site from the archaeological record – all societies in the past would have recognized, as do all societies in the present, some features of their landscapes (if not all the earth) as special."
>
> Ucko, 1994: xviii-xix

This aligns with the definitions that regard landscapes as being a mere construct of human attitudes and values towards them. Marquardt and Crumley (1987: 6) describe landscapes as being "the spatial manifestation of relations between human groups and their environment". In fact, it is what people make out of what they see before them, that makes a landscape a landscape. Without the human element, it can be argued, a *landscape* would just be classified an *environment.*

Thus:

$$Human + Environment = Landscape$$

This line of thought goes hand in hand with the creation of places through spaces (see Munn, 1977, Bradley, 1997, 2000; Nash 2003, Heyd 2003). Hence, the way that human beings interact with their surroundings is partly a projection of their own culture (see Ingold, 1993 for a similar claims). An inspiring way to think about the conversion from environments to landscapes and spaces into places is Munn's 1977 conversion plane (see Fig 2.5). During his work on the Kula exchange system on one of the Trobriand islands in Melanesia, Munn observed an intriguing process unfolding with regard to the lifecycle of their highly dependent canoes (ibid). From preparation to construction and exchange of canoes, these valuable material goods change their identity, shape and symbolic meaning during each step of their lives. Here, one conversion plane might be the selection and felling of the right tree and subsequent surface preparation. Another conversion might be the first use of it as a utilitarian product after its planning and designing stages. Overall, Munn observes a total of six of these conversion planes ranging from the raw material to the eventual canoe exchange ritual in the famous Kula ring. Alongside Nash's observations in Tumlehed, Sweden (2003), this conceptual process can be adopted from the Kula stages and adapted for the production and use of Palaeolithic rock art:

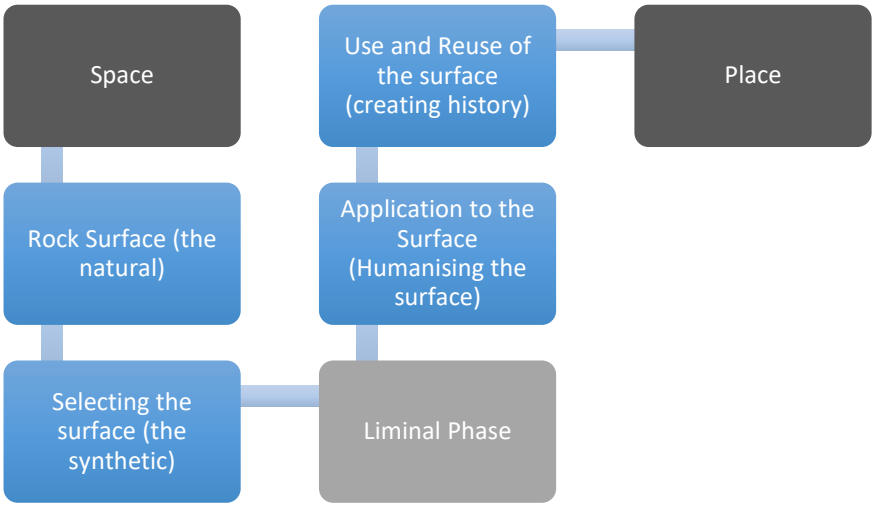


Figure 2.5.: The creation of place through space (after Munn, 1977 and Nash, 2003).

This creation of place will feature throughout the following chapters, as it is the human interactions and alterations of spaces that makes such a study, without any written records to inform us about them, so intriguing. As per the environmental equation above we can now conclude by acknowledging the following:

$$Human + Space = Place$$

A fascinating thought for the creation of *places* might be whether there are parts of the world which are only considered as *spaces*. Yet, from a purely conceptual point of view, as soon as we tried perceiving these *spaces*, they would become *places.*

2.4. Cave Art versus Open-Air Art

Open-air rock art of Upper Palaeolithic age is known from several local regions in Germany (Welker, 2016), Iberia and southern France (Batarda Fernandes, 2004; Bicho *et al.* 2007), but, unlike cave art, which is highly constrained in terms of visibility and context, offers many possibilities for contextualising the art in its quotidian landscape. Although Palaeolithic engravings have been assumed to be confined to rock shelters and caves, only relatively recently has open-air rock art found in the Côa Valley and its surroundings added an entirely new dimension to our understanding of the Upper Palaeolithic artistic repertoires. Suddenly the supposedly 'unique' art in caves enters the realms of the open and new models of function and use must be re-evaluated and applied accordingly - both for the caves and for the landscape art. With these new dimensions come investigations on how inhabitants organised their landscapes. As the course of the rivers and the sedimentation of valley sides are very well understood since the Upper Palaeolithic onwards, one can be confident that the current context of the art has not changed. Given that art is more favourably preserved in deep caves, our understanding of 'cave art' is far more advanced than its open-air equivalent. The used medium of Upper Palaeolithic artistic repertoire can be divided into two broad types. The artistic record can be found in both parietal (immobile) as well as portable (mobile) form. This thesis deals with the former, which can in turn also be divided into the broad categories, i.e. open-air landscape art and cave art. Overleaf is a table that elucidates the significant differences between these two types:

	Cave Art	**Open-Air Rock Art**
Art Type	Mixture of petroglyphs and pictographs	Only petroglyphs survive, very rarely can pigments be found
Detail/Precision	High in pictographs	Often low due to carving techniques
Location	Hidden - indoors	Open - outdoors
Context	Highly constraint	Variable – very public, very secluded
Visibility/Lighting	Darkness → Use of fire or artificial lighting	Natural light → Very varied and dependent on seasons
Accessibility	The deeper inside the more difficult to reach	Very easy to access the majority of sites, some require varying degrees of athleticism
Creators	Specialists	Specialists
Audience	Specialist, knowledgeable about its locations	Broad, everyone can have access
Modern Preservation	Well preserved due to cave environment, many caves closed to the public to sustain micro-climates	Petroglyphs survive, but weathering effect affects carvings over time

Table 2.2.: Characteristic differences between cave art and rock art.

The main differences between cave art and open-air art are arguably the dimensions of space and light. When discussing light, effective lighting conditions to view the art must be discussed. Whilst the visibility of cave art in dark environments can be artificially altered and produced, open-air rock art lacks this easily controllable conditioning (see Keyser and Poetschat, 2004 and Pettitt, 2016 for a discussion on art, light and shadows). There are often only certain times of the day that allow for visibility of the art on the rocks, and in some areas only on certain days of the year (for examples see Bradley, 2002). Whilst it is not the objective of this study to delve deeper into the differences between these two occurrences, findings from this thesis as well its applied methodologies will certainly be able to elucidate new aspects in both 'worlds' that have hitherto been unknown. In fact, new insights from open-air rock art sites can contribute a great deal towards our understanding of Upper Palaeolithic human behaviour, complementing, enriching, or even turning on its head the knowledge that already exists from cave systems.

2.5. Limitations of this Study

Foremost, limitations can be assigned to the investigation of *just* one of the senses more broadly. Whilst it would be desirable to investigate rock art with regard to all human sensorial experiences (i.e. also hearing, touching, smelling) the set-up for this research is heavily steered by a fascination for the exploration of the earliest *visual* cultures. In fact, research on the auditorial dimensions of rock art creation and its subsequent function, especially in the echoing landscapes of the Côa Valley, ought to be conducted in future. Ideas surrounding sound creation during rock art creation and a speculative absence of sound upon its consumption are only but a few areas to explore. The sensation of touch, also in relation to the art's outdoor characteristic (being exposed to the elements making rocks with or without engravings wet, dry, obscured, faded, mirrored, overgrown etc.), is another avenue which would attract and generate significant insights. For whichever *sense* addressed here, the question, however, ought to be that of ease of investigative depth. The centrality of vision, with critiques of euro-centricity, in much of what makes up our current corpus of rock art research (whether in Bronze Age Sweden or Upper Palaeolithic Portugal) must, of course, be acknowledged yet never lamented. After all rock art is inherently visual (quite literally upon first inspection). By nature, through researching emic traditions, we will not be able to ascertain whether the act of rock art making was the main function of the art itself which would then hypothetically make the art on display meaningless, thus deeming the act of viewing irrelevant and this research inconsequential. Yet, without giving too much away of what is to come, aspects such as the sheer effort that was exerted by artists to make depictions come to life, the ingenuity of (subconsciously) applying visual short cuts, the technicalities of revealing anatomical details even when superimposing imagery, the artistic

minimalism interspersed with minute detail and specific visual placemaking in the landscapes, all reveal that artists assigned great importance to the visual aspects of their creations, requiring investigations even beyond what this research eventually achieves.

This links to usual thesis limitations such as considerable time constraints and the fact that several operational as well as field-factors restrict certain aspects from successful investigation. The outcome of these limitations will be evaluated in chapter 8, but for now, rock art specific preservation issues account for a big limitation that readers ought to be aware of before reading the rest of this thesis. Unfortunately, a big issues rock art researchers must circumvent is that of selection bias, which mainly concerns the taphonomic effects of surviving assemblages of rock art (i.e. rocks art visible now versus rock art originally created but now lost). This argument could also apply to the discipline of archaeology, since much of its study examines existing material culture, rather than being deterred by the fact that not everything from the past is found or even enters the archaeological record in the first place. Adding to the problem of selection bias, the start of the EDC damming submerged many engraved sites, which were uncovered when the dam was emptied to build the supporting constructions. Thus, many panels have been found that were previously submerged and it only remains speculation as to how many more are still submerged or to be found in the Côa and adjoining areas. We need to accept that observations made herein are based on what is available at the time of research.

Furthermore, the open-air panels under study comprise of only engraved motifs nowadays. However, it is important not to rule out the possibility that these engravings were complimented by painted art in the landscape, which has not survived due to their perishable character when exposed to external factors such as adverse weather conditions. If paintings were indeed present in the open-air locations, they would have washed away long ago, leaving no traceable evidence behind. The incised rocks may hence be a simple taphonomic by-product of what chances to persist (Hyder, 2004). Preservations issues prevent us from reaching conclusions on the entire art corpus of the region. During the fieldwork phase for one of the later experiments, one entirely new panel was uncovered amidst a site called Penascosa and Fariseu 9 in early 2020. This highlights enormous potential that exists in finding new archaeological sites and the fact that not all has been found yet, by far. We must work on materials that are present today and dwelling on or being overly sceptical about the fact that not all art is incorporated, will not advance new breakthroughs in rock art research. Having said this, more often than not, rock art researchers are accused of ‘cherry-picking’ their examples of rock art that fit with their assumed theories, leaving aside motifs and sites that do not align. This study assumes no such position and includes all known-to-date rock art sites into its datasets.

Chapter 3 - Historiographies of Rock Art Research and the Psychology of Vision

3.1. Rock Art Research Historiography

This chapter examines the historiography of both disciplines, individually placing focus on study-specific idiosyncrasies of their respective fields. As such, themes like animal rock art imagery and research on the psychology of perceiving art and moving animals will be critically reviewed. Furthermore, areas in which visual psychologists have advanced our understanding of how, when and why humans observe animals in the landscape will be introduced.

3.1.1. A research trajectory of Upper Palaeolithic rock art

The study of prehistoric art, let alone that of the Upper Palaeolithic, has experienced many ideological impulses over time in search of their underlying meaning and function. During the time of their first discoveries, mythological, 'function of shrine' and shaman-rich interpretations prevailed in academic discourse. The discovery of portable Upper Palaeolithic art as well as the hitherto unknown and unimaginable open-air landscape art, drastically changed the unilateral opinion that cave art was the pinnacle of social function and a place of divine and mythical artistic congregation of Upper Palaeolithic people and skills. The year 1880 saw the first public announcement about the discovery of cave paintings situated in Altamira, Spain. This statement spurred a sudden onset of public criticism surrounding the 'artistic', 'intellectual' and 'religious' capabilities of early humans. Hence, an early circulating theory among rock art scholars was that of 'art for art's sake' proposed by Edouard Lartet and Edouard Piette. It was said that the lines and depictions on rock were meant for decorative purposes only and bore no intrinsic artistic expressions. It was argued that the depictions were created simply because people seemed to like doing it, with no underlying spiritual or other notion attached. Yet, the placement of the depictions, their painting/engraving style and repeated patterning as well as their great attention to detail devoted to naturalistic beings had to mean that 'artists' were at work. The aforementioned theories were soon disregarded. In fact, as more and more cave paintings were recovered since, the growing complexity of the engraved and painted depiction necessitated an alternative reasoning behind their creations. When thinking about their meaning more generally, there are several different functions and possibilities coming to mind that have been proposed, favoured, and disregarded over time:

1) **Language/semiotics:**

There are several rock art researchers who regard rock art images and their overall composition to possess semiotic bearings. In accordance with early writing by de Saussure and Sanders Peirce

(end of the 19th century), semiotic studies form new perspectives on the validity of early writing systems and "the evolution of human cognitive and communicative functions" (Bouissac and Khan, 1995: 49). Fernando Coimbra names several examples from Portugal in which he sees the existence of a cognitive 'code' or even 'grammar' within the images (2008: 36). He notes that the *Rock of Signs* in Barcelos (Portugal) is organised in a circular pattern that leaves a spherical empty space in its middle. The rock Laje da Fechadura in Serta (Portugal) combines seemingly 'alphabetic letters' and a fylfot, making it a specific concept that was depicted by using symbols rather than letters to convey its meaning. Llamazares (1991: 245) observes the importance of using a semiotic language system to advance rock art research under the condition of "determin(ing) in it the presence of some organizational regularities which follow a certain rule".

2) <u>Art for art's sake:</u>

As emphasized above, the 'art for art's sake' theory is likely to be the one that has the least appeal amongst researchers. The notion behind it regards Palaeolithic art as possessing "no meaning" with no attachments from the worlds of religion, myth and magic and neither being connected to any metaphysical or practical origin. The argument of taking art for art's sake is based on the foundation of art serving a simply decorative and aesthetically pleasing purpose, with "no strings attached" – something simply "good to think" (Halverson *et al.* 1987: 63). Leroi-Gourhan regards this explanation as "the most harmless and also the [intellectually] poorest" (1967: 33) and Sieveking labels it with only two words: "too trivial" (1979: 108). In actual fact, when thinking about the limited range of motifs available in the Upper Palaeolithic repertoire, the theory of creating art for its artistic value seems rather misguided. For, if artistic license is the driver behind these creations, surely a much wider subject matter would have been employed rather than focussing mainly on ever-repeating animals and abstracted signs. The same argument could be used for the rationale behind using unusual settings for their art, such as in the very depths of caves and in locations almost impossible to reach (Waller, 1993).

3) <u>Sympathetic hunting magic:</u>

During the early parts of the 20th century, an ethnographic analogy originating from the actions of Australian Aborigines was assimilated onto rock art traditions of the European Upper Palaeolithic, arguing that hunting-magic as practiced in Australia can be directly translated into the workings of the Western European Upper Palaeolithic traditions (Reinach, 1903). The depictions are made during gatherings or single ritualistic experiences in 'sacred spaces', or as part of a larger ceremonial act, coupled with actions involving chanting and dancing. It is argued that the resulting images are then used to compel the Upper Palaeolithic hunters and for that

matter also Aboriginal hunters to aid in pursuits of their next hunts (Breuil, 1952). In his influential ethnography, anthropologist James Frazer (1939) associates cave paintings with the act of 'sympathetic magic' hence its name of *sympathetic hunting magic* (or volt magic) ever since. Just as a sorcerer would stick a pin in a doll to destroy their real-life enemy, Upper Palaeolithic hunters would have created a multitude of rock art animals depicted with penetrating spears in the hope of multiplying and killing game in their next hunt. However, a big dissonance (let alone the other frequently employed arguments against using ethnographic analogies for rock art exploration) is the fact that the animals portrayed onto the rocks in the Upper Palaeolithic do not actually equate to what they will have eaten and hence needed to survive on. The art in Australia tells a different story in that regard. For another rock art investigation that disregards this line of enquiry, refer to Whitley's record on the 1500-year-old rock art tradition in the Coso Ranges in eastern California (Whitley, 1994).

4) <u>Religious/ritualistic/shamanistic:</u>

The 19th century experienced a prolonged period of believing that the Upper Palaeolithic was a time before the emergence of religion, with populations not yet having developed ideas surrounding the supernatural and spiritual. This idea does not stand a chance against modern theory, and as such an ever increasing following supports the notion of a number of characteristics of religion in association with the art. Apparent evidence from, for example, the cave of *Les Trois Frères* (southern France) that bears an alleged sorcerer, equipped with antler-horns and zoomorphic and anthropomorphic features, fuelled the upsurge of popularity of such explanations. Margaret Murray (1962: 38) convinced her contemporaries that the depiction is "the first (…) of a deity on earth", yet Hutton (2006) accuses Breuil (the first to publicise a sketch of the depiction in 1930) of falsifying his drawing to fit his hunting magic theory of cave art, by way of adding and deleting bits that are actually not present. However, supporters of his sketch commonly interpret the figure as a shaman that performs a hunting ritual (Clottes and Lewis-Williams, 1998). The occurrence of several such alleged 'sorcerers' seem to satisfy the proponents of this theory, supporting the beliefs of Upper Palaeolithic inhabitants adorning themselves with hunting gear, antlers and drums to perform rituals. This is despite the fact that no direct evidence of religious practices or shamanic rituals can testify for them.

5) <u>Cognitive:</u>

The process of cognitive archaeology came about by investigating symbols and the way that they were being used and repeated over time and across media. Largely, the cognitive approach to rock art facilitates researchers with a psychological principle in search of artistic meaning.

Aside from Lewis-Williams (2002) and proponents of his "Neuropsychological Theory" in "The Mind in the Cave" in search of rock art meaning, it was already touched upon in the last chapter that the cognitive approach to rock art comes with many flaws. This is why an alternative but related discipline of Visual Palaeopsychology is proposed here. Furthermore, the cognitive dimensions of sensoriality, phenomenology and embodied experiences can be grouped underneath this point as well. Working with and from the senses when one researches rock art is widely regarded as a worthwhile endeavour. Testament for this are for instance Tilley's (1994) phenomenological landscape surveys in and around Sweden (see chapter 1.3.2 for further explanations) or Firnhaber's (2008) experiential exploration of rock art of the Barrier canyon tradition in Utah where he emphasises embodied discussions of being-in-the-land and acknowledges agentive properties of artists and the art itself. Yet, the art's inherently tactile and visual nature has been touched upon in chapter 2.5 when the limitations of this thesis were teased out, especially with regard to the fact that studying material culture through the use of our modern senses is often subject to euro-centric biases. How can we be certain that the way we feel, see, hear, touch and smell things nowadays portrays similarly into the workings of the past? Can we be more sure about the aspect of hearing over that of seeing? Have our sensorial functions changed since the Upper Palaeolithic? In a similar way, the concepts of consciousness as well as notions such as Heidegger's *Dasein* (being in the world) do not easily translate into quantifiable research avenues, making it hard for researchers to truly make advances backed up by scientific underpinnings rather than hypothetical speculations. Hence, a great downside of looking at archaeological material through the lens of human cognition and human thought is that of modern bias. The information gained of applying modern thought onto ancient thought is likely to be miniscule, when only extracted in a hypothetical way. What is needed instead is an empirical, testable framework that does not purely rely on theoretical modes of research. The sensation of modern and ancient eyesight was deemed robust enough to withstand critiques such as these (see discussions in Chapter 3.2.1. on this topic).

6) <u>Mnemonic/territorial/practical:</u>

The mnemonic interpretation is more practically inclined, with rock engravings serving as visual aids to remember oral traditions or visual occurrences by. Although these tend to be mainly mythical in nature, Upper Palaeolithic artists might have used cave walls or open-air rock slabs as mnemonic devices to preserve their collective memories (perhaps in form of a tallying system to record hunted or visible animals or times visiting a particular site). For this, there must have been a certain corpus of common knowledge that both the artists and the audience will have understood in an instance and will have orally transmitted to next generations (Assmann, 2006;

Jones, 2006). Like the mnemonic interpretation, another practical way of thinking about/with rock art is that its depictions might have served as territorial markers between communities roaming the lands. They may have denoted places of food storage, killing sites, animal sightings, dwelling sites or similar. This aligns with a documental character: its aim as representing a special social event that needs to be remembered. An ever-increasing academic body of works on territorial bands and territorial behaviour amongst UP people points to the acceptance of such zone–making. Rock art might have been the key to marking their boundaries. Whilst not strictly pertaining to the Upper Palaeolithic, a frequently cited example within the rock art research community surrounding ideas of memory creation, boundary demarcations and place making is found amongst the Aborigines in Australia (e.g. Morphy, 1991 and Layton, 2000). Connections to ancestral entities are established throughout the making, use and reuse of indigenous art, which brings with it further contemplations on memory making and the sanctity of places and spaces (see also the distinctions in Chapter 2.3.2). In fact, a recent resurgence of that line of thinking sees the creation of rock art being more frequently linked to endeavours of place making in other parts of the world too (e.g. Mulk and Bayliss-Smith, 2007 on Sami liminality in Laponia Northern Sweden; Gittins and Pettitt, 2017 on space creation through costly-signalling in UP caves and Ambrosino, 2019 on rock art territoriality in the Andean highlands). Going hand in hand with place making, inevitably, is the notion of boundary making and territoriality. Connotations that at first contemplation seem heavily imposed-upon by western theoreticians. Smith and Blundell (2004) give an excellent account of how the modern emphasis on *landscapes as boundaries* is often-times disconcerting, by recalling the writing of Gro Mandt (1995: 278): "The tiny fjord, surrounded by steep and *seemingly impassable* mountains, with its large number of rock pictures *gives the impression* of a very special – even a *sracred place*. The view from Vingen towards a characteristic mountain formation called Hornelen adds to this impression." The emphasis placed here (i.e. seemingly impassable, gives the impression, sacred place) reveals the highly subjective and euro-centric nature of accounting for boundaries. What is lacking in many of these case-studies is evidence for such writing, the data that would concur with such speculations. What is required, is a methodological, data-driven approach that would turn words and phrases such as *seemingly* and *giving the impression of* into evidenced facts, which is where the presented research henceforth comes into its own.

7) Visual Palaeopsychology - a new direction?

By way of concluding these theories, one is not able, of course, to claim that any of them are evidently wrong or right and of course all can equally be linked to the psychological/cognitive function and underpinnings of art if laid out in particular ways. However, direct evidence for the

hunting-magic theorists is non-existent. Evidencing a cognitive (including sensorial, phenomenological and embodied) or semiotic explanation is equally difficult to bring about with exclusively emic insights. Although these interpretations have mainly been aligned in the interest of interpreting cave art environments, the same kinds of ideas could be applied onto rock art in the open-air. More recently, the last 30 years have seen active changes in the interpretative approaches towards the art. Recent advances surrounding the dating and subsequent chronologies of the art as well as the more empirical approaches such as reconstructing artistic methodologies and the relationship between artist, subject and environment have toned down the voices of the rather one-sided interpreters of the past. Having said that, the shamanic and mythological interpretations have gained resurgence lately, most likely due to mass media circulating sensational storylines on the art's origins. What is more, the discovery of the rock art in the Côa Valley area widened the debate that was hitherto confined to caves and rock shelters. Suddenly, a similar corpus of art additional to what was only known from cave environments sprung up in open-air environments, which completely changed the nature of arguments provided for these depictions and for that matter the discourse of the Palaeolithic as a whole. The dimly lit environments once thought to be the breeding ground that supported ritualistic and shamanic activities no longer held true for rock art of a similar nature in a vast and airy landscape setting. This is only further supported by similar outdoor panels that can be found in places such as Mazouco (Jorge *et al. 1981; 1982),* Siega Verde (Balbin-Behrmann *et al.* 1991), Domingo Garcia (Martín and Moure, *1981)* and Piedras Blancas in Spain (Martinez Garcia, 1986) as well as Fornols-Haut in France (Sacchi *et al. 1987)* and Gondershausen in Germany (Welker, 2016). The reader should refer to Bahn's (2001) compact summary for a more complete overview of this outdoor phenomenon. The lack of suitable and adequate methodological advances so far for many of the functions described above have steered the research for this thesis to focus on the visual psychology of art, for which systematic psychological experimentation is able to yield statistically sound and reproducible results standing in stark contrast to subjective theoretical ponderings.

3.1.2. A research trajectory of rock art animal motifs

The motifs under study

Upper Palaeolithic art is overwhelmingly dominated by depictions of prey animals, and the Côa Valley art is no exception. It is comprised of engraved and 'pecked' outlines of animals that constituted key wild prey species to the region's Upper Palaeolithic hunter-gatherers, notably wild horse, red deer, ibex and the extinct bovid aurochs. The initial discovery of depicted forms of 'animals' in caves of France and Spain prompted a sudden and almost overwhelming scholarly

interest in such material. Hence, much writing has been devoted to the representation of animals on rock surfaces over the past decades. Over time, the existence of animalistic portrayals has been subjected to a myriad of interpretations. An early explanation considered the images to possess magic-religious origins relating to the practice of totemism:

> "I have often insisted on the religious character of the batons de commandment and I think it is quite legitimate (…) to attribute cave men with highly developed religious beliefs. Perhaps, the animal figures, so common in their art, are evidence of some kind of totemism." (Reinach 1899: 478)

The concept of *totemism* (*totem* from the Ojibwa of native North America) as well as of *shamanism* (*shaman* from the Tungus of Siberia) are often mentioned in tandem with each other, both are cross-culturally regarded as types of religions referring to the essense of *being* in the world (Layton, 2000a). Totemism refers the belief system that humans engage in mystical relations with animals, spirits or plants through the use of totems as emblems or symbols of ineraction (Frazer, 1899). Similarly, shamanism assigns the use of spirit to individuals who are reached through the state of trance (cf. Layton, 2000a and Rozwadowski, 2017). Although Reinach speaks of parietal art above, he later widened his ideas to include Palaeolithic engravings and paintings of animals onto cave walls. He thought of the animal imagery as "mankind's first steps on the road that leads to the worship of animals" (Reinach 1904: 8). In the latter part of the 20th century, literature on totemic practices becomes more nuanced and systematic. As such, Lévi-Strauss endorses the conceptual use of the term totems "not because they are good to eat but because they are good to think" (1965: 128), something that, as Davidson (2018) notes, has become a subsequent cliché when talking about animal representations in rock art. The incorporation of spiritual beings, especially through the internalisation of trance links back to potential cognitive triggers in the making of art (see also Clottes and Lewis-Williams (1998) and Bednarik et al. (1990) for shamanic explanations of rock art, stances which are not supported within this thesis due to their speculative nature).

A thought-provoking study regarding animal depictions is called "Thinking with animals in Upper Palaeolithic rock art" by Sauvet *et al.* published in 2009. The authors base their discussion upon an earlier study conducted by Layton (2000) which they adapt and broaden in scope. Layton linked the choices of depictions and their relative frequency and distribution in specific stretches of lands to a tripartite system of underlying meaning (Table 3.1):

	Distribution	
Frequency	***Each motif only appears in certain sites***	***The same motifs are present in nearly all sites***
Certain motifs are present at least twice as frequently as the mean for other motifs		Shamanic [C]
All motifs have low or similar frequencies	Totemic [A]	Secular [B]

Table 3.1.: Rock art motif frequency, their distribution and underlying belief systems (Layton, 2000b).

The theoretical framework states that artists are able to "choose which motifs to select from the repertoire or vocabulary of their artistic system" depending on the geographical context of the region (Sauvet *et al.* 2009: 321). In other words, artists have the means to choose their to-be-depicted motif based on their current contextual setting. In that way, depending on their disposition, whether their intention is shamanic, totemic, or secular in a particular area of their land, motifs will be gathered or be avoided in areas as detailed in Layton's table above. Totemic art for instance will tend to be concentrated at sites which "mark significant points in the group's territory, while the art of secular foraging will occur indiscriminately in any suitable habitation site" (Layton, 2000: 180). A study such as this brings fresh perspectives to the field of rock art research as it does not attempt to reconstruct meaning but rather to discriminate between different cultural contexts and locations of potentially different beliefs (by way of incorporating all three systems into his model).

Whilst Clottes and Lewis-Williams (1996) adamantly hold on to their one and only shamanic *explanation* (rather than *hypothesis*), providing a blanket explanation is unquestionably no means of stepping closer to a more nuanced understanding of what the art is all about. As for the actual way in which the animals are depicted, the artists seem to have worked based on a similar set of engraving conventions. Most notable is the fact that the majority of depictions follow strict profile views, simple contouring and a noticeable lack of detail. Hence, without giving too much away of what is to come in the next chapters, the basic characteristic of the art of the Côa Valley (and for that matter most of Upper Palaeolithic art) is that it is an art of outline. The uniformity of animal characteristics suggests that this specific system of visually representing animals was most successful at conveying the artists' ideas. This system is dependent on the outline of the animal itself and most of the time excludes all else, all things unnecessary. At first glance, the way in which animals are portrayed seems to disregard many of the following specifications (yet, often utilised in cave environments):

Unnecessary detail;
Infill colour and rock pigmentation;
Texture and relief;
Surface incorporation and rock surface;
Lighting and atmosphere;
Context and surrounding features such as mnemonic landscapes attributes

The striking pre-occupation with depicting animals, in ingeniously similar ways have startled many researchers of the past. The following sections sheds light onto the underlying perceptual reasons for preferring depictions of animals as well as their predominant contoured style.

3.2. Psychology of Vision Research Historiography

3.2.1. The scholarship surrounding the psychology of perception

A deciding factor for a study such as this to be successful, is that the parameters of basic perception between Upper Palaeolithic artists and modern viewers of the art overlap. It is therefore paramount to understand if our modern perception equals that of the ancient one. For, if the general anatomical set up of how humans perceive nowadays cannot be matched to ways of seeing in the past, this study can be deemed redundant from the start.

The question of how visual perception and memory actually work has attracted many researchers for decades. What types of information our brains utilise to create representations of our surrounding world and make us recall faces, remember names and appreciate artworks, are just some of the major aspects of visual psychological research. However, the root of this inquiry dates back to as early as Aristotle's observation that our minds are able to create images as "internal representations of the external world", which are then utilised for future thinking (Aristotle, De Anima 431 in Hicks, 2015).

On a very basic physiological level, we are able to *see* when a source of light hits an object which is then reflected back to our eyes. The entering light gets refracted by the *cornea* and the *pupil* regulates its size controlling how much light can enter. The *lens* which is situated behind the *pupil* then focuses the light onto the underlying photosensitive *retina* (Fig.3.2.1). The *photoreceptors* of the *retina* can turn this light into *electrical signals* that are then passed onto the brain through the *optic nerve*. Therefore, our eyes only collect the visual information necessary for our brains to 'see' (National Eye Institute, n.d.).

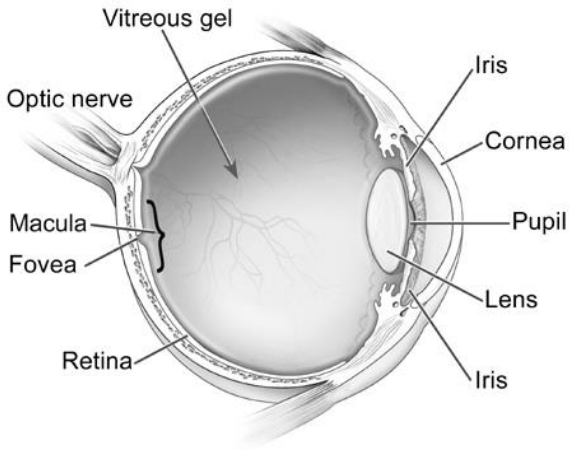


Figure 3.2.1.: The different parts of the eye aiding our ability to see (National Eye Institute, n.d.).

Visual psychologists Pessoa and Adolphs (2010) propose a visual processing flowchart by which visual information is processed in multiple waves and cells within the visual cortex of the brain are activated dependant on their processing stage. It takes 240 msec for the human eye to react to light and as a result several hundred milliseconds for our brains to pass all the stages when presented with visual information. However, having said this, only about 5-10% of those visual

stimuli arrives through the retina and is processed as data by our visual system. The remaining 90-95% corresponds to the stored ontogenic history of the brain (Guillery and Sherman, 2002). This stored memory area of the brain, within the higher areas of the so-called "inferotemporal cortex", feeds previously experienced visual memory and imagery back to the visual cortex and then includes up to 10% of the new visual stimuli into the equation to make up for the whole visual experience (Brosch *et al*. 2015: 605). This is an intriguing thought when one considers how hunter-gatherers will have made use of their stored memory of animal anatomy and behaviour, for instance, and how then the added 10% of visual information of the actual act of "seeing" contributes to them identifying a particular species.

With this in mind, readers may be forgiven for thinking that the working of the brain and hence eyes will have been considerably different during the times that Upper Palaeolithic artists were creating their works, be it due to either cultural or evolutionary causes. Instead of testing high-level aspects of vision (determining meaning and wider impact of art in question), the more fundamental, low-level vision aspects (detecting stimulus, discriminating between different types of animals, establishing viewing patterns and directions) are being put to the test here, which are all factors known not have changed since the creation of the art.

Hence, researchers who concern themselves with how people in the past (often also the very distant past) will have seen things, work on the proviso that the scientific status quo of how the eye functions also extends back into the past. It is generally accepted that the physiological set-up of Anatomically Modern Humans (AMH) will have paralleled that of living humans nowadays (see Balzeau, *et al.* 2012). Therefore, the mechanisms of how we as humans can perceive our world (i.e. the mechanisms of the eye and retina) can also be extended into the Upper Palaeolithic surroundings[9].

[9] If interested, the reader should refer to studies on colour perception in Neanderthals and humans in Pearce *et al.* 2013; on perceiving polychromy in antiquity in Brinkmann *et al.* 2010 and Seglins & Kukela, 2016.

3.2.2. The scholarship surrounding the psychology of perceiving art

Despite critiques over the reductionist approach of analysing art psychologically and the apparent over-simplification of art appreciation when turning it into simple numbers on a spreadsheet, the argument that the consumption of art is very subjective and thus too rigorous for scientific enquiry, is slightly easier to grasp. However, it is exactly this aspect of subjective appreciation that is intriguing, which in scientific ways can be equalled to the subject's previous familiarity, knowledge and preference (i.e. culturally mediated) when presented with specific types of imagery (Kose, 1984; Quiroga and Pedreira, 2011).

Leaving the matter of subjectivity aside for a moment, an early visual art experiment by Buswell (1935) investigated the way in which people look at pictures. His 200 participants (sample size thus sifts out possible subjective biases) were exposed to an array of works of art with the aid of an eye-tracker testing the way their eyes move around the presented imagery. Even though there appear to be many exceptions, some of his observed conclusions conforming to a more general trend are as follows:

- The eye starts off by moving quickly across the entire surface of the picture, this is interspersed with brief pauses. This seems to be "related to the simpler processes of visual perception" (1935: 143).
- This is followed by longer fixations in specifically detailed sections of the pictures. This seems to "indicate a mental process of reflection or at least a higher degree of interest" (ibid).
- The duration of looking at a picture is more dependent on individual's characteristics rather than the differences in the pictures being observed.
- Effect of colour and its fixation duration is "less-striking than had been anticipated" – changes in coloured pictures to black and white versions did not reveal a big difference in fixation time (ibid).
- When inspecting pictures with repeating designs, subjects' eyes tend to swing to the left end of the border and then move along the border from left to right.
- Participants with an artistic background tend to make shorter fixations than lesser artistically trained subjects.

When participants are presented with three picture of the same motif (i.e. a church - one with just the outline, one with details and one portraying only a silhouette of the church, see Fig. 3.2.2), the detailed one attracts the most eye-movements, followed by the silhouette, followed by the simple outline:

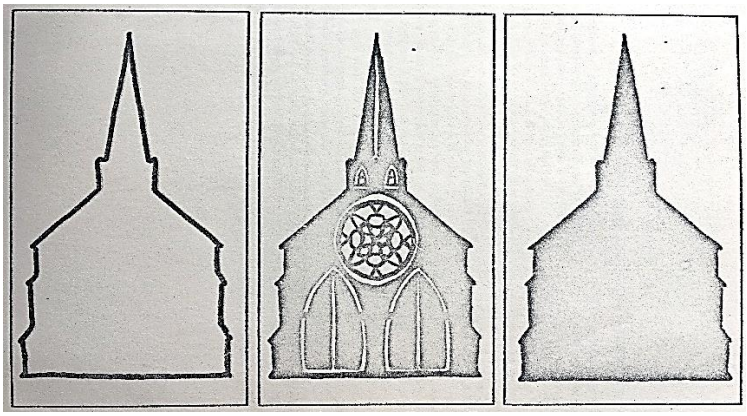


Figure 3.2.2.: Buswell's (1935: 51) church stimuli - outlined, detailed, silhouetted.

By foreshadowing to the reader now that the majority of the depiction in the Côa Valley are made up of simple outlines, the tendency for people to view outlined stimulus with much fewer eye movements is highly interesting. Rationally, this pattern is, of course, of no surprise since more detail naturally requires closer study and more movement of the eyes. Alternatively, the lack of numerous eye movements might also signal that the brain processes simple outlines and features much quicker, especially if the outline is relatively minimal and easily detectable. This difference in depiction style is being queried in chapter 5.

In a more recent study, Quiroga and Pedreira (2011) examined the way participants look at pieces of art with deliberate alterations to the paintings between viewing episodes. Again, the use of an eye-tracker resulted in intriguing outcomes that indicate what is and is not affecting visual attention. Their main findings very much resonate with the results obtained by Buswell almost eighty years earlier. Fixation patterns indicate that the eye is more commonly attracted to regions within the images which exhibit high saliency. Furthermore, the more contrast provided between the figure and its ground, the more fixated the eye becomes. The sharper the resolution within parts of an image, the more fixation it obtains. Consequently, uniformity in gazing pattern comes with the more basic principles that guide perception and variability in gazing pattern stem from greater cognitive complexities such as previous knowledge, experience and preference over the data presented.

By way of concluding this short excursion into the science of art, it has to be said that multiple studies exist, utilising eye tracking and art gallery heat mapping based on tracking participants in galleries and museums, that try to understand how people are attracted to and view works of art. The ones mentioned above are a mere snippet of the overall works, yet effectively describe what kind of results are commonly concluded. All the aforementioned observations will become pertinent in this present investigation and will be referred back to alongside the progression of the next chapters.

3.2.3. The scholarship surrounding the psychology of perceiving moving animals

Visual monitoring of animals in the landscape

The visual system takes a shortcut in interpreting visual data in order to respond to it as quickly and effectively as possible. As such, we perceive what we expect to perceive since it is harder and more time-consuming to perceive what we do not expect to perceive. Within a Pleistocene environment, but also for that matter a modern environment, reaction time is crucial to one's survival. Monitoring both human and non-human animals in a hunter-gatherer territory will have been the "two most consequential and time-sensitive categories on an ongoing basis" (New *et al.* 2007: 16598). Social gains and dangers will have had to be evaluated on constant terms: "alert watchfulness, stillness and patience are important both as part of hunting skills (stalking) and for protecting the group from danger" (Morriss-Kay, 2010: 172). Overall, recognising prey within the landscape will have been of the utmost importance to the survival of the hunter-gatherers of the Upper Palaeolithic.

Distinguishing between species and selectively hunting for different types of prey will have meant that hunter-gatherers required expert and intimate knowledge of prey morphology, prey behaviour as well as suitable hunting strategies. In fact, regarding the depiction of animals in Chauvet cave, Morriss-Kay (2010: 172) argues that "the vivacity and accuracy of (these) drawings suggest that the artists spent long periods of quiet observation of these animals". For instance, when encountering a herd of bison, the approach and subsequent attacking strategies will differ from the approach tactic of a herd of horses, deer, or ibex. Hunters make observations about the herd and in particular which animals are to be selected for killing based on size, age, sex and general state of health (Mithen, 1988). Understanding the next moves of the animals so that they do not escape was vital and different situational practices for different animals will have had to be employed.

Moreover, Fijn (2011) has studied animal-human interactions within a Mongolian nomad community and found those living in close proximity to wild carnivores understand the "organisational strength, social structure and division of labour underpinning a group's hunting success" (Fijn, 2011: 57). Given the steppe-like environment at the time (see Aubry *et al*. 2011; Wood *et al.* 2013), often with tall growing plants, animals will have used the camouflage effect of the surrounding nature to their advantage. It follows, that rapid animal detection and identification even in a camouflage landscape was of key importance for hunting success. There

is a strict tendency of the neuro-visual system to sustain vigilance, especially in the vicinity of animals (New *et al*. 2010; Hodgson and Watson, 2015). Hodgson (2013: 1) suggests that this necessity could explain the "preoccupation with animals and their portrayal in rock art".

Caramazza and Shelton (1998) were able to identify, through a performance study with brain-damaged subjects, that said participants revealed a "clear-cut category-specific deficit" restricted to the category of animate objects involving both visual and functional acquaintance with animals. Moreover, New *et al.* (2010: 53) found through their concept termed "animate monitoring bias" that changes to animals were detected more swiftly and reliably than changes to non-animate objects such as plants, buildings, tools and vehicles. In fact, subjects were quicker to notice changes in animals than they were in changes to the state and varying localities of vehicles. This means that the modern-day life-or-death determining example of detecting an unsuspected vehicle on the road receives less monitoring bias than animate animals, species that once were life-or-death determining when it decided over the survival of hunter-gatherer families but possess little precedence nowadays.

Another stimulating perceptual function our brains hold is that of *pareidolia.* Pareidolia is the psychological phenomenon of interpreting random stimuli as familiar shapes. The mind responds to stimuli (most often images or sounds) and interprets patterns in ways that appear meaningful. Pareidolia is often associated with the more widely known Rorschach Inkblot test, which tests participants' mental states by way of analysing what subjects perceive in random inkblots on a paper (see Fosberg, 1941). The phenomenon of pareidolia has recently been adopted by scholars in conjunction with rock art studies (see Hodgson on cave art 2003; 2004; 2008 and Bednarik on general pareidolia use and rock art, 2016). What is more, it will have made sense for hunter-gatherers with a pure survival perspective in mind to rapidly enter flight or killing mode even when a perceived bison turns out to be a rock shaped like a bison after all. The pareidolia is at work with the figurative pattern (the bison-like structure) being detected even though no actual bison is present.

Studies like this reveal that the human brain holds within its temporal cortex a specifically dedicated neural structure for the recognition of animals (see Hodgson, 2013). The 'hard-wiring' of such selection pressures is given priority even nowadays when it comes to comparing it with modern life-threatening in-animate objects.

3.3. Archaeology and Psychology Symbiosis Reviewed

3.3.1. The scholarship surrounding the psychology of perceiving Upper Palaeolithic art

The advent of Palaeolithic art is generally equated with the emergence of a fully developed 'modern' mind. Several recurring patterns within the visual art engraved into rocks can be found amongst a wide spread of non-literate societies. Their rock art follows a 'basic logic' by providing us with a comprehensive expression of the fundamentals of the human cognitive system (see Chippindale and Nash, 2004; Anati, 2004 and Pettitt, 2016). Rock art of all ages provide an invaluable source for our understanding of human behaviour and ultimately of the human mind and logic displayed since the beginning of our own species, *Homo sapiens*, with evidence of artistic capabilities extending further beyond (Hoffmann *et al.* 2018).

Furthermore, on the basis that the neurological wiring within the brain will not have changed from the times that Upper Palaeolithic artists were at work till nowadays, it is therefore possible to investigate the ways in which art was made and perceived at the time. Albeit there are factors such as modern euro-centric biases, changes in contextual environments and the aforementioned 'subjective' knowledge and experiences individuals bring that need to be kept in mind.

A few scholars have previously attempted to bridge the gap between the disciplines of archaeology and psychology. This resulted in a couple of reviews of common material occurrences that indicate a large spread pattern (most notably the reader should refer to Halverson, 1992; Hodgson, 2013 and Dobrez and Dobrez, 2013). More specifically, it was noted by the former two authors that there seems to be pan-global occurrence of in-profile rock art animals.

3.3.2. Animal outlines: a pan-global phenomenon?

The aforementioned dominance of depicted prey animals as opposed to depiction of humans or other signs in Palaeolithic art is striking. However, there was not just a *preoccupation* with animals per se. Also, a very specific 'grammar' of exactly how these animals were widely portrayed can be detected. Animals are most often depicted in profile view, mostly in 'strict' profile with two legs and one horn showing (although sometimes a twisted perspective reveals two horns on an in-profile animal), depicted by contour lines, accentuated on their dorsal lines and horns, exaggerated in certain places and are often missing their lower legs and hooves. It could be suggested that the aforementioned steppe environment can be linked to the missing depictions of lower limbs and hooves (more on that in the next chapters). Depth perception is non-existent, and it is not uncommon that the size of an ibex is the same as a horse on the same panel. There is no other indication that diminishing sizes of animals could indicate animals on a distal plane (Halverson, 1992).

More astoundingly, several examples of rock art animals from around the world illustrate that this particular grammar of depicting animals as stated above can be regarded as a pan global phenomenon. Examples include the animal outlines on a Yunnan Province cliff face in southwest China (Taçon *et al*. 2010), animal depictions in the Dampier archipelago (southern Australia) (Watchman, 1993; Mulvaney, 2013), contoured bovids from Qurta I in Egypt (Huyge *et al*. 2007) and the recently discovered outlines of babirusas ('pig-deers') in Sulawesi, Indonesia (Aubert *et al.* 2014; Hayes and van den Bergh, 2018).

This pan-global appearance of similarly depicted animals begs for further investigation. One ubiquitous explanation could be the constant 'preoccupation' of being a hunter-gatherer in a prey-rich territory upon which the success of one's survival depends. However, this socio-economic argumentation only goes as far as explaining why predominantly animal depictions exist in the artistic repertoire of the hunter-gatherers. In fact, hardly any other depictions of Palaeolithic age exist within the compositions. One can observe the occasional fish or find geometric lines. It does not account for the reasons as to why animals were depicted and constructed in a similar manner across continents. Hodgson and Watson (2015: 782) concur that this "does not (…) imply that humans are pre-programmed to depict animals in a stereotyped way, rather this can be overridden by socio-cultural input".

Another possibility in search for the reasoning behind such universal contouring and profiling of animals can be found in the constraints of our own visual capacities with Hodgson (2013: 1) arguing that "such pervasiveness derives from the way the visual brain functions" (see also Hodgson and Helvenston, 2006). This reasoning will be specifically tested in this thesis, with its main parts investigating how the functions of the visual brain correlate to what we see appearing in the rock art. Accordingly, the next chapter bears two experimentations that test how people draw animals and how the visual brain focuses in on the most salient (most diagnostic) parts of those animals. The importance herein lies when the results of these trials are being compared to the rock art motif reality. Will the rock art conform to the hard-wired visual preferences of humans and vice versa?

Chapter 4 - Research Methodology

4.1. Introducing the Methodological Approach

This chapter gives an overview of the methodological approaches applied within this thesis. There is no question that rock art in an open-air context requires different methodological techniques as used in, for instance, cave art recording and its applicable interrogation procedures. As seen in chapter 2, one of the most important features of this difference in investigative style is the influence of space and light onto the marks in a cave and in open-air environments. The overall approach fuses interdisciplinary methodologies borrowed from visual psychology with traditional archaeological scholarship. This blend of conventional archaeological investigation and experimental procedures from the field of psychology gives this investigation an unprecedented look at some of the earliest artistic marks of humanity.

4.1.1. Informed versus formal methods

The engravings that were created on the rock surfaces can be considered an integral part that contributes to our understanding of the Upper Palaeolithic of the Iberian Peninsula. This opposes directly *informed* accounts by for instance South African San Bushmen or Australian Aborigines who can give us their insights into the reasons of creating their art and what it meant to them (Layton, 1992; Lewis-Williams, 2002). The absence of written and oral records coming directly out of Palaeolithic communities makes an *informed analysis* impossible (Taçon and Chippindale, 1998). What needs to be applied instead is what Taçon and Chippindale (1998: 8) regard as the alternative way of approaching rock art, namely the *formal method*: "The information available is (…) restricted to that which is immanent in the images themselves, of which we can discern from their relations to each other and to the landscape, or by relation to whatever archaeological context is available". This formal methodology will be employed throughout this thesis.

4.1.2. A question of scale: zoomed-in and out rock art

Many studies concerning rock art include investigations that consider wide spatial patterns. Yet, all too often, there are studies that exclusively investigate individual peck marks, incised lines and their making techniques. These studies rarely end up in large scale all-encompassing studies that investigate their significance in connection with wider distribution patterns throughout the broader region. Therefore, the particular emphasis within this study is exactly this connection between the individually created pecked outlines with that of the surrounding landscapes.

Whilst the separation of the concepts of prey, perception and landscape are important in shaping the research objectives and in recognising the different factors that individually operate together on this interdisciplinary project, they are in fact very much methodologically interlinked. In order to understand the nature of the prey species depicted on the rocks, one has to perceptually analyse them. Likewise, to comprehend the relationship between prey, their hunters, the carvers of the prey animals and the subsequent spectators of the art from different perspectives, one also has to consider the realms of the broader landscapes and its inhabitants (both humans and animals).

Henceforth, this study comprises of the investigation of many different rock art locations and is not constraint to just one rock art site. Whilst a single site analysis allows for great depth of discussion, a multiple site analysis engages with consistency testing regarding patterns, metonyms in the landscape that attract specific types of depictions as well as large scalar distribution patterns of the rock art sites themselves. This study illustrates the value of recognising the micro-landscape of the individual marks, the amalgamated panel compositions but also the macro-landscape of the overall environment in which the art is situated. Hence, the following methodology is informed by three different scalar levels that are employed within this thesis. In other words, rock art will be studied on multiple scalar levels. From the zoomed-in motif perspective to the zoomed-out landscape perspective, every aspect of rock art will be considered. The order goes as follows:

1. **Motif Level/The Graphic or Gestaltian Landscape**
2. **Panel Level/ The Compositional Landscape**
3. **Environmental Level/ The Contextual Landscape**

The rock art on these three levels will be explored through a series of different fields of study, such as the performance of psychological tests, correlating spatial geographical data, measuring distances between features within the landscape and matching up certain rock art depictions with actual archaeological assemblages from the chosen sites. The following chart (Fig. 4.1) illustrates the interrelatedness between these different levels:

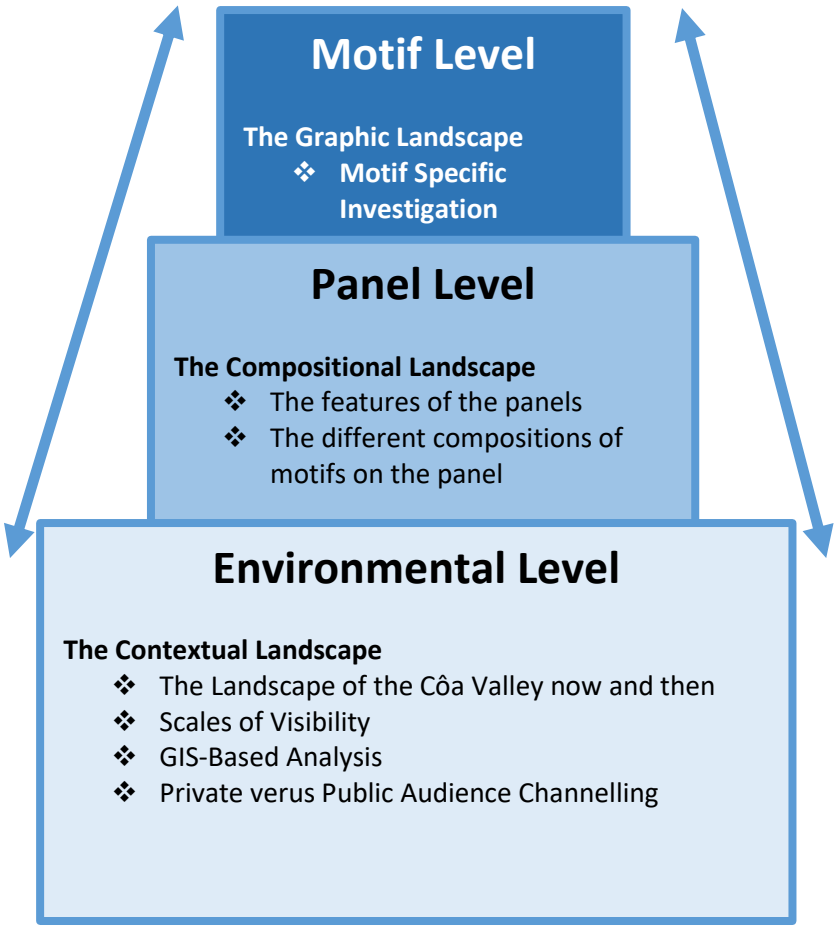


Figure 4.1.: Scalar levels of rock art analysis.

4.1.3. Methodological structure

The intended purpose of this chapter is to give the reader a structured way of how to navigate this thesis and to briefly explain what is to be expected. It gives a broad overview of how the methodology of this thesis is approached, since every individual rock art level, be it the motif, panel, or landscape level bears individual methodologies, separately described in their own chapters hereafter. Nonetheless, the need for this shorter chapter at this point of the thesis seems appropriate since a closer look at the methodological working procedure will put this thesis's layout into its bigger intended framework. In practical terms, the layout of this thesis, lends itself to a detailed description of methodological steps during the course of each experimental investigation.

As such, each 'level', as described above, will have a dedicated section devoted to methodological aspects, rather than explaining all methodological steps within this preliminary methodology chapter. This makes it easier for readers to follow and not to have to go back and forth between sections. Each 'level'-chapter will follow the same pattern, so that the beginning of each encompasses a thorough investigation of the 'archaeology' of the rock art before experimental procedures will be methodologically introduced and then applied to the motifs and their geographical locations. That means, that the rock art will be assessed for what it depicts first, before delving deeper into the assessment of why it might be depicted in this particular manner. Hence, the following steps will be taken:

1. **Archaeological groundwork –** What and where is the rock art depicted?
2. **Psychological & geographical vision experiments –** Why is the rock art depicted as such?

4.1.4. Regional assessment for data collection

Whilst planning these experiments, a series of preparatory research steps were undertaken. First, a schedule of field visits was drawn up to be able to familiarise and pilot a couple of concepts and then fully study the engravings and their localities in depth. The following field visits and associated tasks were undertaken throughout the course of research for this thesis:

Field Visit 1: September 2017

- Initial familiarisation with the material
- Assessment of other potential studies fitting into the realms of Visual Palaeopsychology
- Pilot study on rock panel and its topography:

Pilot study: Rock Art Panel Topography and Location[10]

1) <u>Rock art at places of topographical significance</u>

In order to understand the positioning of rock art within the Côa Valley, the following table presents features that will have been important for hunter-gatherers during their day-to-day as well as long-term orientation and usage of the landscape. Apart from creating art for art's sake, there are certain important locations, at which rock art creations could have served as signposts within the landscape aiding remembrance and future repetitions of certain tasks. These tasks could have included but are not limited to sourcing fresh water, finding shelter, navigating landscapes, procuring food, and establishing various hunting and trapping techniques in the specific terrains. Throughout the assessment of these various topographical occurrences, the sites of importance are tracked in relation to the art with a GPS tracker (Smart Phone – also available when offline).

	Places of topographical significance	Description
1	Crossing point	e.g. connecting two obvious routes/paths merging within the landscape
2	Waymark	A conspicuous/unusual rock outcrop located within an otherwise similar landscape/rock art pattern
3	Metonymy/Synecdoche	Constructing meaning by association. E.g. A rock face or parts of it in the shape of a particular animal.
4	Vantage point	A location allowing wide stretches of the landscape to be overlooked.
5	Special landscape feature	e.g. hilltop, near river's edge, saddle, cul-de-sacs, open field, bottlenecks, charts depressions, precipices, blind corners, cave-like

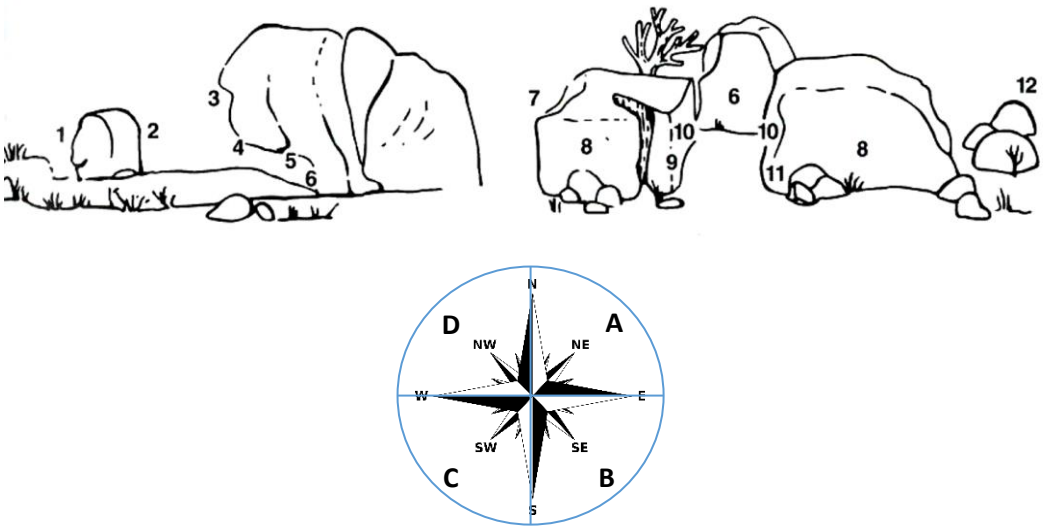
[10] All site tracking/tests assume that the landscape has not changed considerably since the Palaeolithic.

6	Concealed setting	a hidden/hard to find rock art panel e.g. away from main path, facing into direction of water not viewers
7	Dispersed setting	Isolated rock art site or single motif
8	Clustered setting	Many rock art panels clustered together in one area
9	Other	Other feature for rock art placement

Table 4.1: Places of topographical significance at which rock art sites occur.

2) Location of pecked rock art on different rock formations

After considering the topographical significance of rock art placement within the landscape, a further investigation is carried out addressing the placement of rock art motifs within and on certain rock formations. Not only will the type of rock formation be considered, but also the exposition and the angle of the rock itself.



Figures 4.2. and 4.3.: Example locations and cardinal directions of rock art sites (adapted from Lenssen-Erz's Namibian rock art survey, 2004).

Rock Art Location	Description
A	Exposition of the pecked rock surface: N/NE
B	Exposition of the pecked rock surface: E/SE
C	Exposition of the pecked rock surface: S/SW
D	Exposition of the pecked rock surface: W/NW
1	Single vertical rock surface without overhang
1a	Horizontal rock surface
1b	Sloping/angled rock surface, e.g. tilting forwards, backwards, sideways
2	At the back of a free standing rock at which Rock Art Location 1 already exists
3	On the overhang of a shelter/open cave/inlet
4	The area between the overhang and the inside of the shelter/open cave/inlet
5	Ceiling of shelter/open cave/inlet

6	Close to the ground of a shelter/open cave/inlet
7	Outside a shelter/open cave/inlet. Opening not visible from this point
8	Outside a shelter/open cave/inlet. Images visible from the inside but belong to the outside rock.
9	On the left hand opening to the covered space or inlet.
10	Either side of the walls of the inside the shelter/inlet.
11	On the right hand opening to the covered space or inlet.
12	On several free standing rocks scattered across the immediate vicinity. Vertical/Horizontal/Sloping

Table 4.2.: Features present at selected rock art location.

Tracking sites of importance in relation to the art with a GPS tracker (Smart Phone – also available when offline).

Field Visit 2: March-May 2018

- Active, participatory museum placement in the museum in the Côa Valley
- Obtained geographical data on panel locations in the Côa landscapes
- Piloting rock art visibility in the landscape:

Pilot study: Rock Art Visibility

Testing of concept of pinning plastic sheets of hand-drawn motifs onto schist to test for visibility and distance perception (cf. Ch. 6 and Fig.4.4+4.5):





Figures 4.4. and 4.5.: Plastic sheet drawings on rocks. Author, March 2018.

Field Visit 3: October 2018

- Carried out large-scale visibility study as piloted during field visit 2



Figure 4.6.: Different types of engraving styles and colours on rock surface. Photograph taken by author in October, 2018.

Field Visit 4: December 2018

- High-resolution photography trip to capture rock art panels at different time of the year, panels selected that were also photographed during previous visits

Outside of the field seasons, a database was created containing regionally available rock art images and associated illustrations together with descriptions of animal species and their features. This aids in the systematic classification of rock art sites but also in the comparison of contemporary experimental results, which can match up modern imagery of animals with its Upper Palaeolithic counterparts.

4.1.5. Methodological modifications

Despite best intentions, the reality of how the rock art sites are scattered around the landscape, their often-times inaccessibility (requiring specific 4x4 vehicles and steep hiking routes and tools to uncover them from plant growth, mud and lichens) and their eroded or submerged nature, meant that the plan of analysing the rock art sites as intended to in the first pilot study had to sadly be deemed impossible within the parameters of this project (or possible with much more time, team members and the right tools available).

What is more, the intention of analysing the importance of specific rock art panels and their shapes in attracting certain artists and hence animal depictions (by way of pareidolic experiences, i.e. seeing shapes of animals in rocks (that are imagined and are actually not there) and thus using them accordingly) had to be dismissed in a similar way due to the conservational status of some of the rocks. Once one has been to the rock art sites in person, one quickly discovers the shift of schists in different directions, the breaking off of rock features that often cut away big parts of animal depictions that once were intact. The decision was therefore taken that any investigations into the panel features involving rock structure had to be rethought.

It can be argued that anyone who attempts to study rock art by analysing the sites and their drawings in publications has not grasped the importance of being in their context. Rock art needs to be studied in relation to its surroundings, especially in the context of open air rock art, where the variability of the landscapes is far greater than in caves. This experience of 'being *in-situ*', has opened up the new possibility of studying superimpositioning, a study that is as exciting as studying rock pareidolia. Of course superimposed rock art can be discerned from simple drawings of the rock art, yet being in the field reveals its sheer magnificence. There is a clear sense of urgency to inquire about why it was that they had to overlap so many of their motifs, despite the clear abundance of suitable rocks that were never utilised.

Henceforth, the site visits helped to orientate this thesis by revealing what might be possible and what not. This chart (Fig. 4.7) illustrates the studies and experiments that were eventually chosen to be used in the final thesis. Each level is discussed in a separate chapter and uses the following structure:

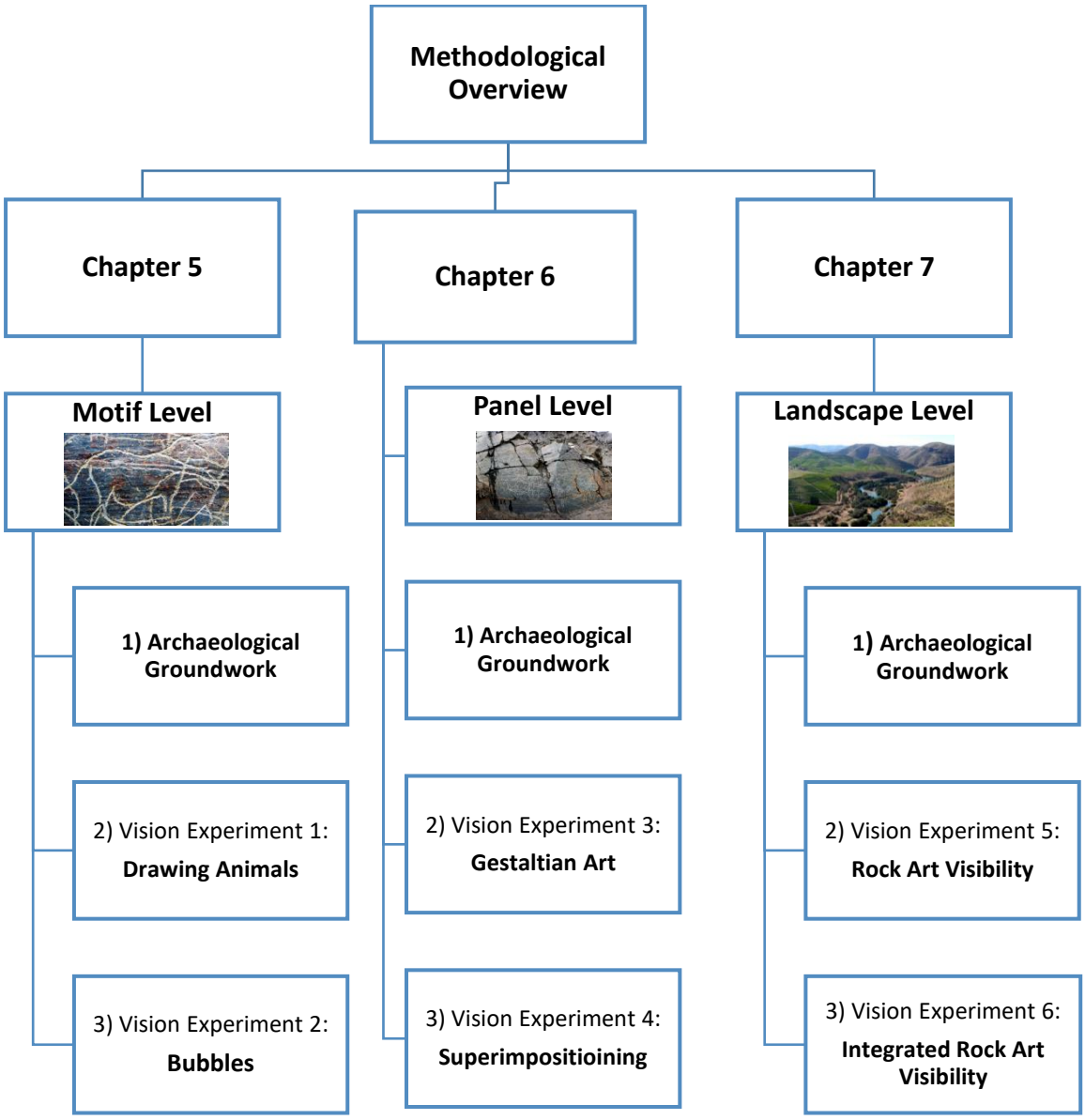


Figure 4.7.: Content and methodological overview of the chapters ahead.

4.2. Archaeological Groundwork

4.2.1. The engraved species database

At the methodological heart of this project lies the overall construction of the *Engraved Species Database* which records petroglyphic depictions in the Côa Valley in connection to their appearance and location. Features such as the animals' bodily characteristics and completion status, pecking styles, geographical locations, overlapping instances and many more features are being recorded. This database will be used to introduce each of the main chapters (Chapters 5-7) to provide the underlying archaeological groundwork.

The data utilised in this database is grounded on hitherto documented recordings of rock art in the area produced by previous researchers, mainly the thesis data by Santos (2017) in "*A arte paleolítica ao ar livre da bacia do Douro à margem direita do Tejo*", since it contains the most up to date rock art recordings found within the area. The reliance upon previously recorded data, rather than collecting it for purposes of this research, is due to rock art accessibility, avoiding duplicate research steps, and time taken to visit all sites to cover enough research ground. The value of collating research conducted by previous researchers lies in the repurposing of it to situate the data into a new framework. The work by Santos and the recordings made by his affiliated archaeological team at the Fundação Côa Parque (including Thierry Aubry, Luís Luís, Fernando Barbosa, Marcelo Silvestre, Mário Reis) is invaluable for purposes of this research and their data will be transformed to generate new insights on the rock art motifs of the area.

More specifically on the motif level, this research will tease out what parts of the animals are present and absent and which types are most and least frequent. On the panel level, the existing data for the archaeological groundwork section will be transformed to look into the configuration of motifs on panels and re-occurrences on panels in geographically close proximities. On the landscape level, the GPS-coding of the motifs will situate them within their own geographies.

4.2.2. The technicalities of the database

Based on the available drawings of the Fundação Côa Parque, any panel that reveals traces of figurative motifs of Palaeolithic age has been considered. Essential features of each animal (i.e. species, sex, facing direction, internal features) have been recorded if available and its image completeness has been assessed. The remit of the recording phase is also constraint to the fact that only Côa engravings are being studied here. This is due to the high occurrence of rock engravings in this particular area of interest, both nowadays and in the past. Having already mentioned a few items that had to hold true for purposes of study, the following list serves as a checklist of things that were considered as being an essential part of being accepted into the study area and database:

1. The location of the rock engraving must fall into a specified geographical area (the Côa park).
2. The panel must have direct recordings; panel rubbings; photographs.
3. The panel must be accessible for research on the ground.
4. The panel must be intact, not too weathered to be deemed illegible.
5. The motif must be of figurative nature.
6. The motif must be of Palaeolithic age (cf. debates on dating in Chapter 2).
7. The motif must be legible, not too weathered.

If any of these markers did not hold true at any of the sites, no admittance into the database was granted. It has to be said, however, that there is a possibility of failure to record other panels that might also have Palaeolithic figurative engravings and agree with all of the other points above. This might be due to inaccessibility or ignorance at the time of recording and researching, both by members of staff at the museum in the region and by the author of this thesis. After vetting the sites, panels and motifs for the basic requirements listed above, the following features were recorded for each motif (the sub points shed light onto the possible answers where applicable):

4.2.3. Database features

1. **Internal referencing number**
2. **Site name**
3. **Panel name**
4. **River connection**
5. **Rock type**
    a. Granite
    b. Schist
6. **Rock surface**
    a. Regular
    b. Irregular
    c. Regular with fractures
7. **Rock texture**
    a. Rough
    b. Smooth
    c. Eroded/Fissured
    d. Porous
8. **Rock colour**
    a. Grey
    b. Brown
    c. Orange
    d. Reddish
    e. Yellow
    f. Mixture
9. **Facing direction of panel**
    a. All cardinal directions possible
10. **Longitude**
11. **Latitude**
12. **Altitude (in metres)**

For the next feature (13. animal types) within the database, the following table (table 4.3) gives an overview of possible drop-down options, i.e. animal species detected within the Côa Valley. All possible animal types are extracted from Santos' description of species and their identification on the assessed panels. A brief description of the faunal characteristics is attached.

Database feature	Available options	Example type	Comments
13. Animal type	Horse		Horses are identified by their elongated nasal passage as well as a smooth curved cervical dorsal line. The tail (often long) extends the dorsal line. A round belly (ventral line) and a standing mane often points to a horse. Rarely an 'M-Shape' (denoting a change in fur coat colour in different seasons) can be detected in the Côa, whereas the Siega Verde corpus counts many such examples. Rather than the modern domesticated horse (*Equus ferus caballus),* the horses depicted here are likely those belonging to the almost extinct (but now reintroduced) subspecies, the Przewalski's horse (*Equus ferus przewalskii)* which exhibit a stockier built, shorter legs and standing mane (Boyd and Houpt, 1994).
	Aurochs		Aurochs are identified by their ox-like features often geometrically pointed hump on their back, by the S-shaped upward pointing horns and stocky bodily features. Nasal features such as a dividing nostril/muzzle line can often be identified. The species (*Bos primigenius)* is now extinct and was the ancestor of the modern domestic cattle. For purposes of this research some of the experiments (especially Experiment 2) use the appearance of modern European bison (*Bison bonasus)* as being exemplary of their extinct build.
	Ibex		Depictions such as the ones on the left are considered to belong to the Iberian caprine subspecies (*Capra pyrenaica pyrenaica),* by many considered as a *Wild Goat,* but here referred to as Iberian Ibex or Ibex for short. These bear rounded rumps, very often depicting two short lines for a tail and their characteristic S-shaped arched back horns extrapolating their short and pointy facial features. Beard 'goatees' can often be observed (cf. Batarda Fernandes *et al.* 2017 for further descriptions). The database sometimes distinguishes between female and male versions when differentiation is applicable.

	Deer		The most diagnostic feature of the male deer (*Cervus elaphus*) is its extravagant display of horns, the female version often in possession of folded back ears. Whilst the females have no horns, male specimen also shed their antler once a year, so a depiction of a deer without horns could equally indicate males at specific times of the year. When differentiation is applicable (even one example of a fawn is likely), the database distinguishes between female and male versions.
	Fish		This is one of the more elaborate forms in which the depiction of a fish is presented. A simplistic version would contain simple striated lines often going either upwards or downwards on the panel that cross over at one end to form its 'tail'/fin.
	Canid/Wild Boar		The single occurrence of this animal gives rise to many questions. Whilst Santos (2017) describes it as a "canid" (Dog? In the Palaeolithic?), it also looks akin to a small wild boar (*Sus scrofa)*.
	Anthropomorph		Stepping away from the main focus of animal imagery, rock art observers are often surprised to see familiar looking faces and shapes of anthropomorphic character on the rocks. Features include wavy arms and legs, phalluses (n=3, one ejaculating), hair is displayed on this female (?) as well as facial features such as eyes and mouths.

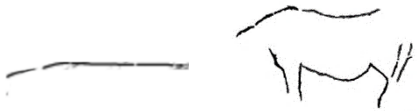
	Bird		Bird depictions are equally rare, yet this example is of extraordinary quality and manufactured with utmost care. Its beak points downwards, pointing towards the left with the addition of an eye and fluttering wings at its back.
	Mustelid		This depiction is termed by Santos (2017) to be belonging to the mustelid family. A mustelid is a mammal of the weasel family which often bears a long body and short legs.
	Undeterminable Lines and Quadruped		There are a number of engraved features that are difficult to identify and 'code' into their specific categories. Whilst the curvature of many lines might indicate certain species, speculative assumptions will not yield the desired outcome.

Table 4.3.: Different motifs identified in the Côa Valley region. All rock art motifs in this section extracted and modified from Santos, 2017.

14. Animal completeness

The identification of different completeness levels of each individual motif was of particular importance to assess those areas of the animal that attract frequent depiction, compared to those that are easily omitted by the artists.

a. Full Outline
b. Full Outline + Two Heads
c. Full Outline + Three Heads
d. Front ¾ Outline
e. Front ¾ Outline + Two Heads
f. Front ¾ Outline + Three Heads
g. Front Half Outline
h. Back ¾ Outline
i. Back Half Outline
j. Head
k. Protomos*
l. Protomos + Dorsal
m. Protomos + Half Head
n. Protomos + Front Legs
o. Cervical Dorsal Line
p. Cervical Dorsal Line + Head
q. Cervical Dorsal Line + Buttocks
r. Cervical Dorsal Line + Back Legs
s. Cervical Dorsal Line + All Legs
t. Cervical Dorsal Line + Ventral Line
u. Cervical Dorsal Line + Ventral Line + Front Legs
v. Ventral Line + Head + All Legs
w. Ventral Line + Front Legs
x. Ventral Line + Back Legs
y. Ventral Line + All Legs
z. Buttocks + Tail
aa. Buttocks + Back Legs
bb. Front Legs
cc. Animal Like

*A protomos is a common description in the field of cave art and open-air rock art recording that denotes the depiction of the 'bust' of animals (Santos, 2017).

15. Facing direction

The recording of facing direction of motifs will be of use when discussing possible walking routes, handedness as well as artistic preferences and conventions:

a. Left
b. Left with frontal face
c. Left with head facing backwards
d. Right
e. Right with frontal face
f. Right with head facing backwards
g. Frontal
h. Upwards
i. Downwards
j. Juxtaposed Heads
k. Undeterminable

The following table (table 4.4) describes the variety of techniques applied to the rock art in the Côa Valley. Whilst there are two main categories into which rock art depictions fall, namely additive and reductionist, only the latter category is being described here in its multiple varieties. This is because additive pigments to the rock are never found in the region, with the exception of one site (Faia, see Ch. 2.1) that is made onto granite rock. The reductionist approach is that of taking away surfaces of the rock to expose newer colours and depth in their working material.

Whilst it is not the focus of this research, an interesting aspect to consider for this type of motif making is the aspect of sound creation, repetition as well as excess material that comes out of the rock. The hammering, repetitive sounds will have undoubtedly made an impact on the overall meaning of mark making in the area, especially when considering the way that sound travels in the region. During one of the field visits to the Côa Valley in early 2018, early morning walks around the museum, located on top of a hill several hundred metres above the course of the river, revealed clear sounds of a wood peckers and cars on the roads alongside the river that would have been at least 3 kilometres away. What is more, the repetitive rhythms created through pecking will have allured the senses and the by-product that gets created when hammering out motifs on the rocks, creating dust and debris, will certainly not have gone unnoticed surrounding the sites.

Database feature	Available options	Example type	Comments
16. Engraving technique	Incised		Incision is the technique for which a hard and pointy stone tool is utilised to create lines on the schist surface. These lines vary in depth and thickness depending on tools and preferences of the artist, so that both bold deep lines as well as thin shallow lines can be identified over the breadth of the Côa region.
	Incised with multiple contours		This technique utilises simple incision, yet rather than deepening the lines that are already there, simply outlines the creations multiple times, often without care to keeping to original line setup. This then results in an incised figure with multiple contouring.
	Abraded		This technique is easily distinguishable from marks of a pecked motif, as the marks are more linear, made by guiding and grinding a sharp-edged tool back and forth, to create solidly abraded grooves to distinguish it from its background. The difference to simple incision is the force behind the grinding and the repetitive movements of grinding and rubbing over a single line (for detailed description of styles, cf. Welsh and Welsh, 2000).

	Pecked		Another common technique is that of pecking. This is done by hitting the rock either directly with a point that is harder than the surface or indirectly with a hammer stone onto a point that then pierces the surface. Depending on handedness therefore, the indirect percussion technique will have peck marks either inclined towards the left or the right.
	Fully pecked out		This method utilises the pecking technique described above, but instead of simply pecking the outline, numerous pecking marks are created within the motif's body to create more substance to the engraving.
	Discontinuously pecked		Again, pecking is the main method for this variation, yet only every few centimetres a peck mark is visible rather than closely aligned to build up a continuously pecked line. Interestingly, in line with Gestalt theory (cf. Ch. 5), this style is as visible as a continuously pecked outline.

	Mixture pecked + incised		This variation simply combines incision with pecking. Many rock art motifs seem to be pre-drawn onto the rock surface by sketching a roughly incised outline, which is then later pecked out. Often enough, these two techniques are still clearly visible nowadays, with parts of the incisions never eventually pecked out.
	Mixture pecked + abraded		This combination of abrasion and pecking is often found amongst other styles, with the artist starting off their motif by pecking the outline first and later adding abraded strokes to the surface. This solidifies the engraving and makes it stand out more than a simply pecked motif.

	Azilian-style		This style is often referred to as belonging to “Phase C”, a style that is well established during the Azilian phase of the Upper Palaeolithic (directly datable to 12.770 to 10.700 cal BP due to portable art slabs and other material from a rock art site called Fariseu in layer 4). The rock slabs primarily boast figures of this geometrically infilled style, and motifs that resemble this style on other rocks are now referred to as having “Azilian” style (cf. Luís *et al.* 2015).
	Partly Azilian/partly incised/striated		This horse on the left bears an incised outline, with “Azilian” type striations inside its body. For purposes of testing visibility, this sub-style was added to the database in this thesis.

Table 4.4.: Different motif techniques applied in the Côa Valley region. All rock art motifs in this section extracted and modified from Santos, 2017.

For the next options within the database a simple Yes or No or N/A was required:

Basics: Simple Outline? Detail?
Features: Head? Nostrils/Mouth? Eyes? Horns? Tail? Mane? M-Shaped Interior?
Overlap: Overlapping other Motifs? Overlapping with which animal number? Overlap where?

4.2.4. Using the database

The assessment and extraction of rock art motifs on their panels might be counter intuitive as to what is trying to be achieved here. After all, the landscape context to different motifs is what is of utmost importance here. It should be made clear at this point that typifying rock art motifs by way of coding their features in a simple Microsoft Excel spreadsheet and therefore placing them into certain 'boxes' cannot be used to classify their extremely varied nature. Indeed, Magne and Klassen (1991: 396) agree by expressing that "the reduction of rock art into binary numbers involves an inherent loss of stylistic and creative nuances and cannot be expected to account for all variations."

The use of the database here is primarily a tool for quantitative extraction, to get an overview into how many different variations and types are being represented in the lands of the Côa River and its tributaries. Therefore, descriptive statistics is easily executed with direct empirical yields. Although statistical approaches such as inferential statistics or even cluster-analyses would be possible to carry out, one needs to question whether they would lead to meaningful results. Other rock art specialists, such as Hedges (1982: 208), also critique the over-use of statistical means by using the example of the Great Basin rock art, stating that "although statistical techniques can provide valuable insights, they cannot substitute for a more holistic evaluation based on visual inspection and pattern recognition". What is being asked here instead is whether a variety of animal forms, completeness and their frequencies can be identified in the rock art, which from the author's perspective, can best and most effectively be analysed by simple descriptive statistics of the different types.

4.3. Psychological and Geographical Perception Experiments

4.3.1. Methodological layout

Following on from the archaeological groundwork covered in the first part of each main chapter, the psychological experiments follow. Each respective psychological experiment will have their own attached methodologies that will be detailed in their associated chapters accordingly. Having said this, the subsequent psychological research experiments will follow a very similar layout and style, closely mirroring those of psychological experiment write-ups. The order will go as follows:

1. **Introducing the experiment**
2. **Experiment methodology**
    a. **Participant information**
    b. **Material set-up**
    c. **Task set-up/running order**
3. **Experiment results**
4. **Experiment discussion**
5. **Conclusion**

Each main chapter will entail two sets of experiments, which will be subsequently concluded in a closing sub-chapter. In order to signpost the reader for what is to be expected in the next few chapters and to introduce specific terminologies right from the start the following brief glossary serves as a preamble to these experiments:

Drawing Animals: Participants are asked to draw prehistoric species with mediated and unmediated prompts and priming, producing insightful drawings and information on processes.
Bubbles: Participants are asked to observe "Bubbles", also called Gaussian openings, on a computer screen that randomly reveal different anatomical parts of animals prompting them to distinguish between separate species, yielding data on what animal parts are most salient.
Gestaltian Art: Côa Valley rock art is subjected to an investigation of the occurrence of Gestalt principles in the construction of scenes and visual prompts on rocks. Gestalt (German - form, shape, essence, whole – perceiving objects as elements belonging to a more composite system).
Superimpositioning: The phenomenon of overlapping rock art motifs is investigated by means of asking participants how many animals they detect in ever increasingly crowded art scenes.
(Integrated) Rock Art Visibility: Participants are asked to indicate at what distances towards the art (in a test environment and real rock art environment) they are able to resolve the art on display (distinguishing between resolution, legibility, readability and comprehension).

To summarise this chapter, the following flow-chart gives an overview of how all these different types of scales, chapters and experimental parts are interlinked.

4.4. Overview of Conceptual and Methodological Relations

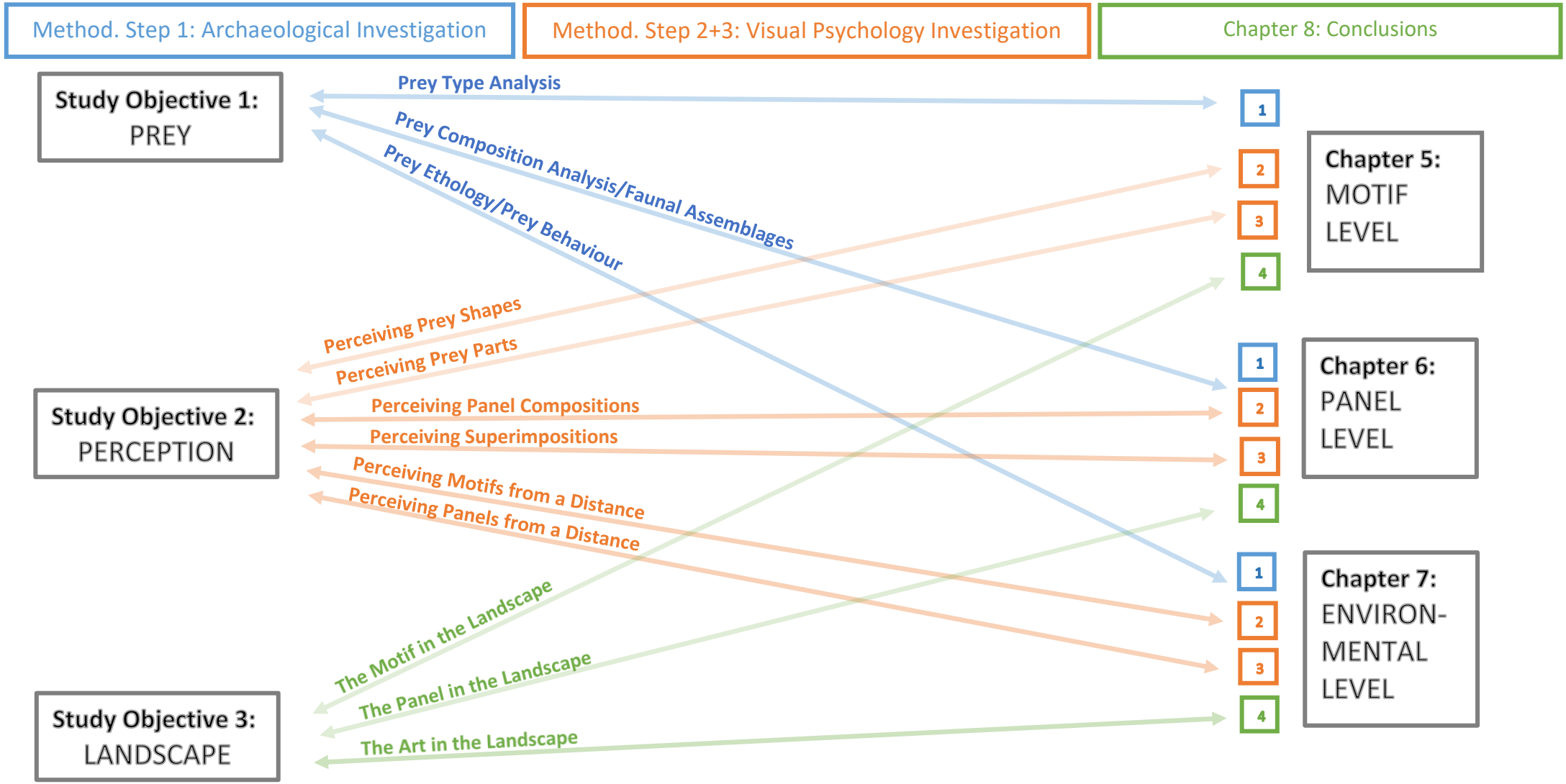


Figure 4.8.: An overview of the conceptual and methodological relations applied within this thesis.

Chapter 5 – Prey – The Motif Level

5.1. Introducing the Prey/Motif Level

The motif level will be approached from several different perspectives. First, within the *Archaeological Groundwork* section, the motifs on display in the Côa Valley will be identified, quantified and unpacked in terms of their component parts that make up a whole motif/animal. Next, the physical act of drawing individual animal species (Experiment 1) will be experimentally approached and analysed. Following on from this, experiment 2 will elucidate the most salient features of animal appearances, testing both horse and bison as species examples. To remind the reader, below is an illustration signalling the thesis' progression, with current experiments circled in green (Fig. 5.1.1):

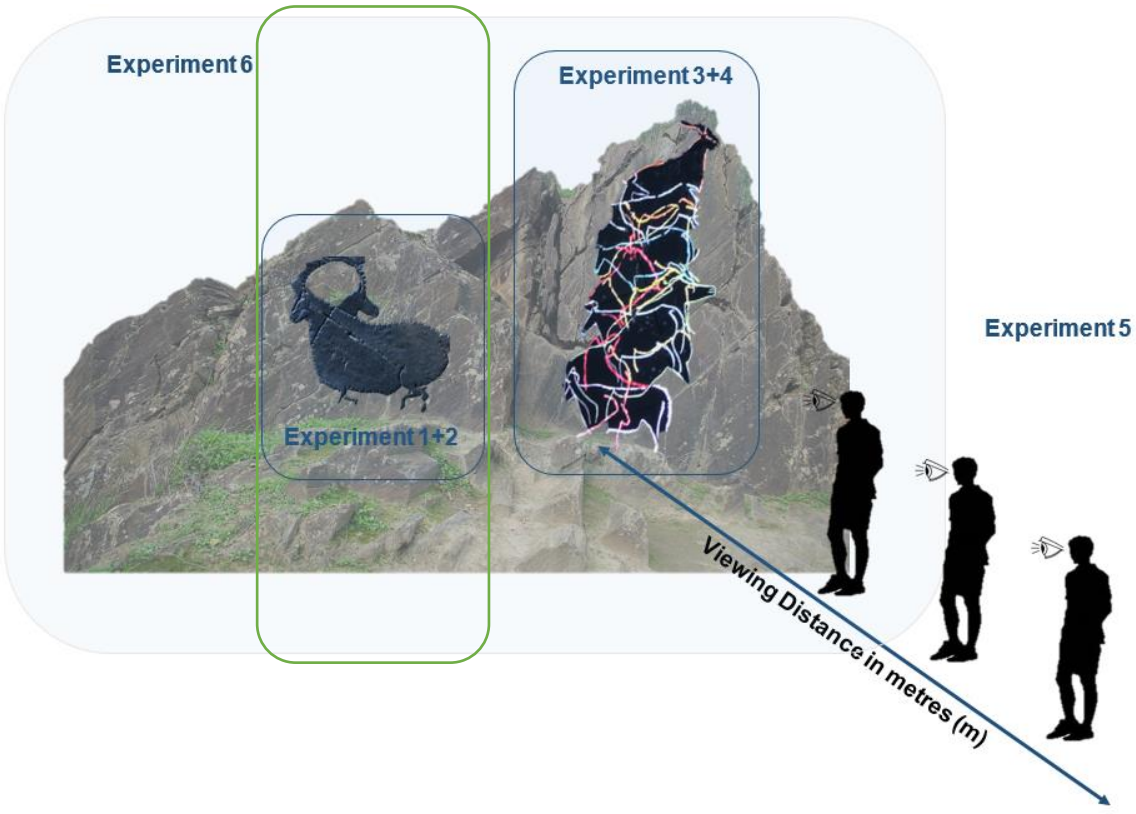


Figure 5.1.1.: The progression of experiments within this thesis. Accentuated in green are the experiments under study in this chapter.

5.1.1. Motif-specific research questions

In order to keep close track to the research questions set out at the start of the thesis, this part's objectives are as follows (see also Fig. 5.1.2):

Archaeological analysis

- What motif …
    - types,
    - frequencies,
    - forms (full bodies or other),
    - features (details such as eyes, nostrils or other),
    - facing directions

      … exist in the rock art of the Côa Valley?

Psychological (experimental) analysis

Experiment 1: Drawing Animals

- What is the general shape of the animals drawn by modern participants?
    - How do participants deal with familiar and unfamiliar drawing prompts? Does visual priming influence the way participants draw?
- What drawing order is noticeable?
- How are animals drawn in their contextual environment?
- What constitutes a minimally presented animal?
- Is there a difference between left and right-handed artists?

Experiment 2: *Bubbles* Experiment

- Can visual psychological processes explain why animals are depicted in the way they are?
    - In other words, do elements critical to the resolution of particular animals correspond to cues known to be critical to human perception?
- Which are the most diagnostic features on (1) a horse and (2) a bison, that actively aid our identification of these particular species?
- Does the minimal amount of information needed for detection or discrimination of an animal, as revealed by the *Bubbles* method, correspond to the features depicted in rock art?
- If rock art features do resemble the diagnostic information established through *Bubbles,* are we therefore able to make inferences on the hunter as the artist?

Overall, the broad research question for this **Motif Level** chapter is: Why are the engravings depicted in the way they are? More simplified, this comes down to the question: **Why this motif?**

Prey - Research overview

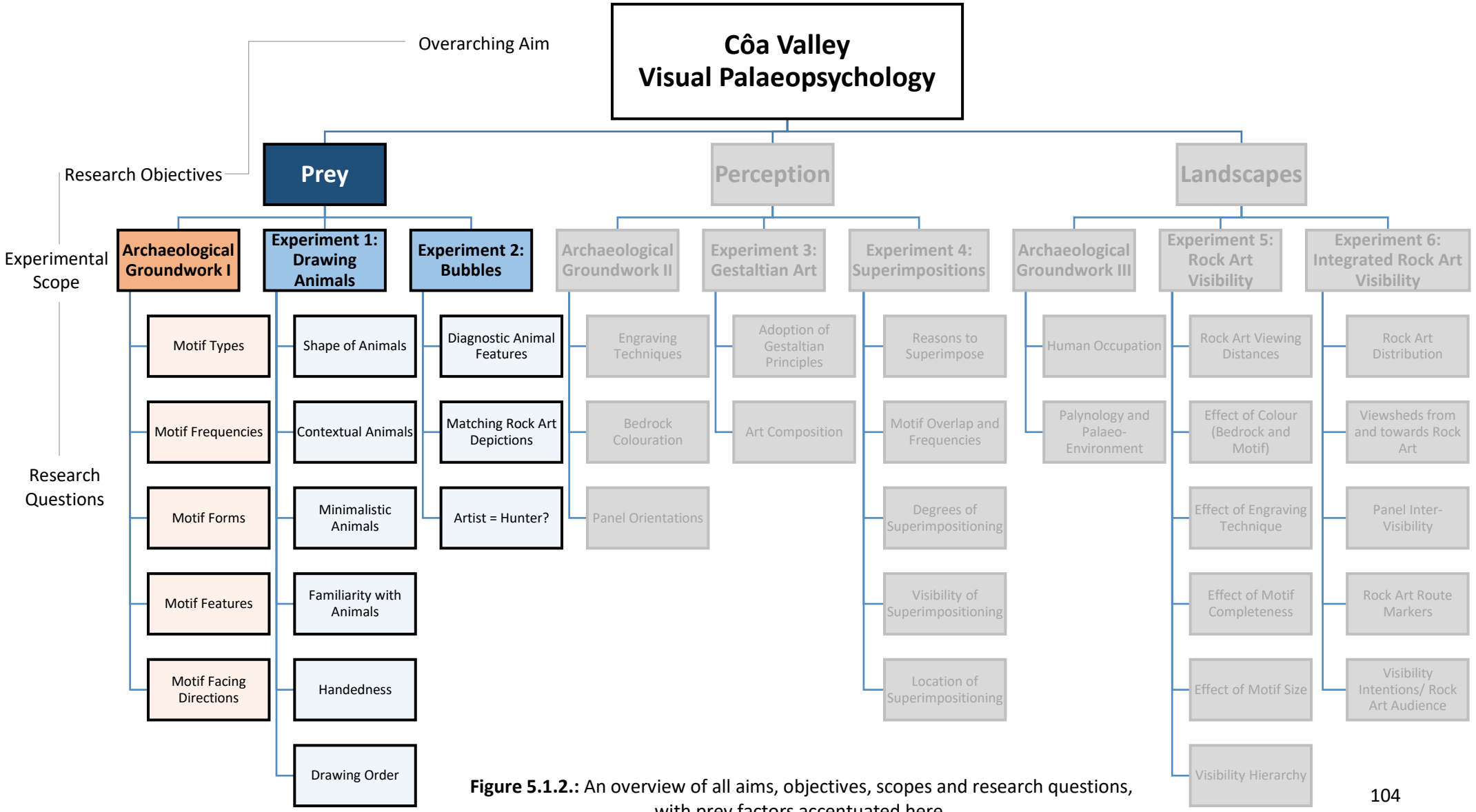


Figure 5.1.2.: An overview of all aims, objectives, scopes and research questions, with prey factors accentuated here.

To begin with, it is worth recalling the remark from the previous chapter, that we are concerning ourselves with creators that are our anatomical and neurological parallels. Thus, we are inclined to think that the marks left by *them* will be easily translated into our modern frame of mind. First, as will be uncovered here, the rock art can have a plethora of underlying meanings (and of those discussed, they will probably not even come close to its true meaning). Secondly, our modern euro-centric way of thinking constantly urges us to find meaning in and for particular systems and wants us to make sense of these in accordance with our worldviews. But is this the correct approach for looking at Upper Palaeolithic rock art?

5.1.2. Questioning the art as the 'prime focus' – what if the rock art was only a secondary by-product?

Something that is often omitted from consideration in the world of rock art research is the issues revolving around art *technology* rather than art *result*. Relating to that is the thought that the ideological function of rock art could have simply been linked to the act of making rather than the resulting artistic outcome. Whilst it is important to talk about the images themselves, since that is what we are left with, rock art researchers should not be blind to the fact that the processes that have come before and during the making of rock art might have been of equal importance.

Therefore, an important thing to realise when considering *their* perspectives and rationales behind making such marks, is that the end result that we have in front of our eyes nowadays might not have been the result that the creator sought from it. The act of creation might have been the essential part in the contemporary lifespan of images, with the finished piece merely serving as a by-product and line of evidence of the events that preceded its making (cf. e.g. Comanche rock art performances in Fowles, 2013). In other words, it might have been the repetitive action of chipping away on the rock that created their desired outcome of the action. It might have been the rocky and dusty material that was to be removed from the rock when creating images that served as a type of manifestation of their existence. It might have been the sounds created during the act of making that were important (see Waller, 1993; Ouzman, 2001 and Díaz-Andreu, 2012).

It might have been the simple act of making the engravings during a celebration or rite, which once completed were literally 'left by the wayside' and merely served as a reminder of actions once having taken place in those spots. Such a possibility is pointed out by Bégouën (1987: 183), who, when considering *sympathetic magic,* alludes to the fact that "it was the act of painting or engraving itself which had been the essential act of the sympathetic rites". His argument is that the real meaning in the images that are left to us nowadays is not the result of the artmaking, but rather the practical-mechanical artmaking itself. The rock art might not even have been the end-result of its journey into being. It might have been what was done with and to the rock art that was important. The motifs might have served as territorial markers, as reminders of generations prior to the creators' own. It might have been the act of starting a motif for someone else to come along and finish or engrave on top of it. Perhaps a combination of all of them, perhaps none of the aforementioned.

Whatever it 'might' have been, the remaining evidence that still persists to this day are the enduring strokes that we can try to tackle and understand nowadays. The journey as to how they have been used in the planning, during and after its making will always remain controversial without enough evidence supporting one or some of the possibilities listed above. Bearing all of these potentialities in mind, we as modern 'interpreters' of the art have indeed got a hard time getting to understand the true meaning of the depictions under study. The discussion above focused on the practice of art creation, yet when it comes to understanding rock art motifs for what they are trying to represent, there are at least a similar amount of possibilities, if not more, that could play a role in the meaning and power of the motifs themselves. This is the focus of the next section that tackles whether the depicted animals are actually *animals*.

5.1.3. Questioning the representation of 'animals' – what if they are not meant to be animals at all?

Palaeolithic rock art, as found in the landscapes of the Côa Valley, encompasses depictions of highly naturalistic and realistic nature. Owing to exactly this realistic feel, modern audiences of the art assume that they 'know' what these ancient carvers intended to depict. The modern observer might jump straight to the conclusion that depictions found in the Côa, are that of animals roaming the landscapes of the past. In fact, a representation of something is by no means the real-life thing in itself, hence allowing for a plethora of many possible meanings. In order to depict something in a 3-dimensional way, such as a real-life animal, onto a single plain rock surface, one has to unquestionably lose the third dimension (except if a bulging concave or convex rock resonates with a specific animal form). In doing so, a real-life creature becomes a representation of what it once was or what it means to resemble. This ultimately results in the compromise that not every feature will be able to be depicted. However, to what extend can we be sure that an Upper Palaeolithic artistic depiction of what we perceive nowadays as a bison, was indeed meant to be a bison and possessed the same conceptual connotations, then, as it does nowadays?

Davidson (2018: 12) remarks that rock art imagery both in caves and in the open-air "have elements of iconicity: they have some resemblance to the target species, even if this is conventionalised in some way". Yet, does this depicted resemblance actually equate to similar motives behind their creation when considering the workings of the ancient and the biases of the modern mind? Bahn (2010: 61) notes that "if it looks like an elephant, and every single person who sees the depiction recognises it as an elephant, then one can be reasonably sure – albeit never completely certain – that it is what the artist intended us to see". Jamie Hampson gives a complimentary example based on one of the rock art motifs that he researches in Trans-Pecos, Texas. By stating that "the directness of visual recognition may be deceiving" he queries: "the painting may take the form of a deer, but is it a picture of a deer? More importantly, what did deer, or that particular picture of a deer, mean to the painter?" (Hampson, 2011: Prologue). It is important to bear in mind that there are potentially other ways of depicting animals, in ways that seems extraordinary in our modern conception of them but was plausible to the Upper Palaeolithic mind. For instance, a simply pecked woven line could mean the presence of an animal perhaps by representation of their dorsal line, an array of such lines by this definition could therefore denote a herd. Similar perhaps to the Japanese symbol for *forest*, which when taken apart and represented singularly simply means *tree*. In fact, we always have to consider

that some vital elements may have been left out of the representation of animals because they are part of the background assumptions of those who made and used the representations. The question is, do animal depictions, that are easily identifiable through their resemblance to animals known to us, actually represent animals, or could they stand for something else? Conversely, there could be symbols that are not easily recognisable by us, but were omnipresent, naturally convincing and recognisable by the ancient mind.

Simply because an image of a rock art depiction looks like something recognisable to us nowadays, does not mean it was understood in the same sense in the past. Even when we find two, three or four symbols that look the same to us, leading to be interpreted in the same way, these depictions could have served a completely different functions and meaning. This can apply to similar looking depictions on one rock face but could equally concern similar motifs occurring on multiple rock faces that are distances apart. One depiction on one rock might not have equalled the same depiction on another rock. Meaning might have even changed depending on season, generational input and general situational circumstances. This conceptual idea can be applied to both portable and parietal art either by way of a *direct representation* (us seemingly knowing that something is a bison) or an *indirect representation* (an obscure piece of art that we cannot find meaning for but might have pertained to a bison in a Palaeolithic symbolic meaning system). Fundamentally, three distinct categories can be made here (Fig. 5.1.3) (whilst also acknowledging that many more are possible) that illustrate how an 'animal' can be portrayed:

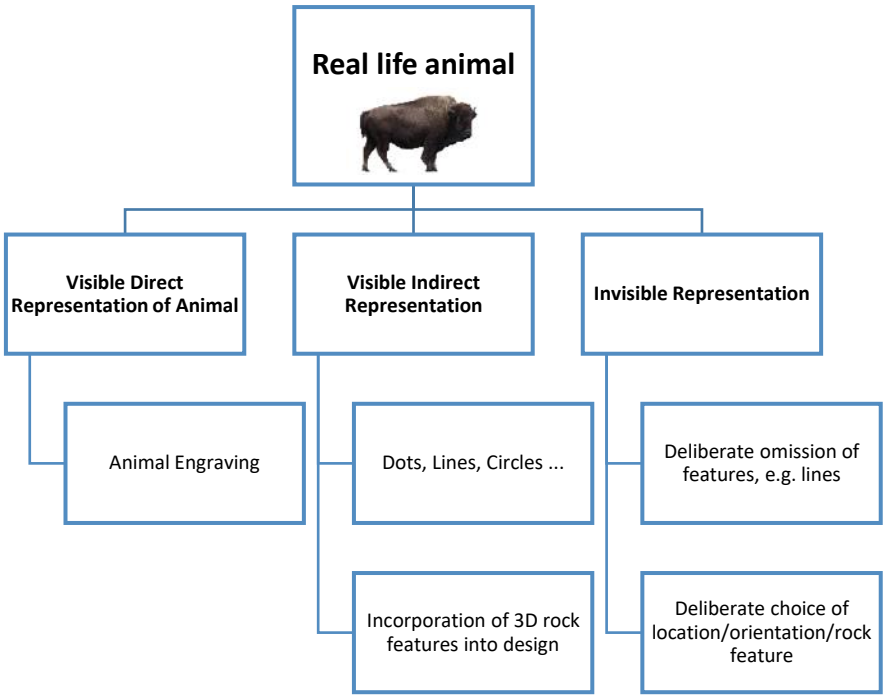


Figure 5.1.3.: Various representation strategies of real-life animals.

This tripartite distinction acknowledges the overt and straightforward reality-to-rock form of depicting animal and the less obvious form of depicting indirect visual cues such as successions of lines or omission of lines to denote an animal. Gell (1998: 98) demands the need for further background information to recognise these "aniconic" cues, in order to identify a line as a representation of a bison for instance. The last distinction is arguably the hardest to decipher, for which again the necessary contextual information is indispensable. In fact, there might have also been 3D concave and convex surfaces shaped like a bison that bore inherent meaning. What is more, it might have even been the deliberate omission of certain artistic features to represent a specific type of subject that was key to artists, yet difficult for modern viewers to decipher.

Reflections such as these are inherently linked to discussions on the semiotics of art, semiotics more generally and what the originators of these signs meant to re(present). More broadly, the three steps (direct, indirect and invisible representation) can be linked to the early work on semiotics by the *founding fathers* (writing between 1857-1914) of the field, Ferdinand de Saussure (translated in 1964) and Charles Sanders Peirce. Picking up the same example of the bison again, their school of thought would split the bison into a *denotation* (of what we would see in it) and a *connotation* (of what we would think of it), alias a *signifier* (the form which a sign takes, e.g. the word bison) and a *signified* (the concept it represents, e.g. an image of a bison) respectively. The *signifier* in rock art depictions could thus be something more abstract, like a woven line (an icon/symbol) to represent the hump of a bison, whilst the *signified* something like a bison itself. Additionally, Peirce would concur that nothing is a sign (bison) unless it is interpreted as a sign (bison); thus making meaning making dependent on the interpreters themselves (1867).

5.1.4. The creator's perspective

Four different layers explaining these possibilities are being proposed at this point, starting with a real-life creature, and ending with hidden or apparently overt meanings. The first diagram (Fig.5.1.4) is from the 'creators' perspective, in other words, the meaning of the creation is obvious to the originator, i.e. the artist.

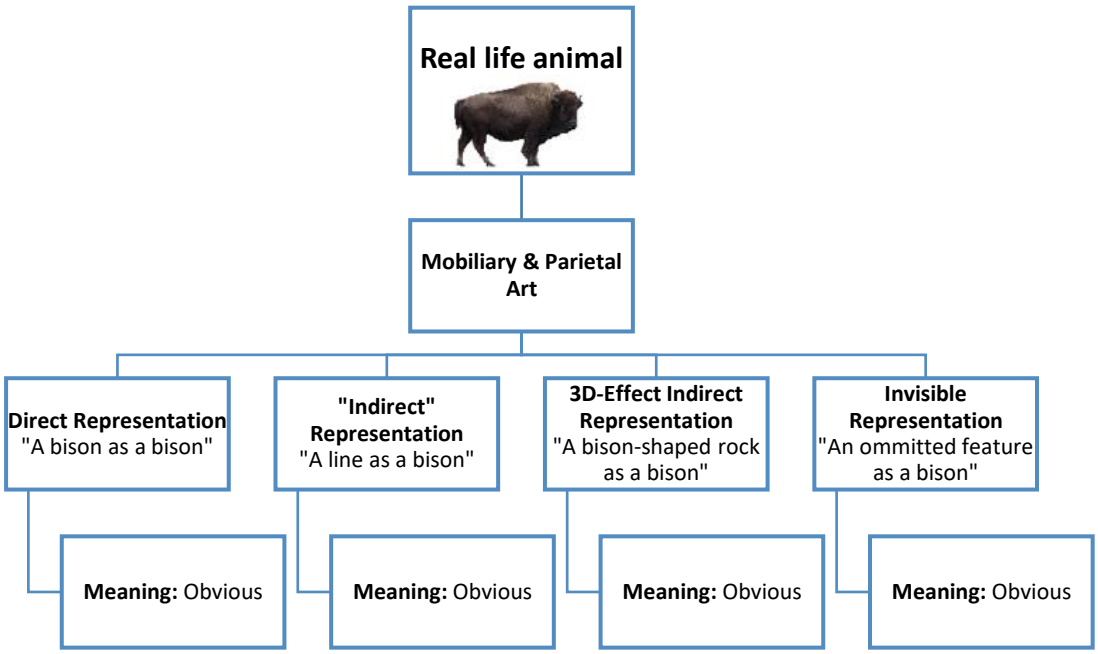


Figure 5.1.4.: The creator's perspective of the representation of real-life animals.

Although the possibilities of lines, rocks, or omitted features as representations of bison might be entirely possible, the high frequency of actual depictions of real-life animals would suggest that this will have been their preferred method of representation. Unless there is another entirely unknown category that is yet to be unveiled.

5.1.5. The modern viewer's perspective

The second diagram (Fig. 5.1.5) is from the viewer's perspective; thus, the lowest layer needs to be adjusted from 'meaning' to 'interpretation'. Present-day audiences undoubtedly have different approaches towards the art, and we can only guess the rationale behind it, with a direct representation simply taken at face-value and an indirect representation able to drive archaeologists into postulating realms:

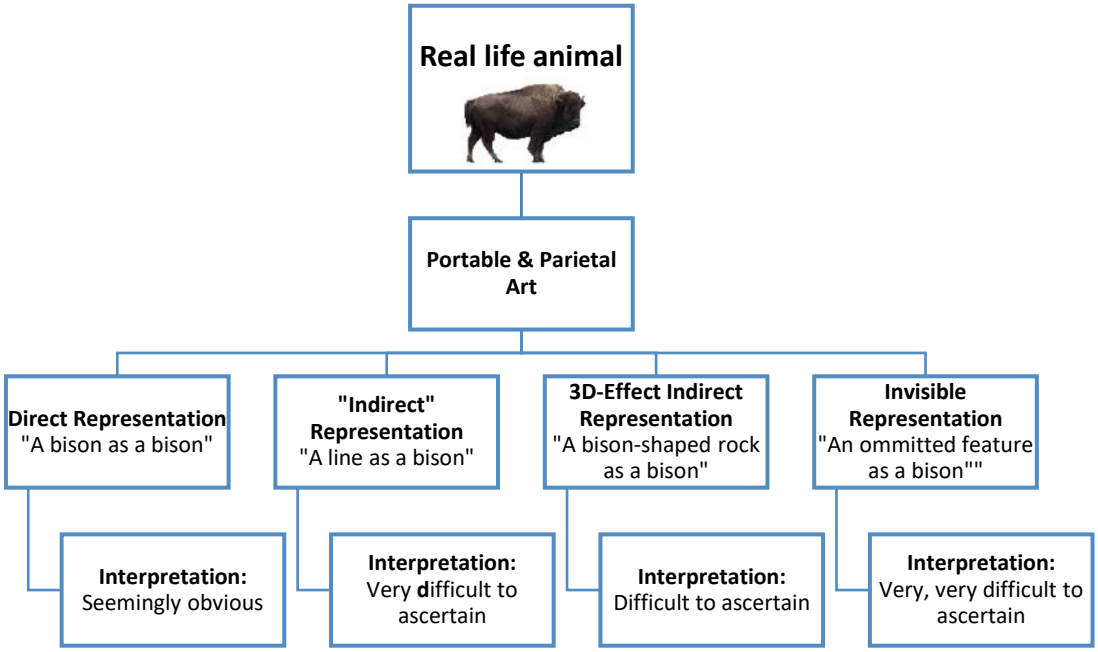


Figure 5.1.5.: The modern viewer's perspective of the representation of real-life animals.

Exemplary are ethnographic studies such as those by Munn (1973) and Green *et al.* (2017) for which they have recorded signs, some of them representing animals, in Australian sand drawings. These take the form of abstract lines and are certainly not easily interpretable in a cross-cultural setting but were meaningful to their creators and contemporary onlookers. Culturally significant symbols depend upon people knowing what they mean. They do not always look precisely like the object or thing that is being depicted. However, without this cultural knowledge, archaeologists must find a way to translate these things that they find.

This rather lengthy but nevertheless important introduction indicates that there is no doubt that the notion of 'representation', that is something standing for something in its place – alias an art object exerting meaning (overt or aniconic) intended by its maker, creates complicated conceptual as well as philosophical problems. Equally, dwelling in potentialities of likely meanings does not advance the field of rock art research either. And even though fundamental questions such as Hampson's must be asked, a straightforward rock-to-reality 'face-value' approach is being taken here for the identification of different animal species on the rocks. This is not to say that this is an inherently subjective approach in itself, but as Bahn states: "if it looks like an elephant it probably is an elephant" (Bahn 2010: 61). Ultimately, the key tool to looking at the images in an impartial way is to look at the images for themselves and not for what we or what other people believe them to be. This is when we begin to see unlock more information of how and why the art was produced.

5.2. Archaeological Groundwork

5.2.1. The engraved species database - conceptual

This chapter investigates the individual depictions as they appear in front of us. In this part, the archaeological groundwork considers the general composure of the art, in other words the types of motifs, their quantities, shapes, sizes and carving techniques are being examined. The layout here will see the introduction of each type of evidence (i.e. types of motifs; quantity of motifs and completeness of motifs), followed by results based on gathered data for each composure and ending with a discussion of potential significances of the findings.

In order to start these considerations, a closer look at the features within the *Engraved Species Database*, which was introduced in the previous chapter, is of importance. Below is an image (Fig. 5.2.1) that indicates what types of data, applicable to this chapter, have been captured in the construction of this database[11]:

	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM
1	Animal Typ	Part of animal	Facing Dire	Incised or Pecked?	Simple Outline	Head?	Nostrils/N	Eyes?	Horns?	Tail?	Detail?	M-Shape	Overlap	Overlap N°1	C	C	C	Overlap Whe	Noi	Attachme				
2	Deer male	Full Outline	Right	Aslian	N	Y	N	N	N	Y	N	N	N											
3	Horse (Cb)	Ventral Line & Head & I	Right	Incised	Y	Y	N	N	N	N	N	N	N											
4	Horse (Cb)	Protomos	Right	Abraded	Y	Y	Y	Y	N	N	Y	N	Y	2				Snout						
5	Aurochs	Protomos	Left	Abraded	Y	Y	N	Y	Y	Y	Y	N	Y	1				Snout		Traces of red paint on the front nasal edge				
6	Undetermined	Full Outline	Left	Abraded	Y	Y	N	N	N	N	N	N	N											
7	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N											
8	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N											
9	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N											
10	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N											
11	Aurochs	Protomos	Left	Incised	Y	Y	N	N	Y	N	N	N	Y	2	4	9	12	Head		Highest Intensity of Overlay, Revivals of Traits, S-Shaped Horn				
12	Undetermined	Protomos	Right	Incised Multiple Lines	Y	Y	N	N	Y	N	N	N	Y	1	10	11		End of Protomos						
13	Goat masc (Cp	Full Outline	Left	Incised Multiple Lines	Y	Y	N	N	Ears	Y	N	N	Y	9	10	11		Whole Body						
14	Aurochs	Full Outline	Right	Incised	Y	Y	Y	N	Y	Y	N	N	Y	1	2	3	9							
15	Aurochs	Full Outline + Two Heac	Left	Incised	Y	Y	N	N	N	Y	N	N	Y	6	10	12								

Figure 5.2.1.: Screenshots of the database in use for the establishment of animal features and their locations. A zoomed-in version is available in Appendix A.

The following features will now be examined:

- Types and quantities of motifs (Chapter 5.2.2)
- Completeness of motifs (Chapter 5.2.3)
- Motif features/details (Chapter 5.2.4)
- Facing direction of motifs (Chapter 5.2.5)

[11] A more detailed view of the entire database can be consulted in Appendix A.

5.2.2. Types and quantities of motifs

Foremost, the identification of the pertinent animals present during the Pleistocene in the region needs to be discussed here. Whilst the 'dilemma' of denoting something as an 'animal' has been established earlier in this chapter, the task at hand now, is the identification of specific species types. These new classifications and quantifications are based on motif descriptions and drawings provided by the Fundação Côa Parque, many of which can be found in Santos' (2017) work.

Types and quantities of motifs - results

Overall, this resulted in a total number of 16 *sites* under consideration, bearing 127 engraved *panels* and a total number of 1117 individual *motifs* under study. The following graph (Fig. 5.2.2) reveals the relative quantities of different motif types entailed within the total sum:

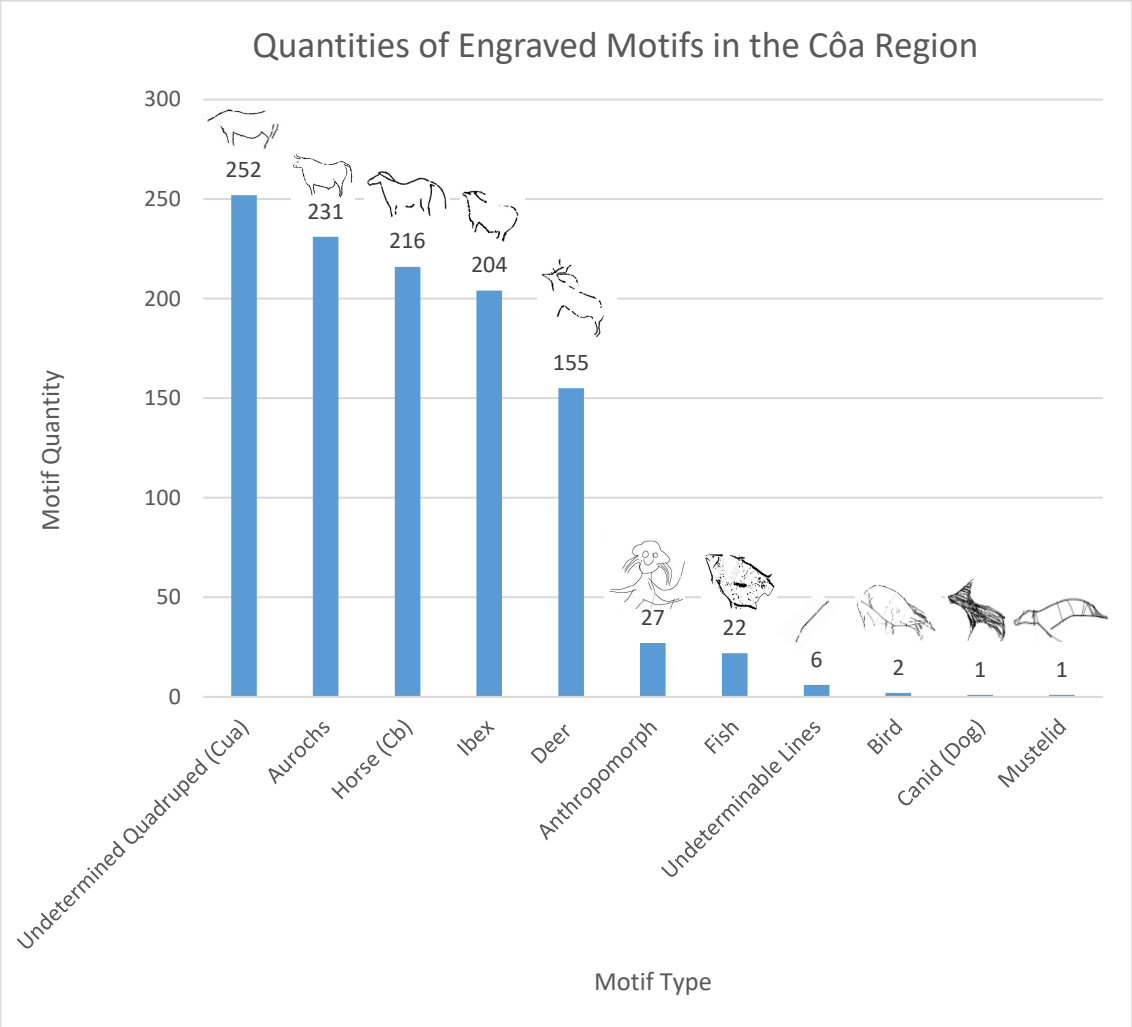


Figure 5.2.2.: The different amounts of motif depictions in the Côa region.

What is remarkable about this data, is the fact that both aurochs (n=231) as well as horses (n=216), ibex (n=204) and deer (n=155) clearly dominate the panels (Fig. 5.2.2). Anthropomorphs (n=27) as well as fish (n=22) appear more frequently than birds (n=2). One big question here has to be whether sparsity or abundance creates importance. Are the depictions of anthropomorphs so sparse because they were regarded as more important and thus would only be displayed in special places? Are horses and aurochs therefore the more mundane species? Alternatively, can the argument be reversed to regard the more frequently depicted species as more important? Attempts at answering these questions will be made later in this chapter.

To permit these results to stand on their own would not be sufficient to grant an attempt at pattern making and result interpretation. For this reason, a comparative study in a neighbouring area to the Côa was conducted to look into the quantities of motifs at a related yet not geographically overlapping area. The region in question is that of Siega Verde in Spain, which (despite modern political boundaries) will have formed, together with art in the Côa Valley, a cohesive whole during the times of the Upper Palaeolithic (refer back to Chapter 2 for an illustration on its location). Even though the region of Siega Verde was considered throughout the research phase of the thesis, lack of local research opportunities, lack of GPS coordinates for specific motifs and lack of sufficient documentation prevented any formal analysis for the next two chapters from going ahead. Thus, merely a literature-based approach was taken for this region, which involved the consultation of the primary datasets publicly accessible (based on recordings by Gonzalez and Behrmann, 2006). The results will be displayed alongside those of the Côa data at this point. All accessible panels in the Siega Verde region have been consulted for purposes of this research. The following table (Fig. 5.2.3) gives insight into the frequencies of different species depicted on the rocks in Siega Verde:

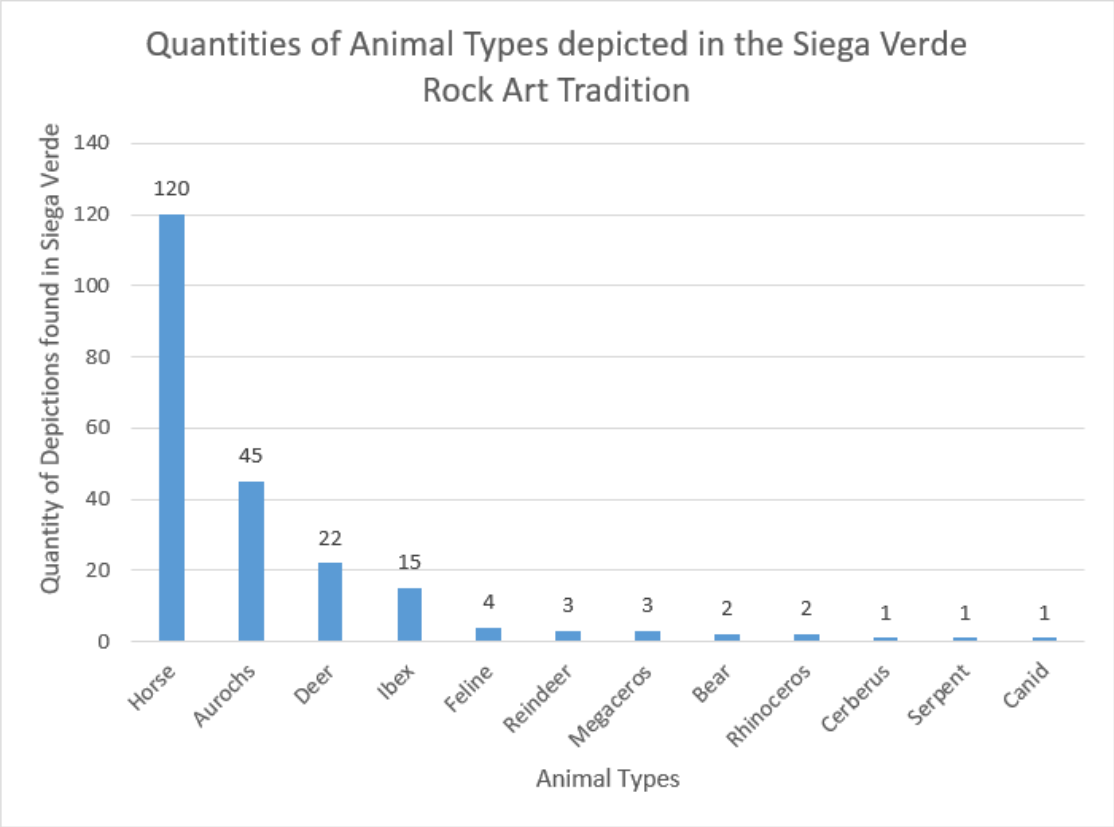


Figure 5.2.3.: Different types of animal species depicted in Siega Verde.

Out of 428 panels assessed in the Siega Verde area, 219 portray decipherable animal depictions. The rest comprise of either geometric lines, forms, or undefined/undeterminable quadrupeds. By far the most common animal depiction in the Siega Verde rock art tradition is the horse (n=120). This is followed by the now extinct aurochs (n= 45). Further common species are deer (n=22) and ibex (n=15)[12]. Comparing this data to that of the Côa reveals a clear abundance of horse in the area surrounding Siega Verde. Moreover, a couple of species are found in this area that never make occurrence in the surrounding landscapes of the Côa and its tributaries, such as reindeer, serpents, megaceros and rhinoceros. Some perhaps due to differential labelling, other due to pure non-existence.

[12] A couple of (sub-)species have been classified under aurochs (with 3 bison and 1 merely named 'bovid' addressed by researchers of Siega Verde material), thus their nature was included into the category as aurochs as whole. Rhinoceros refers to woolly rhinos, feline to weasel-like creatures.

Does abundancy coincide with importance?

One might swiftly assume that large abundancy of one type of motif mirrors the importance it must have held to the community that created them. On the contrary, the opposite could equally hold true, in other words, the rarity of depictions could indicate their special standing within the community and are thus rarely depicted with a clear intended purpose. In fact, Berrocal and Garcia (2007: 693) emphasize that "the training process required for its representation can facilitate the restriction of access to the ideas embedded in the rock art". This points to an important dimension in the quest for body specific meanings. The knowledge of how to make rock art was certainly not something that was available to all Upper Palaeolithic inhabitants. Are we seeing the ideas of a few carvers who had the monopoly and control over the portrayal of their own ideas rather than those of the masses? Could the conceptualisation of animals and of the sparser depictions of anthropomorphs thus be founded upon the ideas of the individual specialists who were able to make such carvings or those who instructed them to do so? It will be interesting to see throughout the progression of the next research objectives whether certain types occur over larger areas to infer whether a kind of 'information exchange' about specific body ideals is reflected in their diffusion over larger areas. What will be of further interest is how these different frequencies occur over the stretch of the lands and whether certain motifs are to be found in only certain areas, or whether they intersperse evenly throughout the area (to be addressed in Chapter 7.4).

5.2.3. Shapes and completeness of motifs

After having established which types of motifs actually occur within the regions under study, the following table and graphs bear information on the forms that the motifs take. This section is of particular importance for this research, due to the interest in reduced/simplified animal features that lead us as observers to identify specific engravings as belonging to a specific type of species.

Shapes and completeness of motifs - results

The following table (Table 5.1) gives an overview of the completeness status of all the motifs in the Côa region:

Part of Animal	Quantity (Σ n=1117)	Percentage (in %)
Full Outline	430	38.5
Front Half Outline	40	3.6
Back Half Outline	27	2.4
Front 3/4 Outline	112	10.0
Back 3/4 Outline	96	8.6
Half Head	4	0.4
Head	30	2.7
Cervical Dorsal Line and Head	11	1.0
Cervical Dorsal and Ventral Line	9	0.8
Cervical Dorsal and Ventral Line + Front Legs	3	0.3
Cervical Dorsal & Buttocks	6	0.5
Cervical Dorsal Line and Back Legs	5	0.4
Cervical Dorsal Line with All Legs	7	0.6
Cervical Dorsal Line	14	1.3
Protomos	148	13.2
Protomos & Dorsal	65	5.8
Protomos with Front Legs	5	0.4
Ventral Line & Front Legs	9	0.8
Ventral Line & Both Pair of Legs	22	2.0
Ventral Line & Head & Legs	5	0.4
Ventral Line & Back Legs	13	1.2
Buttocks & Tail	6	0.5
Back Legs & Buttocks	16	1.4
Animal Like	2	0.2
Front legs?	7	0.6
Full Outline + Two Heads	18	1.6
Front 3/4 Outline + Two Heads	1	0.1
Full Outline + Three Heads	1	0.1
Front 3/4 Outline + Three Heads	1	0.1
Undeterminable Lines	4	0.4
Total	**1117**	**100%**

Table 5.1.: Different quantities of motif completeness in the Côa Valley.

Based on the discussion above on mere head depictions and additional torsos, the following graph (Fig. 5.2.4) simplifies the table above into a more effective chart that groups certain feature together and sheds light on the frequencies of animal depictions based on their body completeness. Yet, for completeness of motifs and their features the previous table overleaf should be used as a referring guide:

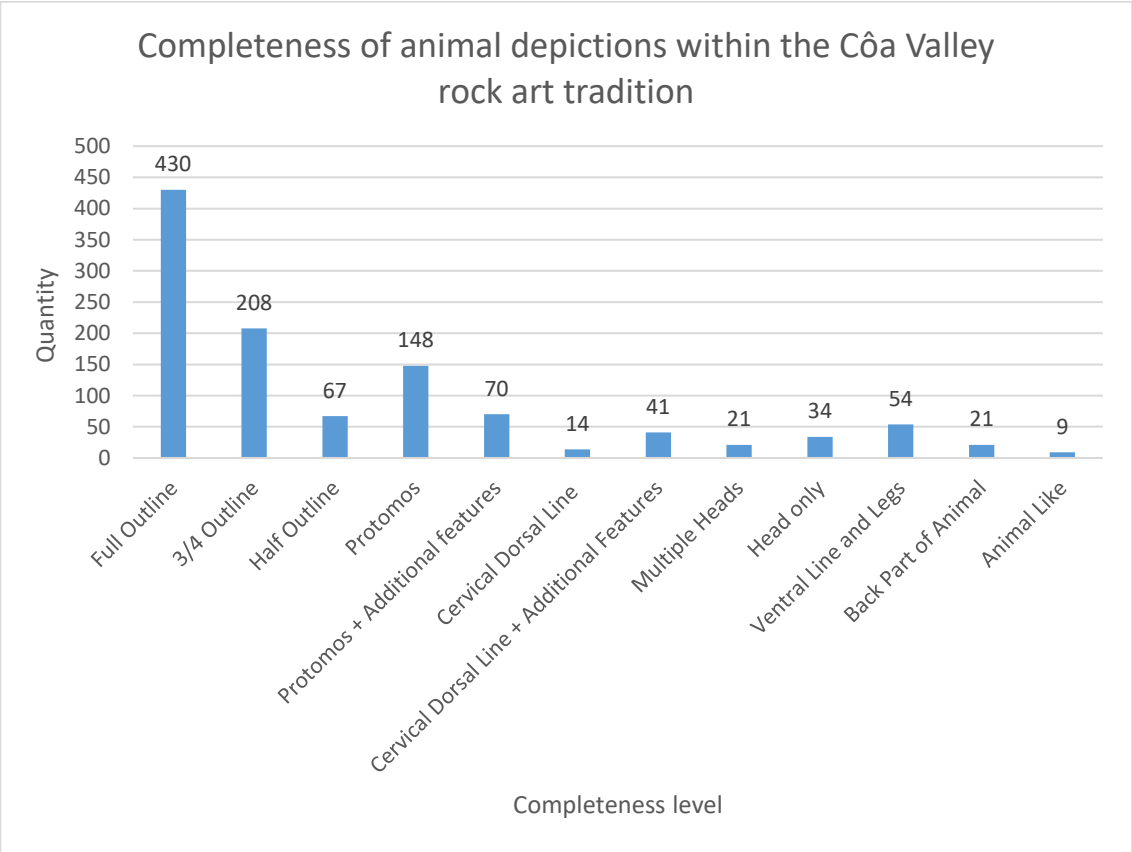


Figure 5.2.4.: The completeness levels (detailed) of motif depictions in the Côa region.

Whilst it seems that the majority of the depiction are indeed complete (n=430), the following pie chart (Fig. 5.2.5) reveals the actual percentages of completeness:

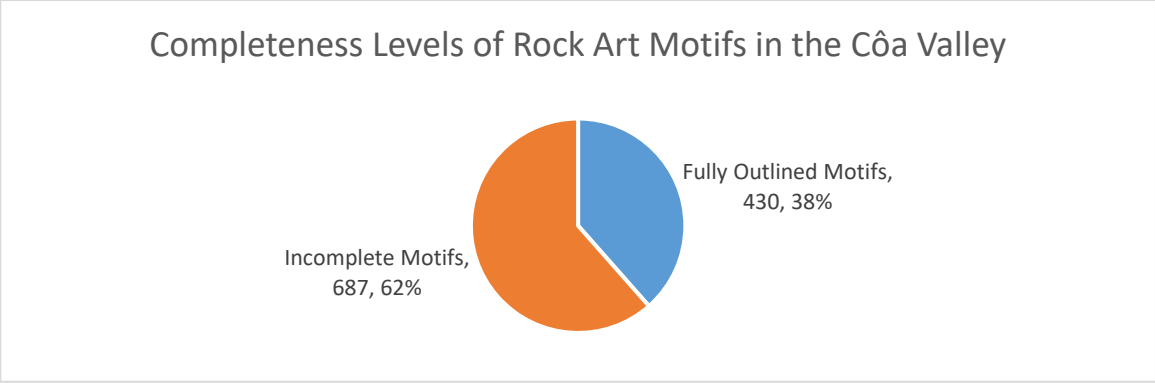


Figure 5.2.5.: The completeness levels (combined) of motif depictions in the Côa region.

The same set of data was generated for the Siege Verde rock art corpus and the essential features of the motifs have been grouped into this graph (Fig. 5.2.6):

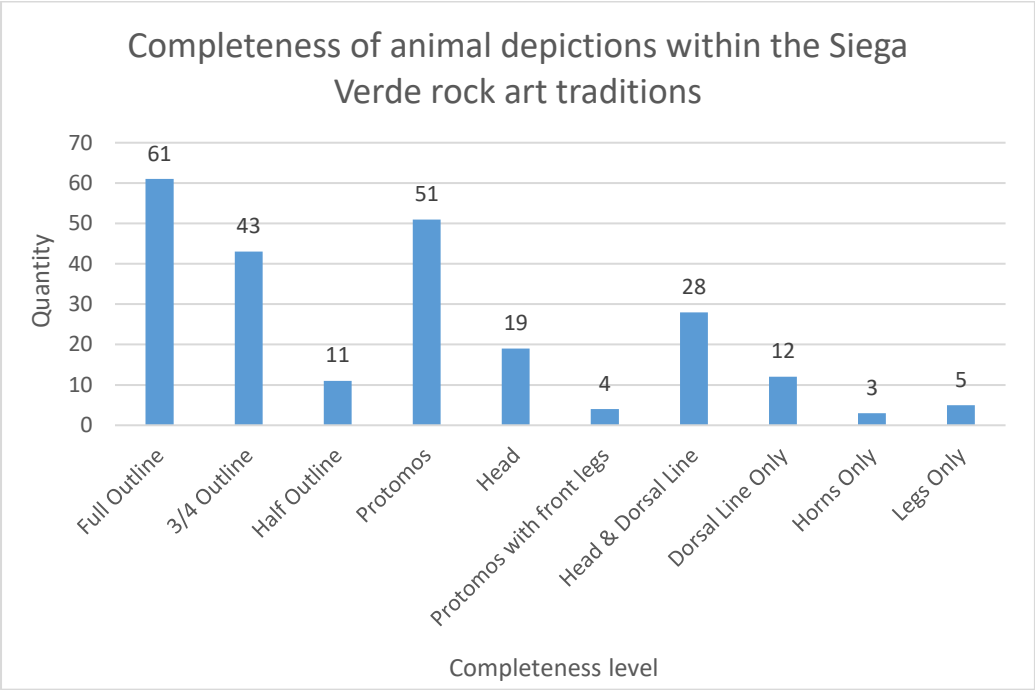


Figure 5.2.6.: Quantity of animal depictions in Siega Verde based on completeness.

Again, the completeness level is deceiving when just looking at the bars above (Fig. 5.2.6). The following chart reveals that almost ¾ of all depicted motifs in Siega Verde are actually not carved to a complete level (Fig. 5.2.7). However, why would a carver go through the effort of starting a carving, only to leave it incomplete most of the times? Why not add the little extra touches to complete the images? The significance of these figures will be explained later in the chapter.[13]

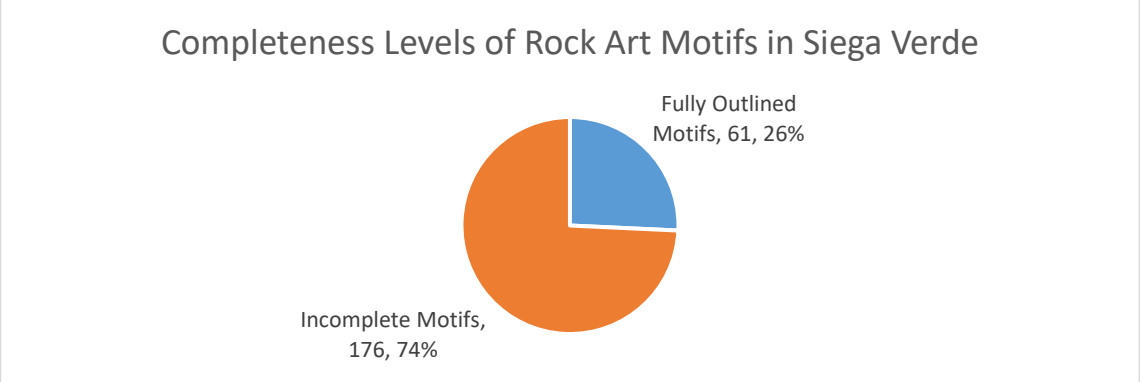


Figure 5.2.7.: The different completeness levels (combined) of motif depictions in Siega Verde.

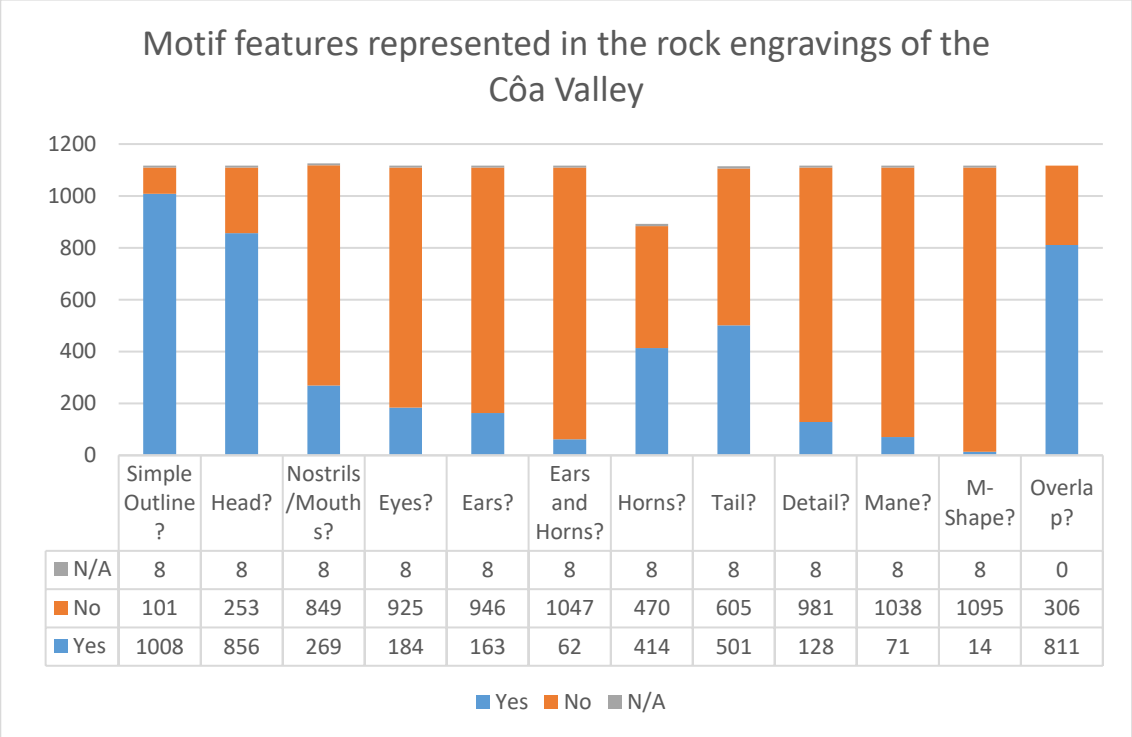
[13] The focus of this thesis lies in the wider trends of the rock art corpus, but if the reader is interested in completeness levels of specific types of animals, for instance whether horses are mostly displayed by head depictions only or whether aurochs are mostly complete, the database in Appendix A can be consulted.

5.2.4. Motif features/details

This subsection gives an overview of how animals are adorned with specific kinds of features. Aside from the basic outlines, the more detailed features such as eyes, horns and manes are being recorded to identify animal completeness in a way that adds to pure outlines and gives more character to the depictions. What is more, it is often the case that the determining factor in identifying an animal is for instance the addition of a horn or a depiction of a tail that gives its identity away. This data is only available for the Côa Valley motifs, since a major part of the Siega Verde engravings have been weathered to such a degree that, whilst identifiable, the very detailed recording of each feature was not possible. It was not clear whether the additional features were never originally presented or whether they had just been weathered away.

Motif features/details – results

The following chart illustrates the nature of these additions (Fig. 5.2.8). The only motifs that could not be evaluated were deemed so undeterminable, that it could not even be termed an undeterminable quadruped, but rather had to be denoted with N/A. A few intriguing results (including lack of ears and manes and fairly even split of horns and tails) are as follows:



	Simple Outline?	Head?	Nostrils/Mouths?	Eyes?	Ears?	Ears and Horns?	Horns?	Tail?	Detail?	Mane?	M-Shape?	Overlap?
N/A	8	8	8	8	8	8	8	8	8	8	8	0
No	101	253	849	925	946	1047	470	605	981	1038	1095	306
Yes	1008	856	269	184	163	62	414	501	128	71	14	811

Figure 5.2.8.: The different motif features in the Côa region.

5.2.5. Facing direction of motifs

An interesting pattern to observe when visiting the rock art sites alongside the river Côa are the clear demarcations of facing direction of the animals. It seems clear that careful consideration was put into the direction into which artists point their depicted animals. Not only that, the facing direction of the animal might point towards possible handedness of the creators.

Facing direction of motifs – results

Facing directions and the motifs' rotations were recorded as would be seen when observers stand face-forward towards the panel in question, with a clear view of its entire extent. A majority of all rock art animals are depicted facing towards the right (n=643). This equals 58% of all the carvings, compared to the rest of the directions illustrated in the following graph (Fig. 5.2.9):

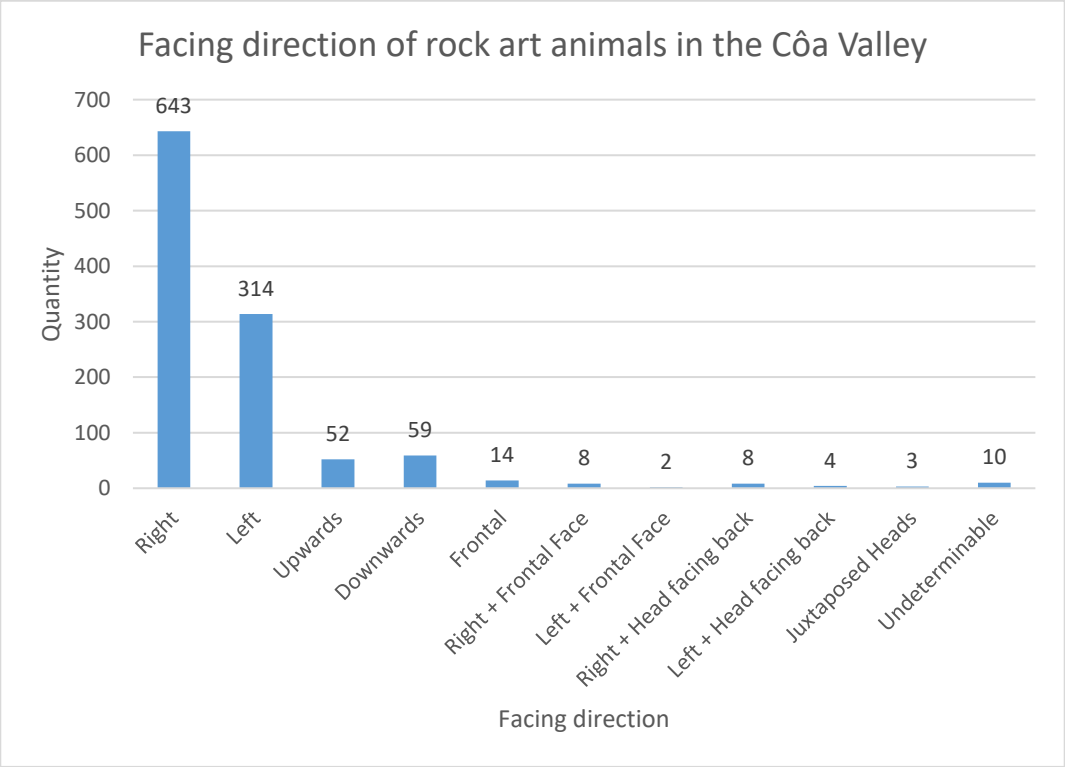


Figure 5.2.9.: The different facing directions of motifs in the Côa region.

Why is there such an imbalance between the facing directions?



Figure 5.2.10.: A photograph of a letter carver in action using a mallet and chisel. (Photograph: Burns-Cox, 2019).

Figure 5.2.9 shows an overwhelming trend in letting animals *walk* towards the right on panel extents. Whilst there may, of course, be a plethora of underlying reasons, such as animals acting as way-markers to certain places, it might be worth thinking about the process of mark making in connection with handedness. When thinking about the way that modern Europeans write and draw, especially for those that are right-handed; it naturally seems most plausible to create something starting on the left and ending right, often associated with the need to prevent ink-smudges (and thus obscuring earlier work). As we will see later on in this chapter, this method oftentimes creates animals walking towards the left. Côa Valley artists have employed several different techniques to engrave their motifs (see Ch. 6.2.2 for in-depth discussion). Their big difference is the way artists handle their engraving tools, either through a method of direct tool-to-rock or through indirect placement of hammerstone-to-tool-to-rock. With the indirect technique, artists tend to have more control over their mark placement, since the tool closest to the rock can be manipulated/angled to make the hammerstone hit in the desired way. The direct technique is more prone to slippage and mark making outside desired realms.

For comparison, Fig. 5.2.10 shows a modern letter carver handling his tools. He uses his right hand for the hammer/mallet (at an angle to the left of his left hand) and his left hand to guide a chisel in the way demanded. Particularly noticeable in the photograph is the way the engraving becomes visible from right to left, due to the specific way in which the carver holds his tools. If done the other way around, the marks would likely not appear as polished and the image would become obscured by overlain hands and arms.

This exploration might shed light on why the majority of animals *walk* towards the right, namely due to particular hand positioning and the need to circumvent the obscuring of motifs in the making process. If this information holds true, the majority of right-facing motifs will then imply that an indirect technique was preferred by artists of the past, in particular by those wanting to keep track of their entire, non-obscured creations. For this to be tested further, a closer examination of the rock art *in-situ* might establish the angles of peckmarks on the rocks. For, if the orientation of the marks could be determined, more information on the facing direction of motifs and artists' handedness could be revealed.

5.2.6. General results derived from the data

A closer look at the rock art motifs reveal a couple of general observations that can straightforwardly be made at this point about the rock art under study. For these results, and also more broadly, Appendix A (see e.g. A.A.3) should be consulted to see these broader trends in a data format. The following points will also guide into specific areas of research that follows on from this chapter:

1) Prevalence of depicting '**prey' animals** (Fig. 5.2.2)
- Mundane motifs such as shelters, the sky or surrounding landscapes are never displayed. Do the motifs that are on display have greater importance over them?
- Anthropomorphs (the essence of their being) rarely depicted
- Preference of depiction seemingly given to things that would have been eaten

2) Prevalence of an **upright standing position** of the animals (Appendix A; Fig. 5.2.9)
- 'Elaborate' examples such as the curled-up bison or the galloping horses of Altamira cave are non-existent
- Movement hardly ever depicted

3) Primarily stationary profile depictions/ depiction of **profile views** (Fig. 5.2.9)
- Uncommon to have animals displayed upside down or *walking* up or downwards on the panels
- Visually aiding our ease of identification
- Motifs most often found *walking* towards the right

4) **Incomplete renders**, could also be called **'shorthand' or 'abbreviations'** (Fig. 5.2.4)
- More motifs are left incomplete than finished to a complete standard
- Deliberate omission of features?
- Dorsal line often sufficient to capture essential form of animal
- Often times radical omission of heads or lower part of bodies
- Many heads without bodies, but not many bodies without heads
- Feet almost never depicted

5) Some animals are displayed with the **incorporation of natural rock features** aiding their completeness, e.g. A horn of an aurochs might be a fissure near the depiction of its head (cf. Batarda Fernandes *et al.* 2017) (Appendix A)

6) Preoccupation with **morphological form** and shape rather than with texture, mass, and colour (Fig. 5.2.8)
    - The shape and form of the animal seems more important than what is displayed inside
    - Detail hardly ever depicted, judged by the presence/absence of features from Fig. 5.2.8
    - Compared to for instance Scandinavian rock art, the motifs in the Côa are hardly ever pecked out (fully hewn out with hammer stones that would add texture and depth)
    - No traces of pigments on schist rocks left

7) Interesting features observable such as **twisted perspective** (Appendix A)

The adoption of a twisted perspective is a common feature within cave art representations of France and Spain and has also made its way to the Côa Valley (that is not to say that it originated in either of these places or that it originates within visual cognitive function). Later rock art traditions for instance that of the Bronze Age of Sweden or even Egyptian art (think i.e. Pharaohs' feet pointing in one direction) also adopt this trait (cf. Meyering, 2016). It seems that artists adopt the use of a twisted perspective in order to maximise visual information at the expense of anatomical reality.

Garlake (1995: 21) concisely describes this "twisted perspective" trait as "a system of multiple viewpoints (…) adopted so that each element of a subject was clearly visible, readily legible and easily outlined". Exemplary is an animal which has its head pecked and body in profile, but has its horns, ears and hoofs seen from the front. Very common is the twisted perspective horns, often visible as two horns next to each other, which if seen from the side would only be visible as one that hides and overlaps the one behind it. The following image (Fig. 5.2.11) is an example of twisted perspective:



Figure 5.2.11.: Display of twisted perspective on Rock 19, Penascosa (drawing made by *Mário Varela Gomes* in Santos, 2017, courtesy of Fundação Côa Parque).

This technique is likely utilised for reasons of fully depicting what is most important to the carver. In this case, the full display of the antlers is of greater importance than sticking to a realistic in-profile view with a properly turned head and a side view of the antlers. Furthermore, there is evidence that Upper Palaeolithic artists exaggerated certain features to facilitate recognition in much the same way that contemporary artists use caricature (Cheyne *et al.* 2009).

5.2.7. Discussion of results

Animal types - why are there certain species in this area?

The next investigative step is to ask why only certain species occur in these areas and not others, and why some take precedence in 'screen-time' over others. So, why is it that these specific types occur over and over on panels alongside the Côa River? Why is it that hardly any anthropomorphs are depicted, hardly any fish represented, when the riverine environment practically cries out for the depiction and catching of fish? Were the animals depicted in great abundance worth more in the eyes of the community? What was their status? Or does the sparsity of fish and humans indicate their unique status? Does motif sparsity or motif abundance create importance?

Unfortunately, the very poor preservation of any faunal assemblages in the regions of both the Côa and the tributary at which the Siega Verde rock art panels exist, means that we cannot make inferences from real animal bones in relation to the art on display (Aubry *et al.* 2002). What is important to note however (based on the visual culture of these regions alone) is that the Côa region is dominated by aurochs and horse depictions. The Siega Verde region further towards the Spanish border is overwhelmingly dominated by horse depictions. Species such as bison and megaceros only occur in the Siege Verde tradition, which may indicate that certain species were attracted to specific types of lands in the past. However, the absence of species depictions in certain areas does not necessarily equal physical absence of them during the Upper Palaeolithic. *Absence of evidence does not equal evidence of absence.*

On a purely geographical line of argument, the regions of the Côa and Siega Verde were ideally suited for animals in search of water sources and subsistence. When approaching the valley from different plateaux above, the steep incisions from above towards the water edges made for great migratory routes into the regions, perfect for hunter-gatherers on the lookout for their next hunt. The climate, vegetation, secluded landscapes and hiding spots as well as the all-important hydration source will have created an excellent location for both hunters and their prey (for geographical information refer back to Ch. 2), and thus the existence of rock art showcasing this importance does not surprise.

Animal completeness - are animal depictions oversimplified?

Whilst, hypothetically speaking, it might be interesting for some readers to know that there are 216 horses, of which half of them display a complete contoured outline and six of them uniquely possess hooves, the real value of collecting this data is revealed when looking at it from a different angle. Since the main focus of this thesis interrogates the underlying psychological principles behind the visuality of the engravings, their final shape and form is immensely important to this research.

What one can appreciate when inspecting and categorising thousands of these motifs, is that collectively depicting animals within Palaeolithic art means simplifying what is seen. Details such as depictions of eyes, manes, fur coat, ears and nostrils have been under scrutiny in much detail, but what can be clearly seen from the data above, is that the prevalent outline is the most obvious manifestation of this simplification. This means the reduction of animals to lines that are their most essential core and engraving the most salient features that are most useful for swift identification, e.g. horns. All in all, a living being reduced to a minimal representation, yet still sufficiently outlined to make it recognisable.

Intriguingly, thanks to these preserved minimal lines, observers are still able to make out which species are being represented. Researchers can pinpoint, often down to its gender, the species depicted on the rocks. How can this be? Which lines or which features are diagnostic cues for an animal to be either a bison or a horse? Which lines need to be switched, which features need accentuating in order for us, as the observers, to distinguish between completely different species? We also have to bear in mind that during the Upper Palaeolithic there will have been the added difficulty of doing this 'detection work' at relative speed in a camouflaged landscape.

Conversely, one contradicting aspect to consider at this point is the large occurrence of 'undeterminable quadrupeds'. Readers will have likely wondered about the large quantity of depictions that were classed as 'undeterminable' early on (cf. Fig. 5.2.2). Why does it seem impossible to determine these animals? What is the missing piece of information to their depiction that would make them determinable? A methodological attempt at classifying their constituent parts, such as dividing them into the elements that would make them diagnostic (i.e. the existence of heads/protome, dorsal lines or other details), was inconclusive. This was due to the fact that there was an even split of depictions (out of a total of n=252) within this category that display either parts of the animal's back or parts of the (most determining) front (n=123; 49% and n=129; 51% respectively). If a tendency towards either side had been

discerned, then a matter of ‘intent’ could have been discussed. A supplementary attempt at dividing them into ‘status categories’ such as (1) obvious; (2) probable and (3) undefinable, appeared not robust enough/too subjective for empirical data generation. What proved to be suggestive of the underlying inability to classify was a closer reading of Santos’ (2017) description of classifying undeterminable species (also confirmed through the author’s own classification work). It highlights, that many of these species are termed as such, because of underlying factors deeming them illegible. Factors include partial weathering, heavy overlap of species obscuring lines of diagnosticity, uncertainty of where lines converge and general refusal of ‘pigeon-holing’ something that might also be something else. Species were only classified as belonging to a specific category if their discrimination was absolutely certain. Hence, as soon as doubt appears as to which category an animal should fall into, its status becomes ‘undeterminable’. Therefore, the following sections allow for a further look into what it is exactly, that make species ‘determinable’.

Species identification

To address the concept of ‘species identification’, a little thought experiment is addressed. Here are three Upper Palaeolithic examples of simplified, contoured depictions of animals (Fig. 5.2.12-5.2.14):



Figures 5.2.12.-5.2.14.: Full outline of three Palaeolithic rock art animal species taken from Halverson (1992: 394).

All three are immediately distinguishable as being a rhinoceros, an ibex and a horse, respectively. Psychologically speaking, this has to do with the principles of recognition and discrimination. In other words, at which point is it possible for us to identify objects or living beings *as something* in particular?

Key figures in this psychological realm are Rosch *et al.* (1976) as well as Tversky and Hemenway (1984) who identify categorisation at different levels, i.e. at superordinate, basic and subordinate levels. If one had no prior acquaintance with a rhinoceros for instance, one would categorise such depiction as an animal due to its 'apparent' (although strictly in profile) quadrupedal nature, this is termed categorisation at *superordinate* level, simply identifying it as an 'animal' and nothing more specific. The next level is that of *basic* categorisation which turns an animal into its more specified genus, a rhinoceros rather than an animal. This level is therefore linked to recognition – a valuable piece of information in search of ways of depicting rock art animals in the Upper Palaeolithic.

A more nuanced level would be that of the *subordinate* categorisation, which would then distinguish between different species of rhinoceros, such as Javanese or Indian rhinoceros. Arguably, this last level is of least importance in a recognition task since the basic level has already identified the animal's general characteristics.

This tripartite way of categorising objects and beings in our world of vision is no stranger in its application to rock art. In fact, Halverson (1992) and Dobrez and Dobrez (2013) have pointed out its relevance in rock art motif identification. One shortfall of this more recent latter paper is their disregard for in their words "confusing circumstances" meaning recognition at times of bad lighting, bad weather conditions, poor eyesight and longer distances to the animal in question. They argue that a superordinate identification might be possible in these *circumstances*, yet basic identification based on their movements in absence of visible features must "clearly (be) a situation of indeterminacy" (2013: 76).

Having said that, our recognition of these animals is based entirely on prior knowledge of them. With no such knowledge, the lines as seen above would just symbolise an array of joined lines. This again goes back to the discussion from earlier of portraying *our* modern knowledge and biases onto *their* ancient rock art.

Species simplification

Going back to the outlines above, all three are in 'strict' profile with two depicted legs and lacking the twisted-perspective horns. No infill pattern can be recognised, no eyes, mouths or change in fur structure are identifiable. No colour or texture can be perceived. The legs are present, yet there are no hooves. Features that are not strictly necessary for their identification are left out. Yet, if the legs are not strictly necessary for identification, what about the entirety of the torso?

If one vertically 'cuts' these three animals above in half, one ends up with three very similar looking torsos – not very distinguishable from each other at all (Fig. 5.2.15-5.2.17):



Figures 5.2.15.-5.2.17.: Torsos of the species based on figures 5.2.12-5.2.14.

If it was the intention of the artist to depict their animals with as limited a number of pecked marks or incised lines as possible (perhaps in the interest of the economy of time?), clearly depicting similar looking animal torsos seems redundant. When comparing all three headless bodies above, they give little indication of its species. On the contrary, when considering only the heads of these animals (Fig. 5.2.18-5.2.20), all species can still be identified without major difficulty, even without the addition of a torso:



Figures 5.2.18.-5.2.20.: Heads/protome of the species based on figures 5.2.12-5.2.14.

What then seems to be of most use is the portrayal of features surrounding the area of the head? It is argued from here onwards (and empirically tested in the second experiment of this chapter) that this is most likely due to the saliency of their determining feature, such as the

swung horn of the rhino, the bent over backwards horns of the ibex and the typical pointy ears and mane of the horse. Again, when referring back to the data above, the majority of the depictions are in fact not complete, much to the support of the underlying ideas presented here and a *pars pro toto* design of motifs.

Another supporting pattern from the data collected is existence of many heads without bodies, yet considerably fewer bodies without heads (also called 'acephalous'). In line with the discussion on the necessity of heads and redundancy of torsos, the data for Siega Verde for instance shows that a large number of figures still follow a complete (full outline; n= 61; 26%) or near complete (3/4 outline; n = 43; 18%) pattern. However, if one combines the depiction of pure animal heads and depictions of protomes (head, neck and beginning of dorsal line including manes), a total of 70 depictions arise (=29%). This result therefore aligns with an argument of identification ability primarily through saliency of head features.

Artistic minimalism

If we go even further in search for artistic minimalism, there are a couple of general observations that can be made in search of instant animal recognition. The fewer the amount of lines one has for the depiction of an animal, the more possibilities arise for it to be of any type. Hypothetically then, the less detailed a line is, the more information can be attributed towards it. Looking at the number of lines available, the following graph (Fig. 5.2.21) exemplifies this trend:

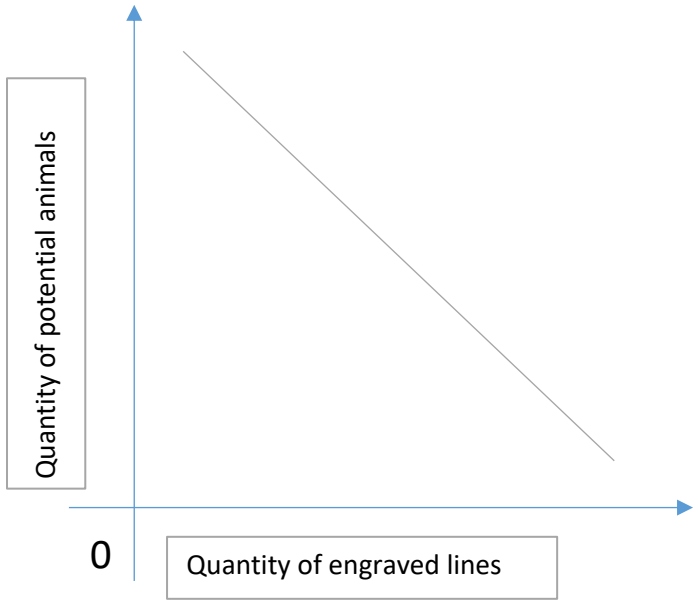


Figure 5.2.21.: The hypothetical relationship between number of lines and number of potential animals.

One engraved line can therefore be associated with an array of animals, whereas two lines in relation to each other lower the species possibilities. The more lines converging into one motif, the more specific an animal becomes. Hence, the more specific and detailed a line becomes, the more rapid the animal identification (Fig. 5.2.22):

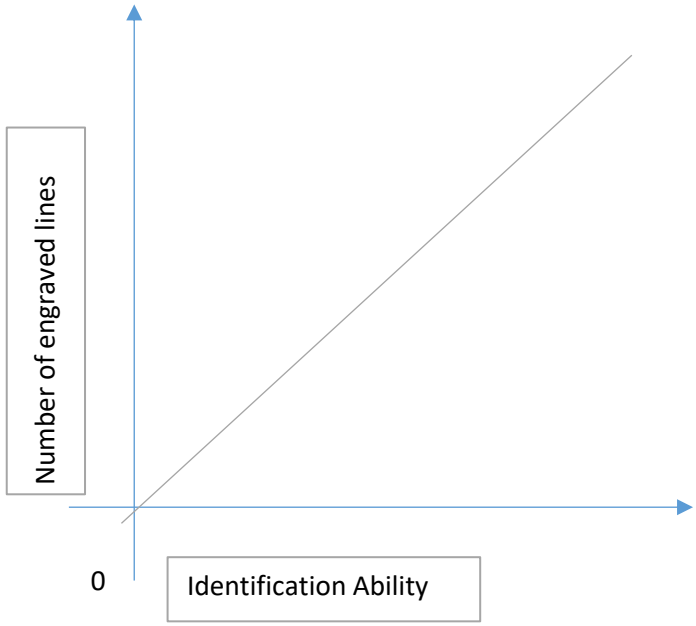


Figure 5.2.22.: The hypothetical relationship between line quantity and identification ability.

Artistic reality

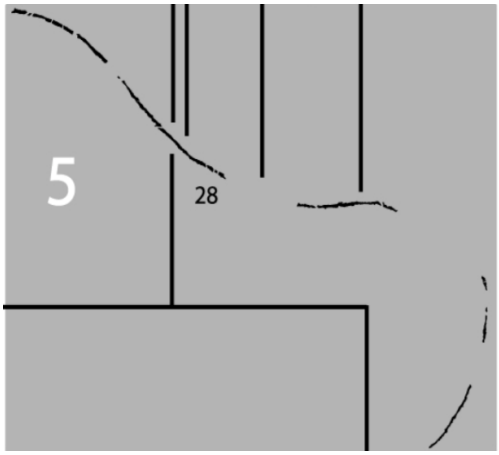
Whilst this is an interesting, yet hypothetical way to think about the amount of lines necessary for animal identification, the world of rock art bears instances which deem this model to be less powerful in its universal applicability. Therefore, going back to real examples from the rock art in the Côa Valley, this animal (Fig. 5.2.23) stands out due to its ingenuity of creating a 'short-hand', by combining incisions for horns with incisions for its head. Identification ability, therefore, does not seem to be reliant upon a specific quantity of lines, but rather on the specific configuration of such lines. It is also sometimes the case that artists utilise the same engraved or incised lines twice or more for different purposes and parts of different animals. As such, a dorsal line of one horse could be the dorsal line of another but walking in opposite directions. Again, cases of rock features incorporated into the design to create horns or eyes also exist (see Batarda Fernandes *et al.* 2017).



Figure 5.2.23: Ingenious 'short-hand'. Animal 16 on rock 14 of Canada do Inferno (drawings made by *Mário Varela Gomes* in Santos (2017) courtesy of Fundação Côa Parque).

What is more, there are a few examples specifically within Santos's work (2017: 218) for which he refers to the "sinuosidade", meaning sinuosity or curviness of specific lines to aid him in animal specifications. Rock 2 at Canada do Inferno (Fig. 5.2.24) and animal 28 on rock 1 of Fariseu (Fig. 5.2.25) display such cases. Both of these curves are likely to be determined as a horse due to their pronounced curviness, also often referred to as their 'S-shape':





Figures 5.2.24.-5.2.25.: Examples of the sinuosity of cervical dorsal lines in the display of horses (drawings made by *Mário Varela Gomes* in Santos (2017) courtesy of Fundação Côa Parque).

It is worthy to note here that Santos has devoted much of his researching career to the form and specification of these rock art animals and can therefore be considered an expert in this area, and thus in their detection. In fact, Rosch *et al.* (1976) and Dobrez and Dobrez (2013: 77) also remark on expertise and the effect it has on recognition: "the greater someone's expertise in an area, the more `subordinate´ their recognition in the eyes of non-experts". A fitting example would be for instance someone with great expertise recognising an Indian rhinoceros as opposed to a Javan rhinoceros as part of their basic level recognition stage. Here, someone's basic level recognition might be someone else's subordinate level recognition or vice versa. It all depends on the level of expertise.

If we now match this thinking up with hunter-gatherer knowledge and expertise, we can be certain that what we might term their basic level recognition can be likened to our modern recognition ability (if existent) at subordinate level or even beyond. Their intricate knowledge of their prey will have regularly put them in great stead to know exactly what type of species and variety they had in front of them. So perhaps the sinuosity of a dorsal line was in fact the discerning and only necessary factor for their *basic* level recognition abilities.

But what does the obtained data reveal about using cervical dorsal lines in depicting animals? Arguably, the simple curvature of the line tells the audience as much information, as it would if it had more lines and was more complete. Is a curved line that denotes a horse really a horse? Was that the artist's intention?

After investigating the amount of times that cervical dorsal lines are being used, in only n=14 out of n=1117 cases an isolated cervical dorsal line can be found. In 8 out of those 14 dorsal lines, they were too ambiguous to determine them to be of a specific species. Five horses and one aurochs could otherwise be identified (the typical S-shape of horses' backs and the hump of an aurochs aided in identification). There are n=41 incidences at which a simple dorsal line is displayed in addition to other features such as hind or front legs, buttocks, tails or even the ventral line. Whilst the percentage of this is minute in the grand scale of things, a dorsal line appears to be more likely to be depicted alongside other features rather than purely on its own. Yet, the generally low occurrence rate of isolated dorsal lines in comparison to the larger number of isolated heads provides a visible tendency towards acknowledging stronger saliency of the latter. Albeit the discussion now circles back to our three Upper Palaeolithic examples by way of horizontally 'cutting' them in half (Fig. 5.2.26-5.2.28). This gives the following view:



Figures 5.2.26-5.2.28.: Cervical dorsal lines of the species based on figures 5.2.12-5.2.14.

Whilst it might be easy for readers of this thesis to identify which animal these dorsal lines pertain to; readers might also be biased due to the elaborate discussion of these examples above. Objectively, identification of this 'cut' seems more difficult to discern than identification through head features alone. When animals possess relatively high positioned head features

(such as the horn in the middle example, Fig. 5.2.27) as well as the dorsal line, faster identification is likely. Yet, this seems too hypothetical to be passed as a concrete mechanism. The following experiments will aid in this concretisation.

Now, there are two possible ways of identifying animals in a swift manner, the first by way of the salient head features, and the second by way of the sinuosity of their cervical dorsal line (in other words the line of the back of the animal). Additionally, the convergence of lines in a particularly meaningful manner seems to have had more importance than minimising on the engraved lines necessary for identification. To conclude, this discussion of results leads to the following observations ranked based on evaluated animal features for fastest identification:

Ladder of identification ability:

1.) Saliency of head features

2.) Saliency/sinuosity of dorsal line attached to explicit head features

3.) Saliency/sinuosity of dorsal line only

4.) Rest of the torso

The following experiments (*Drawing Animals* in Chapter 5.3 and *Bubbles* in Chapter 5.4) are designed to test whether this ladder of identification ability does actually hold true when subjected to rigorous psychological testing. To start with, participants are being asked to draw animals whilst being subjected to different priming mechanisms and drawing prompts. This is followed by subjecting participants to an experimental software, testing the visual saliency of different animal features.

5.3. Psychological Experiment 1: Drawing Animals

5.3.1. Introducing the experiment and research questions

This first experiment was put in place to set the scene of this research project. The experimental research approach sees the flow from the small-scale rock art motifs, to the large scale locations in the landscapes of exactly these motifs. Henceforth, it seems only fitting at this point to start the first 'level' with an investigation of how we as humans perceive and recall our knowledge of animals and their characteristic traits and shapes.

For exactly this purpose, an experimental workshop with undergraduates from Durham University, enrolled on the course "Advanced Skills – Experimental Approaches to Understanding Upper Palaeolithic Art", was held over a series of four consecutive years with a changing set of students with different backgrounds. The experimental workshop was conducted together with Professor Paul Pettitt to understand Upper Palaeolithic engravings and possible making techniques from the perspective of the creators.

Getting accurate insight into these perspectives seems to be difficult, especially with critics of such an approach questioning the validity of our 'modern minds' and ways of thinking, superimposed onto those of the past. However, as has been established earlier in this section, with material for which no emic insider knowledge is available, one has to think of alternative ways to interrogate that material. Additionally, the hardware of our modern brain is the same as the brain of anatomically modern humans (AMH) responsible for the art in question. This gives credence to the often-critiqued frame of mind of 'they were not the same as us'. These 'enduring strokes' are interrogated through the processes and results of the drawing sessions, during the conducted experimental workshops. New 'firsthand experiences' will bear insights into art creation and as such the following research questions will be addressed:

1. How do participants deal with familiar and unfamiliar drawing prompts?
2. Does visual priming influence the way participants draw?
3. What is the general shape of the animals drawn by modern participants?
4. What drawing order is noticeable?
5. How are animals drawn in their contextual environment?
6. What constitutes a minimally presented animal?
7. Is there a difference between left and right-handed artists?

5.3.2. The rationale behind letting subjects 'draw' animals

When thinking of the often inaccessible places where open air rock art occurs, it seems unlikely that the artists used the rocks to display what they were seeing right in front of their eyes at that exact spot. Recalling a scenario in which portraitists sketch subjects sitting right behind their canvas seems unfitting here. Consequently, it is worthy to look into memory recall, more specifically the psychological concept of *visual mental imagery* as a way of how Upper Palaeolithic artists will have approached memorising their artistic subjects. The study of the processing and recalling of mental imagery has stimulated the psychological discourse over the past decade and continues to fascinate even neuroscientists to this day.

Visual mental imagery, also called "seeing with the mind's eyes" (after Cicero's *mentis oculi*), works on the basis of visually experiencing pictures in the absence of actual stimuli. In fact, early research by Posner (1993: 108) shows that visualising any cognitive activity stimulates similar brain areas that are usually engaged when actually carrying out that cognitive activity: "Thinking about a telephone activates (…) the same brain areas as seeing a telephone".

In view of what is being studied here, there are two distinctions of memory recall to be made. One is of remembering a horse for instance (termed here as *prototypical imaging*) and the other form is remembering when one has last seen a horse (termed here as *direct visual recall*). The visual outcome in both scenarios is completely different. The latter scenario begs for answers such as seeing a horse herd grazing in their paddock or running on the beach, which ultimately includes their context and background information. The former prompt will produce the features of a horse as if it is stationary, with as much detail attached to it as the person wishes to recall, most likely leaving out contextual background and natural behaviours. As already established earlier in the results section, the inclusion of natural background scenes or the positioning of animals on different plains cannot be identified in the rock art. Halverson (1992: 224) not only gives similar examples along those lines, but also postulates that in the case of the latter prompt of purely imagining a horse, rather than the instance when one has last experienced a horse:

> *"It would, moreover, almost certainly appear standing in profile with a strong outline but with dimly perceived colour, texture and mass. It is very unlikely that you would imagine it lying down or from a head-on viewpoint or that it would be grazing, running, mooing, or doing anything in particular."*

This current experiment is partly set up to test Halverson's hypotheses, by way of inviting participants to draw two types of animals, one from recall, one from seeing animals in action.

5.3.3. Experimental methodology

Participant information

A total of 43 (17 males, 26 females) individuals participated in this experiment. 28 (9 males, 19 females) undergraduate students with an interest in Palaeolithic art took part. All undergraduate participants were recruited through their attendance of the module described earlier and prior consent was given, provided that their identity remains anonymous. 15 (8 males, 7 females) participants were recruited outside the realms of academia, archaeology or rock art and were asked about their familiarity with drawing, animal knowledge and handedness. 7 out of the total participant pool were identified as having observational drawing experience, all of them had (close-up) familiarity with horses (including 6 horse riders) and none of them had any previous close-up experience with bison. Below is a table (Table 5.2) with the key information for this first experiment:

	Under-graduates Year 1	**Under-graduates Year 2**	**Under-graduates Year 3**	**Under-graduates Year 4**	**Additional Drawings collected**	**Total (∑)**
Number of Participants	6	5	8	9	15	43
Male	4	1	1	3	8	17
Female	2	4	7	6	7	26
Right-handed	4	5	5	8	12	34
Left-handed	2	0	3	1	3	9
Familiarity with horse	All (1 rider)	All	All	All (2 riders)	All (3 riders)	All
Familiarity with bison	None	None	None	2	None	2
Drawing experience	1	0	1	2	3	7

Table 5.2.: Further participant information for experiment 1.

Experiment material set-up

The materials that were used prior and during this experiment are:

- Prior selection of images and videos of bison and horse for priming.
- Projector to portray the task instructions and the images and videos for priming purposes.
- Sheets of white paper and black pencils (for ease of scanning, manipulating, and investigating on screen afterwards).
- Follow-up questionnaires to gather information on individual reasoning behind drawings (for sample questionnaire, refer to Appendix B).
- Scanner and Microsoft PowerPoint to investigate and disseminate results to each cohort.

Experiment task set-up

For this experiment, the following running order was devised (Table 5.3):

Task Prompts
Drawing Practical (Drawing-Time a total of 45 min, excluding video showing)
1. Imagine and draw a horse (5 min)
1.1. Initial the top right of your A4 sheet and number it **1**.
1.2. Draw your horse, any way you like.
2. Imagine and draw a bison (5 min)
2.1. Initial the top right of your A4 sheet and number it **2**.
2.2. Draw your bison, any way you like.
3. Now look at this picture of a Przewalski's Horse (2 min)
4. Now draw another horse …. however you like (5 min)
4.1. Initial the top right of your A4 sheet and number it **3**.
4.2. Draw your horse!
5. Now look at the following image of a horse's head (2 min)
6. Now draw a horse head …. however you like (5 min)
6.1. Initial the top right of your A4 sheet and number it **4**.
6.2. Draw your horse head!
7. Now look at these two images and concentrate on detail (5 min)
8. Complete the questionnaire
9. Now look at this image of a bison (2 min)
10. Now draw another bison …. however you like (5 min)
10.1. Initial the top right of your A4 sheet and number it **5**.
10.2. Draw your bison!
11. Now look at these two images and concentrate on detail (5 min)
12. Now draw an isolated horse leg in as much detail as you can imagine (5 min)
12.1. Initial the top right of your A4 sheet and number it **6**.
12.2. Draw your horse leg!
13. Complete the bison question on your questionnaire.
14. Now we will watch a video related to horses… (Link attached)
15. Now draw a horse herd (with 3-6 animals) (10 min)
15.1. Initial the top right of your A4 sheet and number it **7**.
15.2. Draw your horse herd!
16. Now we will watch a video related to bison… (Link attached)
17. Now draw a bison fight (10 min)
17.1. Initial the top right of your A4 sheet and number it **8**.
17.2. Draw your fight!
18. Now think about what aspects/lines really define each animal (e.g. manes, hooves, dorsal line, head, thighs…&c?) (5 min)
18.1. Initial the top right of your A4 sheet and number it **9**.
18.2. Draw the outline of both a horse and a bison using the minimal amount of lines you think necessary to distinguish the two.
18.3. Describe on the sheet exactly how you distinguish between the two. Why did you choose the elements you did? How might you describe the anatomical differences between the two?

Table 5.3.: Drawing tasks for experiment 1. Images/videos mentioned in this prompt sheet can be found in Appendix B.

Priming

The conscious decision of priming our participants was important in order for us to see changes in drawing practices between tasks when familiar or unfamiliar with a certain species. This was particularly important since many of the participants were unfamiliar with the appearance of bison. It was assumed that everyone had familiarity with the appearance of horses, but not with bison. In the field of psychology, the tool of *priming* ones' subjects is a useful technique that introduces one stimulus that then influences the way subjects respond to subsequent stimuli.

Stimulus

Stout (1898: 57) describes a stimulus as a "condition external to the central nervous system itself and operating upon us". In the case of this experiment, people were asked to draw a horse and a bison without having been primed prior to their first drawing attempt. This was the 'control setup' to understanding their acquaintance with the task and animal at hand. Another trial included the priming of participants with an image of a typical Przewalski's horse (Fig. 5.3.1) and an image of a bison with its winter fur (Fig. 5.3.2) illustrating the change in coating on the front and rear of the animal:





Figures 5.3.1.-5.3.2.: Priming imagery between trials. (Sources in list of figures).

A video stimulus was also used to subject our participants to their 'natural' habitat in the hope that they would pick up on some of the situational context in their next drawings. The following images, one of a Przewalski's horse herd (Fig. 5.3.3) and one of a bison fight (Fig. 5.3.4), are still images from videos selected from an online video platform:





Figures 5.3.3.-5.3.4.: Still image scenes from video priming for additional drawing tasks (video links in list of figures).

5.3.4. Experimental results

Below are drawings from the first cohort (Fig. 5.3.5), portrayed next to each other for easy comparison. For more examples, please refer to Appendix B. To clarify, the observations made here are based on the entire sample of drawings and not just those presented below.

Drawing Tasks: Drawing a horse (before and after priming) and drawing a bison (before and after priming)

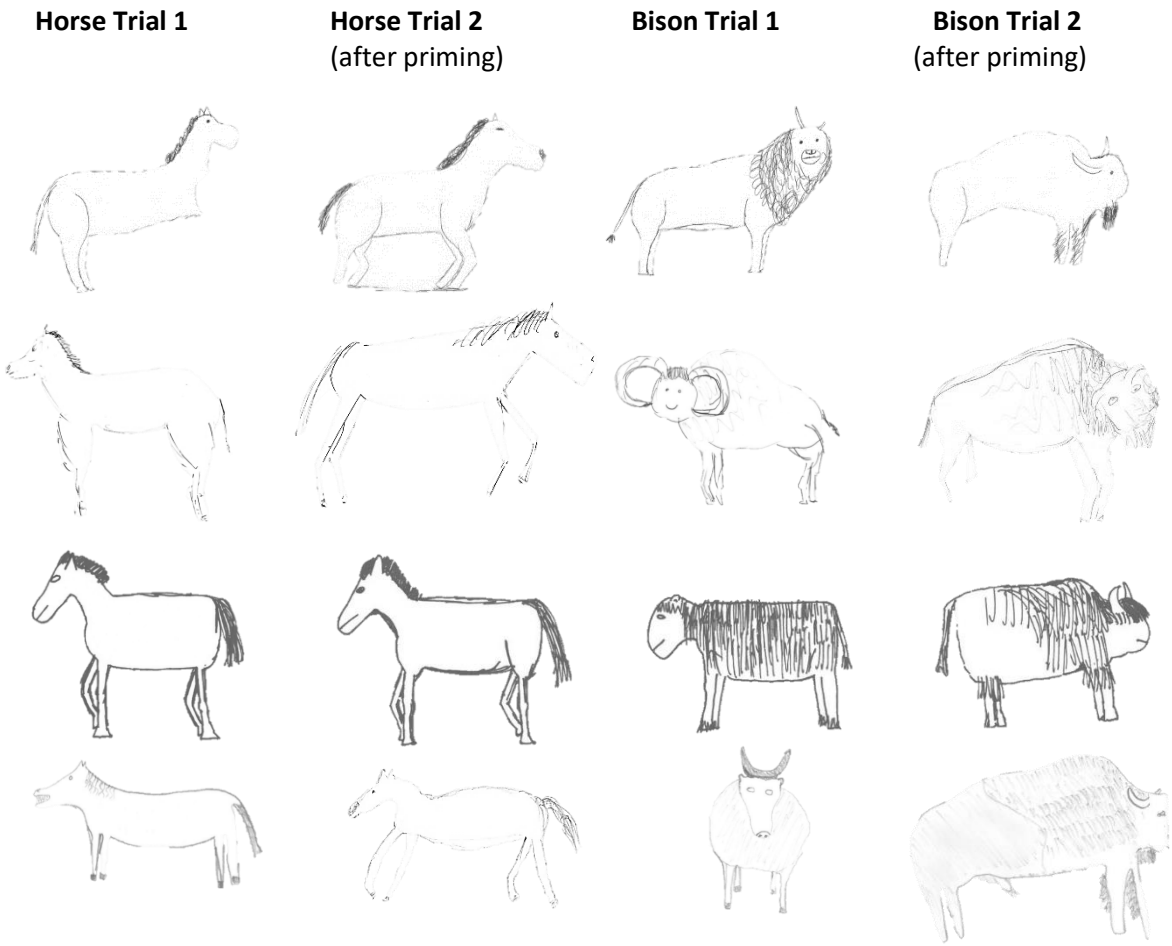


Figure 5.3.5.: Array of sample drawings depicting horses (left) and bison (right) prior to and after priming. Drawings produced by the first set of participants in year one of testing. More images of the same task available in Appendix B.

The following observations can be made about the way participants attempted to draw the general shape of the animals:

- Animals are almost always, except once, drawn in **profile view.**
- **Contour lines** usually suffice and texture/other infill patterns are rarely found (n=39 (19%) out of n=204 which is the total number of drawings produced in the experiment).
- Participants are **more familiar with the look of horses** than with bison, as seen when comparing all four attempts.
    - All four attempts in the column of *Bison Trial 1* (Fig. 5.3.5) vastly differ from each other and none of them come very close to looking like a bison. This is a general trend amongst all of the 43 first attempts of drawing bison.
- **After visual priming**, participants emphasise further on **detail**, such as manes, horns, and movement of the animals in their second (post-priming) attempts.
- The **general uniformity** of and between all drawings even before visual priming is striking.
    - In other words, a general 'code' of utilising profile depictions rather than 3D versions or drastically different perspectives or viewpoints is identifiable.
- **Priming** had a **greater effect** when participants were **not familiar** with the animal before (in the case of bison).
    - Priming was incredibly important: "I added further detail of fur, improved definition of the bison's ventral hump, and depicted the horns in profile more convincingly." (anonymous participant)

Another observation to be made is that bison are more frequently depicted with a frontal facing head than horses. These are facing the viewer instead of facing their 'orderly' walking direction. The reason for a larger total of head-turning by bison, as opposed to by horses, can be easily explained by the fact that the horns of bison are more salient than any head features that horses possess. A head turned by a horse would therefore produce no extra value, whereas a turned bison head displays the horns in their full spread. This pattern can hardly be seen in Upper Palaeolithic art, since their strict profile views do not allow for head turning or similar audience facing heads. What is used instead is the method of twisted perspective (as described earlier in this chapter) to grant a full view of antlers and horns, thus by-passing the need to engrave additional head and facial features (such as pairs of eyes, nostrils and mouth features) if it was facing an 'audience'.

As can be seen from the general points made overleaf, the effect of priming had a stark impact on the way drawings were altered on participants' second drawing attempts. Whilst priming participants with an image of a Przewalski's horse meant that the post-priming second attempt drawings ended up looking more like an Upper Palaeolithic horse with stocky features and a pointy mane, the effect that the priming image of the bison had on participants is even stronger. The appearance of bison was largely unknown to participants in this experiment, meaning that the priming image had a great impact on the way that participants then conducted their second drawing. The learning effect, when compared with that of horses, appears to be much greater for the subsequent depiction of bison. This is due to the preconceived notion of how a horse 'ought' to look like and the unfamiliarity with bison and willingness to learn, memorise and replicate their general appearance. Images of bison, which previously featured downwards pointing horns, no indication of humps and omission of their iconic beards and coat changes, turn into very accurate, post-priming depictions of heavy humped, S-shaped horned and bearded creatures. This reveals that the priming effect advantages situations of unfamiliarity.

What is more, the handedness of participants was recorded during the trials. This was to see whether handedness affects the way and order in which animals are constructed and whether the priming images influenced the animals' orientations. Right-handed participants drew their animals with the head first, usually head left, rear right (95% of all cases). Left-handed participants constructed their drawings in a similar manner, i.e. head first but in opposing direction. Nevertheless, 80% of participants (n=34) changed the direction in which the animal was facing, after the priming imagery showed, in this case, a horse walking into one particular direction (towards the right). This reveals that the priming effect takes precedence over handedness. In the case of the bison priming image, the direction into which the bison subsequently moved in the second drawing attempt was to 100% the direction as in the priming image itself. This reveals that the priming effect, in situations where a subject is unfamiliar with the stimulus at hand, is extremely strong and influences the subject to a great extent. So much so that in all of the cases, the direction of the bison changed, mirroring what had just been seen. This in turn highlights that priming is most effective on ignorant participants, which also overrides handedness.

If we take these figures back into the world of rock art, a contradiction occurs. Recalling the quantities from the data collated for the Côa Valley, the statistics for facing direction of motifs showed that 58% of all motifs face into the right-hand direction. That means that the head is

orientated towards the right and the rear towards the left – the direct opposite to what was found in the drawing exercise. This might either mean that artists were of different handedness, or alternatively (and more likely yet hypothetical) this inconsistency might stem from the medium on which and with which the drawings and engravings are made. Whilst there is easy manoeuvrability of a pencil on a white uncompromised sheet of paper, the reality of hammering a specific motif into often uneven rock surfaces adds an additional layer of difficulty. As the personal experimental trials of the author can testify, the commonly used technique of indirect percussion, using a hammer stone to hit a navigable sharp flint, will have meant that certain features where more easily depicted in specific directions with specific grip on the materials in hand.

Another brief thought that can be explored in another thesis is the fact that modern day artists might be subliminally inclined to draw the defining features (such as salient head features) further towards the left, since Western traditions dictate (or try to enforce) the reading of visual sources from left to right. As an example of this one could use eye-tracking sensors in a visual sense, where one would start with the most important pieces for identification on the left to ensure swift information gathering. In the absence of writing systems during the Palaeolithic, this line of thought has its application difficulty, yet might explain why the data in this drawing experiment seems so heavily skewed.

Next are a couple of drawings from the first cohort (Fig. 5.3.6) that display animals in contextual surroundings, drawn after having been primed with videos of a horse herd and a bison fight. For a wider selections of drawings, refer to Appendix B.

Drawing Tasks: Drawing a horse herd and a bison fight after priming.

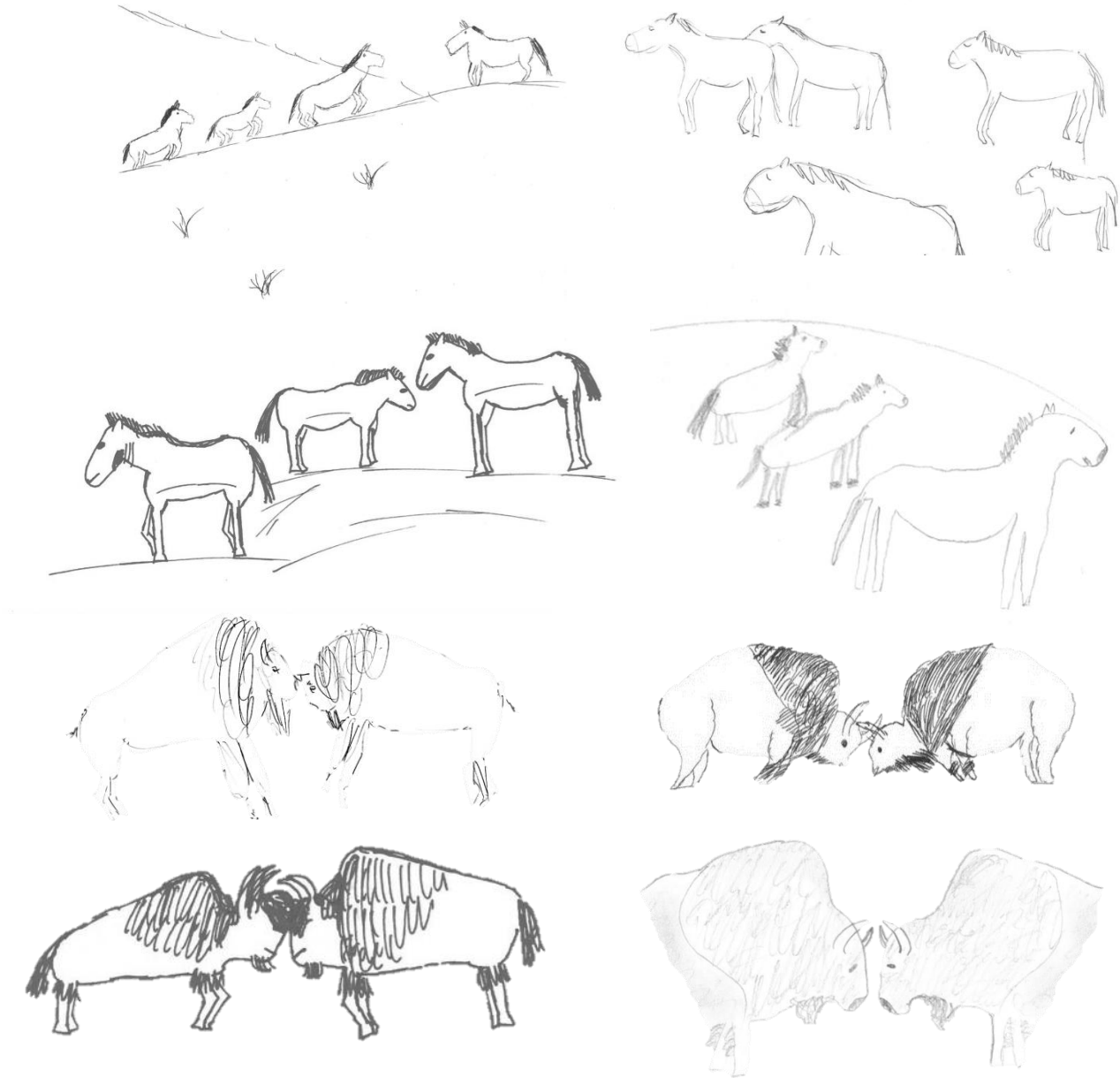


Figure 5.3.6.: Array of sample drawings depicting horse herds (top) and bison fights (bottom) after priming. Drawings produced by the first set of participants in year one of testing. More images of the same task available in Appendix B.

The following observations can be made about the way participants attempted to draw these animals in a contextual environment:

- Almost all herds (90%, n= 39) are depicted with a sense of landscape and distance in the background.
    - Plants as well as sloping hills are portrayed to indicate perspective and depth of field.
    - This is something that does not occur in Upper Palaeolithic art.
- Many herd assemblages are portrayed in such a way that some horses overlap, indicating their closeness and unity as a herd (50%, n= 21)
    - Deliberate compositions like this are hard to find in the Upper Palaeolithic art of the Côa Valley. However, for a paper that attempts to identify compositions in this area, the reader should consult Santos's (2017) thesis. The nature of compositions is also examined in the next chapter (Chapter 6).
- One or more animals as part of the herd are portrayed with a walking 'gait', that is with legs at various angles to indicate movement (65%, n=28).
    - Again, this is quite rare in the art of the Upper Palaeolithic of the Côa Valley. More common are movements or multiple depictions of heads and associated features to indicate mobility. It seems that on a large scale not as much attention is given to legs and their positioning, yet a few exceptions exist (see Luís *et al.*2015).
- In all cases, the bison fight is very realistically portrayed with interlocking horns and bison fighting stance. One of the examples above intriguingly only portrays the front part of both animals to show their fighting nature, deeming the rear torsos unnecessary for conveying such information.
    - Stand-off scenes such as this are visible in a number of Upper Palaeolithic contexts, both in open-air art and cave art settings. Often, two animals of the same species are portrayed facing each other, similar to mirror images. An example from a cave environment is Lascaux's Hall of the Bulls.
- The fighting bison are all expressed with detailed coat/fur changes towards the head and a clear demarcation of their pronounced hump towards their front, features that were clearly visible in the priming video.

Interestingly, in none of the drawings connected to the bison fight are landscapes or vegetation featured, with more focus given to their fight rather than their environment. This might suggest that if the task is to portray a particular kind of *action*, the focus seems to lie on that, and no particular setting or scale is required. On the other hand, drawing a horse herd does not initiate any type of action other than their close unity for which a perspective or scale in the form of a landscape seems appropriate.

Arguably the most anticipated results were those for which participants had to draw the animals with the least amounts of lines necessary for identification (Fig. 5.3.7).

Drawing Task: Drawing a horse and a bison using only the minimal amount of lines necessary to distinguish the two.

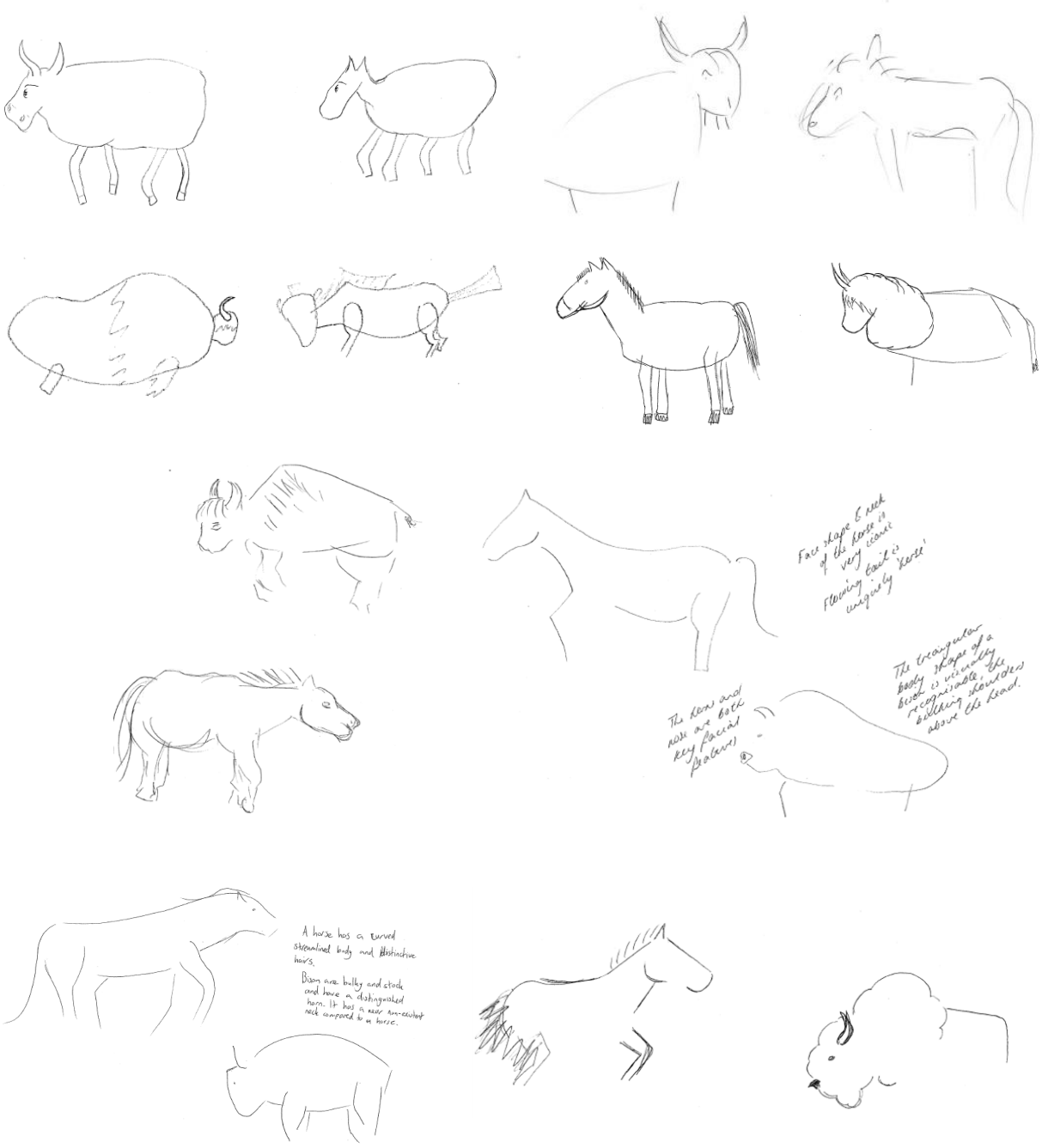


Figure 5.3.7.: Array of sample drawings depicting minimally depicted horses and bison. Drawings produced by participants across all years of testing.

The following observations can be made about the way participants attempted to minimise the amount of lines needed for identification purposes:

- Most participants (90%; n=39), bar three, drew the entire bodies of both animals when considering their most distinctive features.
    - Surprisingly, even the eyes and sometimes their nostrils seemed to be 'most essential'.
- The hump and horns of the bison were more accentuated as were the manes, pointy ears and long tails of the horses.
- Some participants even deemed it necessary to annotate their drawings to describe their minimal features (see the examples overleaf in Fig. 5.3.7).
    - One could argue that this completely contradicts the idea of what was trying to be achieved here. Additional words to describe attempt at reduction in features.

These results stem from un-primed attempts at depicting animals in a minimalised fashion. No prior discussion on artistic minimalism or saliency preceded these trials and participants were unaware of what was to be subsequently evaluated. A further discussion on these results and on artistic minimalism in general will follow in the next section.

Moreover, an evaluation of the questionnaires that participants filled out in addition to and as a descriptive aid of their drawings revealed stimulating patterns relating to the order in which participants drew their animals (Table 5.4). Whilst there were naturally a couple of outliers to the trends, the following order was mostly adhered to when attempting to draw horses (80% drew horses in this order; n=34) and the less familiar bison (65% drew bison in this order; n=28).

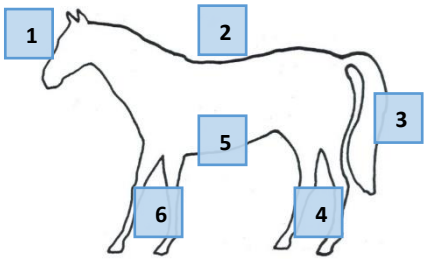
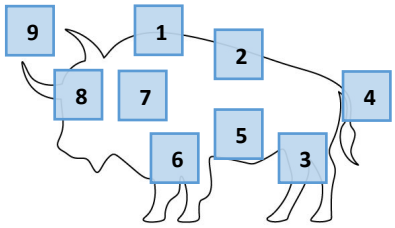
Horse	Bison
	
1) Head + Ears ↓ 2) Cervical Dorsal Line ↓ 3) Tail ↓ 4) Rear Legs ↓ 5) Ventral Line ↓ 6) Front Legs ↓ 7) Additional Details	1) Hump ↓ 2) Rest of Cervical Dorsal Line ↓ 3) Rear Legs ↓ 4) Tail ↓ 5) Ventral Line ↓ 6) Front Legs ↓ 7) Change in fur towards front ↓ 8) Rest of Head ↓ 9) Horns ↓ 10) Additional Details

Table 5.4.: Drawing order of both horse (left) and bison (right).

The difference in drawing order between the two species is striking, yet perhaps not surprising. Whilst the horse's head is frequently started upon, the bison's hump is the one that gives room for the rest of the depiction. In fact, what has been established up until now as the most salient features of the bison (the hump and the horns) are also started and ended upon in the same drawing process. Overall however, the general drawing movement of starting towards the head feature, then going around in a clock-wise manner and finishing up almost where one has initially started (that is the same for both species studied), reveals much about an 'unspoken' code of image fabrication and conceptual thinking. If one is now interested in whether any differences in drawing order was noticeable between right and left-handed participants, the answer is no. Even though the animal in itself might be simply pointing in a different direction, the order in which the animal had been drawn is the same amongst both left-handed and right-handed participants. The following quotes by participants give more insight into the reasoning behind the drawing order:

> *"I chose the view/profile I drew because: To me drawing is like writing from left to right, therefore starting with the head and not the back on the left-hand side."* (anonymous participant)
>
> *"I chose the view/profile I drew because: A profile view is the clearest way to depict a horse with my level of skill and materials available."* (anonymous participant)
>
> *"I chose the view/profile I drew because: Of how a horse is usually depicted in profile view which makes it perhaps easier to draw features such as mane, tail, face etc."* (anonymous participant)
>
> *"I began the drawing with the profile view but turned the head as I forgot what a bison's head looked like."* (anonymous participant)
>
> *"I began the drawing at the head because it is most intricate and easier to scale the body to the head rather than the reverse."* (anonymous participant)
>
> *"I began the drawing at the hump to define my bison's size and then followed it around in a clockwise direction. I finished with the horns."* (anonymous participant)

Although the number and variety of backgrounds of participants is not immense, the high percentage trends towards particular depicting orders and 'conventions' seems striking. In future studies, it might be interesting to match these findings up with the art creation and engraved line sequencing on portable art pieces (cf. Fritz, 1999). Overall, these experimental testing sessions were useful in offering early insights into how participants perceive and memorise characteristic features of animals, with which they have (i.e. horses) or do not have (i.e. bison) previous acquaintance with. The following sections will now delve a little deeper into some of the mechanisms described until now.

5.3.5. Experimental discussion

Using minimal lines

An experiment that closely aligns with the one presented here is that by Kozbelt *et al*. (2010) entitled *Limited Line Tracing Task* in their paper called *Visual selection contributes to artists' advantages in realistic drawing*. The investigators provided a photograph of the face of writer Samuel Beckett placed inside a clear plastic folder. Participants were instructed to use exactly 70 pieces of tape of equal lengths (2cm x 2mm) to precisely trace the face onto the plastic sheet. The task was to reproduce the face "as accurate(ly) as possible, given the constraints of the medium" with an explicit emphasis on "accurate realism, rather than creativity" (2010: 93). Kozbelt's underlying intention was to test and compare drawings by artists against non-artists resulting in an intriguing set of outcomes. A similar study by Ostrofsky, Kozbelt (again) and Seidel two years later goes one step further by asking their participants to trace an elephant rather than a human onto a plastic folder. The following outputs (Fig. 5.3.8) show a striking difference between tracings made by artists (top row) and non-artists (bottom row):

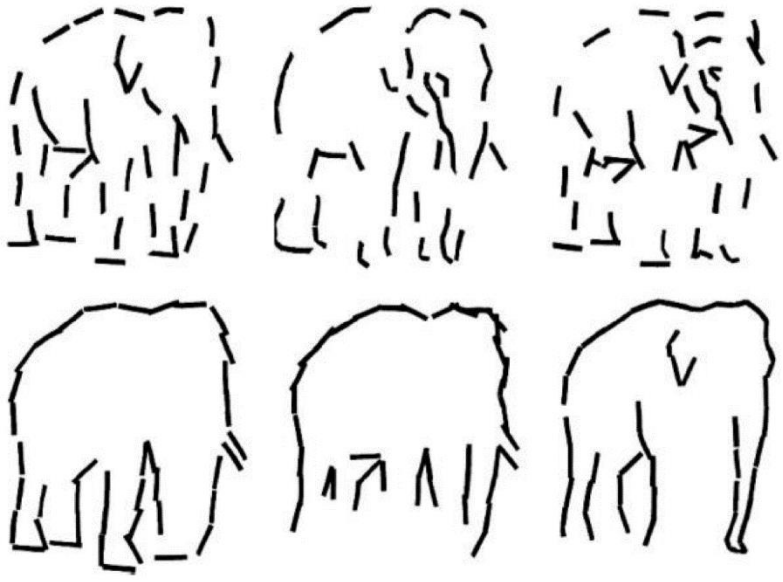


Figure 5.3.8.: "[Six] limited-line tracings of a photograph of an elephant". The tracings that comprise the top row are by artists; the three bottom row tracings by non-artists. (Images by Ostrofsky *et al.* 2012).

If we now go back to our own present experiment, as already touched upon above, the most anticipated and resultantly interesting outcome was that of the last task. This task involved asking our participants to draw the two types of animals with the least amount of lines that they deemed necessary for subsequent identification. In fact, as already mentioned during the procedure of our last task of our drawing experiment, restricting participants to use a limited amount of lines/tape is highly insightful and an important methodological control (Gombrich, 1960). It forces subjects to elicit careful choices about which features to focus on and which ones to leave out. Unlike Ostrofky *et al.*'s (2012) study, participants in our study were not divided up into artists or non-artists, nor was a specific recruitment structured to achieve an even split. This is something that, upon evaluation, might be considered for future experiments of such kind.

Whilst still not entirely minimal, the following examples (Fig. 5.3.9) present some of the better attempts by participants, who have come to the same conclusions that the majority of saliency within both animals lies in their head region, closely followed by the sinuosity of their cervical dorsal lines:

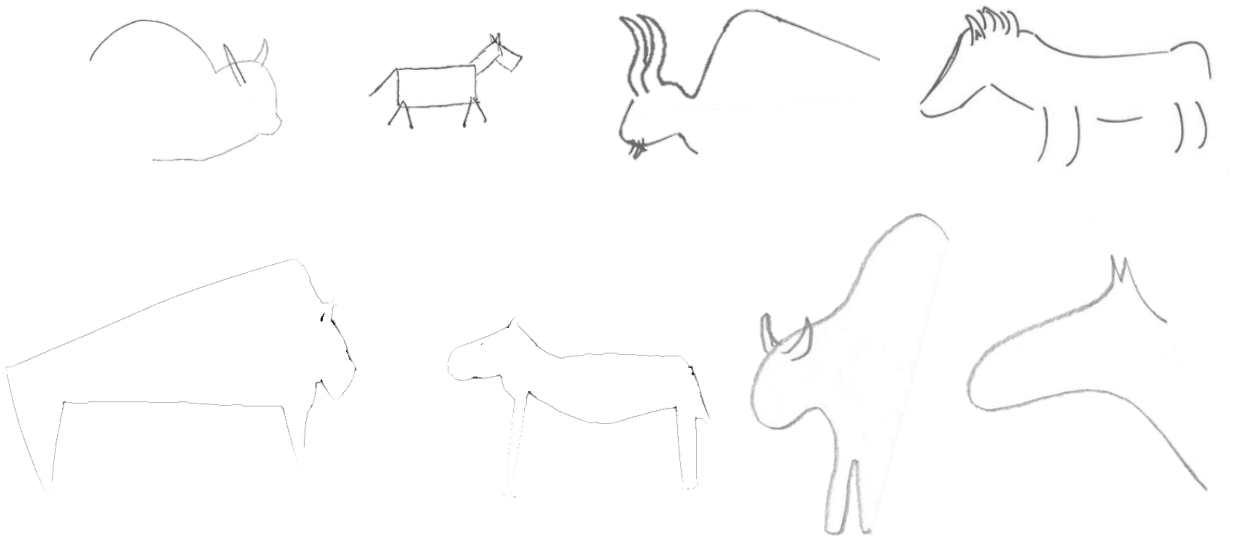


Figure 5.3.9.: Array of sample drawings depicting minimally depicted horses and bison. Drawings produced by all participants in year one of testing.

Follow-on discussions after the testing session between all participants and experiment initiators, led to the identification of additional examples, which could equally represent these two animals under study. One such set is presented here (Fig. 5.3.10), the first one symbolising the typical M-Shape that the coat of a Przewalski's horse bears during winter before it is shed and the second simply indicating two humps and a dash for the representation of a bison and its hump and horns.



Figure 5.3.10.: Short-hand drawings produced after a collective discussion by all participants in year one of testing.

This type of 'short-hand' would however only work in a specific scenario like this, especially after now having an informed emic perspective of what background understanding the groups, i.e. the participants, have about these depictions. An outsider (even just beyond the realms of the experimental classroom) might not understand this short-hand. Additionally, when more animals and their representations are added to the mix, these arrays of lines could easily be mistaken for other types of animals.

Why are only certain rock art features depicted?

At this point it is worth describing to the reader that there are two main mechanisms (at least) of thinking about things which produce different kinds of imagery in one's head. An analogy to exemplify these mechanisms would be asking an artist to "imagine a horse" and in a second instance to ask the artist to "imagine the time when you last saw a horse". The first example would likely produce an example such as the one on the left (Fig. 5.3.11) and the last imagination prompt would likely produce a mental image similar to the depiction on the right (Fig. 5.3.12):



Figure 5.3.11.-5.3.12.: Unmediated (left) versus mediated (right) imagination – a profile view horse versus a horse placed within a scene.

The simple prompt of imagining a horse, which will be termed *unmediated imagination* (stemming from the concept of *prototypical imaging*) from now on, will most likely result in participants thinking about various features of a horse, especially those that make a horse a horse. The second command of letting participants remember when they have last seen a horse, now termed *mediated imagination* (stemming from the concept of *direct visual recall*), will result in them thinking of the contextual information surrounding the depiction of a horse. This distinction is significant in revealing what the underlying notion was for rock art production. Hence, if we now mirror that onto what is likely being depicted in rock art imagery, the first prompt matches up with the entirety of depictions in the rock art under study. In fact, no contextual indicators are found in the rock art of the Côa Valley and are a rarity in Upper Palaeolithic art all together. It is postulated at this point that the underlying *prompt* that rock artists had in mind when producing their depictions, was guided by *unmediated imagination*, thus simply picturing an animal rather than the alternative of imagining ones last *mediated* acquaintance with that animal.

Visual versus mental realism

This task of *unmediated* and *mediated* thinking can be applied to the way we depict things. The first such category is that of 'Visual Realism', in other words representing objects or living beings as we optically see them at the time of depicting (see Rademacher *et al.* 2001). This takes into account depth of field, proportions as well as relations between different objects. The alternative is that of 'Mental Realism', which Luquet pioneers in 1927, after having studied children's drawings, by arguing that this process is the opposite to the one formerly described. Within a mental realism frame of mind, we represent things as we perceive them, and we reveal the representation of things and living beings in all their constituent parts making them all individually recognisable. The purpose of this is to depict things as they appear in themselves and not as they appear visually and in reality.

Exemplary of this phenomenon is the introduction of the twisted perspective as described earlier. An animal is 'visually folded' and its constituent parts are pieced together to represent the most important features of their essence. The animal is therefore not made according to perspective nor with regard to volume, but in line with what is physically present. For a more elaborate description of this phenomena, the reader should refer to Meyering (2016) where this visual folding technique (*rebattement visuel* by Luquet, 1927) is being described in more detail and accompanied with examples, such as the iconic and mentally realistic birds-eye view representations of horse-drawn chariots throughout prehistory.

The act of 'Mental Realism' therefore produces a chain of visual codes. As such animals are not represented optically but as they appear in themselves. They are entirely represented through their lateral planes, which is the case in the analysed data collated for this thesis. By this definition, human faces are shown through their frontal plane. This also matches up with the sparse yet existent representations of anthropomorphs in Upper Palaeolithic rock art.

This act of perceiving connects to the human ability to remember certain things about the subject under scrutiny. Thus, perception is connected to memory. Here, we can pick up on the earlier discussion of Halverson's *mental imagery*, which is the image that essentially remains in the mind from repetitive acts of object perception. Rock (1983: 52) specifies that if one is exposed to viewing horses on a more frequent basis, the mind will form a more generalised mental image. It follows no particular moment of perception but instead is "analogic but still picture like and concrete". Both Paivio (1986) and Seymour (1979) indicate that after more

frequent exposure to a stimulus, the mental image tends to have a standard orientation, whilst Rosch *et al.* (1976) compliment this pattern by arguing that well-known animals are usually imaged from a side-view, which is often called the 'canonical view', resulting in the more comprehensive 'canonical image' (Hochberg, 2007). This side-view perspective may come about through a more habitual perspective or may actually be a result of the "maximisation of relevant information, since a profile view of a (horse) provides more information about it than a rear view, for instance" (Halverson, 1992: 226). The highly stylised nature of Upper Palaeolithic rock engravings might, therefore, be due to this generalised rendering of *unmediated* images and the formation of a 'canonical view', as opposed to being constrained by the economisation of engraving time, *mediated* contextual information or mental and physical affordances.

Although there is a plethora of studies that could be discussed at this point that concern themselves with mental imageries, studies involving animal stimulus seem the most useful at this point. An influential figure within the research field of mental imagery is Steven Kosslyn, who in 1975 trialled participants in a study of imagined imagery of different types of animals. Namely, he asked his subjects to imagine differently sized animals standing next to each other, such as a rabbit beside an elephant (Fig. 5.3.13). In a second 'imaginary' trial he asked the same subjects to then think of a rabbit next to a fly. In total he tested 20 different types of animals against each other. The impact of size and relation to the imagined animals in the same picture influences the ability to subsequently answer questions about specific details of the named animals.

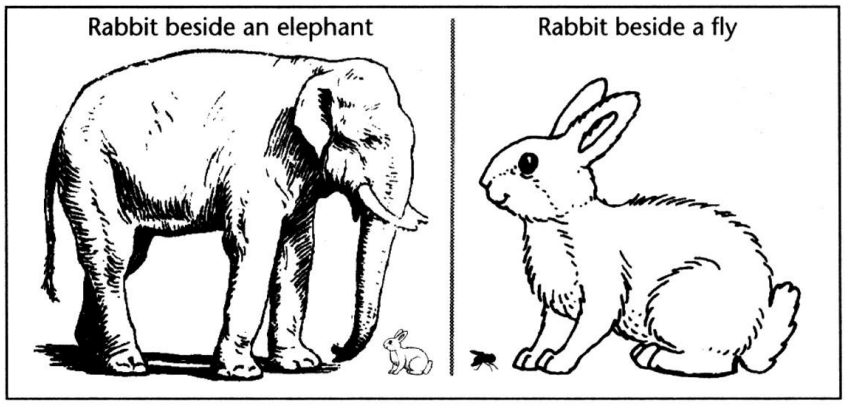


Figure 5.3.13.: Example images of stimuli followed by questions on appearance of differently sized animals (drawings by Dewey, 2007).

One set of participants was shown the elephant next to the rabbit first, the other set the fly next to the rabbit first (Fig. 5.3.13). The participants were asked: "Does the rabbit have two front paws?" in both cases, but interestingly people generally took considerably longer to answer these questions when the rabbit was placed beside the elephant. Therefore, when asked questions about the smaller animal in each image, the answering rate was slower than for questions concerning the larger animal. This experiment displayed to Kosslyn that "little models, which we can manipulate much like we do actual objects" are formed in people's minds, meaning that animals can be made smaller or larger depending on which animal it is imagined alongside. This experiment supports the previously established idea of *unmediated imagination*, for which more focus (and thus a quicker response rate) is given to the specific features of the imagined animal at the time, rather than its contextual environment.

Preference of outline over detail

After acquiring that background knowledge, it is now possible to delve into the subject of outline over detail. In fact, the idea of fading details over time has been circulating in the heads of psychological perceptionists for decades. Readers might now recall situations of viewing very detailed images, yet within a couple of days, specific details fade and what one is likely to be left with is *overall meaning* rather than specificities and technicalities of the scene.

In 1975, Baggett revealed in a rigorously controlled study that *picture memory* already starts to fade over just several days. She presented two versions of a scene to her participants, one termed the "explicit" version in which a longhaired person is getting her hair cut, the other the "implicit" version, which did not show any cutting of hair in any of the pictures. The latter "implicit" version can be viewed here (Fig. 5.3.14). Baggett presented one of these two versions to different sets of participants with an interest in determining whether people would remember the test image as displayed in Figure 5.3.14. The test image was never

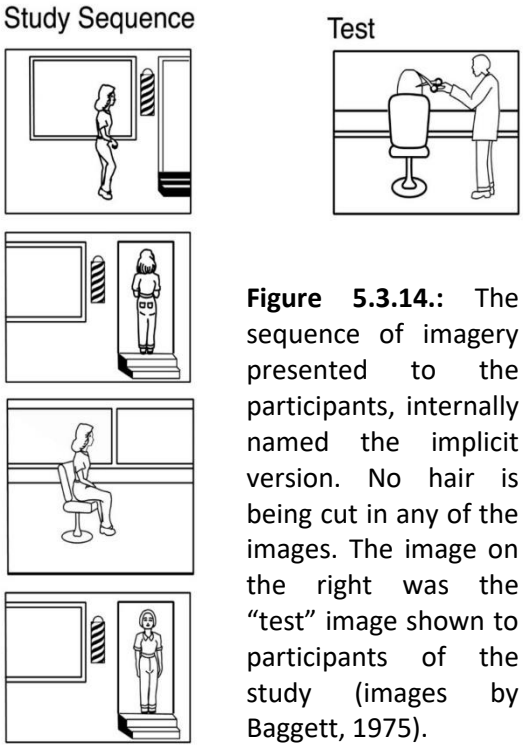


Figure 5.3.14.: The sequence of imagery presented to the participants, internally named the implicit version. No hair is being cut in any of the images. The image on the right was the "test" image shown to participants of the study (images by Baggett, 1975).

shown in the original sequence of implicit pictures. Results from Baggett's study showed that the longer she waited to ask her participants whether the image had in fact occurred in the sequence, the more likely it would be that they had seen it. More specifically, Baggett asked her participants at different time intervals, and those that she had asked within a three-day window stated they had *not* seen the image. On the fourth day after being presented with the stimuli, participants started thinking that they had in fact seen the ladies' hair being cut, which was an image that was never actually shown. This reveals that mental imagery, although often remembered in canonical forms due to repetitive observation of the same stimuli, will be subjected to loss of detail after a surprisingly short period of time. This might indicate why the contoured frame of the animals, rather than particular detailing of animal specifics is given more 'screen time' on these ancient canvasses. Noteworthy, however, are the possible differences in memory capacity when comparing the visual worlds of a hunter-gatherer, with that of a modern participant, being bombarded with different types of media at vastly varying levels.

5.3.6. Conclusions: Drawing Animals

This section serves as a brief conclusion on selected findings for the questions that were asked at the start of the experimental set-up:

1. **How do participants deal with familiar and unfamiliar drawing prompts?**

As noticeable from the drawings created, participants tended to be more familiar with horses than with bison (predominantly constructed with bend heads and no humps), yet after the initial onset of a bison picture, their knowledge of bison features improved immensely. This shows that the effect of priming participants proved to be particularly effective.

2. **Does visual priming influence the way participants draw?**

See answer to Question 1.

3. **What is the general shape of the animals drawn by modern participants?**

Participants spent much of their time on perfecting the interior details rather than the sculpting of the overall shape of the animals. This is contrary to what we see happening in the rock art of the Côa Valley.

4. **What drawing order is noticeable?**

Participants start drawing the horse's head and then continue in a clockwise fashion, whereas bison are frequently started upon on their hump and following a similar direction. The most salient features of horses (head/ears/mane) and of bison (the hump and the horns) are started and ended upon in the same drawing process revealing an 'unspoken' code of image fabrication. Handedness does not influence drawing order.

5. **How are animals drawn in their contextual environment?**

Animals tend to be drawn in perspective, meaning that vegetation is often recreated to show animals in their embedded situations. This is, however, not explored in the Côa rock art.

6. **What constitutes a minimally presented animal?**

The participants most successful in the quest for animal minimalism, represented their horse by just its head (including ears/mane) and parts of the neck. They represented bison by their diagnostically salient hump and horn structure. An M-pelage representation is also conceivable as a minimal representation of a horse.

7. **Is there a difference between left and right-handed artists?**

Whilst there does not seem to be any strong difference in the way participants construct their drawings (see question 4), once particular animals are shown (as part of the experiment priming) to be diverging from the participant's initial drawing direction, the same participants would swap facing directions of animals according to the direction of the animal in the priming image. This reveals that the priming effect takes precedence over handedness.

The dangers of mediated imagination

In trying to summarise all of the ideas presented above, we ought to be cautious of imagining the purpose of the artists' imagery, since all we do is *mediate* about the circumstances around which they have come into being. We as modern investigators of the art need to be aware that there might be other reasons, besides the prerogative of the artists to display their animals in an as unmediated and canonical way as possible - with deteriorating memory influencing the reproduction of details. Just because the author wants there to be an underlying reason for the creation of minimalistic depictions, does not mean that there actually is one. One of the many examples that come to mind, is the one hinted at in the last paragraph. Our visual worlds will have varied substantially from that of rock art producing hunter-gatherers of the Upper Palaeolithic, vastly influencing the manners of visual reception and subsequent visual reproduction. The following reconciling statement by Arnheim might bring researchers and readers of this thesis back to a neutral level of investigation:

> *"Art works best when it is unacknowledged. It observes that shapes and objects and events, by displaying their own nature, can evoke these deeper and simpler powers in which man recognises himself. It is one of the rewards we earn for thinking what we see".* - Rudolph Arnheim 1969: 315

Readers might now wonder whether with this statement, all of the research above is negated and whether the experiments that will follow are simply unusable. In short and as will be become clearer throughout – no! However, it is always useful in reminding ourselves that we have no emic insights into the rock art under study and that looking at it requires an unbiased mind. One aspect that we can be certain about is the sophisticated thought processes that came before any engravings were hewn into the rocks. This, in turn will aid us in the identification and realisation that other aspects of their lives and cultures will have required equal amounts of such sophistication. Following on from this dilemma and with an unbiased mind towards the data collected thus far, it seems justified to ask - acknowledging the big elephant in the room (rather than the small rabbit) - why it is that there is still an apparent obsession with complete figures and that some species depictions sporadically bear significant amounts of detail. This chapter's analysis so far tried to illuminate to the reader that torsos are useless in swift identification and that memory of species fades over time. Yet why are our participants still drawing fully contoured animals with detailed eyes and hooves and why are Upper Palaeolithic artists drawing full blown animals if the torso of the animal can essentially be made redundant, when a head alone can create a positive identification? These questions are incorporated into the following experiment which assesses which parts of animals are most visually salient in a task to differentiate between two visually different species.

5.4. Psychological Experiment 2: *Bubbles*

5.4.1. Introducing the experiment and research questions

As stated in the introduction to this chapter, it contains experiments that seek to explore why the Côa Valley engravings are depicted in the way they are. To attain a better understanding of how *art* is created, especially bearing in mind that a link back to Upper Palaeolithic art is required, one must dig a little deeper into how the processing of visual information can be correlated to ways of depicting. Henceforth, with optimally minimal lines and drawing patterns established throughout the last two sections, this part of the chapter interrogates the potential underlying visual psychological processes behind the appearances of motifs. It is hoped that the reasoning behind the seemingly universal contouring and profiling of animals is to be found within the constraints of our own visual capacities.

In reminiscing about the way *Visual Palaeopsychology* was presented in the introductory chapter, it was pointed out that the recent decade has seen rock art specialists turn to aspects of neuroscience and psychology to try and explain why the art adopts its characteristic outlined forms. These specific artistic conventions have so far been considered in relation to evolutionary constraints and the developmental stages of our cognitive system (see Hodgson, 2012 and Dobrez, 2016). The first to recognise a relatedness of graphic strategies in antipodal areas of the human globe were Kennedy and Silver who claimed that "lines can be 'surrogates' for what we may call the basic sources of optical structure" (1974: 313). As established, rock art animals in Portugal are made up of a sequence of contoured lines that then appear as a whole animal (cf. also Chapter 6 in which contoured lines are inspected further). Perceptual psychology was further employed by scholars such as Deregowski (1989) and Hudson (1998) and by Halverson (1992). The latter illustrated how silhouettes reinforce external contours of animals by pointing to a clear demarcation between the Gestaltian principles of figure and ground and its uses in art creation (explained further in Chapter 6). Once neuroscientists were able to explain the link between the visual brain and its processing of visual information, Hodgson (2000, 2013); Dobrez and Dobrez (2013) and Watson (2011 and 2012) amongst others, appraised the importance of what neuroscientific processes can reveal about the commonalities of the earliest art. Hodgson (2013: 1) concludes that "such pervasiveness (i.e. similarity of motif structure) derives from the way the visual brain functions".

A serious flaw in these, otherwise very attractive, narratives on how art is dictated by cognitive processes, is the inability to turn them into empirically testable and falsifiable hypotheses (cf. other perception-based experiments in Rosch *et al.* 1976; Arnheim, 1969; Deregowski, 1995).

Yet, it goes without saying that investigating the combination of human brain and human behaviour events count as "one of the greatest methodological challenges in Cognitive Science" (Gosselin and Schyns, 2003). By way of taking the two aforementioned criticisms on board, the specific experimental endeavour set out for this chapter requires sufficient methodological soundness, to withstand such existential questions. This is why an adapted version of the original so-called *Bubbles* software, "a technique that reveals the information that drives a measurable response [and able to] handle search spaces that have so far proven to be elusive", is utilised here (Gosselin and Schyns, 2001).

The previous experiment ended with the important question as to why it is that there still seems to be an obsession with complete figures, despite the fact that the torso of animals can essentially be made redundant and a head alone is able to signal identification. In search of answers, a visual psychological experiment, originally developed for the recognition of facial features, has been adapted here for the use in testing Upper Palaeolithic imagery. It is adopted and adapted from a method commonly used in the field of vision science, namely *reverse correlation.* Reverse correlation can generally be regarded as a "reverse" viewing and analysing process, for which a person adds up all the stimuli received over a specified time period to then elicit a response (Ahumada, 1996; Beard and Ahumada, 1998). One alternative to usual reverse correlation techniques, is called the *Bubbles* technique, which presents sparsely populated, computerised stimuli to participants in order to determine the diagnostic visual information of the presented categorisation tasks (Gosselin and Schyns, 2001). It reveals exactly what information is exploited by human observers when making judgements/interpretations of visual images, and is especially helpful in identifying the extent of perceiving real and illusory contours within the presented stimuli (more on this in Experiment 3 of this thesis). The key for processing stimuli such as the categorisation of specific scenes, faces or objects lies in the type and amount of input of visual information. *Bubbles* assigns "the credit of human categorisation performance to specific visual information" (Gosselin and Schyns, 2001: 2261).

The method addresses the question of which stimuli regions aid a system in giving the right response, as opposed to the question of which regions influence the systems responses in any way at all. For the first implementation of *Bubbles*, Gosselin and Schyns (2001) instructed their experimental participants to discriminate between happy or neutral faces displayed in photographs of eight male participants and eight female participants. The photographs were only partially presented to the observers, with most of its extent covered by a grey mask and only a small proportion of the stimulus revealed through small round openings, henceforth called *bubbles*. By revealing only small bubbles, as parts of the entire stimulus, the

experimenters aimed to test whether small sections were able to yield successful discriminations between the two stimulus types. In fact, all areas of the faces were equally likely to be displayed to the observers, as the bubbles were programmed to appear in randomised locations covering the entire possible coverage of the image in question (see Fig. 5.4.1)[14]. Although the original *Bubbles* software has been trialled with facial recognition tasks based on gender, expression and identity, and most recently on natural scenes (McCotter *et al.* 2005) and infant perception (Humphreys *et al.* 2006), the original authors are open to the possibilities that "the principle of *Bubbles* should generalise to other objects and scenes." This possibility is hereby taken up within this task, for which the stimulus within *Bubbles* is based on two different types of prey animals, namely horse and bison.

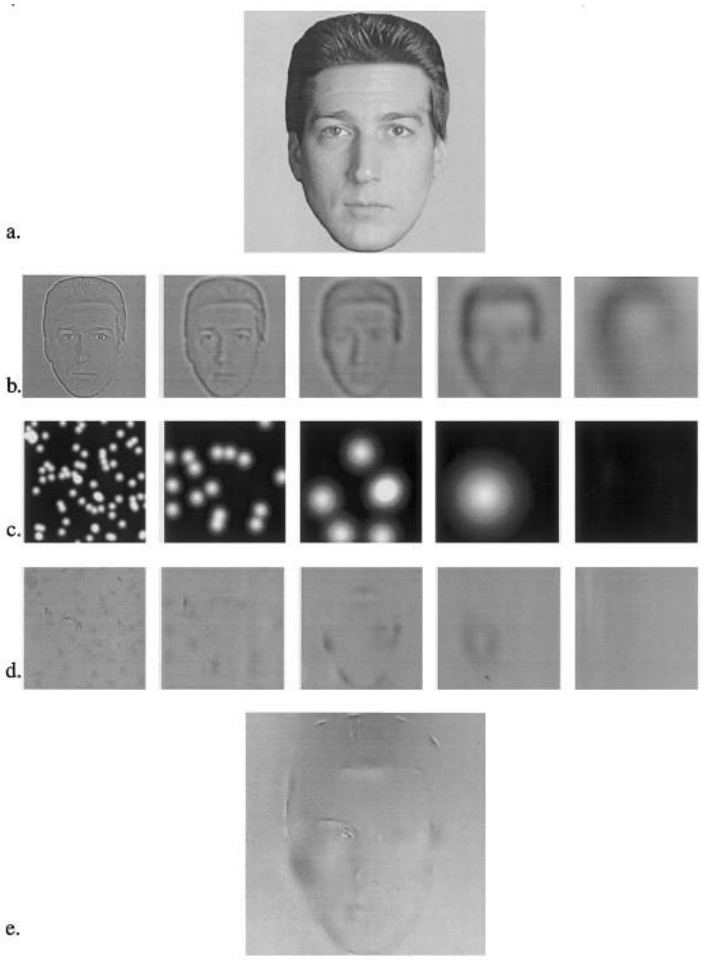


Figure 5.4.1.: Example of stimulus of a male face utilised for "*Bubbles"* by Gosselin and Schyns (2001).

[14] "Pictures in (b) represent five different scales of (a); (c) illustrate the bubbles applied to each scale; (d) are the revealed information of (b) by the bubbles of (c). Note that on this trial there is no revealed information at the fifth scale. By integrating the pictures in (d) we obtain (e), a stimulus subjects actually saw." (Gosselin and Schyns, 2001: 2268).

With this in mind, this next experiment sets out to query the saliency of different animal parts in the search for a possible resemblance found within rock art depictions. In particular, when applying this to Upper Palaeolithic art, research questions that can be tested through the use of this experimental software are whether perceptual factors can explain why so many images are drawn in the way they are.

The research questions assessed within this section are:

- Can visual psychological processes explain why animals are depicted in the way they are?
    - In other words, do elements critical to the resolution of particular animals correspond to clues known to be critical to human perception?
- Which are the most diagnostic features on (1) a horse and (2) a bison, that actively aid our identification of these particular species?
- Does the minimal amount of information needed for detection or discrimination of an animal, as revealed by the *Bubbles* method, correspond to the features depicted in rock art?
- If rock art features do resemble the diagnostic information established through *Bubbles,* are we therefore able to make inferences on the hunter as the artist?

5.4.2. Detection versus discrimination

During the Upper Palaeolithic, hunter-gatherers will have often encountered animals at varying distances and under difficult viewing conditions. Animals will have hidden in undergrowth and were likely to appear during times of the day during which poor lighting conditions would have hampered a hunter's sight. Under a variety of circumstances, hunters would have needed to equip themselves with knowledge on animal features and their behaviours. Familiarity with animal features aiding in their detection and discrimination would have been critical.

Consequently, in adapting this software, it is being tested whether it is achievable to identify the parts of an animal within an image that are most important in first hand *detection* of that animal *within* the stimulus and to test if participants are then able to *discriminate* animals *between* different stimuli. This is because, from a perceptual point of view, there are two main tasks that a Palaeolithic hunter has to excel at: first, to be able to *detect* prey species in the landscape, and secondly, to be able to *discriminate* between different types of prey species (i.e. to identify them to a specific taxon). Applicably, it will be tested whether the minimal amount of information needed for detection or discrimination of particular animals agree with the features seen in the rock art.

The *detection* ability of primates is critical in ensuring their survival when on the lookout for potential danger (Caro, 2005). Before responding to potential threats, however, they need to detect them first by means of the "capture of attention", in other words attention needs to swiftly shift towards the potential danger (see Cronin, 2005; Yorzinski and Platt, 2014). In fact, Coss (2003) and Isbell (2006) regard it as likely that our extended evolutionary history with predators specifically shaped our perceptual system to rapidly respond to dangerous animals. As presented in the research historiography of detecting moving animals in chapter 3, New *et al*. (2007) found that participants exhibit a superior performance in detecting animate objects (i.e. animals) compared with inanimate objects (i.e. vehicles even when in motion). They concluded that "the human attention system evolved category-specific selection criteria to monitor animals" (New *et al.* 2007: 16604). Accordingly, many researchers have studied participant behaviours when subjecting them to visual-search tasks involving threatening and non-threatening stimuli. It is repeatedly found that threatening stimuli are more successful at attracting and holding attention when compared to non-threatening stimuli (Yorzinski *et al.* 2014). This even applies to infants (as young as eight months old), who are also able to detect snakes, spiders and lions much faster than they are able to with non-threatening animals, such as frogs and caterpillars (LoBue and DeLoache, 2008).

The ability of discrimination, in other words for humans to be able to distinguish between different species of prey, is always accompanied by focal attention (i.e. prey needs to be fixated in order to be identified). In an early experiment by Sagi and Julesz (1985), the authors came to realise that observers were able to successfully discriminate between stimuli only once they achieved focal attention on a fixated target. The following images are a modern adaptation of the tests carried out by Sagi and Julesz. In the left-hand example, one is able to instantly discriminate the horizontal from the rest, yet in the right-hand example, finding the red horizontal bar is not as instantaneous.

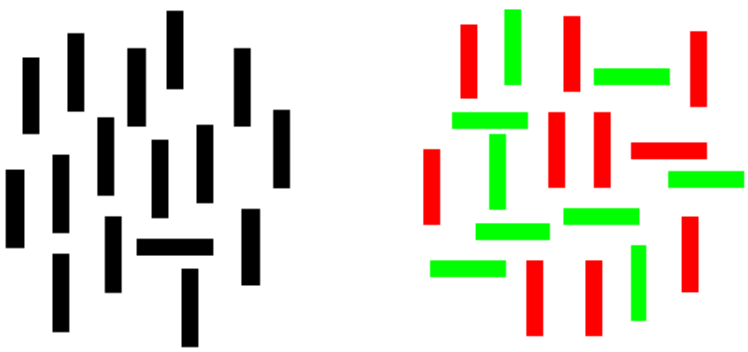


Figure 5.4.2.: Which features "pop-out"? The difference between single change (left) or multiple change (right) discrimination tasks.

Whilst it appears easy to *detect* a single change (one horizontal line amongst otherwise vertical lines) very quickly, "a serial search by [shifting] focal attention [to each line segment] is required for *discrimination* between different combinations of features" (ibid: 619). These experiments show that prey species will only be discriminated once they are fixated, once the eyes are fully on the target so to speak. The graphics above illustrate that a change in a single feature (such as the change in direction) attracts immediate attention and directs the hunter's gaze to a possible target, whilst a combination of features does not. As already established in chapter 3.2.2. which discusses eye-tracking results based on different target images, it is clear that apart from orientational direction, a single event in brightness contrast, colour contrast, spatial frequency or motion would have the same effect (cf. Buswell, 1935 and Quiroga and Pedreira, 2011). Furthermore, it ought to be mentioned that the process of visual discrimination is not only visually confined but is also task dependent. An experiment that seeks to test discrimination ability has to have a clearly defined task, which clearly states which classes of stimuli are to be tested and discriminated. The task prompt within this experiment will be clearly defined in the methodological section, which will subsequently aid in our understanding of which features are maximally useful for specific task prompts.

Speaking of target fixation, the frequently adopted *visual salience model* by Itti, Koch and Niebur (1998) was the first to map, using eye-tracking equipment and fixation patterns, areas of particular visual salience in a so-called *saliency map*. Largely speaking, *saliency* refers to a dominant object visible at any given time, with the object also often referred to as being most visually salient (see for instance Rosenholtz, 1999; Itti and Koch, 1999). A saliency map can be likened to a heat map with red (hot) areas classed as particularly noticeable or detectable within a scene and blue (cold) areas not as noticeable/salient. So, based on the detection/discrimination example above, the following response would be generated within Itti *et al.'s* (1998) saliency model.

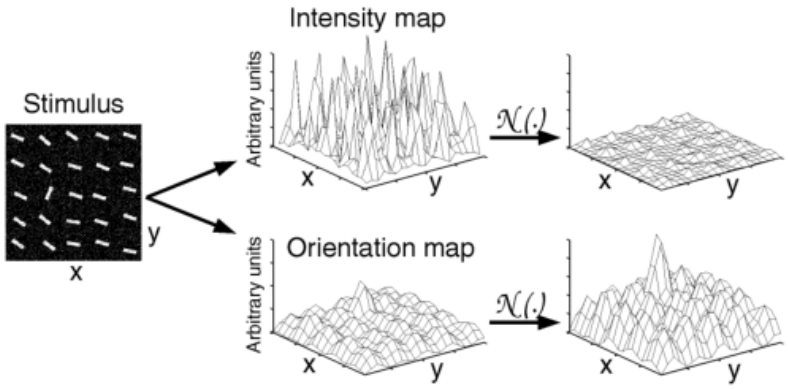


Figure 5.4.3.: Graphics illustrate how visual "activation spots" are determined through the normalisation operator (Itti *et al.* 1998) .

Their model incorporates a normalisation operator ($N(.)$) which amongst other computations allows for the selection of a map's global maximum (M) and "computing the average $\overline{m}$ of all its other local maxima" (ibid: 1255). The global maximum is nicely observable in the orientation map of Fig 5.4.3 after normalisation ($N(.)$). When the difference between this localised maximum is significantly large (i.e. when there is a significant change in the stimulus in relation to its immediate surroundings), it creates an "activation spot" and the map is strongly promoted at this location. An example of heatmap of these activation spots, in comparison with its corresponding scene fixation map is mapped below (Fig. 5.4.4):

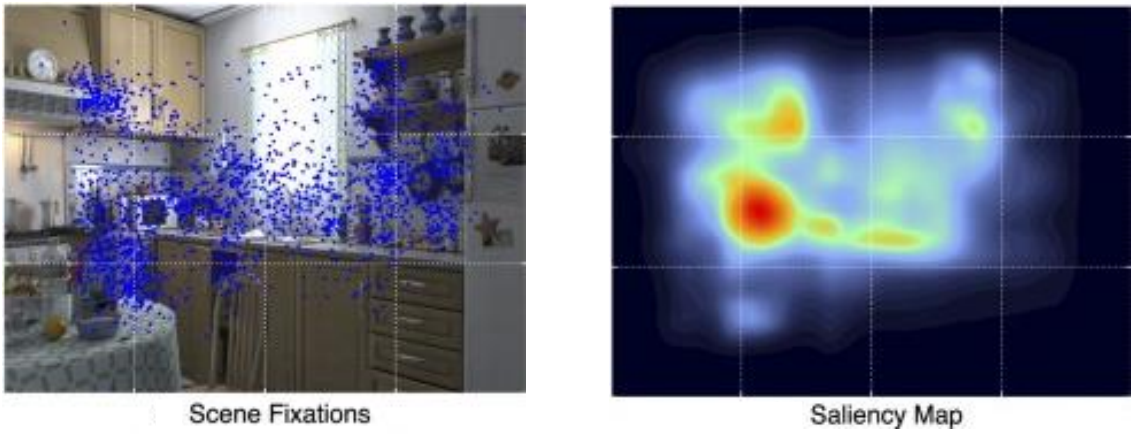


Figure 5.4.4.: A scene fixation map (left) based on eye-tracking data and its corresponding saliency map based on the model proposed by Itti *et al.* (1998). Images taken from Henderson and Hayes (2018).

Bearing all of these previous studies in mind, the following experiment is set up to identify the areas of animals to which the human gaze is primarily fixated to. Whilst no eye-tracking is conducted in this iteration of the experiment, results will still culminate in easily comparable saliency maps, similar to the ones proposed by Itti *et al.* (1998). Rock art occurrences can hence be cross-checked for overlaps between important points of saliency in animals and the repeatedly recurring features in the motif structures. These considerations are then able to bring us closer to understanding why animals are depicted in certain ways and also stay so consistent over time and space.

5.4.3. Experimental methodology

Inspiration for the structuring of the methodology section of this experiment and for ways of analysing participant responses is taken from the "*User's Guide to Bubbles*", which was also published by Gosselin and Schyns (2003).

In order to address the question of animal distinctiveness with *Bubbles*, six basic decisions are set out from the onset of the experiment:

1) Who will the participant(s) be?
2) What will the stimulus set be and in which space will the stimuli be generated?
3) What will the bubble(s) be? → **Independent variable**
4) What will the experiment set-up be?
5) What are the possible task responses? → **Measurable dependent variable**
6) What are potential limitations?

(1) Participant information: A subset of the participants that were recruited for the drawing task (Experiment 1) also took part in the *Bubbles* Discrimination Task. A total of 17 (5 males, 12 females) individuals participated in this experiment, all of which had normal or corrected-to-normal eyesight. Prior consent was given, provided that their identity remains anonymous (see Appendix C for a sample participant information sheet and a sample consent form). All participants were identified as being familiar with horses, with one having direct experience with the handling of horses, none with bison. The following table (Table 5.5) reveals more participant information:

	Under-graduates Year 1	Under-graduates Year 2	Under-graduates Year 3	Total (∑)
Number of Participants	5	4	8	**17**
Male	3	1	1	**5**
Female	2	3	7	**12**
Right-Handed	3	4	5	**12**
Left-Handed	2	0	3	**5**
Familiarity with Horse	All (1 rider)	All	All	**17**
Familiarity with Bison	None	None	None	**0**
Drawing Experience	1	0	1	**2**

Table 5.5.: Table revealing participant information for Experiment 2.

(2) Stimulus generation and selection: The selected stimuli for this study comprises of images of real-life animals mimicking physically engraved species of animals within the ancient rock carvings of the Côa Valley. For the participants' trials, these were composed of a photograph of a bison and a separate one of a Przewalski's horse. These two species were chosen since they possess great prominence amongst the rock art repertoire of the Côa Valley. Their selection was also dependent on accessibility to photograph first hand, which explains why the now extinct aurochs were not chosen as stimuli for any experiment. A photography trip to Farnless Farm Park, Bishop Middlesham comprised of obtaining photographs of bison in late 2016 (Fig. 5.4.5). A trip to the Scottish Highland Wildlife Park yielded photographs of a rare herd of Przewalski's horses in early 2017 (Fig. 5.4.6). The best profile shots were subsequently selected. In order to assume a level/neutral search space within and between trials, the stimuli are set up to show similarly sized animals, which feature in greyscale and are set up to randomly face either left or right, to avoid detection through colour and learned-repeated responses.

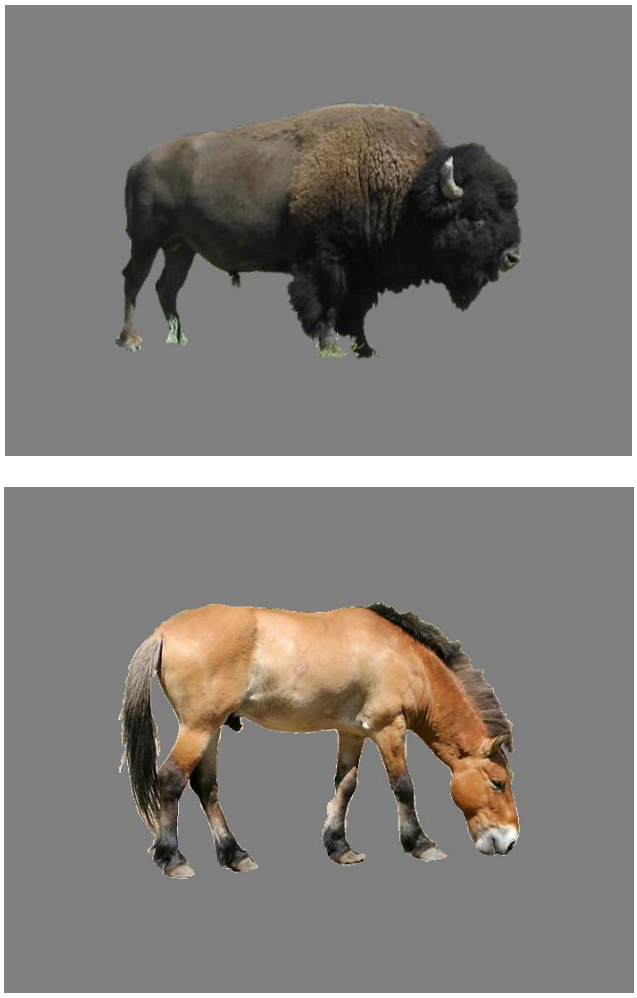


Figure 5.4.5.-5.4.6.: Two different classification images. Bison (top) and Horse (bottom).

(3) Bubbles: The *Bubbles* technique devised by Gosselin and Schyns in 2001 allows for an investigation into exactly what kind of information is being utilised by observers to detect stimuli during categorisation tasks. *Bubbles* operates by randomly sampling information in a stimulus space (e.g. in the original dataset, facial information is revealed by a number of randomly allocated Gaussian windows) while observers attempt to classify the sampled information (e.g. according to its gender, identity, or expression, depending on task). During the procedure for this experiment, which is based on animal species, the target image of both bison and horse is continuously and in random order presented to participants. These presentations are interleaved with presentations of visual noise between individual detection tasks. This allows for the target image to be constantly nearing the threshold of detection (this concept is shortly expanded upon). Stimuli are presented through a mid-grey mask revealing only a portion of the underlying entirety of the animal, namely through small openings (bubbles) also called Gaussian windows. These are, in line with Gaussian geometry, kept smooth and symmetrical (Marr and Poggio, 1979; Chauvin *et al.* 2005).

Bubbles appear in randomised positions and in randomised order on the screen and animal stimuli can be flipped, so that animals are able to point either to the left or the right. All of these technicalities culminate in the following images, with the image on the right exemplary of the 'end'-view that is being presented to the observer, interspersed with random noise. The image on the left illustrates how the software sets up the target image, which is eventually covered by a grey mask, leaving just one *bubble* at a time in the actual trials, as seen on the right. The next *bubble*, for instance, might appear as a horse head in the lower left of the scene.

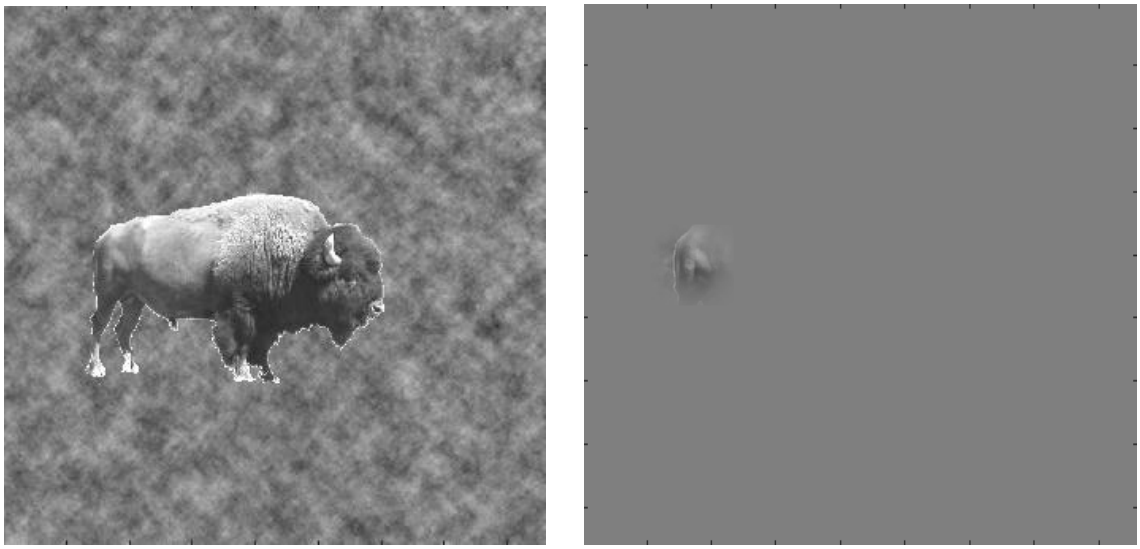


Figure 5.4.7.-5.4.8.: Greyscale classification "behind the scenes" (left) and end-user Gaussian bubble opening revealing the buttocks of a bison (right).

Detection Threshold

The absolute threshold of detection, which in this case is the minimum amount of information necessary for a participant to detect a horse or a bison successfully, is taken into consideration in this experiment. Commonly, participants do not always perform without fail (i.e. to 100% correct) at this absolute threshold level (see for instance Field *et al.* 2005). To take this into account for this experiment, the sizes of the bubbles were coded to allow for self-calibration. In other words, the apertures of the bubbles are automatically adjusted/"titrated" in order to reveal just enough information of the animal stimuli to maintain a 70% correct categorisation criterion (cf. procedures in Gosselin and Schyns, 2001; 2002 and in Gibson *et al.* 2005 who test *Bubbles* on pigeons). To put it simply, this methodological threshold adjustment means, that depending on how well a participant performs during the trials, the openings of the bubbles either adjust to being bigger (if frequently answered incorrectly) or smaller (if performance is kept up). Every 10 trials the number of *standard deviations* (*std*) of the window through which we see the target is adjusted, making it bigger by 25% if participant performance is poor, and smaller by 25% if participant performance is too good. This performance-based adjustment to the openings, therefore, reveals either more or less information within the bubbles.[15]

(4) Experiment material set-up: The materials used prior and during this experiment are:

- Presentation of Participant Information Sheet and Consent Form (see Appendix C).
- Prior generation of photographs of bison and horses.
- Photo manipulation software (in this case Adobe Photoshop and Gimp).
- Prior selection of images of UP prey animals for priming.
- Projector to portray task instructions and images for priming purposes.
- *Psychophysics Toolbox for Matlab* software for programming and execution of tasks[16].
- Post-experimental analysis using *Matlab*, Microsoft Excel and SPSS.

Priming: Prior to the start of the categorisation task, participants were instructed to familiarise themselves with a set of four different species (horse, aurochs, deer, ibex) occurring in the Upper Palaeolithic of Portugal (selected based on their respective frequencies). This was done in order to refresh the participant's perception of the different species, and two species were included which did not eventually feature in the experiment, to avoid selection bias.

[15] The size of the bubbles titrates by manipulating the standard deviations contained within them and is adjusted if the "TitrationHitCount" is either < or >= to 7. In these cases, the initial bubble size (blobNsds) is either divided or multiplied by a value of 1.125, respectively.

[16] The photographs from both fieldtrips were inserted as stimuli into the Psychophysics Toolbox within a software called *Matlab* (Brainard, 2007) in which *Bubbles* was then developed. It must be acknowledged at this point, that the initial coding for this experiment was facilitated by the author's supervisor, **Professor Robert Kentridge**, a visual psychologist, highly experienced in developing *Matlab* perception tasks. He was instrumental in the coding of these early versions of the *Bubbles* software.

Practice Session: Participants were asked to complete a practice session prior to starting blocks of trials to ensure their familiarity with the task. Each observer repeated a practice run of a maximum of 20 trials (i.e. 20 bubbles). Once observers felt that they could perform the task smoothly, the practice session ended (cf. test trial runs in results section). The task was the same as the final task set-up, meaning that the stimulus used was the same. Practice cycles not only ensure familiarity with the software and viewing task, but also signals to the experimenter that respondents are able to accurately use the response mechanism, described below.

(5) Task responses: The basic task of the observer was to signal if a target is present in each trial or not. During the task procedure, each participating observer was instructed to press differently labelled keys for either bison or horse on a keyboard depending on what the target animal was believed to be. The participant prompt in the *Matlab* interface reads as follows: 'Press any key to start, then press either "1" or "2" followed by "Enter" on each trial for "Horse or "Bison" respectively. A function was put into place, by which any other response (i.e. a wrong key press) would result in a negative selection. Below is an example of a presented stimulus (Fig. 5.4.4) during the task procedure which shows a horse head pointing towards the right seen through a Gaussian aperture. In this instance, if detecting correctly, participants would press "1" for "Horse". Once a key was pressed, the stimulus would disappear, resulting in a mid-grey mask, shown for 500 ms and another trial of bubbles.

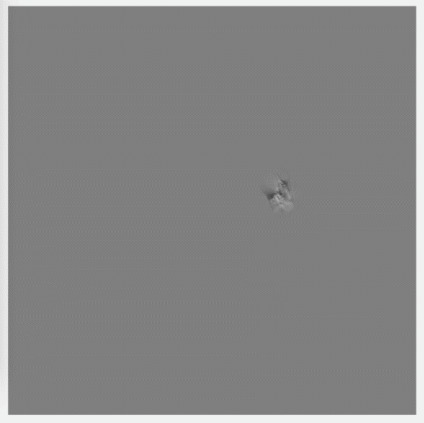


Figure 5.4.9.: The presented stimulus, here depicting a Gaussian bubble of a horse head.

There are, of course, a multitude of responses that could be collected during the *Bubbles* trials. Response capture systems, other than the key-press response, include measuring eye movements and *preferential looking* (Humphreys *et al.* 2002) as well as looking into the *N170 component of ERPs* (event-related potentials; i.e. the brain responses directly resulting from a sensory stimulus onset), which is an amplitude that reflects neural processes of faces or familiar visuals such as words and objects (Schyns *et al.* 2002). Moreover, even fMRI results or galvanic

skin responses could be collected (Gosselin and Schyns, 2003; Smith *et al.* 2008). Yet, the reasons for selecting the key-press response mechanism in this experiment is to allow for easy analysis of correct and incorrect answers, either by realising that the presented bubbles formed part of a specific animal (correct) or not (incorrect) and for ease of technical set-up.

Tasks were set up to either leave the bubble on screen until a decision was made or to have bubbles appear on screen for up to 5 seconds before the screen returned to a mid-grey mask, prompting participants to respond. Once responses were collected (i.e. a key was pressed) a new bubble would appear for another specified time span, as is illustrated in the next set of images (Fig. 5.4.10) (an example of arbitrarily selected milliseconds is provided to give the reader a sense of procedural sequencing; it will become clearer in the results how long individual trials lasted):

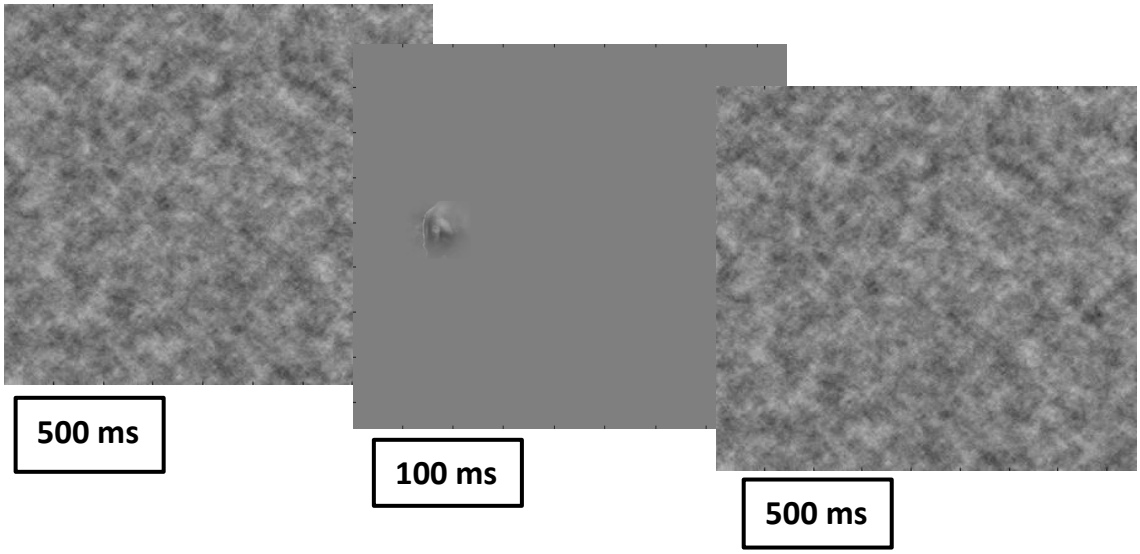


Figure 5.4.10.: The succession of noise interleaved with a stimulus bubble and noise again.

(5) Limitations: Apart from some procedural limitations with the software (e.g. "Troubles with Bubbles" (Murray and Gold, 2004) and "No troubles with Bubbles" (Gosselin and Schyns, 2004)) which have largely been rectified with this current version, it has to be mentioned at this point that the running of the experiment between the different years changed slightly upon realising how participants are able to cope and understand the task at hand. Arguably, the inherent value of this experiment within this thesis lies in its step-by-step methodological advancements, with each year of testing coming closer to a more nuanced understanding of why some animal parts feature more than others once depicted. Hence, the software versions between the three years of testing all expanded upon each other and with each year, new functions ensured better links

between participant answers, stimulus classification and its final art correspondence. Despite this, there are a couple of task specific changes that can reveal even more inclusive results, which is why the results within this section should be regarded as preliminary, albeit very suggestive of the general nature of the wider outcomes. These specific alterations are described now.

The software currently utilises images of animals in profile, yet for future iterations of testing, new animal photographs will need to be fed into system (Fig. 5.4.11). These will need to feature different types of animals, so that salient features of other Upper Palaeolithic animals can be tested, but most importantly, the photographs will need to be showing animals from different angles. Suitably, Gosselin and Schyns (2003) acknowledge that "the larger the stimuli set, the better the *Bubbles* solution should be [which] will tend to prevent observers from adopting strategies atypical of natural processing". When testing how people are able to detect and distinguish between different animals in landscape environments, animals very rarely present themselves only in profile view. Animals are mobile, make often-times unpredictable movements and are thus seen from all sorts of different angles, which ought to be picked up on in future versions of *Bubbles*.



Figure 5.4.11.: Variations in stimuli adoptable for future uses of *Bubbles* (all photographs by author).

What is useful, however, about this current adaptation of *Bubbles* with the testing of only strict profile (sideways) views, is that most Upper Palaeolithic art also aligns with this pattern. Hence, this iteration of *Bubbles* is able to shed light on the importance and saliency of this fundamental stance, with successors able to delve into the idiosyncrasies of the more nuanced animal poses.

Moreover, another limitation that needs mentioning, is that of viewing distances. It is recognised that this experiment assumes target species to be extremely close to the gaze of the

observer. This, of course, in a hunting scenario, is unlikely. The need for testing species at a distance is hereby acknowledged and the same methodological procedures, as are applied here, can be applied to images of animals rendered as if they were at specific viewing distances. This can be done with filtering spatial frequency which correspond to limits of human visual acuity at a variety of distances in order to identify features that were critical to detecting animals at the limits of vision.

The study, and thus the results and conclusions, are confined to a small number of participants and iterations of the search task. Albeit a multitude of visual categorisation studies feature a very select number of observers, often due to the nature of the set-up, running costs and extended periods necessary for trialling. In one study published in *Vision Science*, for example, it became apparent that only "two persons served as observers; one of them was the author" himself (Näsänen, 1999: 3826). These studies should by no means be used as a benchmark for participant numbers, yet, even within this piloted stage, the observer count for this experiment, is significantly above that of many published works.

Going further, not only should more participants be tested, but also other types of participants should be subjected to interact with the *Bubbles* algorithm, such as observers who are particularly familiar with the rearing of horses and/or bison or observers who are well-versed in hunting large prey animals. Their response would then ideally be compared to the current datasets in search for varying response levels.

5.4.4. Experimental results

Due to the aforementioned stages of methodological adjustments, the results presented below, are by no means complete and ought to be widened out significantly in future. What is possible, however, at this stage of the experimental progression, is the presentation of results in a three-fold manner:

(1) Participant performance results on adaptation to the software and bubble sizes.

(2) The generation of classification data based on participant hit and miss rates.

(3) The comparison of these images with those typically found in the Côa Valley rock art.

5.4.4.1. Performance results

Participants underwent a series of different blocks, each consisting of a specified amount of trials within them. At the onset of each block of trials, each participant was instructed to insert a number of parameters to start off their block of trials:

- Number of trials per block (e.g. 10) (**nTrials**)
- Stimulus duration in seconds (e.g. 0.15) (**stimDur**)
- Initial bubble size (e.g. 0.125) (**blobNSds**)

This information is collated in the following table, split up by years and participants in each year, respectively. As already discussed within the limitations, the first year's instalment of the software did not allow for data capture on titration performance of the bubble sizes. Results from year one will be displayed (see Appendix C), yet should be regarded as the test-run for adapting the methodology for the following years of testing (applies to 5 out of 17 participants). The version that participants in years 2 and 3 undertook (12 out of 17 participants in total), was improved with the random left/right flip of the stimuli and the save function of the titration bubble stage across all testing blocks only applied to year 3 participants. More rigorous data capture in year 2 and 3 allows for initial task results to be concluded as follows:

Trial Version (Year)	Anonymised participant number	Block Number	nTrials	stimDur	blobNSds I.e. bubble size at the end of trial block	Sds Difference between trials (excl. practice)
Year 2	**1**	Test 1	10	0	1.777778	
Year 2	**1**	1	100	0.5	6.407227	
Year 2	**1**	2	100	0.5	6.407227	0
Year 2	**1**	3	100	0.5	6.407227	0

Year 2	**2**	Test 1	5	0	1.777778	
Year 2	**2**	1	100	0.5	8.109146	
Year 2	**2**	2	100	0.5	12.989284	4.880138
Year 2	**2**	3	100	0.5	10.263138	-2.726146
Year 2	**3**	Test 1	5	0	1.777778	
Year 2	**3**	1	100	0.5	6.407227	
Year 2	**3**	2	100	0.5	10.263139	3.855912
Year 2	**3**	3	100	0.5	20.806323	10.543184
Year 2	**4**	Test 1	10	0	1.777778	
Year 2	**4**	1	100	0.5	5.062500	
Year 2	**4**	2	100	0.5	10.263138	5.200638
Year 2	**4**	3	100	0.5	8.109146	-2.153992
Year 3	**5**	Test 1	10	3	5.618656	
Year 3	**5**	Test 2	10	5	7.111111	
Year 3	**5**	1	100	3	2.463569	
Year 3	**5**	2	100	2	6.320988	3.857419
Year 3	**5**	3	100	2	8	1.679012
Year 3	**6**	Test 1	10	5	7.111111	
Year 3	**6**	Test 2	10	8	7.111111	
Year 3	**6**	1	100	3	8	
Year 3	**6**	2	100	2	10.125000	2.125000
Year 3	**6**	3	100	2	12.814453	2.689453
Year 3	**7**	Test 1	10	1	7.111111	
Year 3	**7**	Test 2	10	10	7.111111	
Year 3	**7**	1	100	3	10.125000	
Year 3	**7**	2	100	2	10.125000	0
Year 3	**7**	3	100	2	12.814453	2.689453
Year 3	**8**	Test 1	10	10	7.407407	
Year 3	**8**	Test 2	10	7	7.407407	
Year 3	**8**	1	100	3	6.320988	
Year 3	**8**	2	100	2	12.814453	6.493473
Year 3	**8**	3	100	2	12.814453	0

Year 3	**9**	Test 1	10	3	7.11111	
Year 3	**9**	Test 2	10	3	6.320988	
Year 3	**9**	1	100	3	6.320988	
Year 3	**9**	2	100	2	10.125000	3.804012
Year 3	**9**	3	100	2	10.125000	0
Year 3	**10**	Test 1	10	1	7.111111	
Year 3	**10**	Test 2	10	9	7.111111	
Year 3	**10**	1	100	3	6.320988	
Year 3	**10**	2	100	2	10.125000	3.804012
Year 3	**10**	3	100	2	10.125000	0
Year 3	**11**	Test 1	10	1	7.111111	
Year 3	**11**	Test 2	10	1	6.320988	
Year 3	**11**	1	100	3	6.320988	
Year 3	**11**	2	100	2	10.125000	3.804012
Year 3	**11**	3	100	2	16.218292	6.093292
Year 3	**12**	Test 1	10	3	7.111111	
Year 3	**12**	Test 2	10	8	7.111111	
Year 3	**12**	1	100	3	10.125000	
Year 3	**12**	2	100	2	8	-2.125000
Year 3	**12**	3	100	2	10.125000	2.125000

Table 5.6.: Participant data on number of trials, stimulus duration and end-of-task bubble sizes in standard deviations. Colour-coded standard deviation differences illustrate performance.

The table above (Table 5.6) sheds light on trial durations/trial numbers and participant performance throughout the course of the experiment. On average, testing lasted about 2.25 hours per observer, included prior participant briefing and priming. Per participant all blocks of trials took place in one day, but not all participants were tested in one day. Disregarding the trials during practice rounds, a total of 3600 trials have been performed, 300 per observer. The test run in year 1 amounted to 1500 trials, yet its pilot status, does not justify closer consideration of bubble titrations. Whilst participants in year 2 completed a single round of practice trials, year 3 participants were asked to set up two practice trials each with different *nTrials* and *stimDur* values, freely selectable by the observer. This ensured adequate familiarisation with the task.

After practicing, participants, in each year, underwent three blocks of 100 trials/bubbles each. In line with constant software and task improvements, year 2's stimulus duration, in other words the amount of time the bubbles would stay on screen before being interleaved with a mid-grey mask, was 0.5 seconds. As will become clear in the next results section, this uniformity in task set up allows for easy comparison between participants. The stimulus duration for year 3 participants was set to 3 seconds for the first block of 100 trials, after which 2 trials were performed with a 2 second stimulus onset. These two last blocks were performed on the basis of stored titration 'memory', with the software feeding the last trial the same bubble size as was stopped on within the previous block. Again, due to the uniformity of this set-up, easy comparative measures are applicable. The reason for altering the time that the stimulus was on screen for, was to test if participants perform better or worse if they are exposed to the stimulus for varying length of time.

The first block of trials was started with the same initial bubble size for each participant. This allows for comparatively testing participant performance as they progress through the blocks. Since the titration of the bubbles indicates whether participants were able to perform poorly or successfully with any given bubble size, and since all participants start off with the same bubble size, their good/bad performance can be assessed by their final bubble size upon finishing a block of trials. In table 5.6, this is illustrated by the means of the colour-coding of the right most column, which calculates either a positive (green), unchanged (blue) or negative (red) standard deviation count (i.e. bubble size increase, stability, or reduction). Overall, it can be seen that participants in year 2 ended on a reduced seem to finish off on a lower bubble size after their first block when compared to their second blocks ending on than bigger bubble sizes. This is also illustrated in the following graph (Fig. 5.4.12):

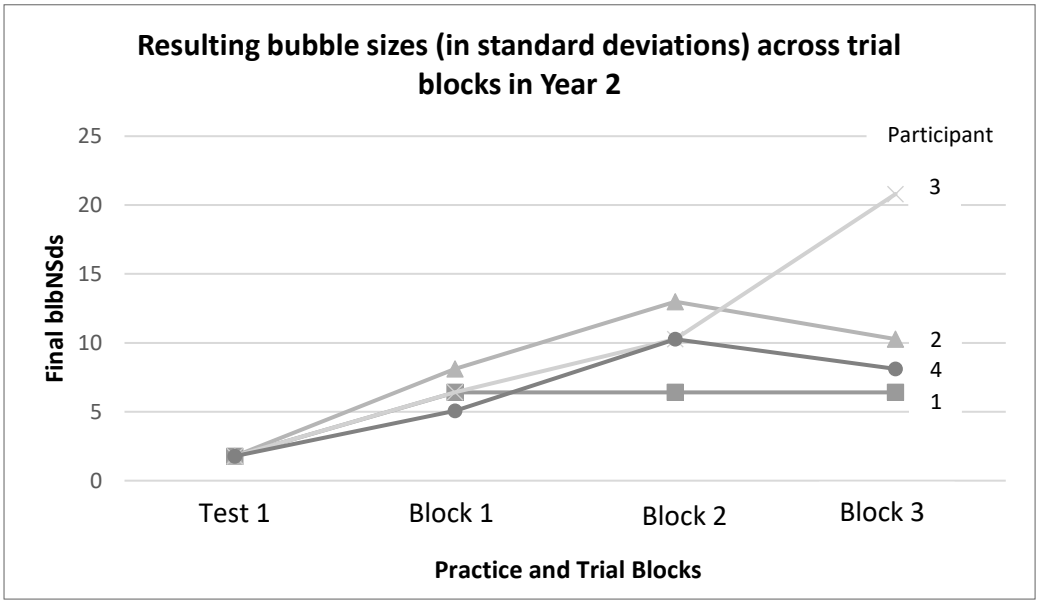


Figure 5.4.12.: Graph showing the final bubble sizes at the end of Year 2 participant trials.

Most participants improve their performance upon finishing their last trial, yet never really reach their discrimination potential of block 1.

The current version of the software does not allow the data capture of performances in-between the different trials. Thus, we are not able, for instance, to view if participants reached their 70% correct categorisation criterion repeatedly during their block performance, making the bubble aperture smaller and smaller or whether their performance rate was poor and then good, then poor again, with bubbles adjusting by 25% with each poor/good performance. We are simply seeing the value of the bubble upon finishing their set of trials. This again, is another improvement in the data capture, planned for future versions. The version of *Bubbles* which was used for testing in year 2 did not allow for bubble titration size of one trial to be taken across to a subsequent trial, for participants to start again where they had left off. This meant that each trial was started on a bubble size chosen by the experimenter and left participants to gain their old momentum again throughout the block, be it a negative or positive one.

In year 3, an improvement in the software meant that participants were able to carry on with their next block of testing with the same bubble size value that was ended upon in the previous block. Interestingly, the following graph (Fig 5.4.13) reveals this behaviour of participants/bubbles:

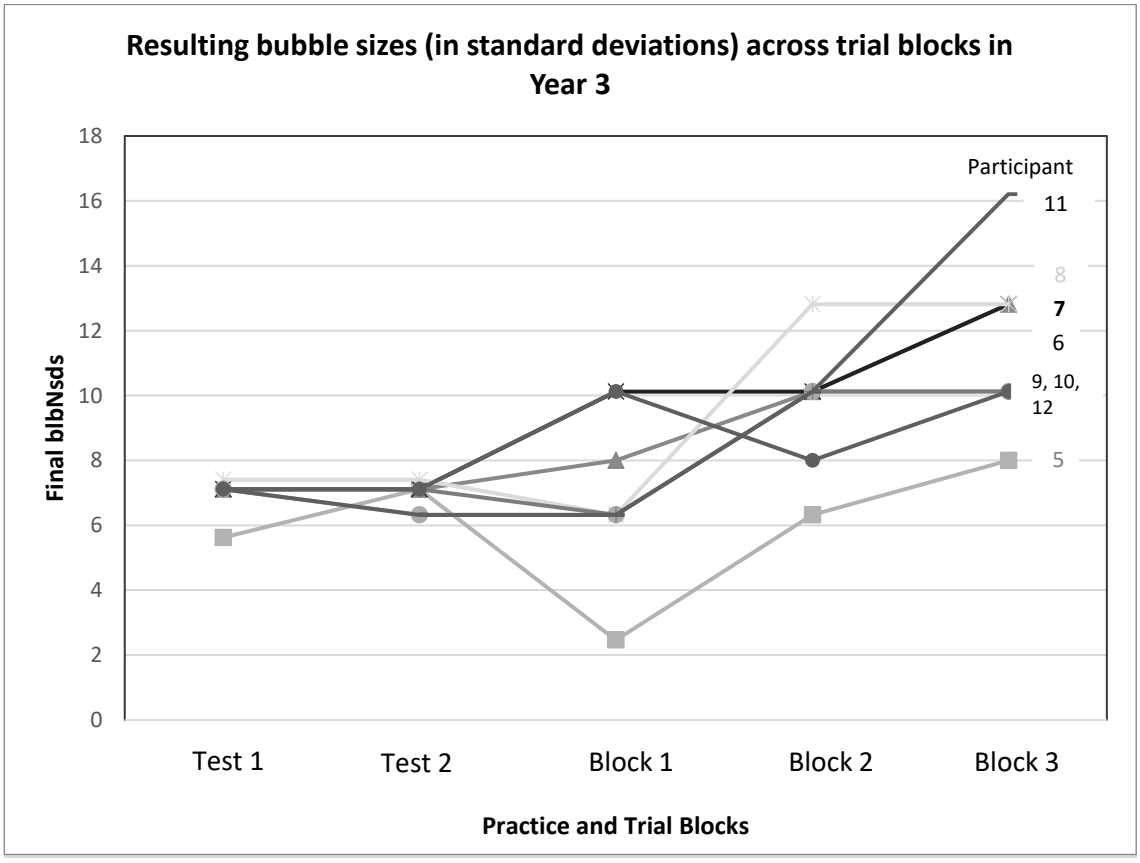


Figure 5.4.13.: Graph showing the final bubble sizes at the end of Year 3 participant trials.

To start with, it can be seen by the lower bubble size across all participants for trial one that the difference in a second of stimulus duration does have its effects. In fact, it seems that in cases where participants are able to view their stimulus for longer, the resulting bubble size is lower than when bubbles are viewed for shorter amounts of time. Of course, more variations need testing, yet this preliminary observation indicates **that the longer a stimulus is presented to an observer, the better the observer gets at discriminating the target correctly.** When applying this insight onto how hunter-gatherers would have viewed their prey, a split second longer of gaze onto prey might make all the difference in their discriminable abilities.

In line with the majority of red field in the right-most column of Table 5.2, participants tend to end on a bubble size bigger to the ones they started with. This gives insight into the performance structure of participants, performing worse towards the end of their last block of trials. This might be caused by a number of factors, including rushing key-presses to get through the trials faster, tiredness and/or lack of focus. Participants were tested for more than two hours and being constantly bombarded with bubbles quickly loses its novelty effect. More work needs to be awarded to study this phenomenon and perhaps even rectify observer performance rates. Conceivable are changes in task procedures, such as shorter but more frequent blocks of trials, to maintain focus.

It is, of course, always possible to delve deeper into wider statistical analyses on task performance, especially in relation to stimulus duration and the number of trials, yet it has to be questioned if this brings us any closer in our understanding of the visual saliency of different animal parts. Henceforth, having discussed the mechanics behind the *Bubbles* software, the arguably more meaningful outcomes of participants' 'hit' and 'miss' rates are revealed.

5.4.4.2. Classification images

Participants have only one way to score successfully in any given trial, namely, to detect the right animal species in amongst the noise pattern. This means that analysis of the responses given by observers is relatively easy to visualise. Readers can think of the analysis process, which goes on behind the scenes of a participant taking these tasks, as a set of binary numbers, i.e. 1 and 0 for either a successful detection ("hit") or an unsuccessful detection ("miss"). Accordingly, the code (simplified here) is set up as follows:

```
If (resp = targetType (target))
        hit = 1;
Else
        hit = 0
End.
```

The mechanisms behind such responses can be attributed to what, in the field of psychology, is called *signal detection theory (SDT)*, in which observers are being tested on their ability to make decisions under conditions of uncertainty. In the case of this experiment, selecting between two different animals. SDT can easily be applied to stimulus requiring either a yes or no response, similar to what is generated from the experiment at hand (Table 5.7):

	Respond Horse	**Respond Bison**
Stimulus Bison	Miss	Hit
Stimulus Horse	Hit	Miss

Table 5.7.: Stimulus versus response – hit and miss categorisation.

Hence, by comparing the noise patterns under which species were able to be detected with the patterns and species under which they were missed, the areas of the species that are most critical for their detection can be identified. This hit and miss analysis yields in a resulting image, called the *classification image* (Cimage), coded accordingly (simplified):

```
hitCimages = arrayOfCimages (hitRecord = 1);
missCimages = arrayOfCimages (hitRecord = 0);
```

In fact, as is the case here, this technique is also applied when trying to establish the specific areas of stimuli that are most important in making specific discriminations, either by identifying specific parts of bison or specific parts of horses.

It is commonly programmed within *Bubbles* set-ups that after sufficiently numerous trials, the stimulus space is exhaustively and uniformly sampled (Gosselin and Schyns, 2001; 2002). From this unbiased sampling strategy, one can estimate the information biases of observers by computing how each information sample can independently determine categorisation performance. Samples giving rise to significantly higher performance are called the 'diagnostic' regions of the input (when regarding Gosselin and Schyns' initial facial stimuli, the eyes within a face in gender recognition or, here, the horns of a bison in species discrimination) for the categorisation task at hand. Given that participants underwent 100 iterations of *Bubbles* in just one block, certainty of space exhaustion is provided. Furthermore, given the large number of trials, the experimenter was confident, from the year 1 pilots, that subjects would have converged to the 70% correct categorisation criterion well within the undertaken trials and, most likely, already in the first block of 100 trials.

To put it simply, within each trial of the animal categorisation task, the randomly computed Gaussian window generates a 2D "bubble mask" eventually revealing a sparse image of an animal. To foreshadow overall results, it was found that participants tend to display "hit" counts when the selected information within the bubble is diagnostic for the categorisation of a specific animal. In fact, the probability of a correct response was computed by image pixels, meaning that all pixels within the stimuli are classifiable. Similar to image processing methods (equivalent to a *least-square* multiple regression performance) employed by e.g. Smith *et al.* 2008, the bubbles that lead to correct categorisation were added together and eventually divided by the sum of all (both hit and missed) bubble masks revealed to the observers within the task. Based on these probabilities, Z-scores were obtained to be used in Cluster Testing (similarly to Chauvin *et al*.'s (2006) approach)[17]. Eventually these Z-score maps are able to reveal, in the truest sense of the word, which information is necessary for performing a correct classification, i.e. *diagnostic information* (see Smith *et al.* 2008).

To summarise, the noise patterns under which the right targets were correctly identified (i.e. hit) compared with those that were falsely identified (i.e. missed) can be determined. This results in the collation of all the *diagnostic information* in a so-called *classification image (CI)*. A classification image reveals areas of the animals which are particularly diagnostic, such as the hump of the bison, or the mane and facial features of the horse. These classification images lend themselves nicely to an instant visual display of results. A particularly useful tool for purposes of this study is the fact that not only positive classification images are computable, but also that

[17] This was done through calculating an average and standard deviation. A Z-score > 1.65 ($p < .05$) was considered ``diagnostic''.

negative classification images are generatable. For, the negative images reveal the areas of the stimulus that were repeatedly miscategorised and thus did not aid in animal discrimination. This information, arguably, is as useful as the positive "hit" images.

The following images (Fig. 5.4.14) illustrate the effectiveness of these resulting classification images in pointing out the diagnostic areas of a stimulus. Used here, as illustrations, are the combined sets of classification images of both horse and bison from the second practice set by participant 5 (ntrials=10; stimDur=3 and blobNSds= 7.1):

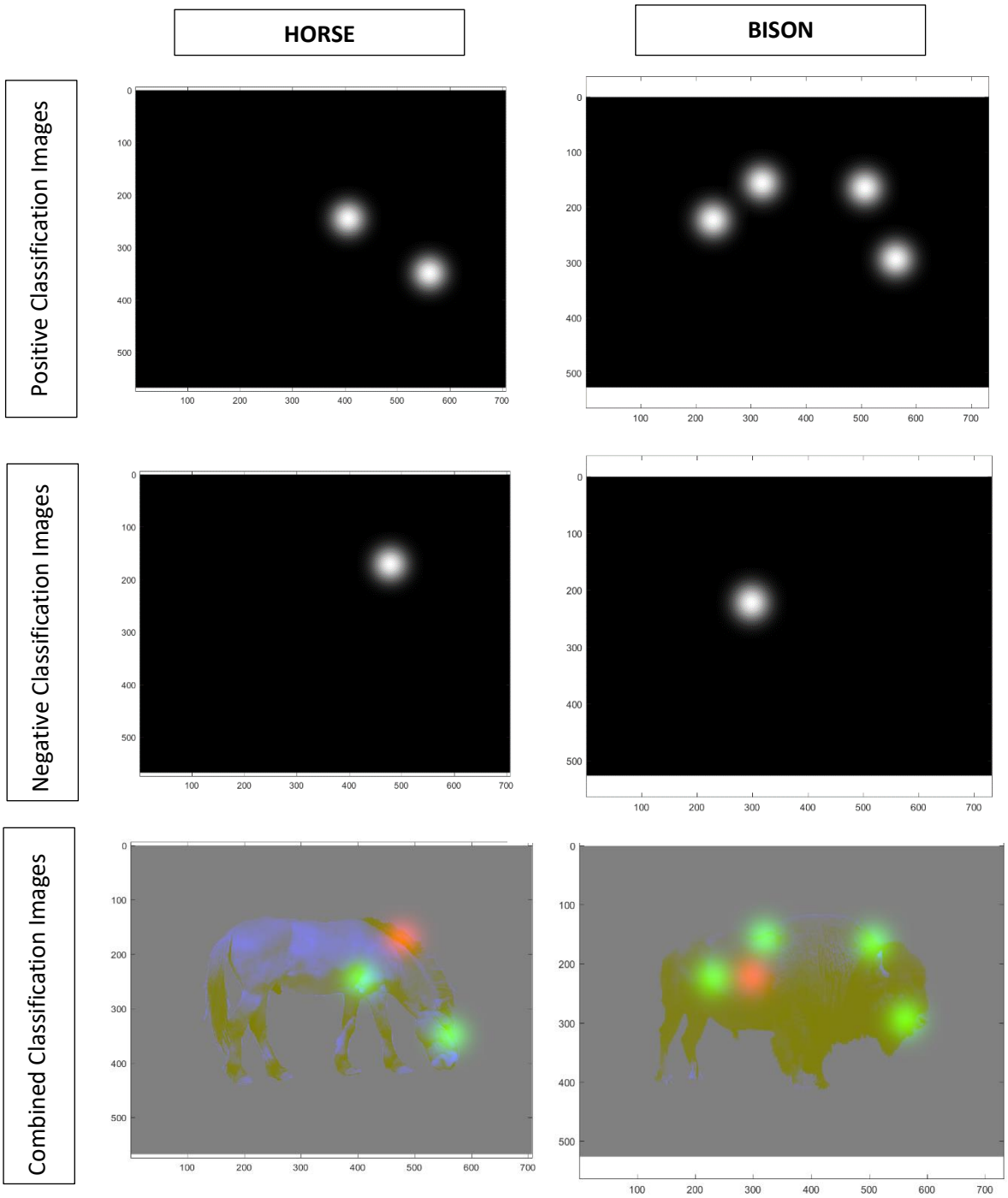
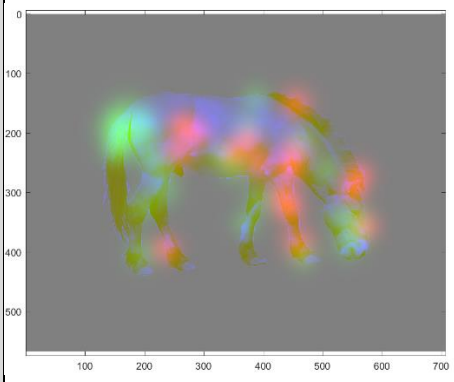
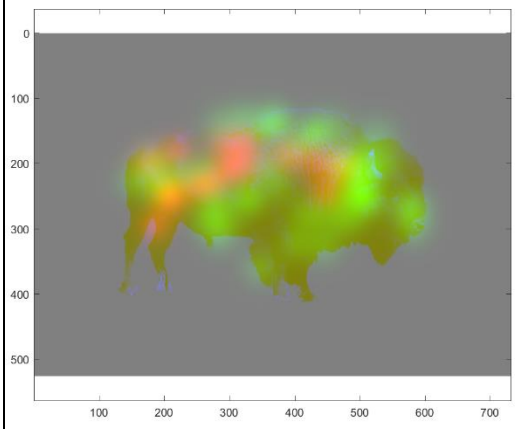
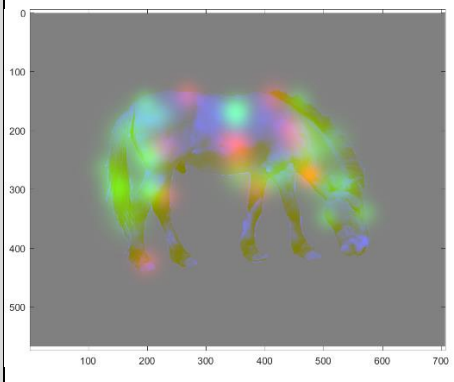
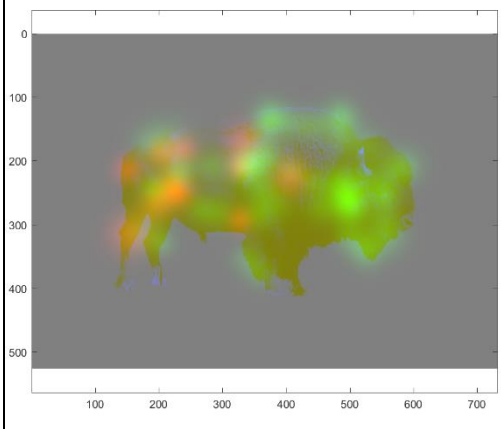
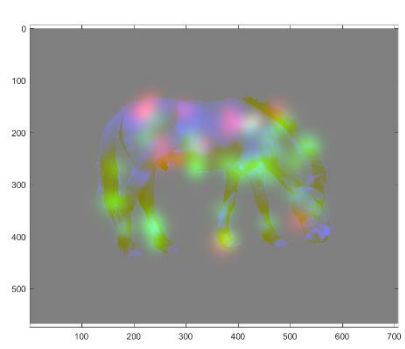
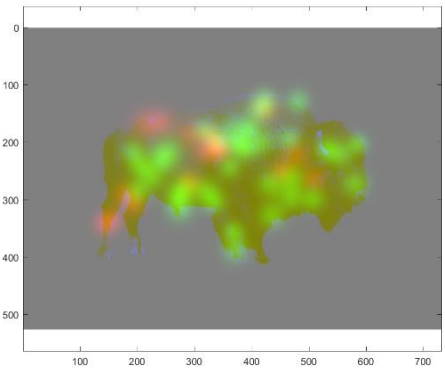
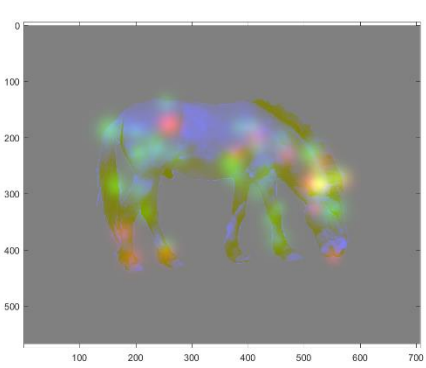
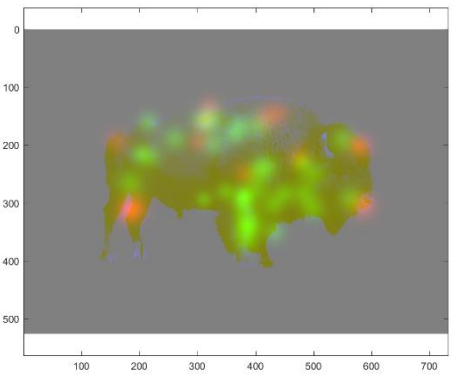
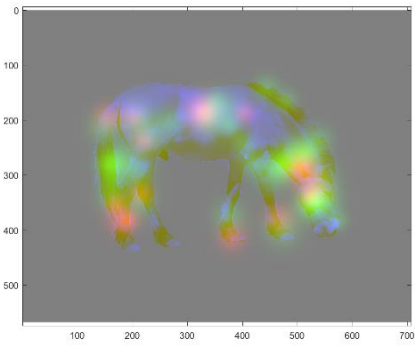
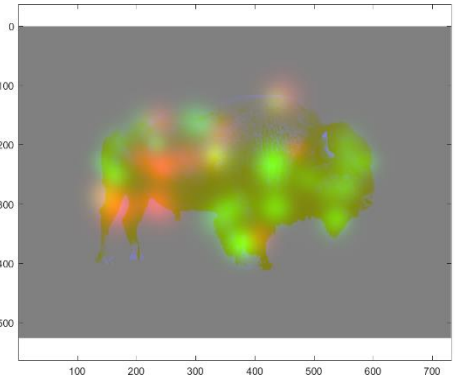
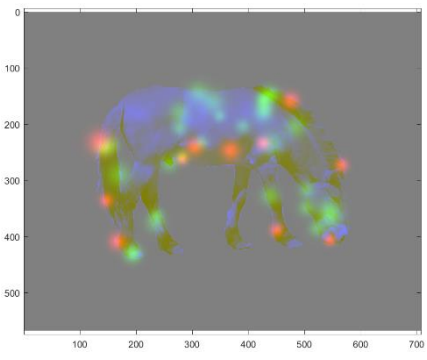
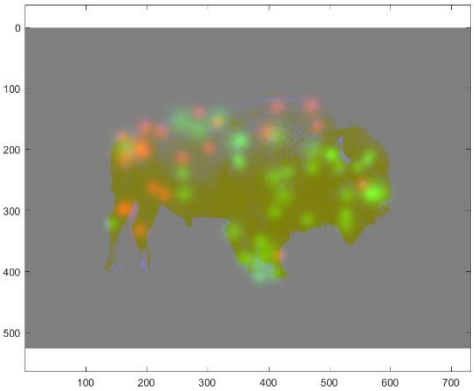
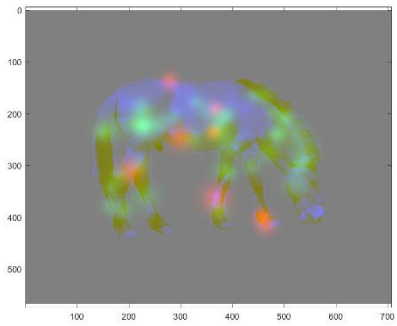
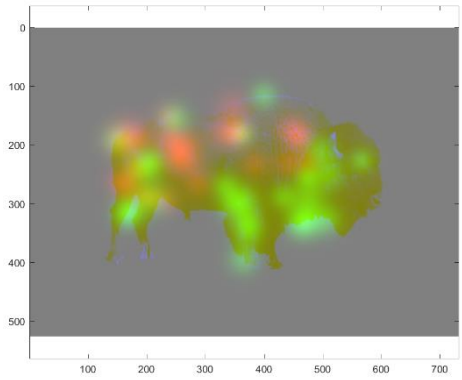
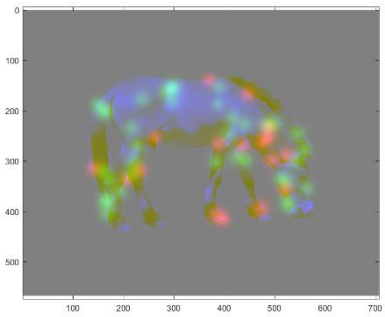
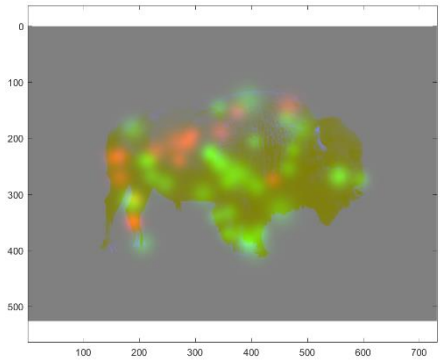
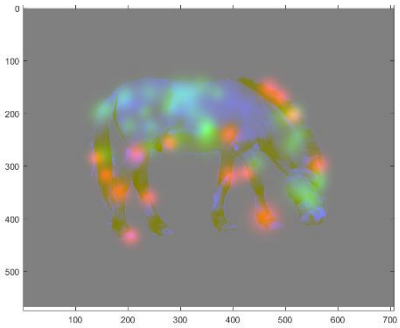
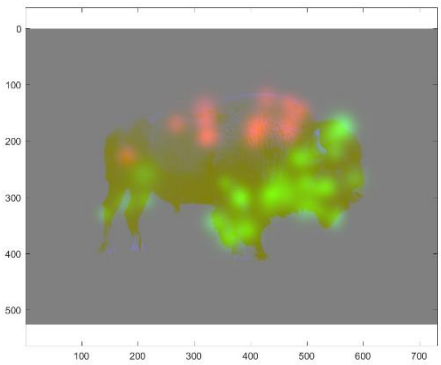
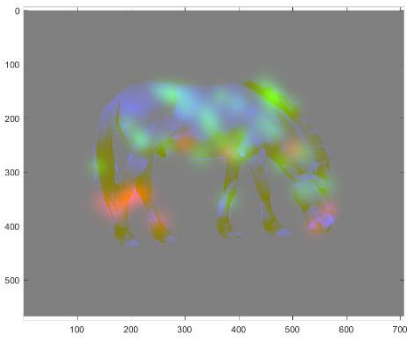
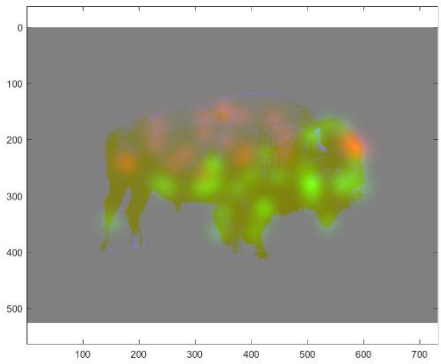


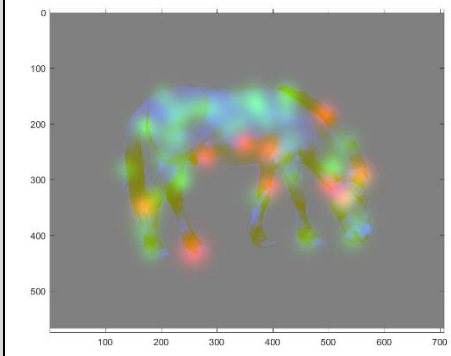
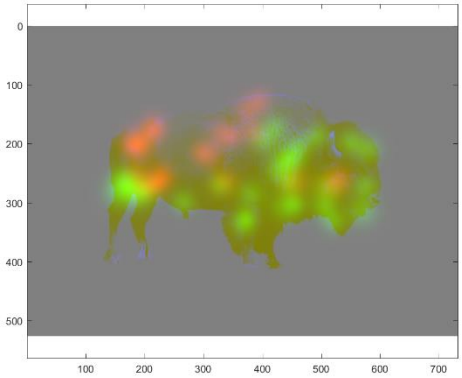
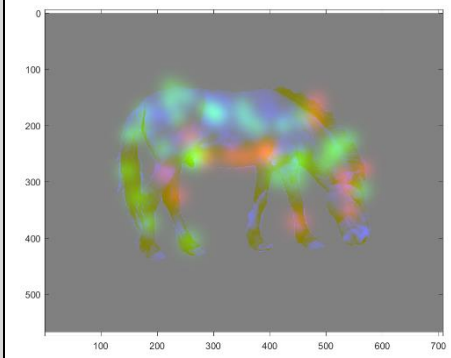
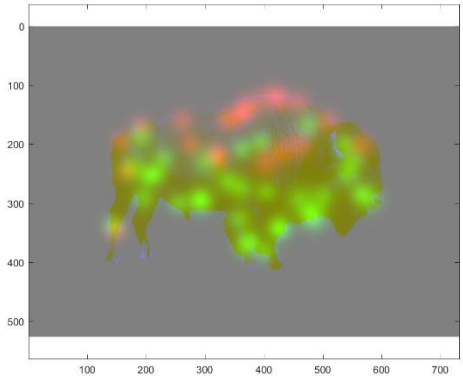
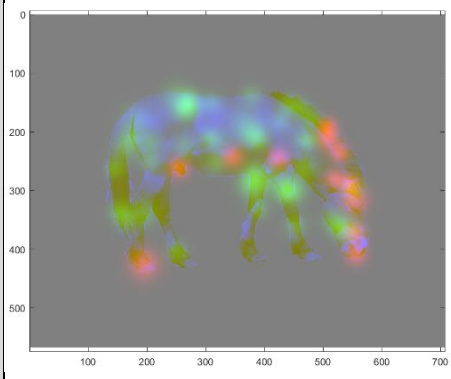
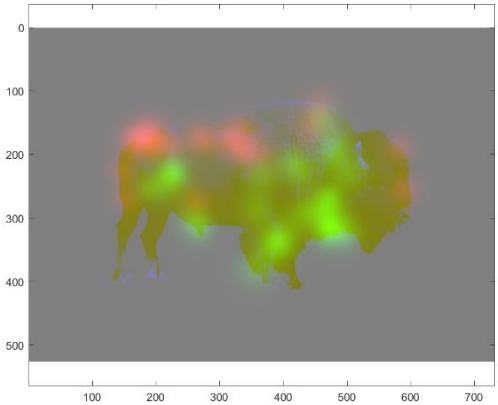
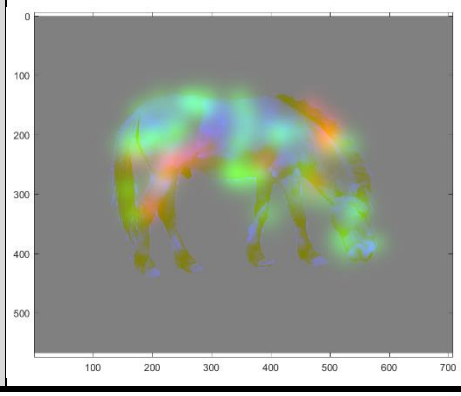
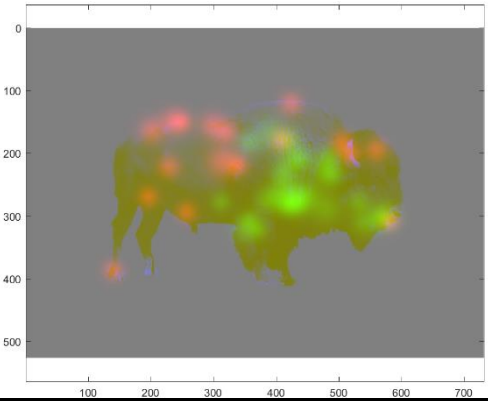
Figure 5.4.14.: Collage of positive (green), negative (red) and combined classification images for horse and bison images.

The results from the practice run classification images are already suggestive of certain parts of animal saliency. Rather than using lengthy statistical means to convey which parts are most diagnostic numerically, it is the anticipated that the following statistically-informed/generated CI's are able to convey the underlying messages best. This thesis is inherently, of course, a work on the visual nature of artistic depiction. Hence, to understand this diagnostic presentation further, the classification images will be populated, using the 100 trials classified by each participant. Whilst more CI's from different years of testing are to be found in Appendix C, this results section focuses on the data from the most up-to-date version of *Bubbles*, thus on the eight participants (Participants 5-12) of Year 3. A list of the combined version (both hit 'green' and miss 'red'; Table 5.8) of the classification image of the last two blocks of each participant are being shown, as they were set up with the same nTrials and stimDur parameters. Moreover, the function of titration memory between these trials was enabled, able to yield more reliable performance-focused classification images.

Obser-ver Nr.	Combined Classification Image Horse	Combined Classification Image Bison
P. 5 Trial 2		
P. 5 Trial 3		

P. 6 Trial 2		
P. 6 Trial 3		
P.7 Trial 2		
P. 7 Trial 3		

P. 8 Trial 2		
P. 8 Trial 3		
P. 9 Trial 2		
P. 9 Trial 3		

P. 10 Trial 2		
P. 10 Trial 3		
P. 11 Trial 2		
P. 11 Trial 3		

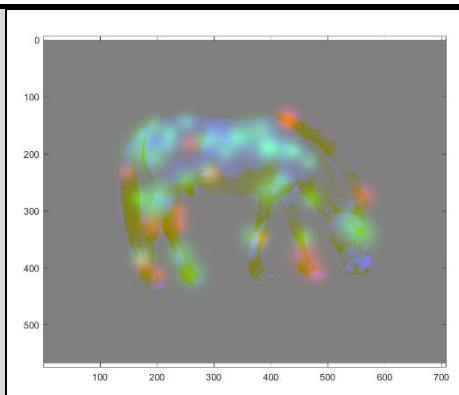
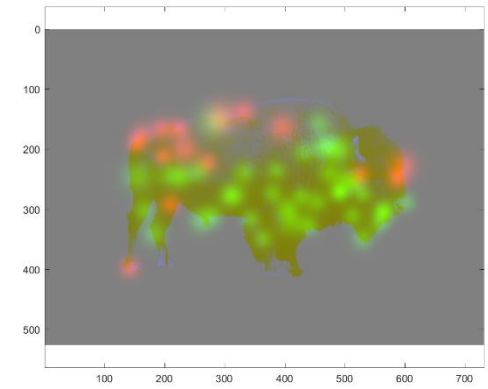
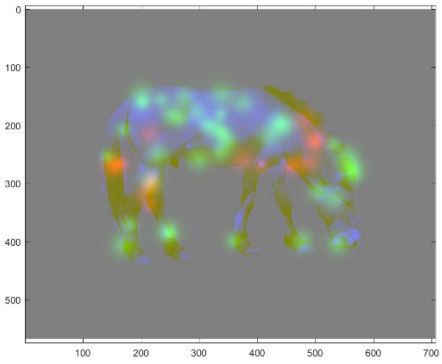
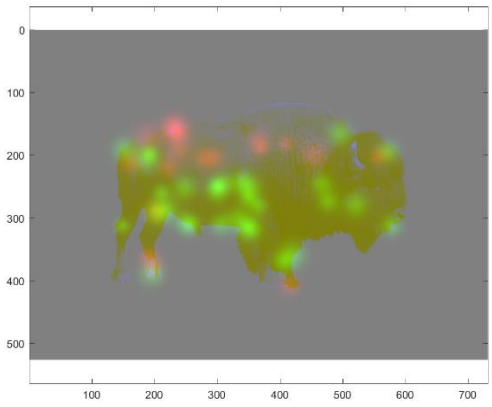
P. 12 Trial 2		
P. 12 Trial 3		

Table 5.8.: Collation of combined *classification images* generated for participant blocks 2 and 3 of year 3 of testing. Colour-coded hit and misses illustrate the *diagnostic information*.

5.4.5. Experimental discussion: interpreting the classification images

The classification images above (Table 5.8) are able to highlight a number of fascinating results. Both animals will be taken at face-value for now before applying their visual salience onto resemblances within the rock art. This allows for an unbiased consideration, which does not allow for cherry-picking of green 'hit' areas to areas heightened in the rock art. Overall, the occurrence of hits and misses in various regions of the animals under scrutiny shows, that not all animal parts are equally detectable. In reiterating earlier writing, it was found that participants display "hit" counts when the selected information within the bubble is diagnostic for the categorisation of a specific animal. To draw parallels to the first experiment of this thesis, individual body parts of both species will now be assessed. Through the assessment of all bodily areas, a closer look can be granted into which areas are consistently discriminable. All classification images have been combined and the animals' primary regions split and shaded according to their averaged classification counts. It is important to mention, that results have been translated onto empty horse and bison canvasses to avoid potential biases arising from image-based features and to make it more translatable onto rock art features later on.

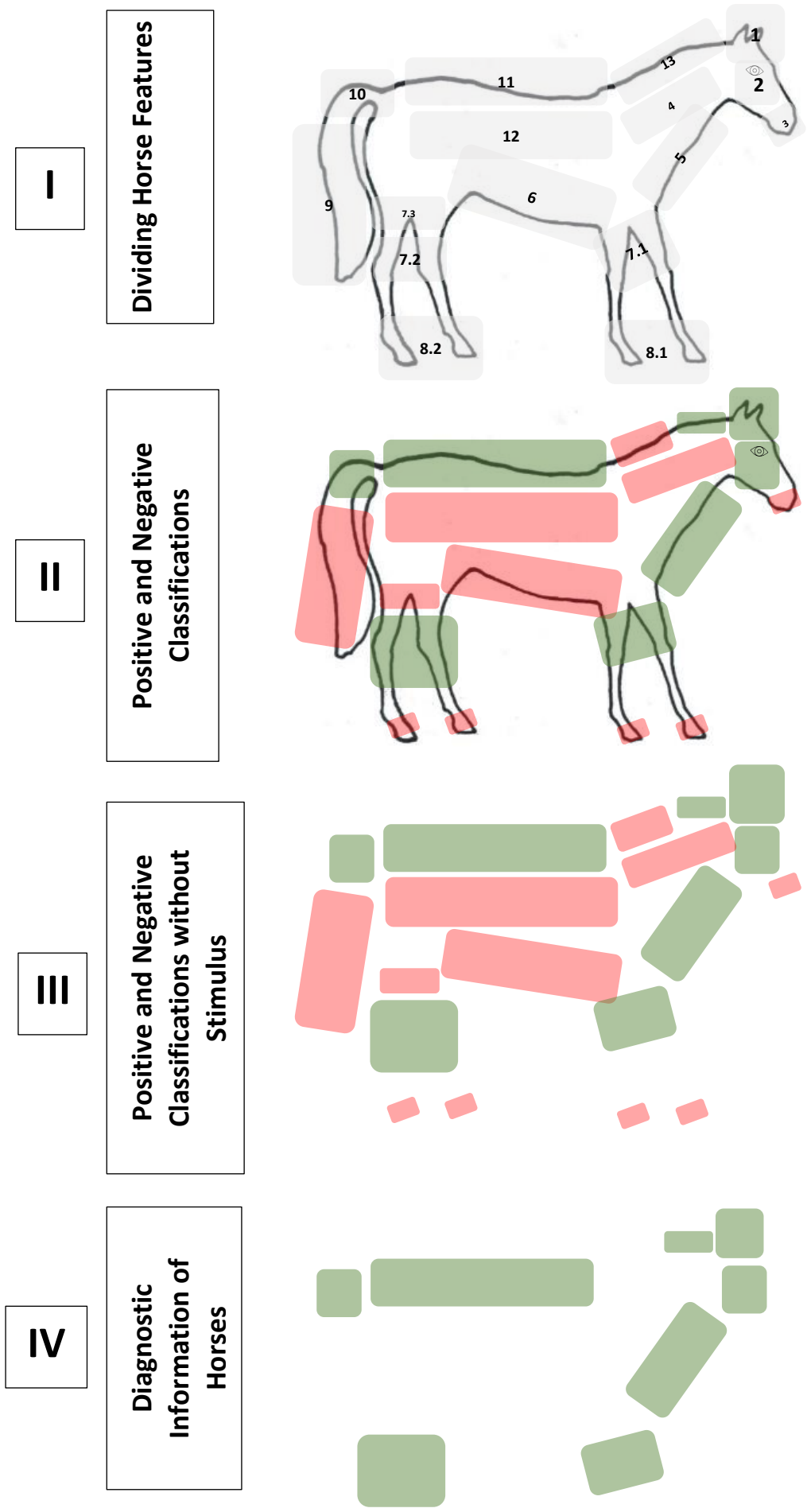


Figure 5.4.15.: Collage of teasing out hit count progressions for the horse stimulus. The red areas account for the negative classifications, the green for positive classifications.

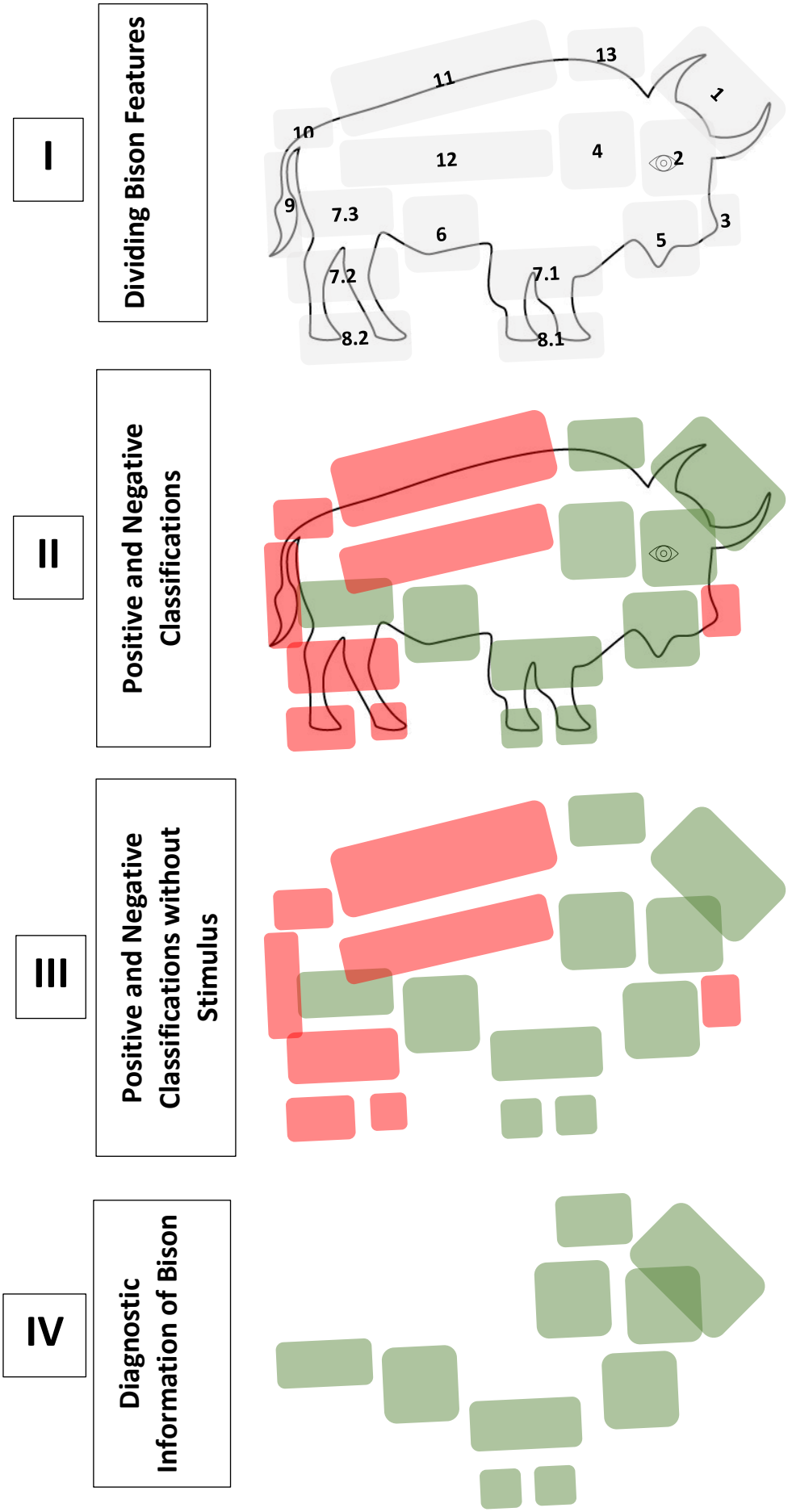


Figure 5.4.16.: Collage of teasing out hit count progressions for the bison stimulus. The red areas account for the negative classifications, the green for positive classifications.

In reading figures 5.4.15 and 5.4.16 from top to bottom, a metamorphosis of teasing out the most salient parts of the animals, those that most consistently yielded positive classification counts, reveals itself. Despite the fact the software is still in its developmental stage and more animal photographs will need to be fed into the system, the results clearly reveal major areas of saliency within the classification images, as seen in stage 3 and 4 of the figures above.

When looking at the diagnostic information that participants identified in horses, **a clear tendency of correct classification alongside the animal's outline** can be noted. It seems persistently easier for participants to identify horse features when the bubble presents parts of the outer edges of the animal (represented in green in Figures 5.4.15 and 5.4.16). From the positive categorisation alone (IV), an outline of an animal can be identified. From collating the data of the classification images of horses, participant responses were a lot more varied than those extracted from bison CI's. An intriguing feature in the positive CI's of horses is that major parts of the mane are often misclassified. This means that participants pressed bison when in actual fact the bubble depicted a horse. Whilst the area of the ears is diagnostic for horses and, it seems, also the area directly behind the ears, the extended mane often gets confused as belonging to parts of bison. Interestingly, the extended back of the horse is largely positively classified. Its similarity to rock art occurrence will be disclosed next.

One methodological flaw within the stimulus ought to be clarified at this point, which might also point to why manes of horses are often confused. Even though participants were presented with greyscale images of both horse and bison, the change in fur structure, particularly visible in the utilised image of the horse, lends itself to being brighter grey than the darker natured bison. This brightness effect has obviously not gone unnoticed by the observers. Especially in trials during which they performed below the 70% threshold, the larger bubbles would have given rise to the much whiter underlying horse features, which would have taught participants stimuli differentiations in between tasks. For, it seems particularly clear that it becomes a 'learned behaviour' when comparing first block hit and misses with final block hit and misses, particularly in the regions of the detailed inside structure of both animals. This might also explain why the darker aspects of horses, i.e. the manes and underbelly are repeatedly considered to be bison. It is likely that the whiter areas surrounding the shins of the horses were also correctly classified due to their whiter colouration, which slightly skews the results of 'hits' around the leg areas of the horse. It is predicted that if these were shaded similarly to those of the bison, their legs would have been indistinguishable and would therefore create red classification marks. This, naturally, needs revising in future versions of the software, but it clearly shows **participants' awareness of colour changes and hence influences discrimination ability**. Portraying this onto

the hunting cues, utilised by hunter-gatherers at the time of rock art creation, this becomes an important aspect to bear in mind, especially since the majority of prey animals would have also only differed by minor changes in fur colouration. This colouration conundrum bears its marks on the more detailed areas of the animals and thus, results, particularly in the inside region of both species, need to be taken with a pinch of salt.

Upon inspecting the bison classification patterns, **a trend towards the protomos (the head, inclusive of the hump) and ventral line is visible.** Furthermore, it appears that, particularly with the case of the bison stimulus, participants show difficulty in generating successful hit rates when it comes to inside details of the torso. In almost all of the classification images of bison in table 5.8 (and in addition those in Appendix C), a diagonal classification pattern on bison features is discernible. At this point, readers should not confuse this viewing pattern as being dependent on orientation of the two figures above since the stimulus was randomly flipped in between trials. This means, viewing animals pointing in either direction yields this pattern of a front ¾ outline (Fig. 5.4.17):

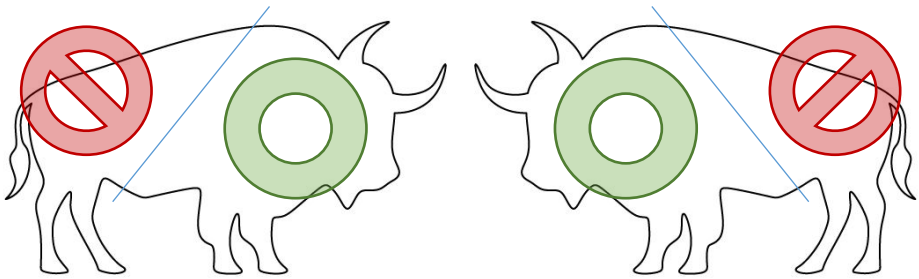


Figure 5.4.17.: Graphic illustrating that the diagnostic information of bison is applicable to the features (feature-dependent) and is independent of viewpoint.

Another aspect to highlight here is that of features being more salient than others. Due to the fact that these results are not based on eye-tracking data, and thus people's eyes and fixations in particular spots are not accounted for, it is not possible to demarcate areas of particular saliency over others within one classification image. The results above reveal that the green areas were classification hits, but do not account for how swift or with what certainty level compared to other hits these were performed. Needless to say, a combination of a modified *Bubbles* software with integrated eye-tracking capabilities, would yield even more nuanced results.

Conversely, the data can also be approached from a different angle. An angle that assesses the classification images generated at the end of a trial on equal terms rather than taking each species individually. For, understanding a participant's 'miss' rates on one animal and applying this understanding onto how 'miss' rates manifest themselves in the other stimulus within the same block is equally illuminating. The fact that participants consistently struggle to distinguish whether they are seeing a horse or a bison when presented with bubbles from the inside of either animal, points to the fact that these regions are notoriously difficult to interpret. A largely uniform bubble, as is the case for torso areas, with no identifying edges that would otherwise give its character away, largely yields a negative response, i.e. one where respondent would 'guess' wrongly. The same goes for bubbles that display features that are similar across species, such as the display of hooves, the muzzle/snout area within both CI's or even the bushy end of tails. Without giving to much away on the art correspondence, the result that feet are not easily distinguishable matches up with what is to be found on rocks, or rather what is not to be found. Participants are equally likely to 'guess' whether feet-featuring bubbles correspond to bison or horses. Again, this guesswork could account for the fact that feet are overwhelmingly omitted in rock art. All of these factors suggest that **the key to differentiation lies in the factors that make these animals unique**. Be it their hump, their horns, their characterising area of thicker coat towards the head for bison or be it their pointy ears, their long faces and their characterising sinuosity/swung dorsal line for horses.

Concluding remarks: How useful is *Bubbles* for an animal discrimination task?

Participant responses throughout all blocks of trials (more data obtainable in Appendix C) confirmed that the *Bubbles* technique is able to isolate diagnostic information in an animal discrimination task. Overall, the most salient features that are exploited during the discrimination of animal types surround animal outlines and are particularly concentrated around the protomos areas of both species.

Now that the basic forms of the classification images have been disclosed, the part of this chapter, and arguably the most anticipated, in which discrimination patterns are mirrored onto rock art occurrences, follows next.

Matching up the classification images with rock art features

It will be tested whether the resulting classification images described previously resemble the art found in the Côa Valley. If, indeed, depictions of animals in Palaeolithic art resemble their classification images, this may explain why only parts of animals are typically depicted to stand for the whole. Largely, it will reveal that rock art forms can be attributed to how the human brain processes and discriminates visual information. Hence, to start off this section, the entire animal masks used earlier have been modified in accordance with the positive classification areas, making it easier for subsequent comparison with rock art features (Fig. 5.4.18):

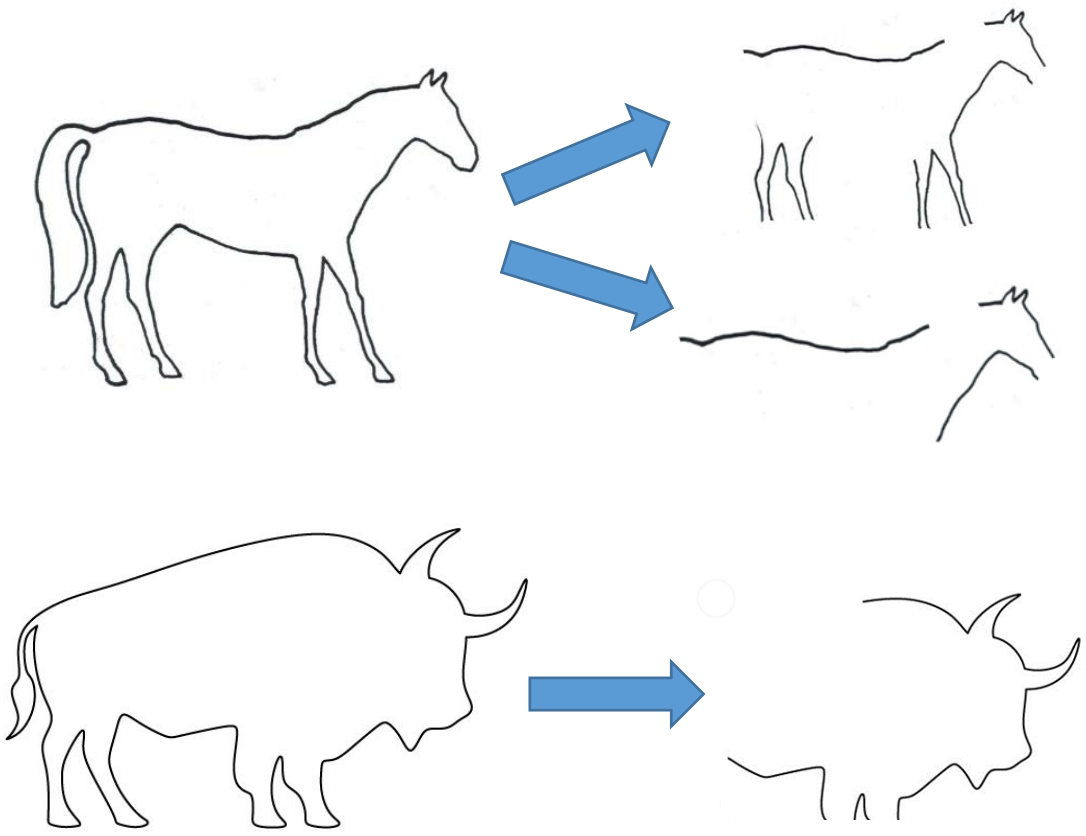


Figure 5.4.18.: Graphics illustrating that the diagnostic information of bison is applicable to the features (feature-dependent) and is independent of viewpoint.

The horse image was divided into two alternatives, one displaying the diagnostic information as revealed in the classification images in Fig. 5.4.15, and one accounting for the fact that the white colouration on the horse's legs in this particular stimulus used for the software likely made participants choose the animal colour and not the form itself. This, in turn, throws up an interesting question on how artists will have handled the notation of colouration, such as changes in seasonal fur change or as is visible in the stimulus input, random spots of colour on the animal. This idea will be picked up on later again.

Broadly speaking, it is possible to deduce that the majorly defining feature of rock art of the Côa Valley, namely that of outlining animals, is also mirrored in participants' hit counts of visual saliency within the same regions. A look at the findings from the previous sections reveals that the resulting classification images strikingly do, in fact, resemble Upper Palaeolithic rock art imagery. For a broad comparative overview of how complete motifs are across all species, the graph entitled "completeness of animal depictions" (Fig. 5.2.4) which was generated for the earlier archaeological groundwork section, should be consulted. Yet, this section presents a more nuanced overview of how complete rock art depictions are that specifically display horses and aurochs (cf. Ch. 4, table 4.3 on 'interchanging' aurochs with bison and vice versa).

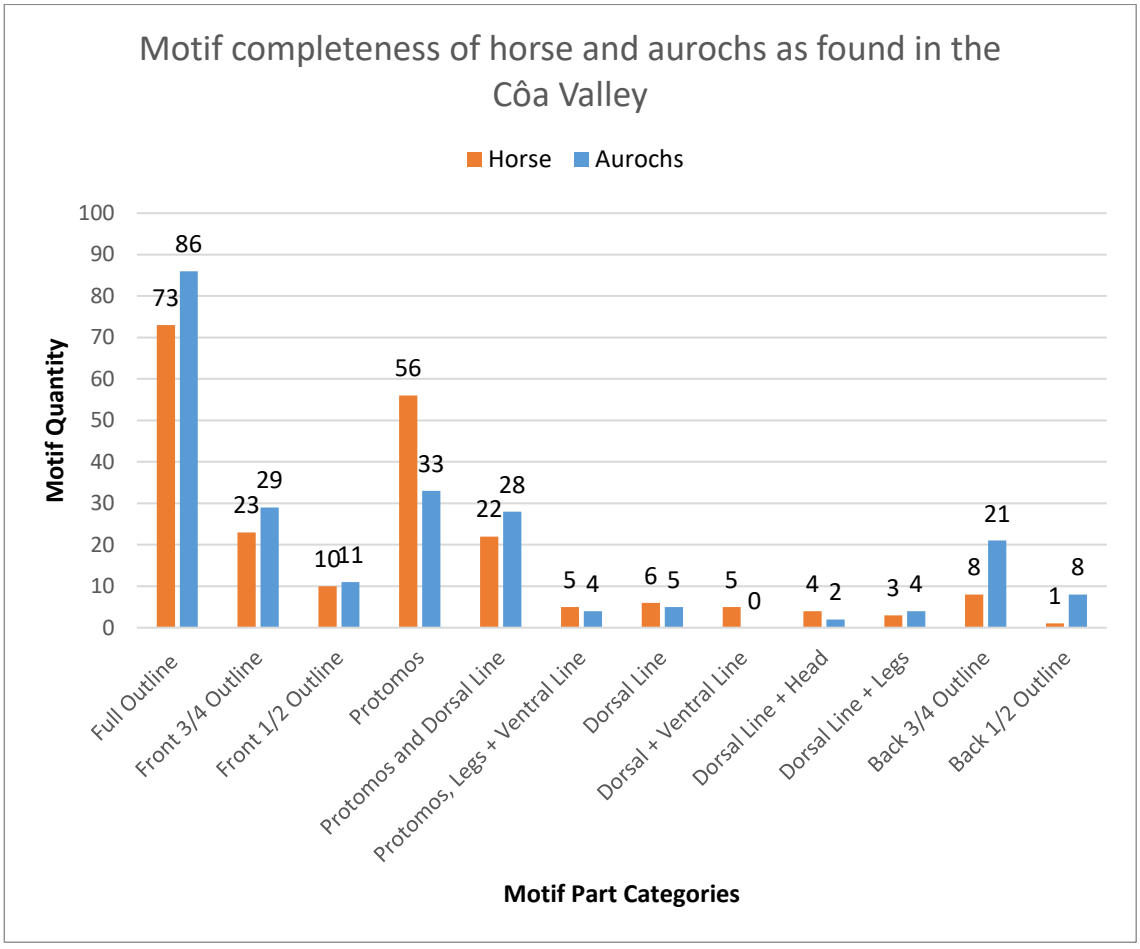
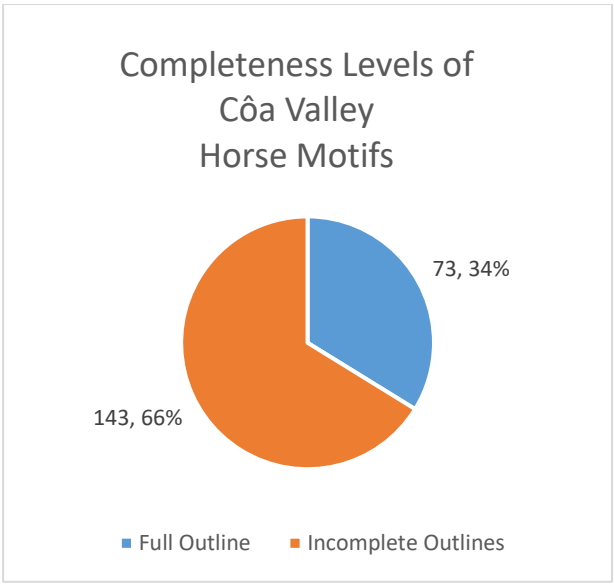


Figure 5.4.19.: The completeness levels of horse and aurochs depictions in the Côa region.

At first sight, it seems as if both horses and aurochs are most frequently depicted by means of full outline (Fig. 5.4.19). Yet, when all other categories are combined, meaning those that render the animals incomplete, the following pattern establishes itself:



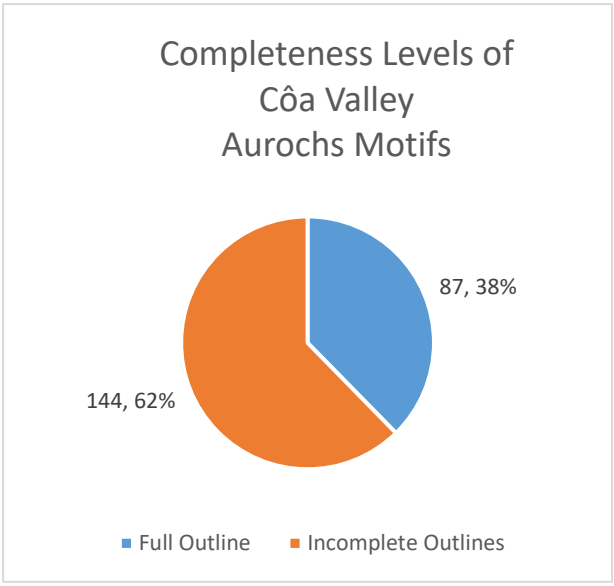


Figure 5.4.20 and 5.4.21.: Completeness levels of horse and aurochs depictions in the Côa region.

In considering these graphs above (Fig. 5.4.20 and 5.4.21), it becomes clear that the majority of animals are not completed by their artists. Moreover, out of the 66% (aurochs) and 62% (horse) motifs that are deemed incomplete, 90% and 80% of motifs display all (or fewer) features represented in the overall positive classification image of these species, respectively.[18]

The concept that motifs are often displayed with fewer features than those specified in the classification images is intriguing. It means that artists utilise their cognitive abilities to derive at the most visually salient format of their depictions, yet subtract even more features from that

[18] This was calculated by adding all motif counts that match the CI criteria and dividing their sum by the overall sum of incomplete motifs. For horses, for example, all motif part categories were summed, bar those of full outline and back ¾ and back ½ outline, as they did not fall into the remits of the positive CI. This sum was then divided by the overall sum of incomplete outlines to come to the final percentage of CI and rock art overlap.

information. This gives rise to an even more distilled version of art creation, an extended short(er)-hand of the already cognitively derived visual short-hand, akin to the versions of *artistic minimalism* created during experiment 1. As previously mentioned, exemplary of this extended short-hand is the aspect of *sinuosity*, as described by Santos (2017), with well-versed rock art enthusiasts capable of detecting animals only by means of viewing the corrugation of the dorsal line. The fact that we have this ability nowadays is, hence, indicative of the same or better abilities of rock art audiences of the past, given that they would have also likely been equipped with *emic* insights into their existence.

Concluding remarks: How is the *Bubbles*-generated *diagnostic information* used by artists?

Interestingly, **artists seem to revert to using an even more honed down abbreviation system of engraving, than would be assigned by the visual brain alone**. Even though there is little doubt that the underlying human cognitive structure, assigning visual saliency, initially dictates the use of diagnostic information in the rock art, a subsequent step/reason for further rock art minimalism must be at play here.

For some reason rock artists wanted to abbreviate their creations as much as possible, but still maintain the ability for discrimination. Upon reminiscing about the discussion points raised at the end of the archaeological groundwork section of this chapter (Chapter 5.2.7), it seems as if they still hold true, even after empirically testing participants on aspects of visual salience. In particular, in accordance with the results from this experiment, the ladder of identification ability can now be reviewed and approved:

Ladder of identification ability:

5.) Saliency of head features

6.) Saliency/sinuosity of dorsal line attached to explicit head features

7.) Saliency/sinuosity of dorsal line only

8.) Rest of the torso

5.4.6. Wider implications of *Bubbles*: What can *Bubbles* do for Upper Palaeolithic art?

What can be inferred from the knowledge of *shorter* short-hands? One rational argument for this desire points to the notion of *expedience* (i.e. speed). Rock artists wanted their creations to be recognised yet did not want to exert great amounts of time on them. This is akin to tasks of hunters who need the ability to swiftly locate prey species, yet also need to move on and switch to other tasks such as the identification of other incoming dangers.

A thought-provoking analogy for *short-hand* caused by *expedience* can be found in the way Disney cartoonists create their characters with gloved, four fingered hands (see Aaseng, 2015). First, it prevents viewers from traversing into territories of the *Uncanny Valley*, by not making their animal characters appear too realistic/human-like (see Mori, 1970), a factor worth future exploration in conjunction with rock art animals and odd-looking anthropomorphs. Secondly, the use of gloves dates back to times when cartoons were featured in black and white. This feature allows for contrast between a white hand and the rest of the body, making the composition appear more identifiable. This can be translated, in the rock art making process, to the figure-ground idea of chiselling away white rock dust from a contrastingly coloured darker medium of rock. A more pressing reason for Walt Disney awarding his characters with only four fingers, however, was his interest in expediency of drawing techniques to minimise on cartoonists' efforts and, thus, his money. This was especially important during the early stages of cartoon making in which each scene in a cartoon had to be redrawn by hand hundreds of times. Even though cartoon creation is now computerised, the four-finger hands on Disney's characters persist. This exposition, albeit anachronistic, into the use of short-hand might give rise to similar structures of its use in the past.

Rock art authorship and rock art audiences

It might be worth taking a step back at this point to think about the position and perspectives of the creator of these engravings. An interesting account by Goldstein (2007) regards the practice of photographing things as acts of "temporal" and "spatial" editing. Accordingly, the most crucial moment for a photographer is that of when to trigger the shutter. Before this though, the *temporal editing* component come into play which is the choice of one moment or image over another. In other words, do I want to take a picture of the sea or the promenade? The *spatial editing* comes after the shutter has been triggered, which constitutes of the selection of one portion of an image over another portion of the same image. The act of spatial editing is that of cropping a "wider landscape view to fit what is most necessary/worthy of depiction" (Goldstein, 2007: 72).

If this idea is applied onto rock art, the temporal editing would be the choice of a horse over a bison and the spatial editing part would be the selection of depicting a protomos over the dorsal line. These two editing stages require the artist to have a reasonable idea of intent for their selected artworks prior to their engraving actions. The difference between a photographer and a rock 'artist' is that the former triggers the shutter, the landscape remains the same and a picture is taken out of the situation to be portrayed elsewhere, whereas the latter creates and shapes the landscape for eternity with their engraved images remaining *in-situ*. Thus, when compared to what a photographer needs to consider regarding the medium they are working with, a rock artist needs to think about the permanency of their creations. Arguably therefore, the most crucial moment for a rock artist in terms of 'temporal' editing is which scene to depict and in terms of 'spatial' editing, which part of that scene is able to convey the desired effect for onlookers. On the other hand, artists in the Côa environment select time and space for their portrayals, but unlike a single photograph, they are able to add and manipulate their image till satisfaction: "The camera is susceptible to the selectivity of the operator, but it is not selective once the shutter is opened" (Collier and Collier, 1986).

As introduced above, one argument that results from the discussion of this chapter is that the prioritising aim of the carver was easy legibility and immediate recognition of creation, rather than affording accurate reproductions. A simple definition of what is on show is created by a limited range of points and lines. Garlake (1995: 23) sees a similar pattern emerging in studying Zimbabwean art and points out that "the (carvings) are intellectual distillations of concepts of reality". Every animal seems to be reduced to its most essential characteristics which creates an effortless immediacy of meaning through mark making.

This would be a satisfying answer if there were no other rock art images that do not abide by this *minimalism* rule, which, as established earlier, is the case. Indeed, after establishing that rock art depictions seem to have been guided by visual attention, why is not all art depicted in this fashion? Why does one, time and time again, find embellished animals, complete with depictions of eyes and hooves (features that, cognitively, are very similar between species)? If the torso of the animal can essentially be made redundant and if, reductively, the head alone can signal identification, why would artists expend more efforts and display additional features?

One conceivable answer would be, that the economising on time (i.e. expedience) was not important in all cases and that their representations were not made purely for onlookers to swiftly identify their creations but are instead made for a different purpose. Perhaps these depictions were for a more *artistic,* feature-rich purpose and were less cognitively-driven?

The hunter = the artist?

The question of authorship has circulated amongst rock art researchers ever since the discovery of art. The preceding writing has, until now, not explicitly distinguished between the artist, the hunter, or a possible amalgamation of both. Readers can be forgiven for thinking that the person who created the art will have also been the hunter in return. In fact, the experimental analysis is heavily targeted towards the implication that the artist was in fact the person who would have used their observation abilities for successful hunting, which is why in turn the art takes its characteristic forms. What if, in fact, the art was not created by the hunter at all, but by an artist outside of hunting community, and that the diagnostic information features in *Bubbles only* apply to hunters or artists but not both?

Given the fact that being able to hunt successfully was key to their survival, the abundance of depictions that signal exactly this information, namely features necessary for successful detection and discrimination of prey, would give rise to **hunters also being involved in the art making process.** Nevertheless, hunters also needed to see their prey from many different angles, perspectives and distances, which can be studied further by using more nuanced Bubble openings. Additionally, hunters will have, undoubtedly, been steeped in knowledge of animal behaviour. They would have continuously gained insights into their preys' ethologies; their physical appearances including coats and how this reflects seasonality; their behaviours and moods; their movements (the way they stood and moved); their sexual receptiveness and competitiveness. With this rich knowledge in mind, coupled with the hunters' own respective degrees of alertness, power and fear, could it not be argued that hunters wanted to reflect their wealth of knowledge on these idiosyncrasies by way of engraving very detailed depictions of animals? This question might provide the clue as to why some more elaborate depictions are found, namely for hunters to, in a way, educate others with more features. Exemplary of detail that could have been used in such teaching might have the M-shape characteristic, frequently found on horse bellies, which indicates a change in seasonal fur. This special feature of Przewalski's horses will not have gone unnoticed by hunters. Despite the fact that the M-shape does not contribute to a horse's diagnostic information in a major manner, this colour change (aligning with the stimulus colouration conundrum from earlier) would qualify as a special feature. Accordingly, in rock art location at which M-shaped horses do appear, hunters might have wanted to record their sightings of these more undiagnostic, seasonal animal changes and thus deemed the M-shape worthy of portrayal. To conclude, all of these scenarios, point to **hunters as facilitators of the art, be it in their hunting/discrimination mode or in their teaching/memory storage, more elaborate feature mode.**

5.4.7. Conclusion: Bubbles

This section serves as a brief conclusion for the questions asked at the start of this section:

(1) Can visual psychological processes explain why animals are depicted in the way they are?

This initial study demonstrates that the *Bubbles* technique is feasible for use with stimuli other than human face recognition. Despite the limitations addressed at the beginning of the chapter, the fact that the feasibility of using the *Bubbles* methodology to mimic responses from rock art making, rouses optimism that this study will pave the way for further applications of the technique to link more Upper Palaeolithic scenarios (applicable, of course, to other archaeological periods and tasks too) with their psychological underpinnings.

(2) Which are the most diagnostic features on (1) a horse and (2) a bison, that actively aid our identification of this particular species?

The established classification images reveal particular areas that entail diagnostic information. This information varies between the species. Horses are most commonly identified alongside their outline, with particular emphasis on the dorsal line and the areas of the head. Bison are distinguishable by their visually salient hump and their protomos extending towards their front legs. The fact that this diagnostic information varies between species indicates that each type is identifiable by their most diagnostic parts and that the *Bubbles* technique succeeds at pointing these features out.

(3) Does the minimal amount of information needed for detection or discrimination of an animal, as revealed by the *Bubbles* method, correspond to the features depicted in rock art?

Overall, the features that human perception prioritises are also most commonly observable in rock art depictions. Aspects such as feet, detailed coat interior lines or eyes are commonly omitted from rock art, as these are uniformly present within all species. This illustrates that rock art creation is cognitively-driven, mimicking the information necessary for hunters to distinguish different prey species.

(4) If rock art features do resemble the diagnostic information established through *Bubbles,* are we therefore able to make inferences on the hunter as the artist?

Despite the abundance of diagnostic features within motif parts, which would point to hunters illustrating these creations in line with what is necessary for distinction, a number of rocks exhibit far more elaborate creatures. This would point to another underlying reason for rock art creation, with aspects such as more elaborate teaching and memorising of places at which features were seen, that go beyond those of saliency, discussed. It was summarised that in all circumstances, hunters would have played a key role in the facilitation or in guiding art making.

Chapter 6 – Perception – The Panel Level

6.1. Introducing the Perception/Panel Level

Having inspected rock art at the motif level and the various visual and perceptual features that motifs and their individual compositions have to offer, the next step is to go beyond the motif stage and consider their wider situatedness in their compositional space – the panel. Panels will be approached from a myriad of different perspectives and above all panels will be treated, just as Keyser and Petschat (2004: 13) do, as "a landscape in miniature". Rock art studies thrive when not only motifs in isolation are considered, but when their locations are contextualised. Within *The Meaning of Things*, Llamazares acknowledges the importance of looking at the relationship between elements and not necessarily at motifs in isolation: "It is important to view the elements as crossroads of relationships (…). It is not so essential to check whether it is a circle or a dot, as to study its combinational possibilities" (1991: 245). In accordance with these ideas, first, the panel's physical composition and its suitability for different carving techniques (Archaeological Groundwork) is investigated. Next, the rock art panels will be assessed for the adoption of Gestaltian principles and what that might tell us about the stylistic choices of the carvers (Experiment 3). Subsequently, the compositions of motifs on a panel are inspected with a special focus on superimposed imagery (Experiment 4). To situate the reader, below is an illustration (Fig. 6.1.1) signalling the thesis' progression, with current experiments circled in green:

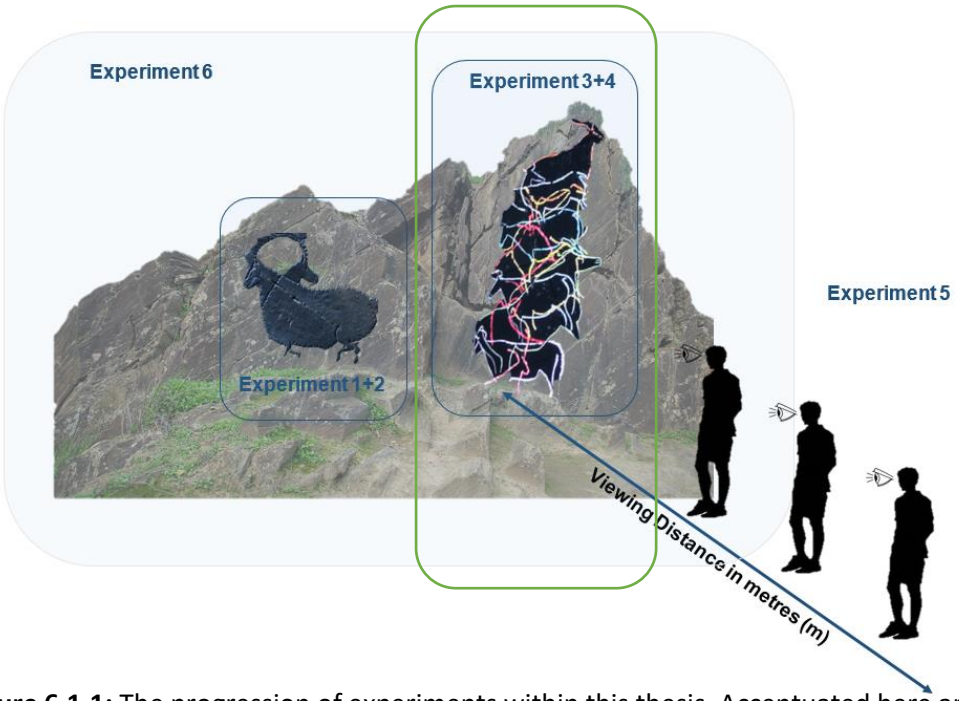


Figure 6.1.1: The progression of experiments within this thesis. Accentuated here are the experiments under study in this chapter.

6.1.1. Panel-specific research questions

As a reminder, here are the questions addressed in this chapter, satisfying the overall research objective set out for this chapter: **Why are specific panels and panel compositions chosen?**

Archaeological analysis

- What types of …
    - engraving techniques
    - base colouration of the schist
    - panel orientations

  … exist in the rock art of the Côa Valley?

Psychological (experimental) analysis

Experiment 3: Gestaltian Analysis

- Do the rock art compositions adopt Gestaltian principles?
- What does this tell us about the rock art making process and about the stylistic choices of the carvers?

Experiment 4: Superimposition Study

- Why might artists superimpose their creations?
- Which motifs overlap each other and what are their related frequencies?
    - Why do certain animal types overlap? Is there a visual strategy behind this? If so, which?
- Are there different degrees of superimpositions?
- How visible are engravings within different degrees of superimpositions and rock types?
- Where do superimpositions occur on the panel?
- Can superimposed images provide insights into the mind-sets of carvers at the time?

Perception - research overview

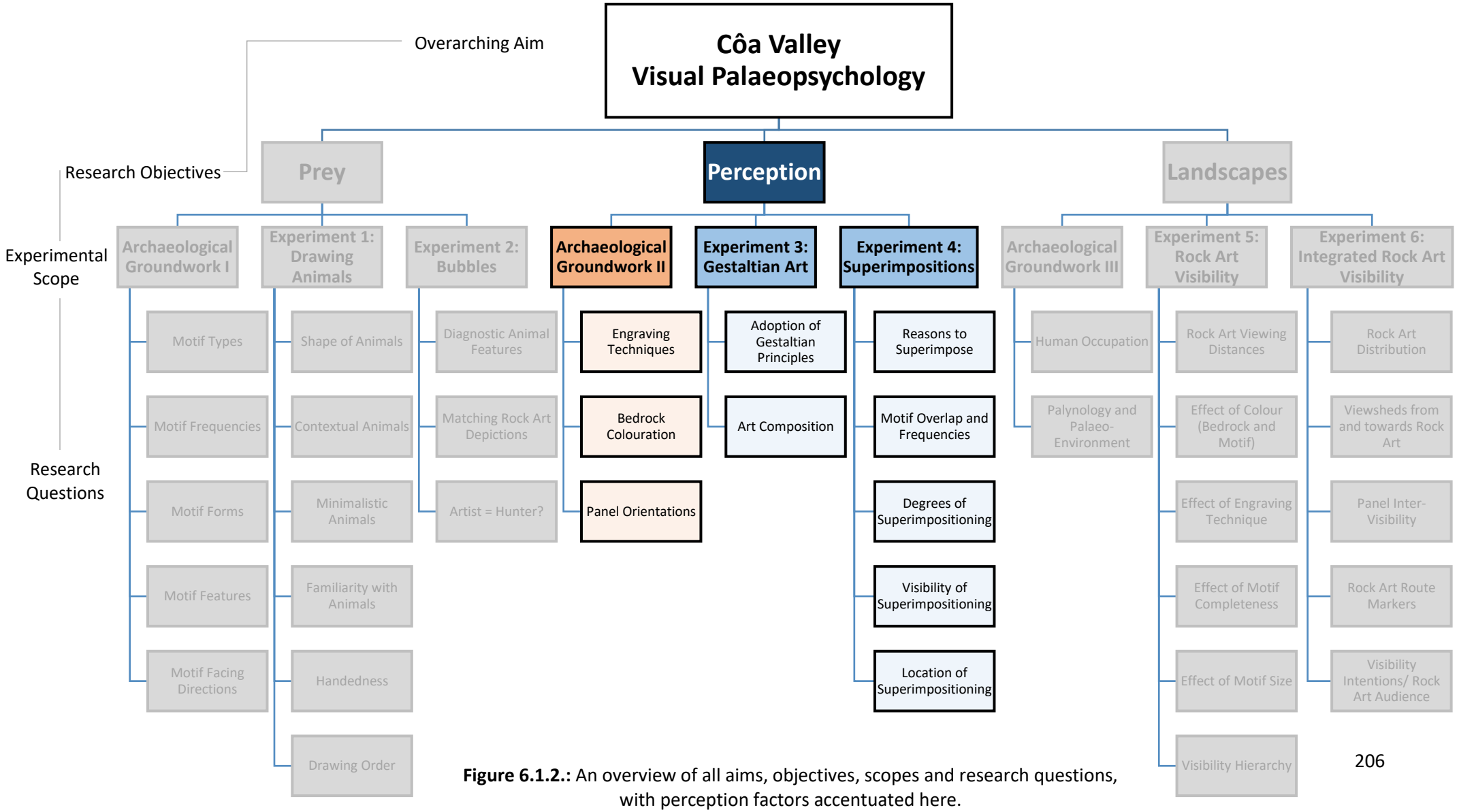


Figure 6.1.2.: An overview of all aims, objectives, scopes and research questions, with perception factors accentuated here.

6.1.2. Perceiving, now and then

As has been previously established, Upper Palaeolithic artists were cognitively and anatomically speaking the same as us (cf. Ch. 3.2.1). Landscape datasets also suggest that past environmental conditions can easily be likened to those we find in the region of the Côa nowadays (Aubry *et al.* 2002). This includes the constancy of rock locations and thus the art itself, which will not have shifted from its original point of art creation. These three relatively speaking constant factors however, fundamentally clash with the availability and variability of visual and material culture, that has survived from the Upper Palaeolithic. Whilst, archaeologically speaking, the period produced a plethora of materials that we can interrogate nowadays when studying their functions and place within their society, the lack of sheer quantity and the variety of colours and styles differs vastly to things modern observers experience on a day-to-day basis. The available materials at the time of the art's origin differ so greatly to the available materials that we have at our disposal nowadays. Essentially, as Peter Wells (2012) argues in *How Ancient Europeans saw the World,* the number of objects in the past was relatively small in comparison to the abundancy of 'stuff' we possess today. Readers of this thesis need to bear this stark contrast in mind when questioning whether Upper Palaeolithic people perceived in similar ways to us today – in terms of nature and nurture.

To reiterate, a deciding factor for the success of this study lies in the similarity of perception ability of Anatomically Modern Humans and modern observers of the art. Another contributing factor to the success of this study is that the material, even though still *in-situ*, has remained relatively unspoilt. Bearing that in mind, originally, it was the intention for this section of the thesis, as also alluded to in the introductory and methodological chapters, to consider the choice of rock outcrops and their specific characteristics as being successful canvases for art creation. A scheme was devised to inspect rocks and their characteristics whilst 'in the field' (see Ch. 4.1.4), yet it turned out that the degradation and conservation of the rock outcrops will not be true to what they once were, deeming the intended study meaningless for purposes of this research. Nevertheless, if the reader is interested in why certain outcrops might have been preferred over others, papers by Antonio Batarda Fernandes in 2008, 2016 and 2017 should be consulted. Hence, in its place, the actual location of rock art accumulation is assessed. Instead of a contextual study of rock outcrop choice, a contextual panel space analysis assesses why certain areas of a panel might be preferred over others. It will be intriguing to come to a better understanding as to why certain areas of rocks were preferentially selected.

6.2. Archaeological Groundwork

6.2.1. The engraved species database - compositional

Just like the proceedings within the previous chapter, this section involves another close look at the gathered data, collated in the *Engraved Species Database*. Below is a screenshot (Fig. 6.2.1) that indicates what types of data, applicable to this chapter, have been captured in the construction of this database[19]:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Internal Num	Site Name	Panel Name	Panel N°	River Connecti	Rock Type	Rock Surfa	Rock Textu	Rock Colour	Facing Direct	LONG	LAT	ALTITUDE	Animal Num	Time Period
2	1	Foz Coa	FC	148	Upstream from th	Schist	Regular	Smooth	Orange-Brown	East South East	-7.10658	41.08024	160	1	Paleolítico; Id. Ferro
3	2	Foz Coa	FC_A (Fragment	1	Upstream from th	Schist	Regular	Smooth	Brown	Fragment	Fragment	Fragment	150	1	Paleolítico
4	3	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	1	Paleolítico; P-H. Recente
5	4	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	2	Paleolítico; P-H. Recente
6	5	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	3	Paleolítico; P-H. Recente
7	6	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	4	Paleolítico; P-H. Recente
8	7	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	5	Paleolítico; P-H. Recente
9	8	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	6	Paleolítico; P-H. Recente
10	9	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	7	Paleolítico; P-H. Recente
11	10	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	1	Paleolítico; Histórico
12	11	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	2	Paleolítico; Histórico
13	12	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	3	Paleolítico; Histórico
14	13	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	4	Paleolítico; Histórico
15	14	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	5	Paleolítico; Histórico
16	15	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	6	Paleolítico; Histórico

Figure 6.2.1.: Screenshot of the database in use for the establishment of panel features and their locations.

The following features will now be investigated and discussed in this sub-chapter:

- Engraving techniques of motifs (Chapter 6.2.2)
- Bedrock colouration - base colouration of the underlying schist (Chapter 6.2.3)
- Panel orientation (Chapter 6.2.4)

These considerations will provide a solid grounding to the variables that are being tested within this chapter's experimentations. As will become much clearer throughout, all of the above panel and engraving features inevitably have a big part to play in how visible a panel appears to its audiences. It will be argued that Upper Palaeolithic artists will have used these key features to their advantage in manipulating what was to be seen by whom.

[19] A more detailed view of the entire database can be consulted in Appendix A.

6.2.2. Engraving techniques of motifs on panels

There are a number of different engraving techniques employed by the artists in the Côa and Siega Verde regions. This is often associated with the natural underlying material that the rock art is to be engraved on. The majority of engravings in the Côa Valley can be found on schist rock. Some surfaces require different techniques than others, with hard granite requiring heavy pecking repetitions and schist rocks requiring only gentle incisions in order for them to become visible. This is, however, not to say that the majority of engravings are done by incision. In fact, a plethora of techniques can be identified within the Côa engravings:

1. Incised
2. Incised with Multiple Contours
3. Abraded
4. Pecked
5. Fully Pecked Out
6. Discontinuously Pecked
7. Mixture Pecked + Incised
8. Mixture Pecked + Abraded
9. Mixture Pecked + Incised + Abraded
10. Azilian Style
11. Partly Azilian/Partly Incised/Striated

Furthermore, there are also a number of things that can be said about why certain techniques might have been utilised by the artist. Certain engraving types lend themselves to being more visible than others; some are so fine-lined that a very close look at the rock is necessary to identify its character. The differences in visibility are considered in this chapter and the next by means of two experiments, one that assesses the multitude of superimpositions (experiment 4) and the other investigates viewing distances to the art depending on changes in technique and colouration (experiment 5 in the landscape chapter). Having said that, there are two dominant engraving techniques used within the rock art traditions of the Côa and Siega Verde. First, incisions that are produced by using a strongly pointed tool to create incised lines. Secondly, a contrasting technique to incision is pecking, whereby a stone tool hits the chosen rocks, through indirect (possibly with a hammerstone to guide the pecking tool) or direct percussion (direct tool to surface). Judging by the accuracy of the peck-marks within the outlined realms that most engravings exhibit, it has been suggested that the preferred technique therefore was that of indirect percussion. This gives the artist a greater guidance through the stability of hitting the rock at the chosen location by placing a stone instrument on the rock and hitting it with a hammerstone (Baptista, 2001; Luís, 2000). Finds from the Côa Valley occupation site of Olga Grande 4, in the form of sharp quartzite points and later experimental replications of such finds have been linked to their function as indirect pecking points (Aubry and Diez, 2000).

Experimental trials near the site of Canada do Inferno however bear evidence that large-scale animals, when its outline has been previously outlined, could have easily been made through direct percussion, with only a few pecked marks leaving the intended outlined zones (Batarda Fernandes, 2011). A combination of both incision as well as pecking can be observed when desired rock art figures have been roughly traced by way of incising the outline and subsequently pecked and/or abraded to enhance and deepen the traces (Zilhão, 1997; Luís, 2000; Baptista, 2001; Sacchi, 2002; Zilhão, 2003). An alternative technique, although observed less commonly, is that of abrasion (scraping away of the rock surface to create depictions).

Further experimental reproductions of creating rock art, done by for instance Trond Lødøen and Morten Kutschera in 2015 as well as members of the Côa archaeological team in Portugal throughout the years (see Aubry *et al.* 2012b), reveal the making processes, energy expenditure and time commitments needed for successful engraving episodes. From the author's subjective experience of creating features on both granite and schist slabs (see Fig. 6.2.2 for a (poor) attempt at incising a horse into schist), both accuracy and detail tend to be considerably poorer than attempts for which pigments were used on different kinds of rocks. In fact, the soft nature of schist rock slabs requires a skilled engraver to not accidentally damage parts of their depiction that were originally intended to remain (Meyering, 2016).



Figure 6.2.2.: Experimental trials of engraving on schist surfaces (author's replication).

Carving techniques of motifs – results

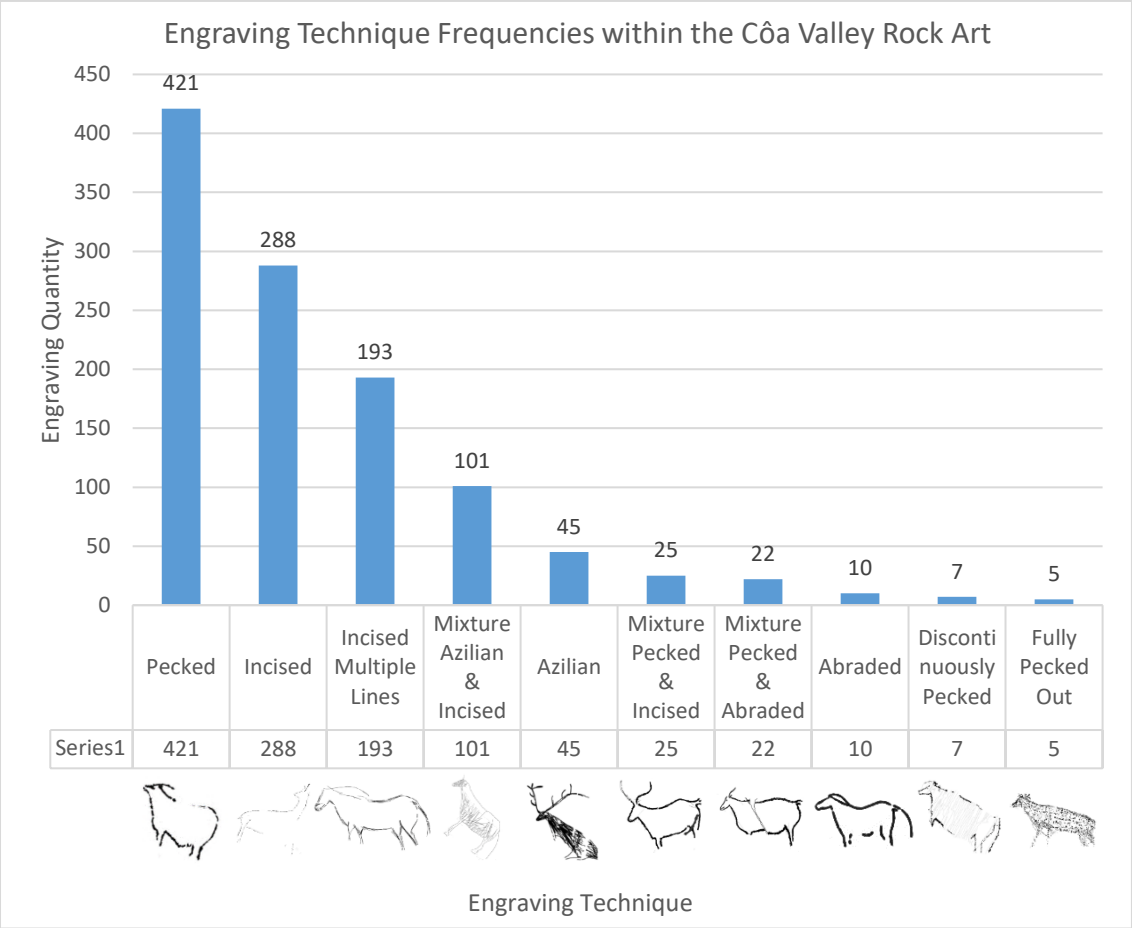


Figure 6.2.3.: Quantity of carving techniques found within the Côa rock art ensemble.

The chart above (Fig. 6.2.3) reveals the relative frequencies of the utilised carving techniques in the region under study. Pecking (n= 421; 38%) seems to be the favoured way of mark-making in the region, followed by simple incision with which n=288 animal engravings were made equalling 26% of all depictions. The more complex incision technique of outlining the incised animal multiple times was recorded on n=193 animals making up 17% of all engravings. The rest that makes up the remaining 19% is filled with a combination of engraving styles applied onto the making of one single motif. Zilhão *et al.* (1997: 25) point out the use of a variety of techniques in the manufacture of a single petroglyph and add that "sometimes, this enhancement is restricted to particular body parts, generally the horns, the head and the forequarters". This observation is highly intriguing, as the tendency for the use of different techniques for the creation of one engraving especially within the region of the head corresponds to the animals' prime and most salient features (cf. Ch. 5). Additionally, a combination of both incision and pecking can often be observed when desired rock art figures have been roughly traced by way of incising the outline and then pecked and/or abraded to enhance and deepen the traces (see Luís, 2000).

Carving techniques of motifs – discussion

The difference in utilised techniques in the Côa rock art corpus is remarkable. Even though the properties of the schist lend themselves well to merely creating a few strokes to make an image, pecking was obviously prioritised. This means that the marks were indeed created with greater effort, and thus with a sense of greater permanency in mind. Moreover, even though incisions allow for greater accuracy and representation of detail, *pecking* a motif into stone was still favoured, which would have allowed for much less detailed precision. This, therefore, gives us an insight into the underlying intentions for the art.

This discussion can be carried out alongside the consideration of technical preferences of the artists. Again, it is important to discuss the surface into which motifs are being carved. Numerous cave paintings known to be of Upper Palaeolithic age and pictographs created by San Bushmen and Aboriginal Australians (who use pigments to create images) often incorporate detailed features such as eyes and adorned depictions of clothing (Chippindale *et al.* 1998; 2004; Lewis-Williams and Challis, 2012). These more detailed features are not found within the rock art of the Côa Valley. This change in pattern between caves and open-air environments makes sense, if looked at in conjunction with the material on which and with which the art is created. Both the underlying surface and the utilised drawing/pecking equipment are important in this regard. Be it a fingertip or fine brush made out of animal hair soaking up pigments or a more robust hammer stone for use in pecking, the outcomes will unquestionably be very diverse.

If the carvings are to be assessed based on their source material and engraving style, the very fact that animals were engraved favourably by pecking onto the rather soft underlying surface of schist material conveys a plethora of associated ideas about the resulting motifs. The following table (Table 6.1.) presents a hypothetical assessment of using incision versus pecking on a soft surface:

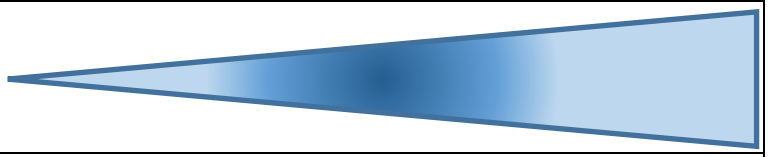
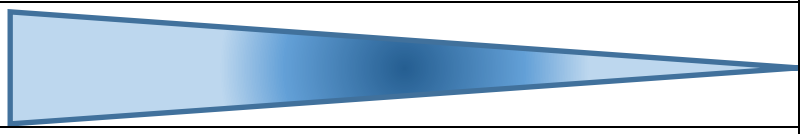
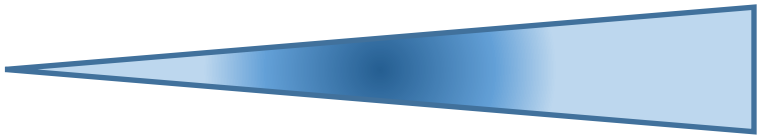
	Incision	Pecking
Permanency, i.e. durability		
Attention to detail		
Energy commitment, i.e. physical force		
Manual Dexterity, i.e. skills		
Time commitment, i.e. attention span		

Table 6.1.: Incision versus pecking and its impact on various mechanical factors represented on the left.

By way of concluding or rather evaluating the chart above, the following additional ideas are observations on the possible influences on the differential ways of depicting zoomorphic motifs throughout the Côa Valley:

Pecking, as opposed to incision, requires more energy, physical force, effort and time-commitment. Hence, one might argue that motifs are to be made more permanent by way of pecking and this eternity of carving means long duration of meaning.

Motifs that are made with incision (which is still a considerable percentage of the overall engraving technique statistics = 26%, see Fig 6.2.3), lend themselves to more precision in the way of conveying exactly what is meant to be portrayed, which arguably requires more skill than pecking rough outlines. Yet, others might argue that the act of creating something artistically minimal by way of pecking requires more skill when intended to convey meaning in an instance (cf. with discussions from Ch. 5).

Carving technique versus artistic style

Noteworthy is the fact that carving techniques should not be confused with that of artistic style, and that is not to be confused with artistic capabilities. Techniques constitute those of pecking and incising, while styles are individual to the artist, for instance holding their hammer stones at oblique angles or making incisions in particular ways. Artistic capabilities are to be determined in the way that they carry out their depictions. Arguably, artists that are more skilled become apparent in the way they construct animals with minimal amount of lines and their audience are still able to identify one particular animal type. Individual artistic styles are difficult to identify in the rock art, especially when the majority of the engravings are done by methods of pecking. The problem of what constitutes a style is a different issue to solve. Often style becomes noticeable in how different artists handle animal proportions, how they display an anthropomorphic figure and how they create certain shapes and detailed features in different ways. Nevertheless, stylistic variations are generally governed by a number of things (see *The Economic Side of Rock Art* by Fiore (2007) for a more in-depth discussion of some of these ideas):

- Individual artists' idiosyncrasies, abilities and skills; associated with personal specifications such as age, gender, social standing, personal skillset
- Knowledge and management of their materials such as tools, landscapes, bedrock, possible pigments and outside weather conditions
- Knowledge of their subjects, animal idiosyncrasies
- Regional school of artists
- Mental attention and affection

Although formal variation and stylistic capabilities of the artist can be discovered from one site to the next in the art of the Côa Valley, their significance is uncertain, and their parameters cannot be satisfactorily defined. However, this completely new avenue of thinking about rock art needs consideration in the future, for which questions such as the following might be a useful starting point:

- Are we only seeing the works of the most skilled artists, the 'old masters'?
- Did beginners and those who were not yet fully competent practice on portable rock slabs, wood, snow, sand or elsewhere?
- Can different talents be observed on the rocks in the Côa Valley?

6.2.3. Bedrock colouration

Chapter 2 saw the introduction of the host materials onto which the engravings are made. Despite a stretch of granite formation alongside the southern parts of the Côa River, the majority of carvings are found on schist rocks. This naturally occurring schist comes in a variation of natural hues, concentrating in the yellow to brown to red spectrum. The following colour chart (Fig. 6.2.4) is collated by the means of data published in Santos' (2017) work, colours which correspond to the hues of the Munsell soil colour book (if the reader is interested in how these colours are determined and how else colour can be studied with regard to rock art, Ruiz and Pereira (2014) offer a useful introduction).

Bedrock colouration – results

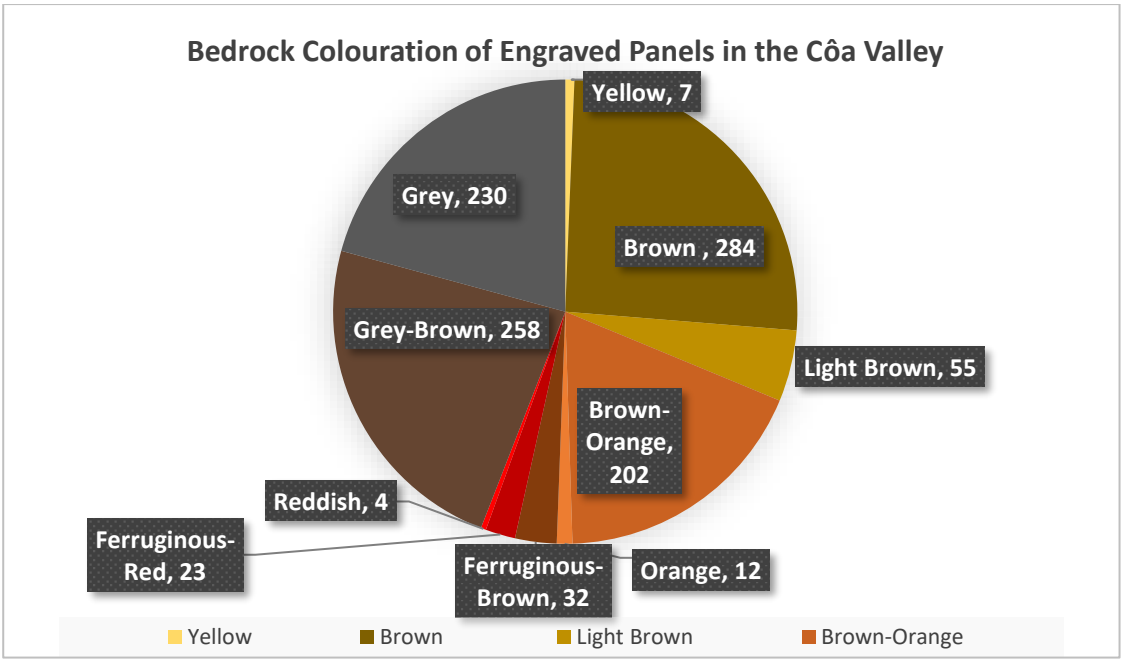


Figure 6.2.4.: Quantity of differently coloured bedrock found within the Côa corpus (colours in this chart are for representation only and do not correspond to the actual Munsell colour hues defined and used by Santos, 2017).

Bedrock colouration - discussion

The chart above illustrates a mostly even split between differently coloured rocks in the region. It needs mentioning at this point of writing that the rock colouration will have slightly changed over time - from the Upper Palaeolithic until now – and that the colours represented in the chart overleaf (Fig. 6.2.5) indicate the current state of colouration. This is due to weathering effects caused by events such as river rises, lichen deposits, acid rain, glacial melting and earthy and ferruginous accumulations affecting the panels and its associated rock art. A big revelation that has come about whilst working with the material firsthand (see Fig. 6.2.2) was the fact that the fresh engravings stand out immediately. The white almost 'dusty' lines that are created when a

sharp tool etches the surface is very much distinct from its background rock colouration. The white colouration will have been undoubtedly very striking to the carvers of the Upper Palaeolithic too. It is with this gained knowledge of the occurring natural white pigmentation from engraving experimentations early on in this research, that the next two experiments have come about and have taken shape accordingly. Furthermore, when hammering one's engravings into the chosen rock, a few millimetres of the surface material (depending on engraving depth) are chiselled away, leaving the rock exposed as a paler percolated area at the point of contact. This exposure is light in colour and leaves an almost white dusty residue, as the hammering goes into the depth of the schist bedrock, bearing different colourations. A thought-provoking study by Ramanaidou *et al*. (2019) proposes that the colour difference in bedrock and that of the scratched engraving can contribute to our understanding of how old certain depictions are. The use of a portable reflectance spectrometer aided the authors in establishing whether a difference in the bedrock colour and hematite/goethite ratio was perceptible, which in *their case* was able to estimate relative ages of petroglyphs on background rocks (ibid).

Additionally, those rocks that have been uncovered by means of excavation rather than natural processes generally tend to be rocks of dark grey/brown colouration. This is for instance the case at the site of Fariseu. Whilst we cannot be completely certain what the colour of the rocks were when engraved upon by the artists of the past, due to repeatedly similar excavations finds, we are able to speculate that the rocks that Upper Palaeolithic artists encountered tended to be on the darker side of the spectrum presented above. Having said this, covered rocks will have been innately subjected to reduced iron minerals in a lowered Oxidation/Reduction Potential (Eh) environment of the soil making rocks naturally darker over time until the point of excavation (cf. Courty *et al.* 1989). Nonetheless, adding further to the idea of selecting darker surfaces in the first instance stems from the fracturing patterns described as *testas* in chapter 2.1, where, periodically, new dark canvasses reveal themselves when natural fracturing of the schists occur, presenting the artists with ideal conditions (fresh, dark, smooth surfaces) for their creations (Luís, 2009). Repeatedly choosing a darkish rock background to host one's motifs and then exposing this darkness by the means of hammering in new lighter motifs certainly reveals underlying motivations of early artists. This insight will become important in the subsequent experiments that test if engraving style and colour impact perception of motifs, which all need to be addressed in association with the underlying bedrock colour (and testing for different potentialities of bedrock colourations will give readers the full breadth of quantifiable insights into which colour it was (or might have been) that artists had to their availability). For, the starker the contrast between bedrock and engraving, the more visible they become.

6.2.4. Panel orientation

The facing direction of the rock-carving surface might provide us with evidence of certain decisions being taken at these particular rocks. Do certain rock surfaces attract particular kinds of animals? Do panels that face into a southerly direction, thus having sun exposure over a considerable part of the day have a different importance over those hidden in more shady areas of the landscape? Do panels facing the river have a different significance to those that face well-travelled paths and are thus exposed to different audiences, or those that are hidden in a more secret location? Does exposure make images more important, or are rocks that are hard to reach and difficult to navigate more important, because of the effort that needs to go into finding them in the first place?

Panel orientation – results

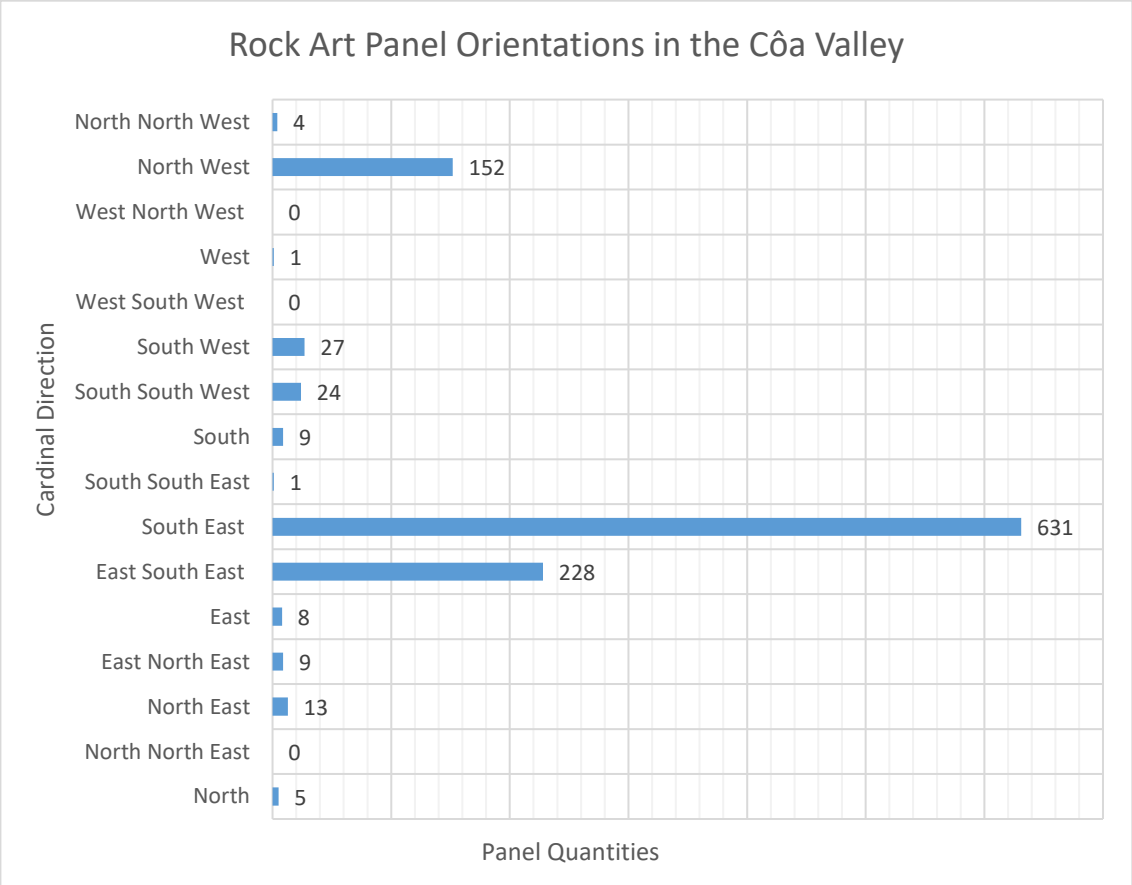


Figure 6.2.5.: Quantity of different cardinal orientations associated with engraved rock art panels within the Côa corpus.

Panel orientations – discussion

The graph above (Fig. 6.2.5) reveals a striking tendency for the rock art to be situated on rocks facing into the south-easterly direction. However, as already explained in chapter 2 (which pertains to the geographical and geological discussion of the region), the natural processes of

traction and tilting during the incision of the forming river systems left vertical fractures behind, creating breaks that are naturally aligning with a south-easterly positioning (Aubry *et al.* 2002). Thus, the data presented above is likely to be skewed by its high abundancy of naturally south-easterly facing rocks, rather than an active choice of selecting these rocks on purpose. This is however not to say that artists did not notice this trend of similar alignment, despite their lack of knowledge of how these fractures had come about.

Nevertheless, in order to evaluate these findings, several rock art studies have previously considered similar questions to the ones posed at the start of this sub-section. One such example of where the facing direction did seem important to the artists at the time of creation is the rock carvings of the Taru Thang, the Daric-speaking people of the Trans-Himalayas (Aas, 2008). Aas identifies a considerable amount of regularity amongst the facing directions of the engraved rock art slabs, stating that "as many as 75% of the panels are facing in a southern direction and 40% of the rock carving surfaces are facing south-east" (Aas, 2008: 33). The south-easterly direction in this case coincides with the direction upstream of the Indus River and therefore largely towards the Indus Valley. This high percentage of similarly aligned rock surfaces for carvings to be created on, might therefore point to an intentional choice, in order to guide the viewers, possibly themselves, to the nearest agriculturally productive centre in this case the Indus Valley. Furthermore, Aas points out that the rock facing direction does not seem to correlate to the direction of the Indus River itself, as water is generally regarded as a very scarce resource in the Ladakhian environment overall. Thus, it is more likely that the rock art faced towards the nearest productive centre, where water would be more abundant. It is also indicated that "the rock carvings are situated alongside an important travel route" and that the art might have been created in such an alignment to "make them visible to herders, nomads, merchants or other travellers journeying up along the Indus Valley" (Aas, 2008: 33).

There are likely to be, of course, many underlying reasons as to why certain rocks were selected for the making of art. In fact, readers are now likely to wonder whether the rest of the rocks listed in Fig. 6.2.5, which face into different directions in the Côa landscape, are occupied by rock engravings that are therefore somewhat different/special to the ones displayed on south-easterly facing rocks. This patterning will be explored in chapter 7, when landscape features are linked to a more general rock art distribution pattern. For now, reasons why certain engraving features appear in more frequent combinations on rock art panels are considered.

6.3. Psychological Experiment 3: Putting Rock Art to the Gestaltian Test

6.3.1. Introducing the experiment

As this chapter is concerned with the general act of perceiving rock art within its immediate surroundings, the following test scrutinises the engravings in terms of their adjoining motif-motif environments. In fact, in order to understand the meaning of an image itself, we have to catch what it shows and how it is visually constructed in the first place. Context is extremely important in this regard. The relations of where a motif or symbol is found in relation to other things tells us something about the thoughts behind its placement. A novel way to perceptually approach the visual construction of rock art is by utilising psychological *Gestalt principles* and their occurrence within the art itself. This test is placed at the start of this chapter, as it aims to guide the reader through all the different visual patterns and accompanying visual strategies employed by these early artists. The established principles are then being used to elaborate further patterns found within the data on panel motif structures and alignments.

Gestalt psychology (*Gestalt* - German for: form, shape, essence, whole) encompasses the perception of objects as part of a whole and also as elements belonging to a more composite system, instead of focussing on every component that makes up the great whole (Wertheimer, 1922). Gestalt theorists wanted to understand how perceptual groupings occur and observed that our minds appear to have an intrinsic disposition towards perception-based tasks that underlie a set of rules and visual hierarchies. The following principles are easier to understand if one considers that the human mind always tends to simplify visual stimuli (ibid). It is important to remember, however, that the mind processes the visual information and not the eyes (see Ch. 3.2). In a way, the human mind is so lazy that it will always find its path of least resistance to make sense of the offered stimuli and will therefore utilise a set of different rules (i.e. The Gestalt principles) to make viewing easier.

The founding law upon which all other principles are based is that of *Law of Prägnanz*, also often referred to as *Law of Good Gestalt*, which arose in the early 20th century in the works of German psychologists Wertheimer (1922), Koffka (1922) and Köhler (1920). Their mission was to study why humans continually seek meaningful and orderly patterns within seemingly chaotic perceptive forms (Köhler, 1942). After a refinement of their original ideas, they teased out six laws (or principles depending on which paper one reads)[20] of Gestalt: (1) similarity, (2) continuity, (3) closure, (4) proximity, (5) multistability, (6) symmetry and order. Over time,

[20] In fact, the term for these observations should be *principles*, as scientific laws by definition are always true. However, since they are commonly referred to as *laws*, its use is henceforth continued.

contemporary Gestalt theorists added new properties and principles to their original set of six such as emergence, reification, invariance and the law of good fade. All of these including the six original principles are now presented in more detail, encased with examples from rock art occurrences in the Côa Valley. To get the most out of this comparative review, the reader is advised to look at the rock art examples first, take note of which perceptual groupings occur in their mind, followed by reading the accompanying descriptions. The illustrations below (Fig. 6.3.1) and subsequent examples demonstrate the majority of Gestaltian principles of psychological perception. The top row exemplifies the four key principles upon which Gestaltian perception is based. The row below exhibits Wertheimer's original laws (1922).

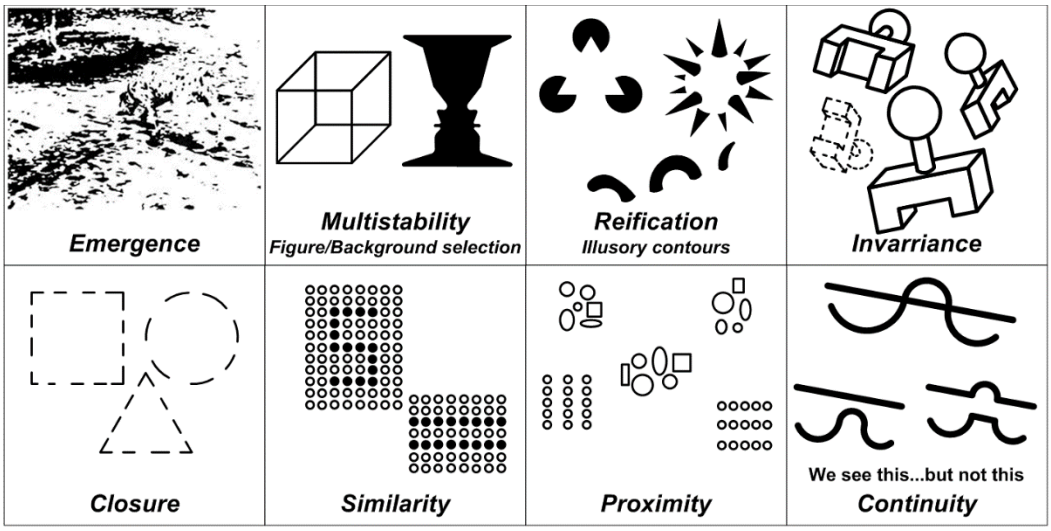


Figure 6.3.1.: Illustrations of the different Gestaltian principles (images by Braungardt, 2016).

In fact, modern designers frequently utilise these principles when designing new projects. It is paramount for a good designer to understand how their designs are perceived by their end-consumer and how tweaks to their designs (in line with these Gestaltian principles) are able to convey the intended message as effectively as possible. Above all, one might wonder whether it is actually possible to relate these principles to depictions seen in Upper Palaeolithic rock art? Upper Palaeolithic artists clearly did not have terms such as *emergence* or *invariance* for their techniques, nor did they knowingly design their horses in congruence with the *law of proximity* for instance. However, since this thesis deals with a subject that is so intrinsically visual and with subjects that are perceptually our parallels, it seems only appropriate to apply a Gestaltian analysis onto the engravings at this stage of writing. They might not have known these formal tools of design, yet if the human mind seeks to order things as efficiently as possible nowadays and does so by pure intuition; Upper Palaeolithic artists will have possessed the same strategic skill (see Hodgson and Pettitt, 2018).

6.3.1.1. Emergence

The principle of *emergence* relies on the idea that various shapes and subsequently entire images gradually emerge upon closer inspection. An image might not spring out at first sight, but once the image is studied further, various images appear from within the picture. As discussed in the previous chapter, one of the critical aspects of identification is the presence of an outline. In many cases of the rock art under study, the occurrence of outlines is abundant. However, despite this large number of outlines, identification ability also relies on how these outlines are aligned on a surface. A freestanding motif is arguably easier to detect than many overlapping motifs for which their boundaries are not instantly recognisable. If many animal depictions overlap each other, which is often the case in the data collected (discussed in the next sub-chapter), the existence of the principle of emergence might aid the reader in understanding why so many superimposed images are present on the rocks of the Côa Valley.

A famous example is that of the Dalmatian dog that is sniffing the ground near the depiction of a tree, which can be seen in the previous figure 6.1.2. It cannot be recognised by observing its component parts (such as tail, legs and its body) but is gradually recognisable as a whole, all in one instance. Additionally, one is able to recognise this array of dots (Fig. 6.3.2) as another Dalmatian dog straight away:



Figure 6.3.2: An array of dots or a Dalmatian dog? (Unknown author, 2008).

This pattern of emergence might remind readers of a tactical incident from the animal world - camouflaging. In other words, blending into the natural environment, for which one's outline is broken up by adapting to one's surroundings, either by way of assimilation of colour/shades or simply by blending into the natural setting. This is important in the grand scheme of identifying the prerequisites for successful hunting in the Upper Palaeolithic. Predators are looking for ways not to be seen by prey animals and vice versa, prey animals will often utilise the effects of camouflaging to their advantage.

However, if we think about what is actually on show in the image of the dog, one realises quickly that it is simply made up by an array of different dots and shaded shapes. Our brain is being tricked into thinking that there is an emerging dog, yet all it really displays is an 'imaginary' dog made up of dots with no outline on show. This visual phenomenon is frequently occurring in everyday scenes, such as spotting faces in clouds or eyes and a mouth on a power socket for instance. As discussed previously, this corresponds to the psychological principle of *pareidolia*. Moreover, we could also compare the pattern of emergence and pareidolia to that of chaos theory from the field of mathematics. Within this theory, emergence is classed as the unprompted presence of order emerging from a background that appears to be random.

If applied to the images found within the Côa Valley, there are images that are immediately recognisable, but there are also images that require the brain to apply this exact emergence effect. Below is an example from rock 33 at the site of Canada do Inferno in the Côa Valley. The simple array of pecked marks, not touching each other in any way, can be labelled as possessing features according to the principle of emergence (Fig. 6.3.3). The human mind combines the assemblage of the dots to form a cohesive understanding of its nature. Especially the additional peck marks surrounding the deer heighten the will to camouflage and confuse its existence, yet its striking pose and elaborate depiction of its horns make it easier for the human mind to visually group proximal dots into one visual alliance.



Figure 6.3.3.: An emerging deer on Rock 33 at Canada do Inferno (drawing courtesy of Fundação Côa Parque).

6.3.1.2. Multistability

The principle of *multistability* gets to work when a viewer is able to perceive a specific object as two or more things (almost) at the same time. This phenomenon is often linked to the better-known visual organisation called *Figure and Ground*. This perceptual grouping and interplay between an object and its context, are important requirements for recognising things through vision. These abstruse perceptual experiences tend to switch back and forth between multiple interchanging interpretations. A well-known example is that of the blackened vase (also named Rubin vase) that is shaped by the profile of two (white) faces facing each other (see Fig. 6.3.1.). One is able to see the vase but instantly switches one's attention back to the faces and then back to the vase. This leads to an interplay between flipping ones view between the positive (white) and negative (black) space. This phenomenon is explained by multistability, which can also be thought of in terms of unpredictable, subjective changes dependent on one's perspectives.

Other examples like that of the Rubin vase that adopt the same principle are Schröder's staircase (Schröder, 1858) (Fig. 6.3.4), "My wife and my mother-in law" (Hill, 1915) (Fig. 6.3.5) and the rabbit-duck illusion (anonymous author, 1892) (Fig. 6.3.6). Those hybrid images, that can be viewed in two different ways depending on one's distance and perspective towards the subject follow the laws of multistability.



Figure 6.3.4.-6.3.6.: Multistability illusions in the form of a staircase, a wife/mother-in-law, and a rabbit/duck (authors as mentioned in text).

This principle guides viewers and artists to the importance of the incorporation of backgrounds. The arrangement in which one sets their images is as important as the created imagery itself. This is also true when thinking about the setting into which rock art motifs are placed. It might be argued that the background has as much influence upon ones viewing and identification ability as the general outline and shape of the motif itself. The background influences the

foreground and vice versa. In search of multistability within Upper Palaeolithic rock art, the deliberate choices of background to create one's foreground must have been imperative. The following examples (Fig 6.3.7 and 6.3.8) show the occurrence of multistability within the rock art traditions of the Côa Valley:



Figure 6.3.7.-6.3.8.: Multistable animals on rock 3 of Quinta da Barca (left) and on rock 27 of Canada do Inferno (right) (drawings courtesy of Fundação Côa Parque).

Observable in these two rock panels are motifs that possess one body but multiple heads. This is undoubtedly a very clever use of the concept of multistability, tricking the reader into believing that the animal is moving its head in multiple directions all at once. The human eye wanders from one alternative to the next and therefore creates its own moving performance, mimicking what animals would actually be doing in real life, akin to a primitive form of animation (cf. Luís and Fernandes, 2009). According to the database created for this research, two-headed animals occur 19 times (19/1117; 1.7%) with two animals even possessing three heads, creating a particularly powerful, multistable visual illusion.

It is worth noticing how in Fig 6.3.7 (animal number 1), the engraver practically demands the viewer to pay particular attention to the inside of the body (playing with figure and ground perspectives) by adding little marks on to the inside of its relatively simple outline. This feature is a unique occurrence within the whole of the Côa rock art corpus. Judging by its actual elevated location in the environment relative to the river's edge and other rock art sites, this site must have been a particularly important spot for hunters, rock art observers or passers-by (more on this in the next *Landscape* chapter, Ch. 7).

6.3.1.3. Reification and closure

The principle of *reification* is grounded upon the perception of objects, despite their actual absence within the visual stimuli. In other words, it links to generative characteristics of perception for which the mind possesses more spatial data than is actually available in the real-life stimulus. Viewers therefore 'bring into being' things that are not actually present in the stimulus, such as the invisible yet visible triangle in the following image, which actually only portrays three ordered, unfinished circles (Fig. 6.3.9):

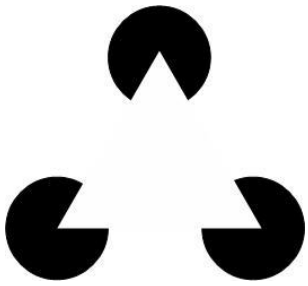


Figure 6.3.9.: A circled triangle? Reification at its best (author's replication).

This phenomenon relies on the fact that humans are instantaneously attracted to the whole rather than its parts that constitute the whole. Our minds, therefore, always want an object to be present as a whole, without realising that no such data points actually exist. The principle of reification often associates with illusory contouring, meaning that one creates contours in one's mind that are deceptive. It is possible for designers of art to leave out certain aspects of their creations, as long as they provide just enough for sufficient identification.

This seems pertinent to the situation we can observe in the landscape art of the Upper Palaeolithic. Many images seem unfinished, but only upon a second glance. Perhaps the missing out of certain less salient pieces of information in one's creation was deliberate since observers seem to fill in the missing blanks in any case and are still able to identify the important characteristics of a motif. This also goes back to the phenomenon seen in the artist tape experiment from chapter 5, who left large gaps in the making of their elephants (Ostrofsky *et al.* 2012). Thus, the animal is identified as a whole, regardless of whether certain features such as hooves or eyes or tails are missing. To illustrate this, it seems odd at first that many Upper Palaeolithic engravings occur in seemingly unfinished, fragmentary forms. Could these depictions have been deliberately or subconsciously incised with the *Gestaltian principles* of *illusory contouring* and *reification* (finishing off incomplete shapes, i.e. seeing them as a whole) in mind?

The following examples of rock art panels (Fig. 6.3.10-6.3.12) exhibit unfinished depictions of different species, yet one is still able to, first, identify them as animals and secondly, in many cases, identify a particular species. It is interesting to ponder on the question of how much information needs to be necessary for this principle to still apply and where its particular threshold lies. This discussion goes back to chapter 5, which handles questions on *Artistic Minimalism*. All these panels depict an unfinished animal (sensory stimulus), yet the experienced *percept* (human mind) finishes off the shape of it, so that the missing parts appear to be visible, but are in fact not engraved.

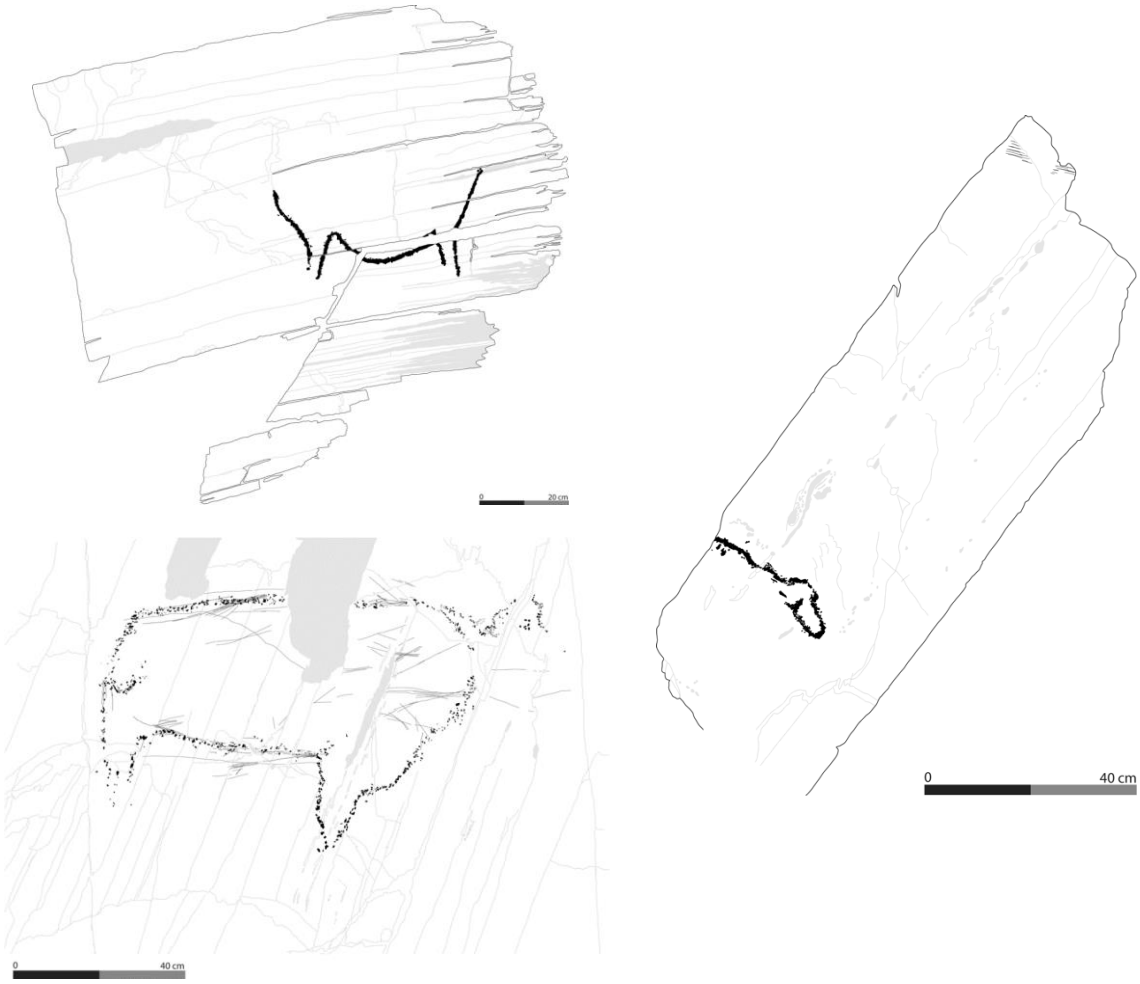


Figure 6.3.10.-6.3.12.: Deliberately unfinished motifs?
Top left: Rock 2 of Vale de Figueira; Bottom Left: Rock 3 of Vale de Moinhos; Right: Rock 9 of Rego da Vide (drawings courtesy of Fundação Côa Parque).

Law of Closure:

The discussed principle strongly relates to that of the *law of closure*, for which our brain simply tends to fill in the blanks and the missing information to create something in its entirety. The urge of completeness is always stronger than rationally inspecting the parts that are actually present (cf. Guberman, 2015).

6.3.1.4. Invariance

The principle of *invariance* regards the perceptive strength of recognising objects regardless of their sizes, rotation, translation, their lighting conditions, or deformations. Humans have adopted to this way of perceiving since encountering objects and real-life situations never occurs under the same conditions twice. When we apply this onto the rock art in the area under study, the principle of invariance can be assimilated by way of realising that animals constantly present themselves in different forms and situations, too. We are able to identify specific species repeatedly even though they seem distorted, do not have their head turned, or are not in their *usual* profile orientation. Even when their head is turned backwards, we are still able to identify the species. Even if they appear to be upside down, we are still able to identify their nature. Likewise, small horses are as identifiable as larger depictions of horses, despite the fact that rock art horses tend not to come close to the actual extent of life-sized horses.

The database produced for this thesis also includes the orientation of depicted motifs. For a closer inspection on the meaning of differently orientated motifs, refer back to chapter 5.2.5. As a reminder, here is a graph (Fig. 6.3.13) of the different rotations as would be seen when standing in parallel orientation with clear view of the entire panel:

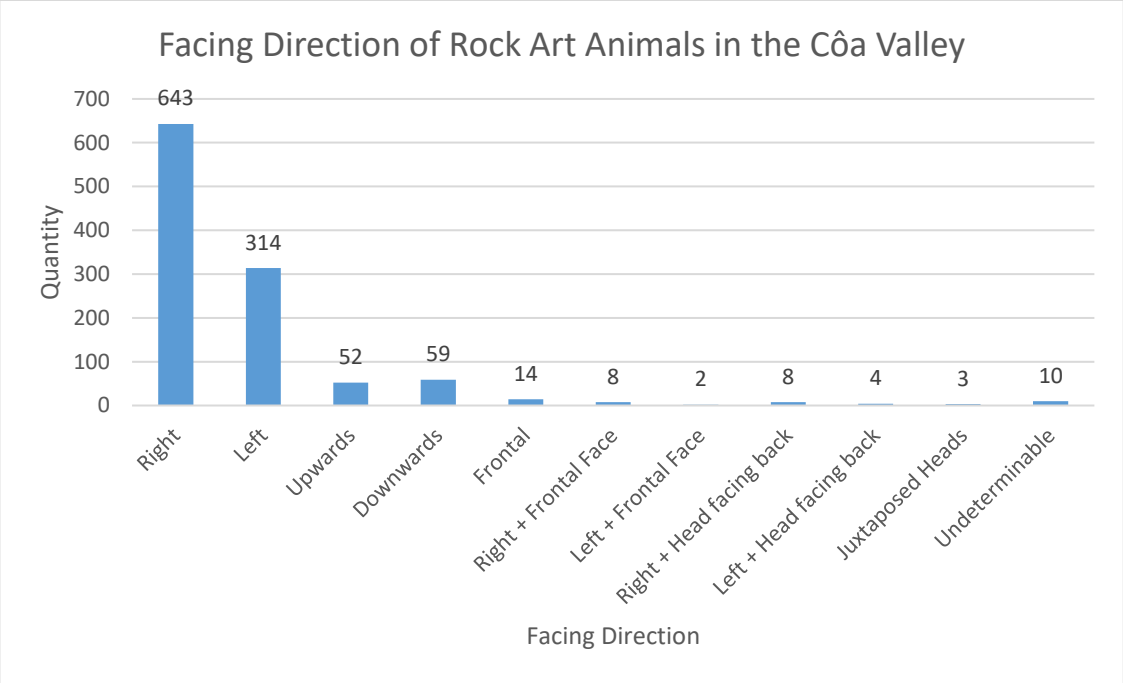


Figure 6.3.13.: Graph repeating the information on motif facing directions in the Côa Valley.

Judging by the number of translated and rotated images found within the collected corpus, there is a high tendency by artists to leave their animals *walking* either left or right, on a natural plain (albeit Upper Palaeolithic artists never provide any sense of perspective or landscape indications). Merely 111 figures out of 1117 are depicted facing upwards (i.e. upside down) or downwards (i.e. with the legs stretching towards the left or right). In these cases, however, our abilities gained according to this principle stimulates our immediate recognition despite abnormal appearances. This also applies to the data on the bottom end of the graph, which illustrates motifs that have atypically facing body features or no discernible orientation whatsoever. Below, artists depicted a number of animals in a rotated fashion (Fig 6.3.14 and 6.3.15). Nonetheless, viewers seem to have no problem deciphering what species they represent.

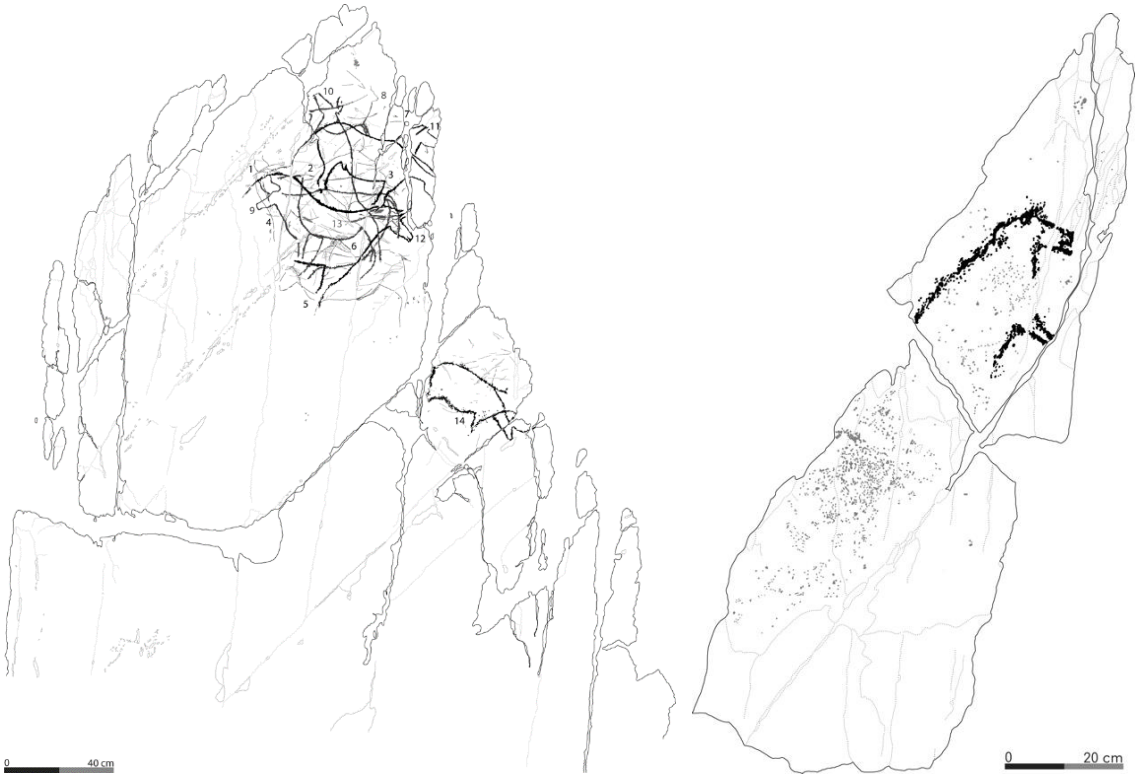


Figure 6.3.14.-6.3.15.: Unconventionally orientated motifs on rock 1 of Canada do Inferno (left) and rock 34 of the same site (drawings courtesy of Fundação Côa Parque).

6.3.1.5. Law of Symmetry and Order (Law of Prägnanz)

This is the fundamental law (also sometimes referred to as Law of Simplicity) upon which all others are based. It was initially conceived on the basis that humans prefer things that are visually ordered, clear, simple as well as easy to follow and understand. Components of an image are always viewed in their simplest form. Conversely, when viewing a particular design, the viewer should not be left feeling 'out of balance' or unorderly and should have a positive connotation about its general appearance, rather than a negative one. An asymmetrical design leaves a viewer with unnecessarily wasted time in deciphering its most essential message, whereas an orderly composition ought to deliver a message in an instant. This law is often in use in situations like traffic control, instruction manuals and chemical hazard pictograms. The famous Kanizsa triangle (Fig. 6.3.16) beautifully illustrates this law of symmetry (the aforementioned principle of reification is also observable):

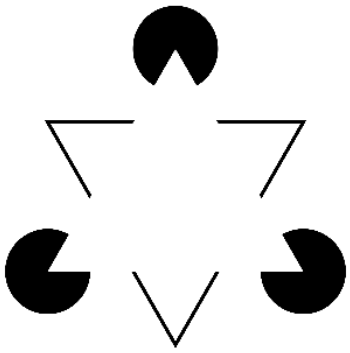


Figure 6.3.16.: Symmetrical triangles and a touch of reification (author's replication).

An example from the rock art repertoire under study is panel 1 of Ribeira de Piscos with its orderly form and rather symmetrical use of motifs – an aesthetically pleasing stimulus. Notice that *reification* is also present within the unfinished horse on the left (Fig. 6.3.17):



Figure 6.3.17.: An aesthetically pleasing and orderly composition on rock 1 of Ribeira de Piscos (drawing courtesy of Fundação Côa Parque).

6.3.1.6. Law of Similarity

This law predicts that similar looking features tend to be grouped together, compared to objects that are of diverging colour, texture, or shape. Arranging elements in a similar way provides aesthetic advantage over elements that are not assimilating in any way. In the example below (Fig. 6.3.18), our minds are instantly able to perceive rows of differently coloured circles, even though they are all of a similar size and distance to each other, all because of alternating colouration:

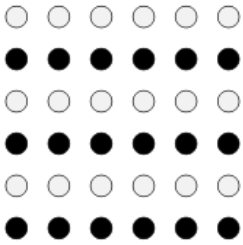


Figure 6.3.18.: Similar yet not similar (author's replication).

When applied to the rock art at hand, the first thing that springs to mind in terms of feature similarity is its engraving technique. A panel will often exhibit many different techniques, so figures of the same fabrication so to speak will likely be seen and grouped together. An engraving that features a simple pecking technique is likely to be associated with engravings of a similar character. A clash in technique on the other hand would indicate a dissonance. Arguably, if one would want to establish a visual hierarchy, the use of a similar technique unifies the engravings more than the depiction of similar motif identity. For, if a pecked horse appears next to a pecked horse, their visual bond would be stronger to the human mind than a bond between a pecked horse next to an incised horse.

In the following two examples (Fig. 6.3.19 and 6.3.20), figures made with similar techniques stand out to the viewer straight away and thus the eye visually groups them together, regardless of whether they actually belong together or not. In accordance with the argument from the previous paragraph, it seems plausible to suggest, that the motifs that reoccur on the panels in almost identical fashion were meant to form a unified composition and not the motifs that are linked, due to their same species heritage.

Hence, the visual hierarchy of perceptual rock art grouping establishes itself as follows:

1) Motif Technique

2) Motif Similarity

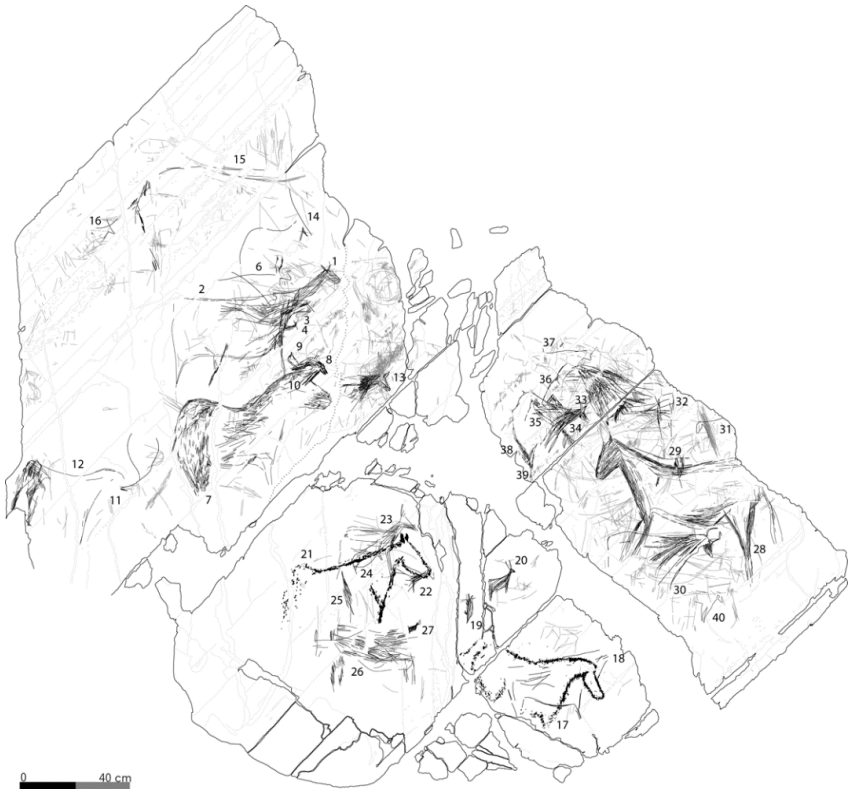


Figure 6.3.19.: Similar techniques stand out on rock 14 of Canada do Inferno (drawing courtesy of Fundação Côa Parque).

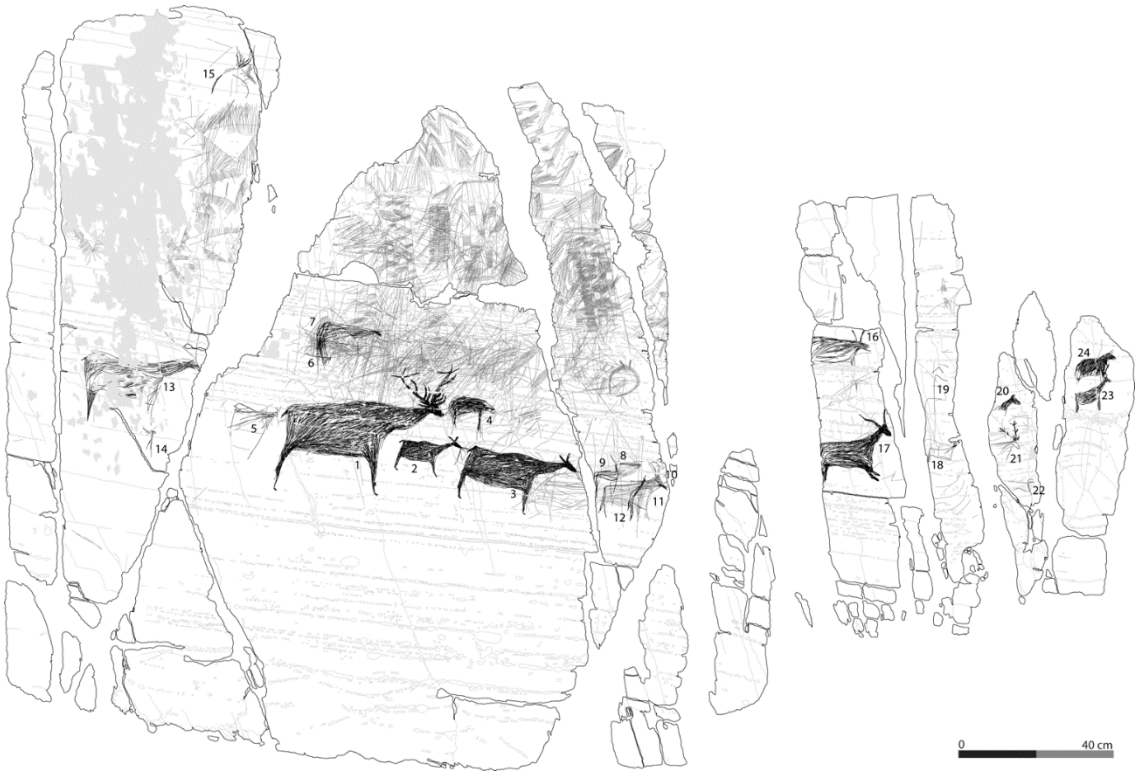


Figure 6.3.20.: Similarly fashioned deer parading on panel number 16 of Vale de José Esteves (drawing courtesy of Fundação Côa Parque).

6.3.1.7. Law of Proximity

As the name indicates, this law identifies objects in close *proximity* as possessing a greater perceptual bond than items that are randomly scattered around within a design. An interesting aspect regarding the law of proximity that will relate immensely to how rock art depictions are perceived is the incorporation of white space in one's design. The spacing in between different aspects of a design indicate different levels of connectedness. This is especially true in written work on advertising campaigns or even within pieces of writing such as essays and novels. Authors use paragraphs (i.e. white space) to indicate a new idea, new character and a new argument. It is common that similar ideas contributing towards one overall idea are presented within cohesive paragraphs to show their connectedness.

The danger of this law lies with grouping too many items in one area making observers think that they belong together. If the white space in between objects becomes too small, the risk of cluttering ones designs becomes high. This is where the law of proximity should be used in conjunction with the *law of symmetry and order* and other principles to create a well-rounded, well-perceived visual stimulus. As will become clearer throughout the section on superimpositioning, some panels seem to drastically disobey this law. The following example clearly sections off the depiction of a horse, making the rest of the engravings appear to be visually linked by their mere proximity to each other (Fig. 6.3.21).



Figure 6.3.21.: Rock 15 of Quinta da Barca marks its motif territories (drawing courtesy of Fundação Côa Parque).

If one compares the law of similarity and that of proximity, Gestaltian theory predicts that a visual hierarchy is built up by which similar looking objects tend to visually overpower those of proximal objects. In the case of the latter rock art example, the mind will first be attracted towards similar looking motifs, such as the very similar shaped horses on the bottom of the panel. Thereafter, proximity comes into the hierarchy of visual preference. The new addition to the visual hierarchy of perceptual grouping goes as follows:

1) Motif Technique

2) Motif Similarity

3) Motif Proximity

6.3.1.8. Law of Continuity

In any situation, regardless if in rock art or modern design, objects are hardly ever represented on their own. As will be seen in the coming sections, overlaps are a common characteristic of the rock art of the Côa Valley. The law of continuity states that the mind is able to distinguish one object from the next despite overlap. This is dependent on the fact that it is easier to decipher smoothly flowing shapes, than broken up, rough edges. Consider for example a simple plus (+) sign; instead of thinking of it as four lines that confluence at a central point, a much more plausible way for the mind is interpreting it as two intersecting lines. Therefore, the easiest path the human eye will take is that of a smooth continuous pattern, regardless of creation order and time difference between each engraved stroke. The human mind then continues this visual patterning.

The Côa rock art example below (Fig. 6.3.22) illustrates this ability. We are still able to identify and follow the lines of specific motifs, even though various overlain lines dissect each other. What is the threshold until when viewers are able to apply this principle? How many overlain lines are too many? The tolerable capacity of maximal overlain lines will be tested on experimental participants later on in this chapter.



Figure 6.3.22.: A superimposed mess on panel 16 of Canada do Inferno? (Drawing courtesy of Fundação Côa Parque).

6.3.1.9. Law of Common Fate

The *Law of Common Fate* is a little harder to apply onto rock art. It relates to the perceptual grouping of things that are physically moving in a similar direction. This law is commonly exemplified by a flock of geese flying in the sky, since their proximity, flying speed and formation make for a perfect Gestaltian group. If we now take this to the rock art environment, this might be likened to a herd of animals seen in its proximal landscape. A herd moves in a similar direction and can thus be perceived as a unified grouping - a perceptually sound and easy to follow stimulus. Often, similar motifs are presented as a cohesive group, possibly to present their motifs with exactly this behaviour of common fate in mind. A nice illustrative example in this case is the following panel from the Côa Valley (Fig. 6.3.23):

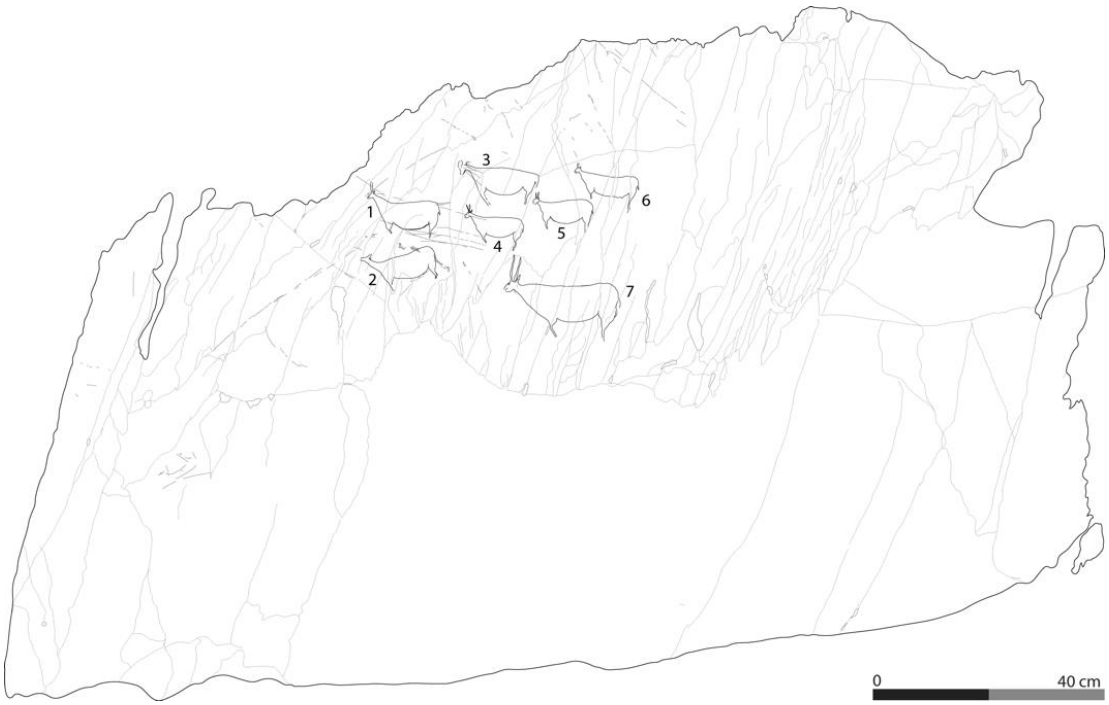


Figure 6.3.23.: Rock 4 of Vale de Cabrões features a 'herd' of similar motifs that all fall under one common fate (drawing courtesy of Fundação Côa Parque).

6.3.2. Conclusions: Upper Palaeolithic rock art – an art of Gestalt?

It appears possible to match up certain re-occurring features within Upper Palaeolithic art with psychological Gestalt principles. Indeed, on occasions it seems that some panels were practically made with Gestaltian principles in mind. Other panels require more deliberation and certainly a close visual reading to comprehend the possible underlying principles, if there are any at all. In a few cases, a number of principles, such as that of similarity and proximity, are working together to form a unified Gestaltian design. Depending on their combination and the perspectives of the viewer, one or the other might dominate, yet generally, the cases examined dictated the following hierarchy: **1)** Motif Technique; **2)** Motif Similarity and **3)** Motif Proximity. This hierarchical structure might even give rise as to how and in what order features on a panel should be read, starting with motifs similar in technique and ending with motifs that do not fall into this pattern (i.e. outliers to these principles). This might expose certain intended storylines for end-users and might also signal how rock art was made (i.e. one principle before the other). It may also indicate by whom it was made (i.e. changes in Gestalt might allude to distinct authors). These ideas have potential to be further investigated in a future study.

Even though the sheer notion of Gestalt principles being associated with ancient art might seem anachronistic to the modern reader, the simple act of visual thinking and communication through images binds both the present and the past. It was essential for Upper Palaeolithic communities to use imagery as their way to explore and express their worlds around them. Thus, it seems highly likely that the imageries in question will have been created with utmost care and most of all, intention for clear communication.

So, do rock art compositions adopt Gestaltian principles? In light of the examples and other panels from the database, based on modern analysis of these early creations, Gestaltian principles are certainly detectable. Yet, whether or not Upper Palaeolithic artists will have actually made their art with care, for perception-based parts-as-whole and executed it in line with strict grammatical and visual schemes, is difficult to determine. Nonetheless, these principles do not rule out the possibility **that Upper Palaeolithic artists will have had some kind of underlying agenda and schemata, which they followed in order to make their art visually appealing and visually coherent.** Perhaps we might think of them as their original versions, the initial foundations if you will, of principles that would eventually become the “Gestalt” principles of today. Fittingly, Güth (2012) established that many images created during the Upper Palaeolithic (her research focus is on Gönnersdorf plaquette art) are made in accordance with the well-known, aesthetically pleasing ‘golden ratio’, something that matches up with our modern desire for aesthetic/appealing image compositions.

6.4. Psychological Experiment 4: Perceiving Superimpositions

6.4.1. Introducing the experiment and research questions

This section sees the examination of all recorded panels available from Santos's thesis in 2017 with a focus on specifically scrutinising the availability of superimposed imagery within the Côa rock art corpus. The term *superimposition* simply refers to the stacking of things, in this case the "supposedly" deliberate overlapping of rock art motifs on a given rock surface.

This particular investigation is aimed at satisfying one of the main objectives of investigating the placement of rock art, in particular locations on the rock. The end goal of this sub-set of experiments is to come closer to an understanding of the reasoning behind overlaps and their deliberate placement on certain parts of the rock. As an illustration, the following rock is exemplary of this quest to understanding placement (Fig. 6.4.1). The rock measures several meters in width and height, yet the engravings are concentrated in a particular location only. It is clearly not for a lack of rock space that these engravings are overlapping. So, what might be the motivation behind it? On a broader scale, one could even argue that there is an unused abundance of rocks within the valley engulfing the Côa River, that never attract any carvings, so why are only certain locations and rocks preferentially chosen in the first place? There was no need to force all their depictions on top of one another since no sparsity of rocks seems apparent. Even on the same rock, depictions often occur in one specific area, layered and layered, with much 'clean' canvas space surrounding the conglomerations.



Figure 6.4.1.: Intriguing location of motif placement on Rock 1 of Canada do Inferno (drawings courtesy of Fundação Côa Parque).

A note on panel composition

More often than not, the term *composition* is used within rock art literature without consideration of what it actually denotes. A composition ought to be regarded as a coherent and intentional arrangement of motifs, rather than just a *cluster* of lines lacking "visually appropriate relations to one another" (Halverson *et al.* 1987: 67). In fact, the simple stacking of motifs, also known as *superimpositioning*, should not be termed a *composition*. Within some of the well-known caves in France for instance, a clear attempt at compositioning can be observed. The deliberate juxtaposition of facing mammoths in the cave of Rouffignac, or the row of animals as portrayed alongside the 'swimming' deer of Lascaux, are two notable examples. Yet, one might struggle to find more of these deliberate compositions, especially in the realms of open-air rock art. In any case, it appears that the creation of composition appears far less common and lower down on the artists' list of priorities, something that will be investigated in this section.

One way of thinking about superimpositioning with the intent to create a scene-like layout is the way animal figures are sized and orientated. If the structural layout is premeditated, animals should appear in similar sizes and relations to each other. If the latter is not visible, the intention to actually create something cohesive is likely to be ill advised. As has been established in previous chapters, rock art animals do in fact appear in dissociation with their natural background: no scene setting surrounds these animals, and no sense of background, distance or natural surroundings in form of trees or grounds are visible. This detachment from the real-life setting of animals is also mirrored in the sizes of animals that appear close to each other. For instance, horses, twice as big as overlaying ibexes, are visible and an aurochs appearing in miniscule size superimposes the ibexes yet again. Not even a horizontal plane seemed to have been important, as floating, turned, and upside-down species are also no single occurrence (see Fig. 6.3.13). With this in mind, the next experiment sets out to question why it is that so many species overlap, despite a clear abundance of rocks on which artists could have performed their creations. The research questions assessed within this section are:

1) Why might artists superimpose their creations? (Chapter 6.4.2)
2) Which motifs overlap each other and what are their related frequencies? (Chapter 6.4.3)
3) Are there different degrees of superimpositions? (Chapter 6.4.4)
4) How visible are engravings within different degrees of superimpositions and rock types? (Chapter 6.4.5)
5) Where do superimpositions occur on the panel? (Chapter 6.4.6)

6.4.2. Reasons for superimposing motifs

Why might artists superimpose their creations?

Studying the superimpositioning of rock art images, other than for relative sequential dating (Zilhão *et al.* 1997; Gunn *et al*. 2010), is an invaluable tool in our appreciation of the significance of such practice. Although superimpositioning has been used thus far to infer dates from successive overlaying patterns and styles, these superimposed images have rarely been studied in any other way to date. Yet, by questioning why artists superimposed different types of animal depictions on top of each other, we might find answers such as changes in mind-sets, changes in importance of the animals at specific times and animal herding. We might identify expressions of large crowds, importance of particular spaces on the rocks and possibly the importance of revisiting sites repeatedly, to update and contribute to the art. Could it be that the later artists disregarded the works of previous artists at the site and thus wanted to claim their territory?

There are a number of reasons to consider when thinking about the placement of superimposed imagery. Recalling the discussion (Chapter 5.1.3) from earlier when debating whether the animals are actually those that we perceive them to be, the same arguments can be laid out here, as we of course cannot be certain why images were covered by others in the first place. What we can do, however, is come closer to an understanding of why that might have been by the means of the following discussion and ensuing experiment. To start with, the first explanation that springs to mind when meditating about the meaning of superimposed imagery:

1. **<u>Rejecting the past:</u>**

It might be conceived that Upper Palaeolithic artists wanted to create a blank canvas for their creations, wanting to absolutely disregard previous artistic attempts by way of defacing what has come before them. Their new way of approaching their art will have meant that their new motifs had to be engraved on top of the old ones in order to invalidate anything that has previously been created. Exemplary of this possible reasoning behind superimposing images on top of each other is that of Stow (1905: 27) who comments on superimposed South African rock imagery: “The second superimposed pictograph meant a defacement of the first. Overpainting would only be attempted when the recollection of the first artist perished. However, sometimes forced by the limitation of the rock surface at the time some aspirant after artistic fame… unceremoniously painted over the efforts of those who preceded him” (ibid). The Upper Palaeolithic artists of the Côa region did not, however, have the issue of having limited availability of rock surface. The opposite will have been the case given the large regional rock abundance. With that in mind, it is interesting to consider why people might want to repeatedly congregate to the same spots, if other areas could have been equally valid.

As presented through this first possibility, artists might have wanted to revisit previous sites of creation to indicate that their new way of drawing, hunting new animals and new ways of thinking had to be clearly visible on top of the old traditions. Arguments against such thinking might be the fact that engravings are never completely worn away, never completely wiped out by way of scraping away old motifs in their entirety. New animals are being placed on top old ones with a clear respect to previous undertakings. What is more, these ideas, again, can be further linked to aspects of territoriality, as already touched upon when the function of the art was deliberated in earlier chapters. In fact, by visiting, engaging with and revisiting older sites, a subliminal degree of territoriality gets exerted through art alone. Art and retouched and added-to art could have indicated to different parties that specific areas were already spoken for. A directly opposing, yet equally conceivable argument in search of underlying intentions of overlain motifs could be the following:

2. <u>Culture jamming:</u>

This motivation might be an action to honour previous generations by the means of tracing and reinterpreting the engraving history of people who have come before them. This would go in line with the previous reasoning, the honouring of underlying engravings without the need to conceal them completely. New motifs are engraved on top of old ones, creating an act of visual updating, for the subsequent artist to feel close to their ancestors or fellow artists in exactly the same spots or creation. Superimposing an image might make artists feel closer to their ancestors and their depicted prey in the hope for a subsequently good season of kills, too. An example of such practice from a modern perspective is that of mounting several layers of advertising posters on top of each other, continuously adding new marketing ideas and event information on top of out of date adverts and long-gone events. Klein (2000: 3) refers to this modern occurrence of superimpositioning as “culture jamming”, which, when applied to an Upper Palaeolithic environment, might fit quite nicely with what they were trying to achieve. Considering the Côa context here, upon closer inspection, multiple layers may reveal the presence of an ongoing cultural conversation between those who have come in direct contact with the visuals. What is more, our present understanding of raw material movement between the sites of the Côa and surrounding lands points to a culturally diverse community: “The Côa could have been an aggregation area, where dispersed bands would seasonally come together to fulfil their economic, social and cultural needs” (Aubry *et al*. 2010: 503). The material evidence within some occupation layers in vicinity to the rock art sites stretches as far east and south as Madrid and Lisbon, indicating a rigorous network of exotic material exchange and cultural stimulation (Aubry *et al*. 2012b).

A further thought-provoking concept to consider is that of *influencing* and *being influenced*. By placing specific marks on specific rocks in specific locations, artists are *influencing* others to do so in similar manners. The inverse of this is *to be influenced* by other artists in order to create similar art in similar landscape settings. Therefore, the existence of one figure might have encouraged the same artist or a successor to 'copy' or create new motifs in similar rock areas. Conceivably, oral history might have played a key role in dictating where rock art was placed. Largely, the resulting aggregate of motifs thus may be the result of a day's work on the rock, or that of several artistic, recurring visits by the same or different artists over longer time spans.

Interestingly, repetitive engagement with the art and through that with ones ancestors, at the spot of art creation and consumption, is vital amongst the Yanyuwa and Alawa groups from the Gulf region (Brady and Bradley, 2014) as well as the Woronora and Wunabal Aborigines from the Western Kimberleys in Australia (Layton, 1992). It is believed, according to the cited ethnographies, that this keeps ancestral spirits happy and on one's side. Another nice example from Garlake (1995: 23), who writes on the prehistoric art of Zimbabwe, indicates that engravings were engraved on top of each other, "incorporating them, drawing them together into a new conceptual rather than visual unity, becoming the field of force within which the minor images act out their being". He continues by revealing that this has meant "that new images could be readily added to those that already existed, to establish new relationships between them and thus to reinterpret or elucidate their significance".

Conversely, it needs addressing that the particular traditions and customs of ethnographic societies are by no means to be equalled to the internal structures and beliefs of Upper Palaeolithic inhabitants. However, a comparative and thought-provoking consideration should be allowed in search of underlying patterns that are easier compared between non-western societies and Upper Palaeolithic humans than our modern euro-centric approaches to art and its analysis.

3. Aggregate killing site:

On a purely rational basis, superimpositions might translate into an aggregation site as observed in real life. Many overlapping animals might simply indicate a large group of animals, a specific herd striding through the landscape, a mating scene, a location that indicates that large herds of animals can be seen from that particular spot. The permanency of the rock might have been used as a way marker and indicator that it was a particularly good location for spotting or killing large numbers of animals. Could this connect to migratory routes and mass killing events? Could a heavy overlap of deer near the water's edge indicate a favoured drinking spot and therefore signal to hunters that this location might be particularly prosperous to exploit. A single depiction by this definition is therefore a lonely animal walking through the landscape without its companions. Perhaps an isolated sighting, a single killing spot, a depicted trophy? Garlake's (1995: 22) Zimbabwean art gives weight to separately occurring rock motifs by revealing that "groups of people and herds of animals are shown with each individual complete and distinct, with little or no overlap between them, giving them maximum exposure and legibility at the expense of any sense of coherence, density or mass of a herd".

In any case, an accumulation of rock art in one particular spot will inevitably mean that a lot more time will have been spent at that spot. A heavily superimposed rock attracted many more 'man-hours' than a panel with only a handful of separate motifs. This gives us an intrinsic insight into dwelling times of artists in particular locations around the Côa Valley. If one were to create a so-called heat map, often used in museum evaluation surveys, the panels with heavy superimpositioning would be much hotter/redder than individual motif panels.

4. Deliberating time:

The previous sections touched upon the deliberation over time intervals of overlapping motifs and the revisiting by new artists to old rock art spots. It is worth thinking about the accumulation of images over time. Were they in fact made *over time*? Alternatively, were they made in one sitting? Are the same artists creating the art, or is it a jamming of culture as well as personnel? A look at the rock art engravings themselves indicate several trends. In terms of artistic techniques and artistic styles, there are hardly any superimposed images that bear a complete break of style and technique, which sheds light on the possible timings and authorship of these engravings. Most of the overlaps that occur in the region surrounding the Côa River do so by overlapping in similar styles. For, if styles and techniques do not considerably vary with consecutive overlaps, there is no grounds to believe that the rock art overlaps were made by different visitors to the rocks at sporadic timescales. It might therefore be the case that the same artist made these superimpositions during a relatively short period. Nonetheless, even

though a motif seems visually coherent with a motif that is depicted close by, any intentionality or significance between those can still not be correctly proven. It is certainly possible that only a few depictions were carved in one sitting, whilst at another session many more were added. To add to this idea, Santos (2017) notes that there seems to be a tendency for the traits that define a particular animal not to touch the ones that define the previous one. This is not only interesting when deliberating why certain aspects of animals are depicted, but it also has the potential to indicate which animal will have come first in a sequence of overlapping carvings.

Although we will never be certain why these superimpositions were put into practice – likely possessing a number of superimposed meanings in itself – what the few panels with clashing techniques and styles can provide us with, however, is an analysis of changing style over time. In these cases, the superimpositions seem to indicate that artists came to these sites with considerable time spans between them, it is impossible to tell, with current dating evidence, how long that time span actually was. It could range from anywhere between a couple of hours to thousands of years in between. The stylistic elements can point us in a possible direction. Thus, even though it is difficult to ascertain which depictions were made first, how many engravings were made in one 'sitting' and when the following set of depictions were added to a panel, there is one specific example from the Côa, Panel 1 of Fariseu, that can shed light on its possible creative biography (Aubry *et al.* 2014):

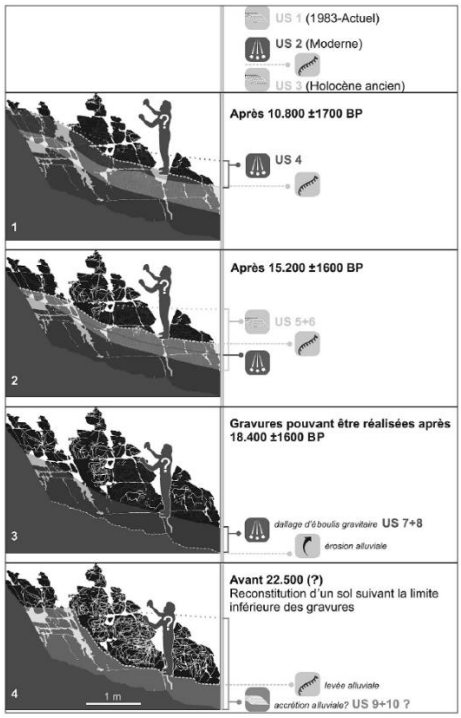


Figure 6.4.2.: The panel of Fariseu reconstructed for the indication of eroded deposits and its associated rock art layers (Aubry *et al.* 2014).

The example from Fariseu (Fig. 6.4.2) reveals that this particular rock was decorated in many different phases correlating to the rise of the soil cover throughout many thousands of years. However, as has been revealed by experimental rock engraving, the freshness of the rocks will fade from view over time. This fading will have happened if the older designs were not painted with pigments after cutting and/or periodically re-engraved. In fact, in the Bronze Age traditions in southern Sweden and Norway, Hauptmann Wahlgren (2002) and Nordenborg Myhre (2004) have identified the practice of re-engraving with the added modification of updating the style according to the new traditions at the time of re-engraving. For instance, a rock art boat will have suddenly been re-engraved with a larger hull type and extended keel, in accordance with changing boat-building technologies. An additional example is the modification of the often-nicknamed 'unicorn' in the Upper Palaeolithic cave of Lascaux, in southwest France. The style of the added horn(s) is very much different to the rest of its otherwise stylistically uniform body, making a later addition of the famous horn(s) possible.

5. <u>Visibility:</u>

Another logical way of thinking about superimpositioning of motifs on panels is connected to its visibility in the landscape. As will become apparent in the last experiment of this chapter and also deducible by the way we see things as standing out the most, a conglomeration of motifs, a heavily superimposed area, will likely stand out more than individually engraved motifs on any given panel. Arguably, the power of the collective therefore contributes to the visibility strategy of the Upper Palaeolithic artists.

Contrastingly, the ideas surrounding visibility of motifs might also diverge us to think about the fading of rock motifs over time. One might argue that artists were simply not aware that a particular rock already possessed engravings, since sufficient time had passed for previous motifs to fade. Specific lines of evidences that would speak against such happenings are for instance the established knowledge that rock art motifs stay intact for a considerably long period of time (likely spanning over several generations of rock carvers). This relates to freshly 'cut' engravings, that still possess their white powdery residue in its midst. Thus, the fading (not disappearance) will have occurred over many decades.

Furthermore, the mere fact that modern rock art recorders are still able to detect such an array of superimpositioning in the rock structures nowadays also points to neglecting such possibility. True to the motto, if we are able to see them now, they will have certainly seen them during the Upper Palaeolithic. Here, the reader might recall the overly cautious use of words to define superimpositioning at the start of this section. The "supposedly deliberate" choice of overlap was used to describe this occurrence. Having established that Upper Palaeolithic artists will have had to notice their forbearers' creations (if, indeed, they were made by different hands), the word "supposedly" can now, after this discussion, be cut out.

Combining the ideas

Rock art palimpsest: style and execution order

In an early publication on the state of research of the rock art of the Côa Valley, Zilhão *et al.* (1997) justify their dating of Côa rock art both by the means of stylistic changes of motif types and by the determinable order of execution once motifs start to overlap. Fitting examples are the various rocks at the site of Penascosa, presented in aide of their argumentation. In fact, panel 5A of said site exhibits a horse with a two-lined mane (typically Magdalenian) depicted towards the top of the superimpositions (red square 1 in Fig. 6.4.3), whilst a horse with a high, forwardly (stepped) inclined mane (typically Solutrean) within the same palimpsest lies at the bottom of the superimpositioning (red square 2 in Fig. 6.4.3). This example indicates that the rock art was created over a span of several thousands of years, unless artists imitated older styles in their contemporary compositions, of course. This means that modern observers are now faced with "th(ese) palimpsests of figures, [that are the] outcome of the last 10,000-15,000 years of increased weathering, which has homogenised the appearance of the ensemble" (Zilhão, 1997: 41). Conversely, observers of the art in the past will have been faced with a clear distinction of where older and newer figures lie, with the latter appearing much whiter and 'functionally active', indicating that "the presence of old patinated figures was not an obstacle to a good reading of the fresh ones" (ibid). This then bears significance on the willingness to create rock art in repeatedly used spaces, potentially in order to uphold ancestral traditions.

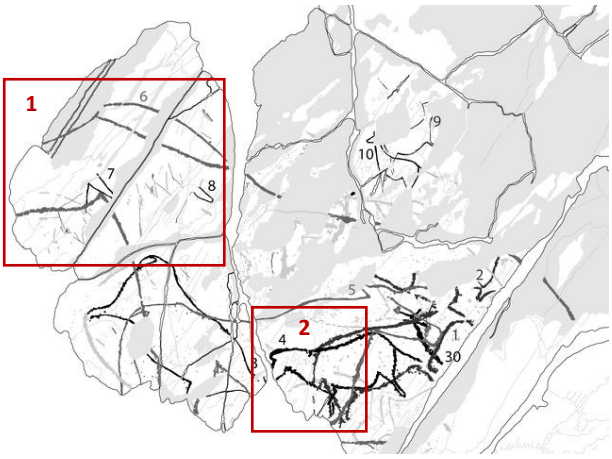


Figure 6.4.3.: The panel of Penascosa 5A revealing two horse mane styles (recordings courtesy of Fundação Côa Parque, red accentuation by author).

Superimposition opposes quick identification

A specific question related to the aspect of visibility might have occurred to readers over the course of this chapter, especially in light of the findings from the *Drawing* and *Bubbles* experiments (cf. Ch. 5.3 and 5.4): Why overlap one's minimally created motif? If the intentions of the artist were to depict their animals with as good a shorthand as possible, for easy perceptual detection purposes, why would they then overlap those simplistic forms? Why would one start with intricately thought out minimal-line engravings to then negate that and destroy it with a myriad of lines overlaying that exact information? Crowding must surely go against ease of identification. The following sections will be a starting point to help and unfold this conundrum, yet more deliberations and further studies, in particular with regard to the visibility of simple and abstract lines in crowded stimuli, need to be conducted to come to a better understanding of this matter. Without giving too many overarching results away, superimpositions are extremely abundant within the corpus under study and so are depictions of animals fashioned in a very stripped-down minimalistic manner. Perhaps this clash of what both are trying to achieve respectively simply indicates to us as readers and interpreters of the art that there were more than just one function underlying their existence, be it for easy identification or in other circumstances for an indication of territoriality or the jamming of cultures.

6.4.3. Overlap quantities within the Côa corpus

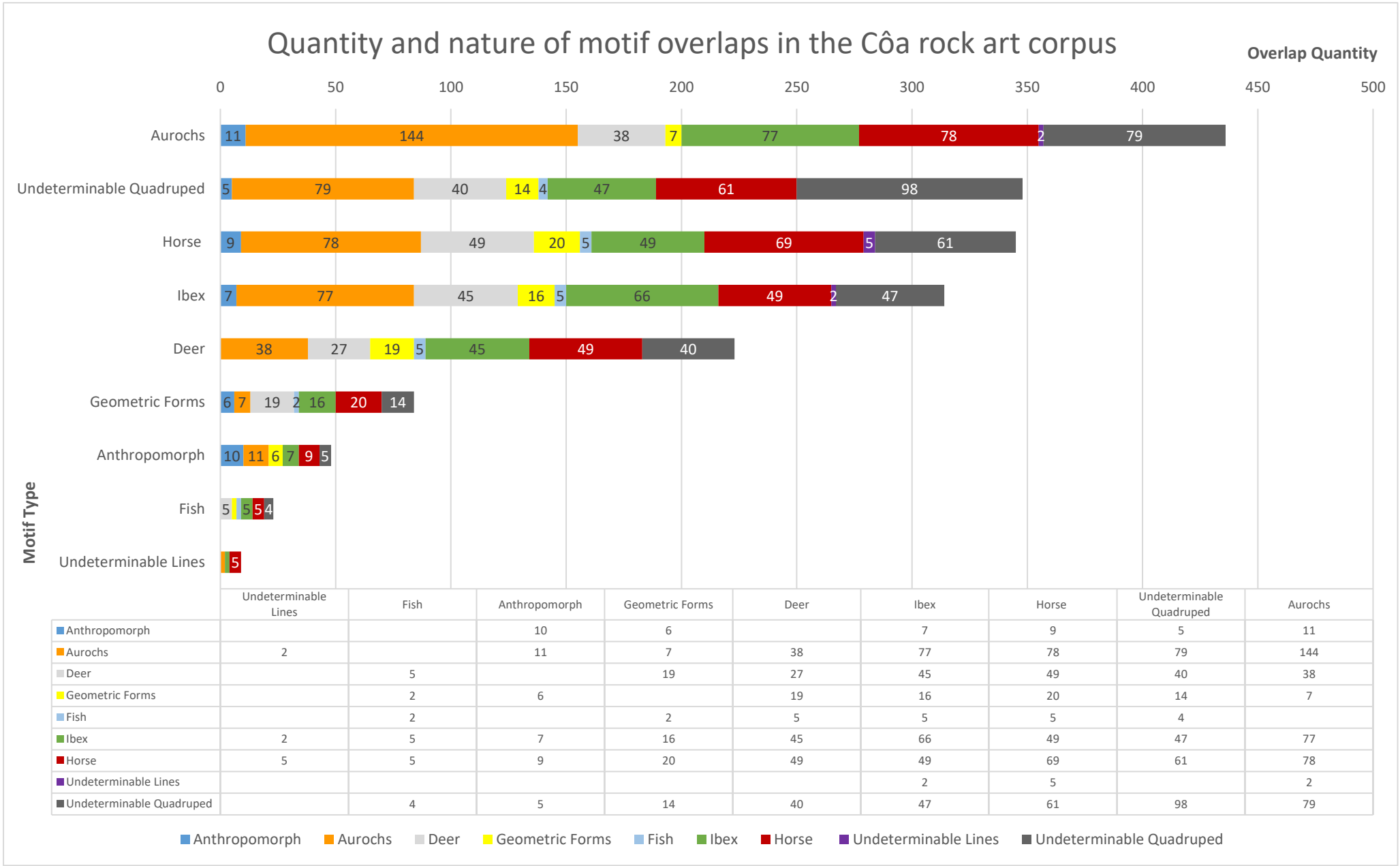
Which motifs overlap each other and what are their related frequencies?

Before we begin to investigate whether any of the aforementioned reasons behind overlaps might actually apply, it is important to understand the nature of overlaps. The following table (Table 6.2) reveals the type of motif (Column 1) and their frequencies within the studied corpus of the Côa engravings (Column 2). Column 3 next to it reveals how many times an overlap was recorded in association with a specific motif. So, for instance, there are 27 anthropomorphs registered in the database, and these anthropomorphs appeared to be linked/overlapped on 50 counts. Hence, a single anthropomorph can be overlapped by two or three different motifs, which makes up 50 associated overlaps in total.

Motif Type	Count of Motif Type	Count of Overlap w. different Motifs
Anthropomorph	27	50
Aurochs	231	436
Bird	2	2
Canid (Dog)	1	1
Deer	51	72
Deer female	47	71
Deer male	56	78
Fawn	1	2
Fish	22	23
Ibex female	77	104
Ibex male	127	210
Horse	216	345
Mustelid	1	2
Undeterminable Lines	6	9
Undetermined Quadruped	252	348
Grand Total	**1117**	**1753**

Table 6.2.: Table featuring motif type, their frequencies within the Côa corpus and the number of times that these motifs are found in association with other overlapping motifs.

What is more, the identity of each overlap has been accounted for (i.e. which motif overlaps which motif). This is to test, whether there seems to be a hidden 'cultural' convention, which might have meant that a panel with previously depicted deer and aurochs might only be added to through new depictions of horse, for instance. This next section will reveal whether such conventions were put into practice, since all overlaps on the recorded panels of the Côa (based on Santos, 2014) have been assessed for the nature and frequency of their overlap.



	Undeterminable Lines	Fish	Anthropomorph	Geometric Forms	Deer	Ibex	Horse	Undeterminable Quadruped	Aurochs
Anthropomorph			10	6		7	9	5	11
Aurochs	2		11	7	38	77	78	79	144
Deer		5		19	27	45	49	40	38
Geometric Forms		2	6		19	16	20	14	7
Fish		2		2	5	5	5	4	
Ibex	2	5	7	16	45	66	49	47	77
Horse	5	5	9	20	49	49	69	61	78
Undeterminable Lines						2	5		2
Undeterminable Quadruped		4	5	14	40	47	61	98	79

Figure 6.4.4.: Quantity and nature of motif overlaps in the Côa rock art corpus.

The chart overleaf (Fig. 6.4.4) makes it clear that there is no such convention demanding that artists overlap species of a similar type.[21] Nor does it not seem to inconvenience artists that an aurochs overlays a horse that than overlays an anthropomorph, for instance. In fact, within the dataset, despite being a miniscule difference, horses overlap with more aurochs (n=78) than members of its own species (n=69). This is also the case for ibexes and deer. This means that a former hypothetical visual strategy of keeping species separate from each other can easily be neglected. As it stands, the opposite is the case with a good split of animals coexisting and overlapping on the same panel - **a true agglomeration of species in just one spot.**

Thinking about its implications for a moment, this overlapping of unrelated species can reflect a number of possibilities. Hypothetically, rock artists simply wanted to show off their broad repertoire on specific panels. Instead, rock artists encountered a plethora of animals at that spot or in their recent memory and thus wanted to reflect that in the area, or even that rock artists revisited sites when new animal herds came 'into fashion' and then updated their workings. Alternatively, an entirely different reason altogether might underlie this (cf. Ch. 6.4.2).

Despite our uncertainty of why artists used the technique of overlap, the certainty of this overlap study is the gained knowledge **that inter-species encounters on the panels seems to have been a normal procedure and common occurrence.** Although not tested statistically here any further, theorising that artists overlap big game animals frequently with each other might also reflect their knowledge of how the animal kingdom itself interacts with each other, let alone the interaction of artists and hunters like themselves. This big game overlap hypothesised here is also only *that* visible because there is an overrepresentations of these species within the corpus itself, which naturally makes the big game data look more substantial in that regard. When anthropomorphic depictions do occur on the panel, they are also not always represented in isolation. Anthropomorphs are also associated with aurochs (n=11), birds (n=1), ibexes (n=7), horses (n=9), undetermined species (n=5), mustelids (n=1) as well as with themselves (n=10). This is not surprising given their daily interaction with and reliance upon these species. It is surprising, however, that they appear rarely on the rocks; clearly, a separate in-depth study is necessary to ascertain where and why they might be occurring in specific spots in the landscape.

Overall, this overlap survey leads to a great potential future study, looking into the panel structure as a bounded unit and analysing their internal working relationships, as evidence for a truly intra-species and intra-environmental archaeological site and beyond.

[21] For ease of representational readability, rock art motifs with no overlap or just one or two overlaps each are not listed in this chart. This applies to mustelids, birds and dogs. Categories with collected data on sex and age divisions of particular species are combined in this chart (see i.e. deer and ibex).

6.4.4. Degrees of superimposed complexity and their respective quantities

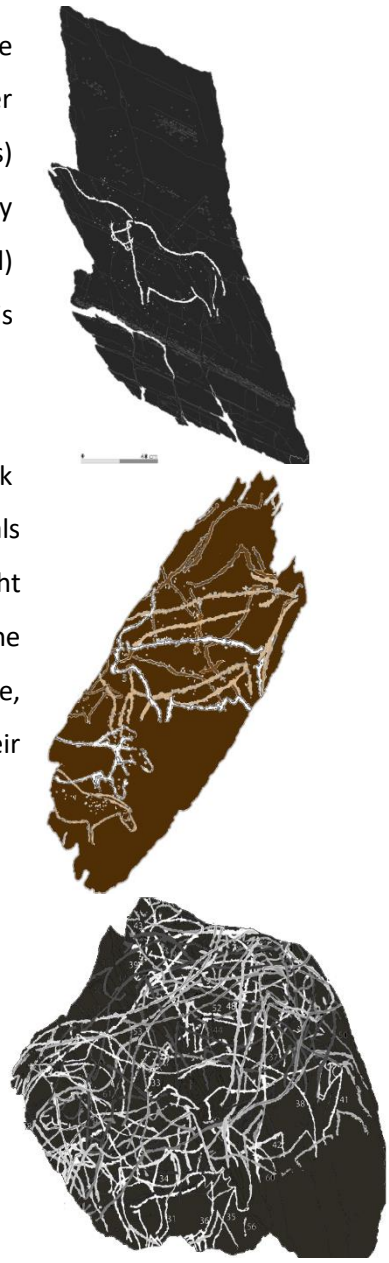
Are there different degrees of superimpositions?

For purposes of better categorisation and ease of identifying animals in the next experimental set-up, three degrees of complexity are artificially created (Fig. 6.4.5 – 6.4.7):

A **basic overlap** is defined here as having a clearly distinct area of the rock that bears a maximum of three animals overlapping each other (this does not necessarily mean one animal having three overlaps) with all motifs being clearly visible and their engraved lines clearly traceable in their entirety. Moreover, the rock background (i.e panel) is predominantly visible, in other words more than 75% of the rock is not occupied by engravings and their overlap.

A **medium overlap** is defined as having a distinct area of the rock bearing a minimum of three and a maximum of seven animals overlapping in this space. Motifs appear visible, but their lines might be confused with that of another animal when trying to trace the entire outline of the engravings. The rock background is still visible, with more than 50% of the rock not occupied by engravings and their overlap.

A **heavy overlap** is defined as having at least seven motifs overlapping themselves in a clearly demarcated area. Most often, the number of overlaps is much higher. Motifs are discernible, but only after considerable study of the superimposed motifs. Many lines perceived to be of one motif will likely be confused with those of other animals. The rock background is least visible (25%), with engravings taking up most of the 'foreground'.



Figures 6.4.5.-6.4.7.: Experimentally prepared and altered rock art recordings (author's replication).

Note: A motif that overlaps a geometric form or simply an engraved line is not considered an *overlap*, merely overlapping *motifs* are counted as part of this study.

How many superimposed panels are there?

As established in the previous chapter, a total number of 16 sites are included in this study, comprised of 127 engraved panels and a total number of 1117 individual motifs. Out of those 1117 motifs inspected, 811 were recorded as overlapping one or more engravings on the panels comprising of various techniques. This is a considerable amount of overlap, leaving just 306 motifs (27%) that are depicted in isolation. This is an important finding in the search for the underlying visual strategies that Upper Palaeolithic artists employed. This suggests that **combination was far more desired than isolation, thus in accordance with the Laws of Proximity and Continuity.**

In compliance with the complexity levels determined overleaf, all of the 127 inspected panels were categorised, bar 5 panels for which the recorded drawings did not reveal their full borders and thus the uncertainty on their full extent and the possibility of extra motifs on the panels lead to their exclusion. A total of 72 panels were recorded as displaying overlapping features, and 50 panels in the area possessed only separate depictions of motifs. The following quantities (Fig. 6.4.8) are recorded (if readers are interested in the full extent of the different overlaps, consulting Appendix D will reveal an image databank of panels and their listed categorisation): (1) No Overlap: 50 Panels; (2) Basic overlap: 48 Panels; (3) Medium Overlap: 20 Panels; (4) Heavy Overlap: 4 Panels.

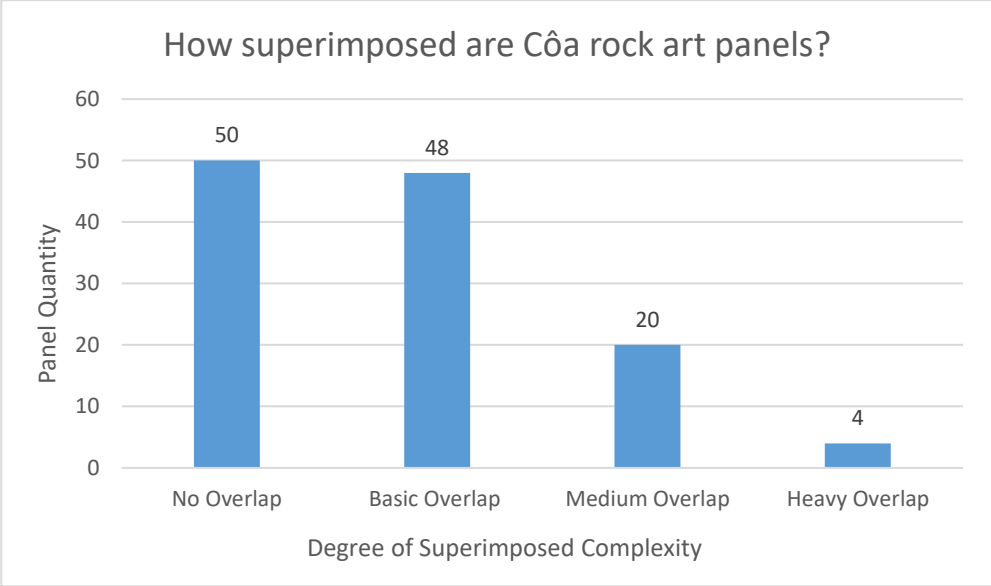


Figure 6.4.8.: Graph featuring the quantities of the different degrees of overlaps found within the rock art of the Côa Valley.

Interestingly, there seems to be a comparable split between panels possessing separately depicted motifs (41%; n=50/122) and those exhibiting overlain imagery (59%; n=72/122). This split points to another likely underlying visual strategy. The fact that panels seem to possess either none or only minor degrees of overlap points to an artistic interest in making their images as visible and accessible as possible. This makes a study of the two other categories, namely medium and heavy overlap with comparatively fewer occurrences even more thought provoking. As will be examined in the next chapter, a stimulating idea is that of spatial distribution and embeddedness of these two extremes (cf. Ch. 7.2). Conversely, it could also be argued that on a grand scale, the panels that possess medium or heavy overlaps will have been more visible over larger distance, due to their accumulation factor. An array of overlain imagery possesses more perceptual significance than a single depiction of a motif for which one would not to inspect the panel close-up. All of these aspects will be considered in the next section.

Again, it should be mentioned at this point that the data presented here only represents what was accessible by the researcher, constrained by time, resources as well as general status and amount of archaeological excavations in the region. There is no doubt that there will have been more panels originally created that are yet to be found by archaeological teams. Moreover, not to be forgotten are all the panels that have been lost forever by the river dam construction and vineyard expansions in the regions. However, as is the case with so many archaeological studies, researchers have to work with the material available to them at the time, knowing that that dataset is likely to be incomplete and can be expanded upon in the future.

6.4.5. Visibility of superimpositions

How visible are engravings within different degrees of superimpositions and rock types?

This experiment was set up to test whether participants respond differently to different sets of manipulated visual stimuli involving superimposed imagery. Ultimately, what will be fascinating to establish is, whether perceived animal numbers vary considerably to actual animal numbers on presented panels, especially when the complexity of superimpositioning increases.

6.4.5.1. Experimental methodology

Participant information

A total of 22 (10 males, 12 females) individuals participated in this experiment. The pool of participants was similar to that of the first experiment *Drawing Animals* (cf. Ch. 5.2). As before, all of the participants at Undergraduate Level were recruited through their attendance of the module "Advanced Skills – Experimental Approaches to Understanding Upper Palaeolithic Art". Prior consent was acquired, provided that their identity and any results obtained remain anonymous. Outside of this module, several other participants were recruited for this task. This was done in order to receive results from a different demographic and age environment. Therefore, a total of 7 undergraduates and a total of 15 further participants from various backgrounds and familiarity level with Upper Palaeolithic art (see Table 6.3) were consulted for this experiment. Below is a table with the key information for this first experiment:

	Under-graduates	**Additional Responses collected**	**Total**
Number of Participants	7	15	n=22
Male	2	8	10
Female	5	7	12
Right-handed	5	12	17
Left-handed	2	3	5
Familiarity with UP art	7	None	7

Table 6.3.: Further participant information for the superimpositioning experiment.

Experiment material set-up

The materials that were used prior and during this experiment are:

- Prior selection of digitally recorded panel drawings with a variety of overlain motifs.
    - Three different 'degrees' of overlap were selected (detailed further in the next section).
- Photo manipulation software (in this case Adobe Photoshop and Gimp) to alter background rock colouration and gradient of discolouration of engravings.
- Projector to portray the task instructions and the superimposed rock motifs with the aid of Microsoft PowerPoint.
- Sheets of white paper and pencils for recording responses.
- Post-experimental analysis using Microsoft Excel and the SPSS statistical software.

Experiment task set-up

Participants were instructed as follows:

1) Note down the rock numbers 1-24 before the experiment begins.
2) During the experiment inspect each rock, count how many animals you can detect and note down your suspected animal number next to the rock number.

Image selection

In order to investigate the ease of identification when images overlap, it was decided to split this perception task into the three different categories of superimposed (basic, medium, heavy) imagery that are available amongst the portfolio of the engraved Côa panels (cf. Fig. 6.4.9). Apart from availability of recorded panel drawings, the reason for selection of these different images was to give participants a great amount of exposure to different degrees of overlaps, just as Upper Palaeolithic audiences will have had, too.



Figures 6.4.9.: Collage of assessed panels each with different degree of overlap (left, basic towards right – heavy). Rock Panels not to scale (author's replication).

Image manipulation

Half of the selected images have been manipulated so that the most recent animals (those that seem to be engraved latest on top of other motifs, often determinable by its engraving technique, engraving depth and perspective) appear lighter than the ones at the bottom. The engravings towards the back gradually assimilate to the colour of the base of the rock itself. This mimics the discolouration, weathering as well as ageing effect of the engravings with continuous years of existence. This whitish colouration of the most recent engravings goes back to the discussion alluded to earlier that when a rock is freshly engraved, its white sharp residue is the feature on the rock that remains most visible for a considerable amount of time. The other half of the manipulated rock engravings did not assimilate to the background colourations, but stayed consistently white, allowing for tests on any noticeable differences. In order to understand how quickly rock art tends to fade, the following rock art making trials are worthy of discussion. The photograph below was taken in 2018 and shows recreations of rock art on authentic Côa Valley schist, located near the original dam construction site. In fact, this modern panel was exposed during the construction itself, meaning that no rock surface available in the Upper Palaeolithic were altered for these trials. Figure 6.4.10 shows three 'modern' engraving phases, all carried out by the same artist, Fernando Barbosa. The first engraving of a horse on the far right of the panel was made in 1994, at the time of the first rock art discoveries in the region. The second phase consisted of another pecked horse, here positioned centrally, and some additional fine line incisions nearby. This phase was carried out in 2005 for the making of Jean-Luc Bouvret's documentary *Côa, la rivière aux mille gravures.* The ibex, depicted on the far left of this photograph, was created in 2013/2014 for the making of a South Korean documentary. Hence, for the reader's comparison, the first phase of this modern rock art was made about 30 years ago, illustrating that the white residual engraving dust perseveres for some time. The latest phase was made only about 10 years ago, showing much clearer lines. When visiting this location in person, it becomes clear that the engravings not only alter with time, in accordance with weathering, angle of rock exposition and related sun exposure, but also the visibility of engravings is heavily impacted by their underlying bedrock coloration. This is nicely illustrated in the photograph, in which the rock changes from light to dark bedrock colouration upon gazing from right to left. Another engraving trial near the Côa River (cf. Aubry and Luís, 2012) also confirms such findings. Yet, putting this trial into perspective, what are thirty years in comparison to the length of time between different Upper Palaeolithic phases? It is obvious that more time is needed to fully assess the discolouration of rock art in various location. For now, various simulations of rock art compositions on differently coloured bedrocks will be introduced in chapter 7.



Figures 6.4.10.: Replica rock art site in the Côa Valley for tests on ease of engraving techniques and their visibilities. Left ibex (2013/14); central horse (2005); right horse (1994) (Photograph taken by author in 2018).

Image sequencing

Ten images of basic overlap, ten images of medium overlap and four images[22] with heavy overlap were shown to participants in a randomised fashion, meaning that one basic overlapped rock can be followed by a heavy overlap rock and not necessarily in strict order of difficulty (cf. Figures 6.4.11-6.4.14). This is to ensure that participants perform as unbiased as possible with no influence of knowing which rock is to come next. What is more, each level of difficulty is given a specific amount of screen time, to ensure participants have enough exposure to the rocks relative to how many animals are to be detected. Timing participants like this mirrors a scenario by which viewers of the art during the Upper Palaeolithic will have also had limited exposure periods to art, before realising what was depicted. Naturally, a panel with severe superimpositions receives more screen time and the stage of active looking prevails for longer than would be the case for spotting the depictions on a panel with a simple overlap of only two horses for instance.

The exposure to the different level of superimposed rocks are as follows:

Basic Overlap: 15 sec

Medium Overlap: 30 sec

Strong Overlap: 60 sec

[22] Only four images of heavy overlap were shown, first due to time constraints during the experiment, and secondly due to actual shortage of available heavy overlaps in the dataset.

The following images, categorised into their degree of superimpositions, are samples of some of the 24 digitised rocks that participants were exposed to:

Examples of basic superimpositioning:

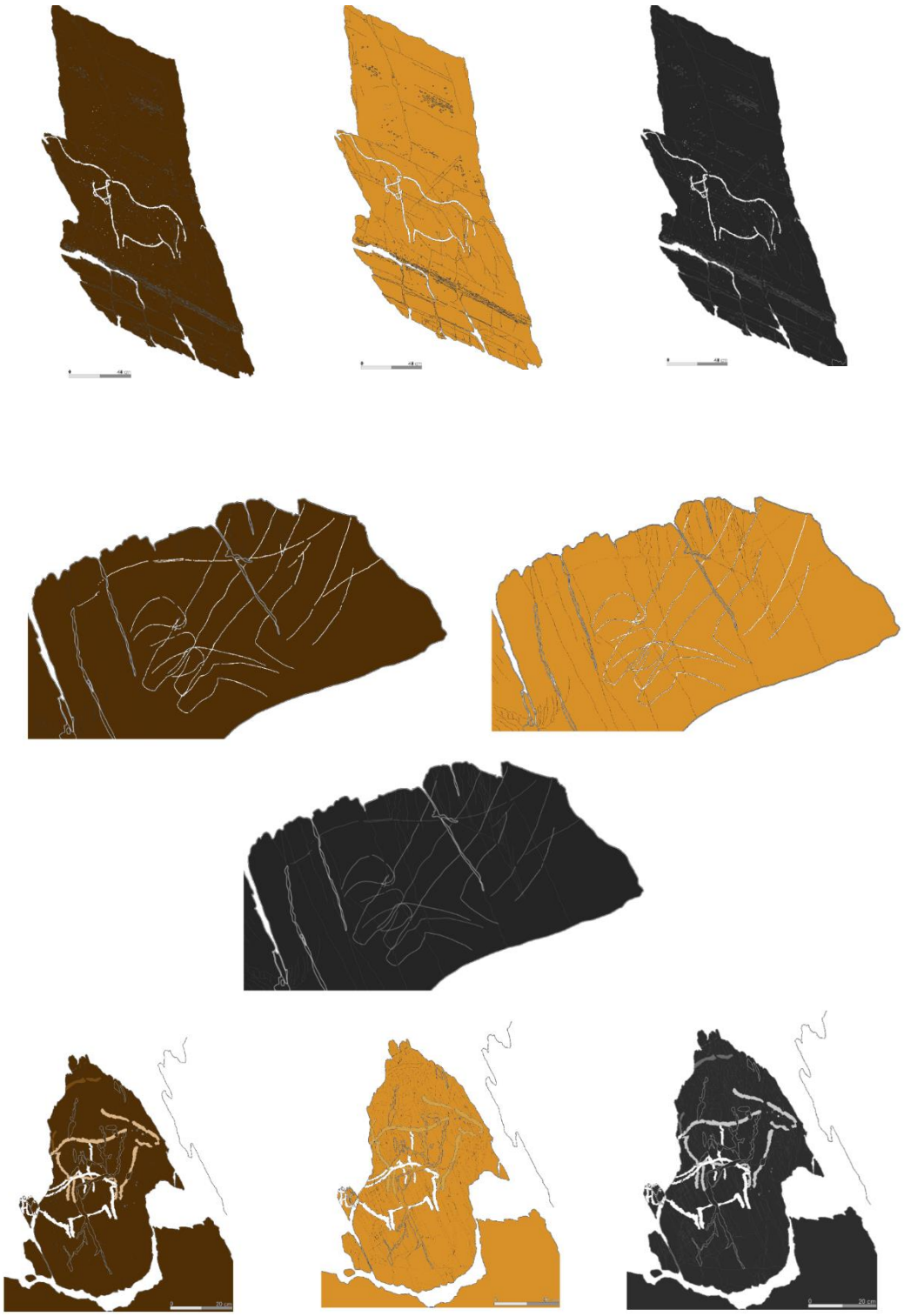


Figure 6.4.11.: Arrangement of features to be used for testing basic superimpositions.

Examples of medium superimpositions:



Figure 6.4.12.: Arrangement of features to be used for testing medium superimpositions.

All rocks with **heavy superimpositioning** used within the experiment:

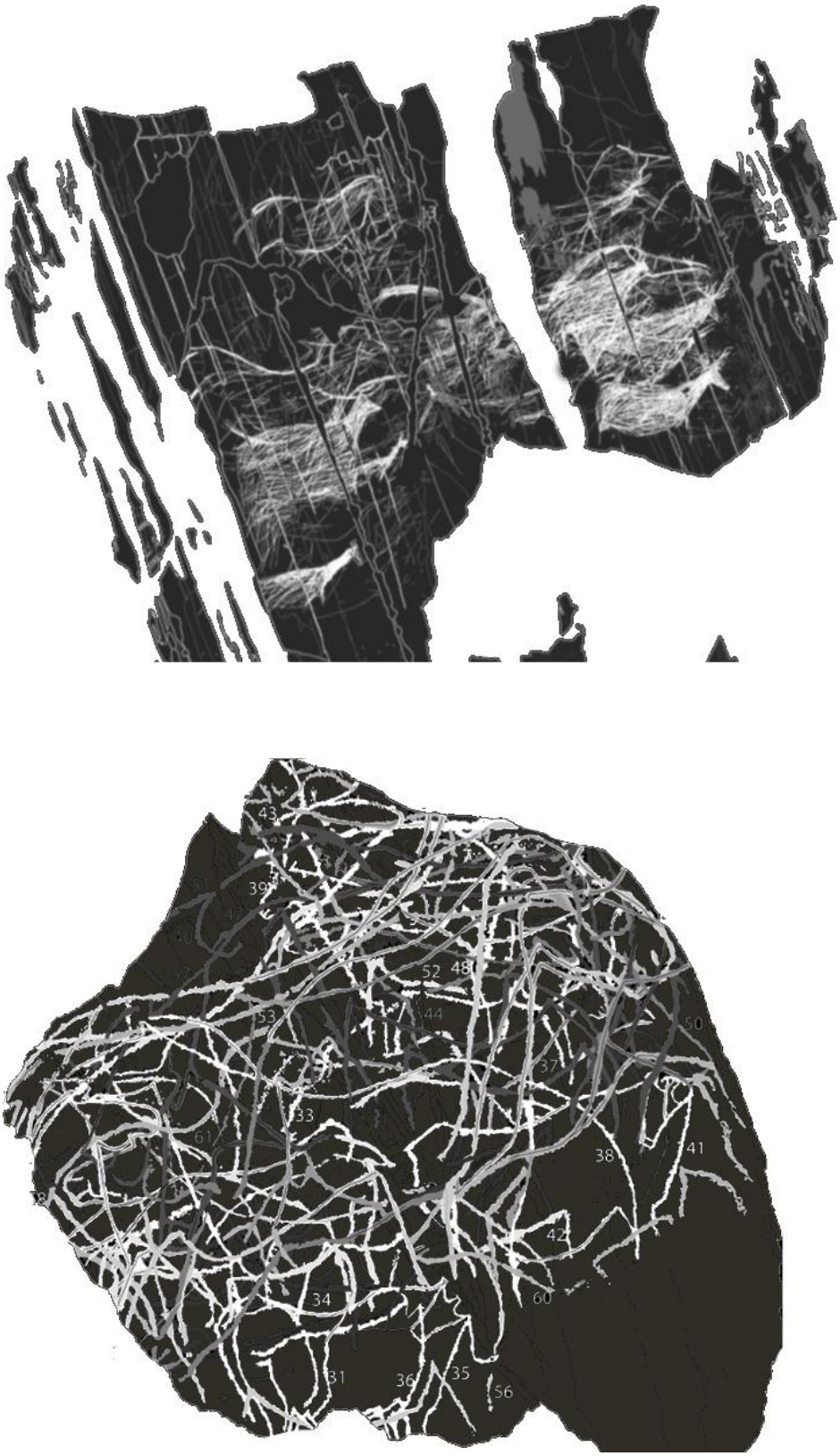


Figure 6.4.13.: Arrangement of features to be used for testing heavy superimpositions.

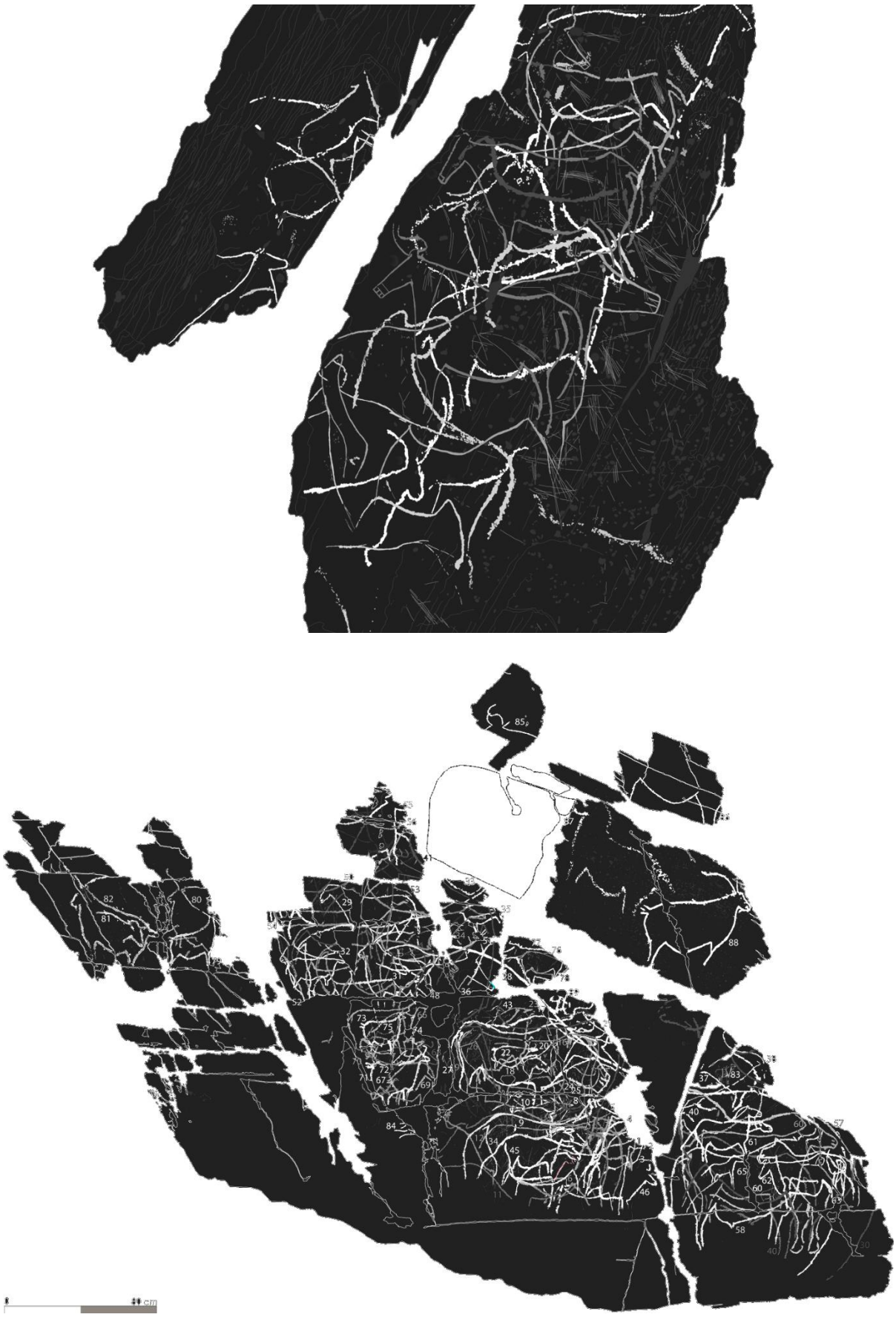


Figure 6.4.14.: Arrangement of features to be used for testing heavy superimpositions.

6.4.5.2. Experimental results - results for basic superimpositions

		Brown	Yellow	Black			Brown	Yellow	Black			Brown	Yellow	Black
Actual Quantity of Animals on the Panel		**2**	**2**	**2**	Actual Quantity of Animals on the Panel		**4**	**4**	**4**	Actual Quantity of Animals on the Panel		**4**	**4**	**4**
Perceived Quantity on Panel	**1**	2	2	2	Perceived Quantity on Panel	**1**	3	3	3	Perceived Quantity on Panel	**1**	2	2	2
	2	2	2	2		**2**	4	5	4		**2**	3	3	3
	3	2	2	2		**3**	4	4	4		**3**	5	5	4
	4	1	1	2		**4**	3	3	3		**4**	3	2	3
	**5**	2	2	2		**5**	3	3	3		**5**	3	3	2
	6	2	2	2		**6**	4	4	4		**6**	2	2	2
	7	1	1	2		**7**	4	4	5		**7**	2	2	2
	8	2	2	2		**8**	3	3	4		**8**	3	2	3
	9	2	2	2		**9**	3	3	3		**9**	3	3	3
	10	2	2	2		**10**	3	3	3		**10**	3	3	3
	**11**	2	2	2		**11**	4	3	4		**11**	2	2	2
	12	2	2	2		**12**	3	3	3		**12**	2	2	2
	13	1	1	2		**13**	4	3	4		**13**	5	3	5
	14	2	2	2		**14**	4	4	4		**14**	3	3	4
	15	2	2	2		**15**	5	5	5		**15**	4	2	4
	16	2	2	2		**16**	4	4	4		**16**	3	3	2
	17	2	2	2		**17**	3	3	4		**17**	3	3	3
	**18**	1	1	2		**18**	3	3	3		**18**	2	2	3
	19	2	2	2		**19**	5	3	5		**19**	3	2	3
	20	2	2	2		**20**	4	4	4		**20**	4	2	4
	21	1	2	2		**21**	3	3	3		**21**	3	2	3
	22	2	2	2		**22**	4	3	3		**22**	2	2	3
Average Quantity of Perceived Animals on Panel		**1.77**	**1.81**	**2**	Average Quantity of Perceived Animals on Panel		**3.63**	**3.45**	**3.63**	Average Quantity of Perceived Animals on Panel		**2.95**	**2.5**	**2.95**
Percentage Difference between Actual & Perceived Quantities (in %)		**12.20**	**9.97**	**0.00**	Percentage Difference between Actual & Perceived Quantities (in %)		**9.69**	**14.76**	**9.69**	Percentage Difference between Actual & Perceived Quantities (in %)		**30.21**	**46.15**	**30.21**

Table 6.4.: Table of results for 22 participants perceiving basic overlaps.

Experimental results - results for medium superimpositions

		Brown	Yellow	Black			Brown	Yellow	Black			Brown	Yellow	Black
Actual Quantity of Animals on the Panel		6	6	6	Actual Quantity of Animals on the Panel		9	9	9	Actual Quantity of Animals on the Panel		12	12	12
Perceived Quantity on Panel	1	5	5	5	Perceived Quantity on Panel	1	10	7	7	Perceived Quantity on Panel	1	7	6	8
	2	6	5	5		2	7	7	7		2	6	6	9
	3	5	5	5		3	7	7	10		3	8	9	9
	4	4	5	4		4	9	8	6		4	7	6	7
	5	4	4	5		5	7	6	7		5	10	3	9
	6	5	5	7		6	9	9	10		6	6	6	14
	7	5	5	5		7	8	9	6		7	6	4	7
	8	5	5	5		8	8	7	8		8	6	8	8
	9	6	5	6		9	9	7	9		9	7	6	7
	10	4	4	5		10	9	7	9		10	8	8	8
	11	4	4	4		11	9	9	10		11	10	11	11
	12	6	5	6		12	10	8	10		12	6	5	7
	13	5	4	5		13	7	6	8		13	12	10	12
	14	6	5	6		14	8	7	8		14	15	7	7
	15	4	4	5		15	7	7	7		15	8	9	8
	16	4	4	4		16	7	5	7		16	9	10	9
	17	4	4	4		17	10	8	8		17	6	6	8
	18	5	4	5		18	9	7	9		18	7	6	9
	19	4	3	5		19	7	7	8		19	7	6	8
	20	5	4	5		20	8	7	9		20	8	9	9
	21	6	6	6		21	9	7	9		21	11	10	12
	22	4	4	5		22	9	7	10		22	7	7	8
Average Quantity of Perceived Animals on Panel		4.81	4.5	5.09	Average Quantity of Perceived Animals on Panel		8.32	7.23	8.32	Average Quantity of Perceived Animals on Panel		8.04	7.18	8.81
Percentage Difference between Actual & Perceived Quantities (in %)		22.02	28.57	16.41	Percentage Difference between Actual & Perceived Quantities (in %)		7.85	21.81	7.85	Percentage Difference between Actual & Perceived Quantities (in %)		39.52	50.26	37.86

Table 6.5.: Table of results for 22 participants perceiving medium overlaps.

Experimental results - results for heavy superimpositions

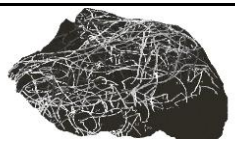
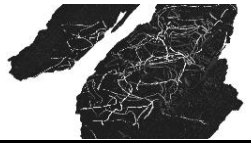
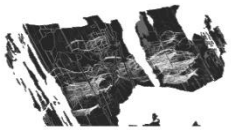
					
Actual Quantity of Animals on the Panel		**19**	**36**	**36**	**88**
Perceived Quantity on Panel	**1**	14	15	9	24
	2	7	4	8	24
	3	9	39	9	35
	4	11	4	8	26
	5	6	20	9	35
	6	12	45	9	48
	7	10	8	9	28
	8	12	8	8	25
	9	9	18	9	20
	10	7	29	7	68
	11	10	5	10	23
	12	8	10	8	30
	13	11	4	9	23
	14	7	12	9	29
	15	6	30	7	24
	16	15	22	11	24
	17	18	7	15	24
	18	7	12	7	35
	19	12	22	8	27
	20	20	9	9	39
	21	8	18	9	25
	22	10	35	8	49
Average Quantity of Perceived Animals on Panel		**10.41**	**17.09**	**8.86**	**31.14**
Percentage Difference between Actual & Perceived Quantities (in %)		**58.42**	**71.24**	**120.99**	**95.45**

Table 6.6.: Table of results for 22 participants perceiving heavy overlaps.

6.4.5.3. Experimental discussion

Before delving deeper into the statistical significances of these results (Tables 6.4-6.6), a couple of general observations can be made about the data collected:

1) The more superimposed a panel becomes, the more difficult for participants to enumerate the motifs
    - [True to actual quantity] Basic → Medium → Heavy [Imaginary Quantity]
2) The stronger the contrast between bedrock and motif colouration, the better the detection
    - Lighter background colour equals a lower detection rate of motifs
    - Yellow base bedrock colouration particularly bad for detection
    - [Hard to detect] Yellow → Red/Brown → Dark [Easy to detect]

Results based on the gradient of shading (getting darker further towards the background) have been loosely recorded whilst participants were giving commentary throughout their experimentations (see Appendix D), yet for a more thorough analysis of how this change in the stimuli actually affect the visibility and detection timings, more thorough mediated prompts (e.g. which shape is observed first, or even a more nuanced understanding of how long it takes for participants to take account of the underlying quantities based on restricted timings again). However, in order to advance and make sense of these results across the different participants, a series of analyses of variance (ANOVAs) have been applied. The tables above present an excellent case for studying variances *within* subject behaviours, since the data and experimental set up presents one or more dependent and independent variables. Based on a series of preliminary steps within Excel and then with the aid of the statistical software SPSS, two ANOVAS are performed, after which Mauchly's Test of Sphericity is applied for statistical significances of the results. Post-hoc paired t-tests are also performed.

As can be seen in figures 6.4 and 6.6, there are two instances where the number of animals on the panels are the same (2 panels with 4 animals (cf. Table 6.4) and 2 panels with 36 animals (cf. Table 6.6). Each panel has its average calculated for variance testing, and in addition to that, for these occasions where two panels bear the same amount of animals on display, their average between the two has been calculated. That means the variance can be tested between differently populated panels. Values within the tables above have been converted to their proportional average, meaning that the perceived number of motifs was divided by the actual number of motifs on the panel. Hence, the data that is eventually entered into SPSS are the animal numbers reported as a proportion of the total number of animals present in each stimulus. A variety of ANOVAs were then performed using the general linear model function and selecting the repeated measures ANOVA, often consulted for within subject variations.

One-way repeated measures ANOVA

This variance testing determines whether there is an interaction between the actual quantity of animals on a dark rock surface and that of the quantity of animals on a given panel as perceived by participants within the experiment (this ANOVA has only been performed on dark panels to serve as an exemplary view into how participants performed on the most contrasting (surface to engraving) panel colourations, from which results of the brownish and yellowish panels can be inferred). The **independent variable** is the actual quantity of animals, being manipulated throughout the experiment. In contrast, **the dependent variable** that is being measured is the perceived quantity of animals on the rocks. In analysing the outcomes of the performed ANOVA's, it is possible to analyse and compare the variability of scores within these conditions. This in turn helps to figure out if the independent variable had a statistically significant effect on the dependent variable.

A one-way within subjects (or repeated measures) ANOVA was conducted to compare the effect of actual animal quantity on perceived animal quantity in eight different conditions (2, 4, 6, 9, 12, 19, 36, 88 distinguished animals on a single panel). To start with, instead of a simple descriptive statistics section, the following graph illustrates the mean values of each experimental panel based on the proportional difference between perceived and actual animal number on the panel. So, for instance, for a panel that possesses four animals, the average between all 22-participant answers was divided by the actual quantity of animals: M (3.34/4 =0.835; second column in graph[23]):

The graph (Fig. 6.4.15) shows that with increasing complexity of superimpositioning, the larger the discrepancy between real and perceived animals on a shown panel. In other words, the more animals are presented to a viewer, the harder it becomes to identify its majority. Conversely, the fewer the amounts of depictions on a panel, the more likely it is for participants to detect all in a given time period. An interesting anomaly is seen in the panel that contains nine actual animals, for which its perceived mean value comes very close to the original nine (M=8.32). This might be because the animals on display are fairly spaced out across the entirety of the panel, which may explain its high degrees of ease of identification, when compared to a clustered set of figures that heavily overlap in just one spot (cf. Table 6.5).

[23] The error bars were manually calculated using standard deviations and Std. Error Means for each panel tested.

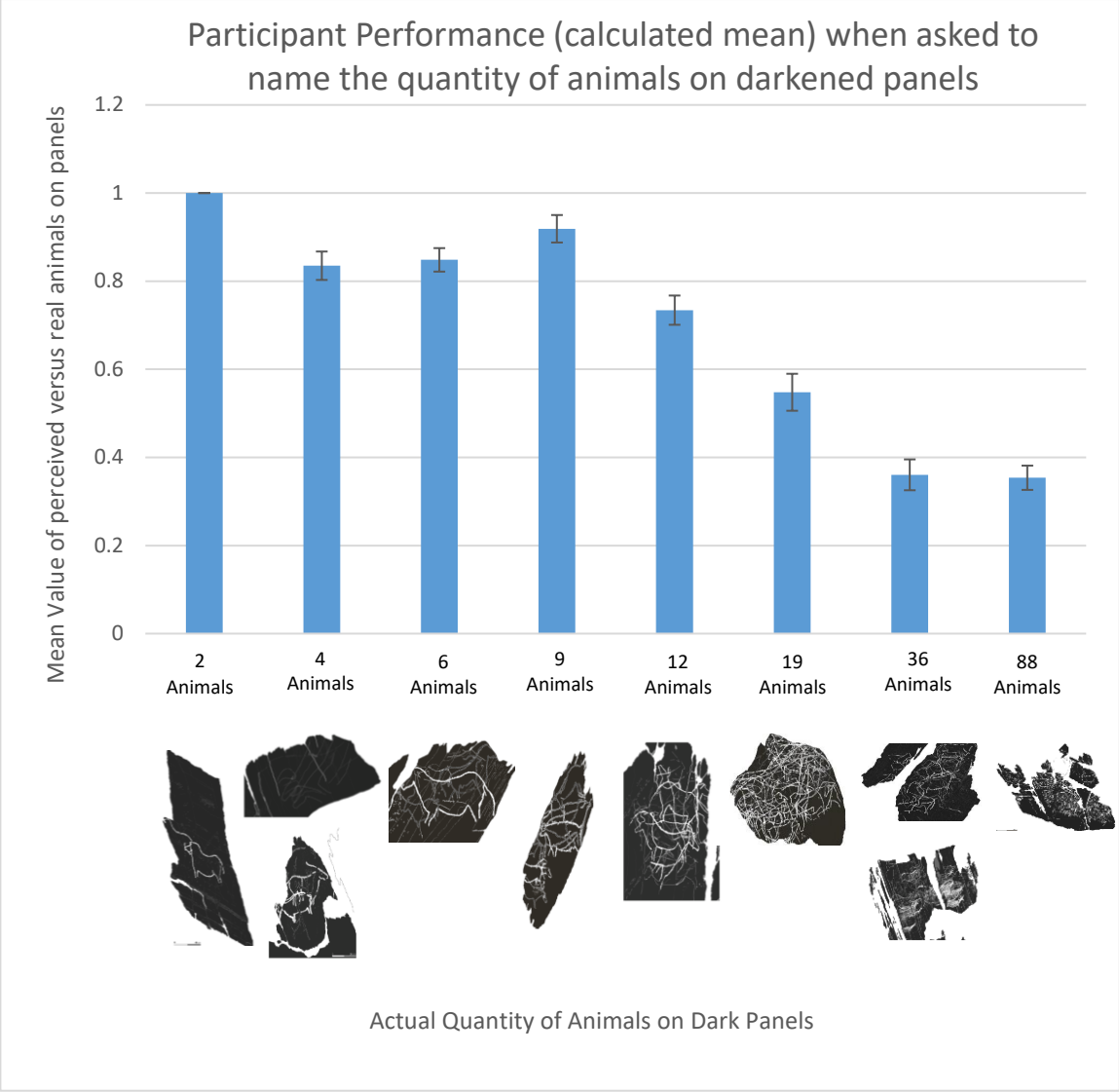


Figure 6.4.15.: Graph indicating mean performance by 22 participants when asked for perceived animals on darkened panel surfaces. The calculation for bar 2 (4 animals) and bar 7 (36 animals) are the combined data from the two panels shown to observers (see discussion).

Overall, there was a **statistically significant difference** within subjects as determined by the one-way repeated measures ANOVA. More broadly it means that the results obtained did not occur by chance, meaning the null hypothesis was able to be rejected. This then indicates that these results are obtained due to the effects of the independent variable (the actual number on the panel) on the dependent variable (the perceived number on the panel). The beauty of a within-subject ANOVA is that it uses the same subjects for the testing of every condition, meaning that the result can be compared across the subjects (refer to the discussions below to gain further insights into this). useful report on the data is that of Mauchly's Test of Sphericity, which presents a more nuanced way of interpreting both significant and non-significant results within a repeated measures dataset. More generally, sphericity often regards "the equality of variances of the differences between [condition] levels" (Field, 2008: 15). In other words, sphericity can

be described as the condition under which the to-be-tested variances of differences between all the measured combinations are equal. A violation of sphericity occurs when these variances are *not* equal. Generally, Mauchly's Test of Sphericity explores the null hypothesis (= v*ariances of the differences are equal).* If this test was therefore statistically significant with a p-value below or equal to 0.05, it is possible to reject the null hypothesis (= *variances of the differences are not equal*), resulting in the violation of sphericity. In this case: $F(7,147) = 72.787$, $p < 0.001$[24] which indicates that the assumption of sphericity has not been violated and that therefore, the sphericity assumption is valid for this data: Mauchly's W= 0.136, Chi-Square (27) = 36.833, p = 0.10. Since the collected data does not violate the assumption of sphericity, no modification to the initial F-value and its associated degrees of freedom need to be undertaken. This means that the F-value as stated above is interpretable and can thus be used to infer statistical significance, which it does.

Therefore, since the initial p-value is well below that of 0.05, it is possible to conclude that there is a **statistically significant difference between the perceived quantity of animals between some of or all of the manipulated animal panels** (the result also concerns the overall change, not just per participating observer). In this case, we can reject the null-hypothesis, which infers that the results were not just derived accidentally, but instead came about because of the effect of the independent variable on the dependent one. These results suggest that actual animal numbers really do have an effect on the perceived number of animals on dark panels.

In this instance, it can be concluded that there is a statistically significant difference between some of the conditions in the conducted experiment. However, as such we are not able to tell where this significance exactly lies. It could lie in between two conditions or across all of them. To combat this uncertainty, paired t-test were conducted between all of the eight conditions to investigate where the significance lies. In total, seven paired samples t-test are used to make post-hoc comparisons between the different conditions (i.e. the various actual amounts of animals on a dark panel).

[24] The different components in this SPSS data are F value = the combination of the variance between and within sample means and sample size (in brackets are the df (degrees of freedom) values for sphericity assumed number of animals and error statistics) and the p-value found in the Sig. section.

Paired Samples:

Test 1 (2 v 4[25]); 2 (M=1.00, SD=0.00) conditions, 4 (M=0.84, SD=0.15) t(21)= 5.11,p= 0.000.

Test 2 (4 v 6); 4 (M=0.84, SD=0.15) conditions, 6 (M=0.85, SD=0.12) t(21)= -0.31,p=0.762.

Test 3 (6 v 9); 6 (M=0.85, SD=0.12) conditions, 9 (M=0.92, SD=0.15) t(21)= -2.23,p=0.037.

Test 4 (9 v 12); 9 M=0.92, SD=0.15) conditions, 12 (M=0.73, SD=0.16) t(21)= 5.10,p=0.000.

Test 5 (12 v 19); 12 ((M=0.73, SD=0.16) conditions, 19 (M=0.55, SD=0.20) t(21)= 3.61,p=0.002.

Test 6 (19 v 36); 19 (M=0.55, SD=0.20) conditions, 36 (M=0.36, SD=0.16) t(21)= 3.28,p=0.004.

Test 7 (36 v 88). 36(M=0.36, SD=0.16) conditions, 88 (M=0.35, SD=0.13) t(21)= 0.21,p=0.832.[26]

It can be concluded that for tests 1, 3, 4, 5 and 6 there is a statistically significant difference between the two conditions. Tests 2 and 7 (marked in bold italics) revealed no statistically significant difference. There was no particularly meaningful outcome when comparing panels with 4 and 6 animals as well as panels with 36 and 88 animals on them.

Two-way ANOVA

Arguably, whilst the results from the one-way ANOVA above reveal an interesting trend, this additional two-way ANOVA will compare subject responses when colour as well as animal quantities on the panels play a role simultaneously. This variance testing will help us analyse whether there is an interaction between the actual quantity of animals on a panel as well as the colour of a panel on the perceived quantity of the animals on a panel. Hence, this testing does not only address one dark bedrock colouration, but instead three different bedrock colours, which is why a two-way ANOVA needs to be applied here. Again, the **independent variable** is the actual quantity of animals, manipulated throughout the experiment. The **dependent variables** are the perceived quantities (0-infinity) and the background colours of the rock (red/brown, yellow or dark/black). To begin with, instead of another simple descriptive statistics section, the following graph[27] illustrates the mean values of each experimental panel based on the proportional difference between perceived and actual animal number on the panel (cf. Fig. 6.4.17). What this graph shows, which the one above does not capture, is the influence of colour on perception of superimposed imagery. Perhaps not surprisingly, a dip in perceived Mean is always (bar once in the two animal panel) noticeable in panels of yellow colouration. This is likely because white engraved lines, as well as gradually assimilating colours towards that of the bedrock do not display large contrasts, and thus their detection and hosting of animals seems

[25] Here, for instance, a paired samples t-test between the condition of 2 actual animal depictions versus 4 actual animal depictions on dark panels is conducted.

[26] This way of denoting significance uses M = Mean, SD = Standard Deviation, t = size of difference relative to variations (within brackets the degrees of freedom) and p = Sig. (2-tailed).

[27] The error bars were manually calculated using standard deviations and Std. Error Means for each panel tested.

counterintuitive. Superimpositions and the number of animals on brown as well dark/greyish-black bedrocks are generally better perceived, **with participants performing best on the darkest panels available.** Hence, if the chart on bedrock colouration choice within the Côa Valley is recalled (see Fig. 6.4.16), it is understandable why **rocks with darker hues take precedence over lighter ones and seem to be the carver's choice.** Having said this, by default, greater availability of rocks with specific hues, for example dark grey, also means more potential for engravings on such slabs. Hence, greater volumes available and corresponding results ought to be borne in mind when contemplating overall results. Furthermore, this data in combination with the bedrock colouration chart might also indicate whether rock art was initially coloured or not. For, if large quantities of rocks of yellow colouration were in fact recorded to have possessed rock art (which they are not), it might have been conceivable that their engravings would have been coloured with as much a contrast to the rock colour (perhaps charcoal or ochre) as possible. Yet, since not many yellow rocks are recorded, this idea can be replaced with the notion that rocks were likely not coloured, but instead the **fresh white-residual engravings in contrast to their dark bedrock will have naturally created this desired effect.**

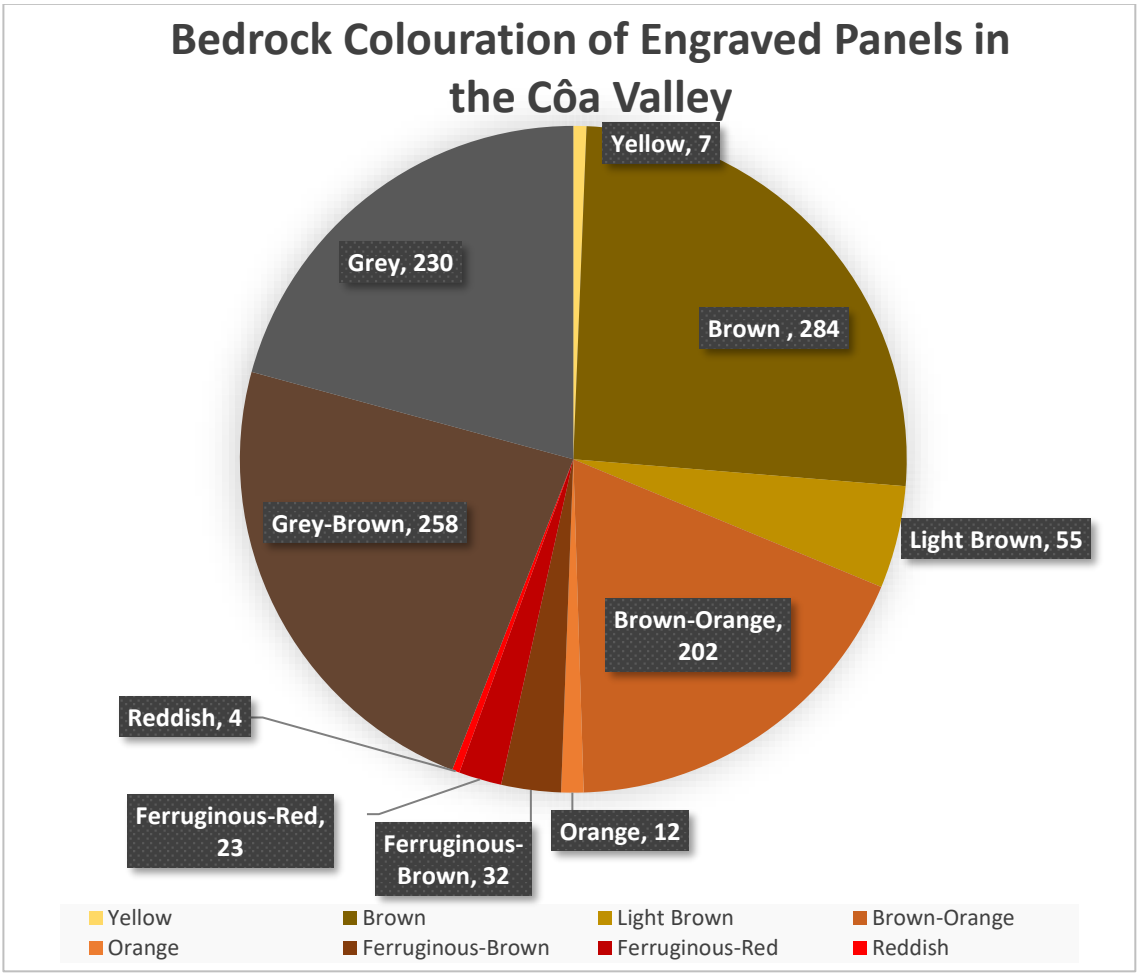


Figure 6.4.16.: Quantity of differently coloured bedrock found within the Côa corpus.

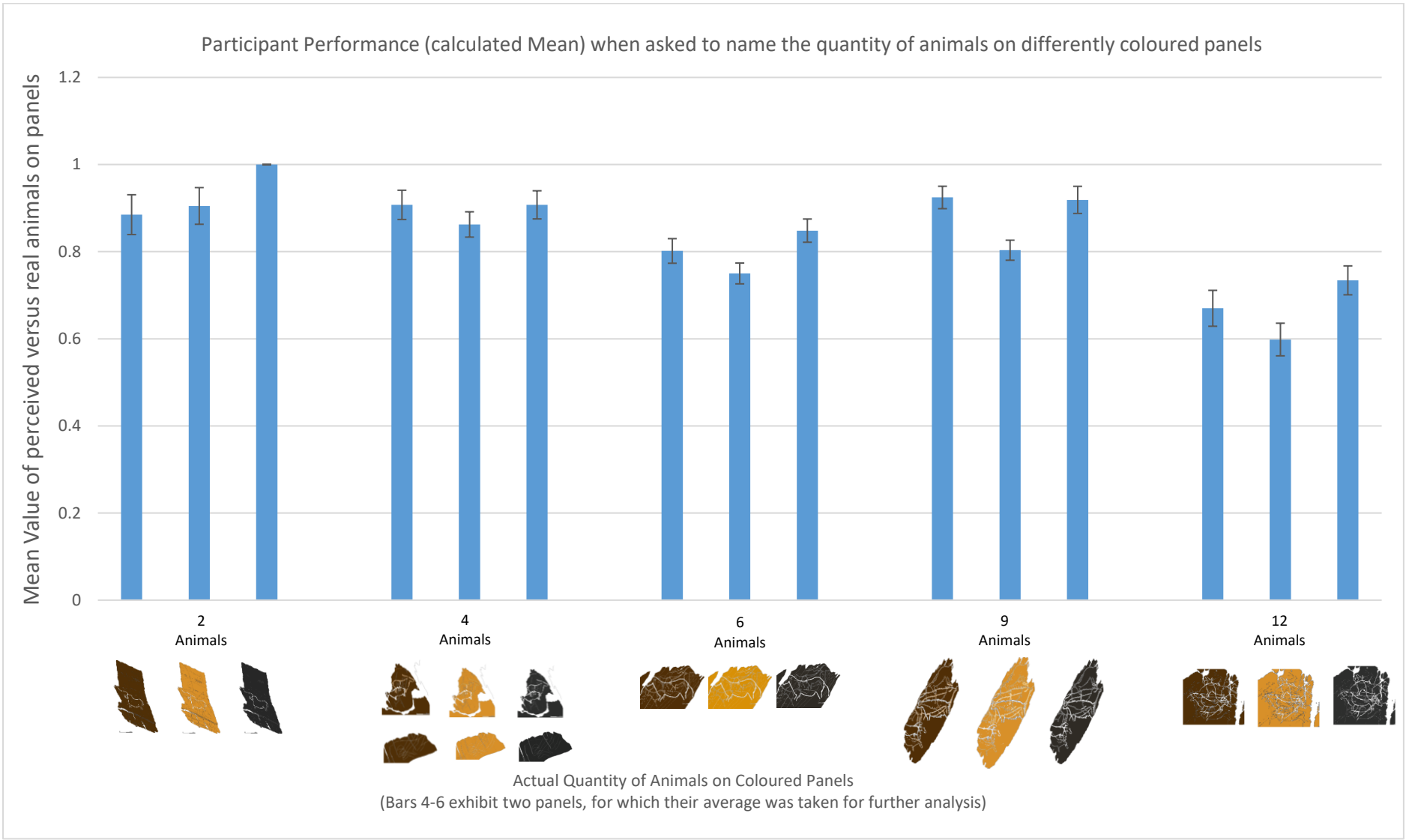


Figure 6.4.17.: Graph indicating mean performance by 22 participants when asked for perceived animals on a variety of differently coloured panel surfaces.

As for the results from the two-way ANOVA, Mauchly's Test of Sphericity was also conducted, but in this case for both number, colour as well as number by colour (see also the graph in Fig. 6.4.17 for the calculated mean of all tested panels).

Number: F(4,84) = 15.662, $p < 0.001$[28] which indicates that the assumption of sphericity has not been violated and that therefore the sphericity assumption is valid for this data: Mauchly's W= 0.600, Chi-Square (9) = 9.915, p = 0.359.

Colour: F(2,42) = 27.064, $p < 0.001$ which indicates that the assumption of sphericity has not been violated and that therefore the sphericity assumption is valid for this data: Mauchly's W= 0.920, Chi-Square (2) = 1.664, p = 0.435.

Number by Colour: F(8,168)=1.620, p= 0.122 which indicates that the assumption of sphericity has been violated and that therefore the sphericity assumption is not valid for this data. Henceforth, since Mauchly's test is significant it can be assumed that statistically significant differences between the variances of differences exist. Since sphericity has not been met, the results are likely to be subjected to something called a Type 1 error (rejecting a true null hypothesis), within which the F-value will appear inflated and the degrees of freedom will appear overestimated. In order to correct this inflation, the Greenhouse-Geisser correction can be applied here, which is a method within statistical analyses to adjust the lack of sphericity within a repeated measures (or within subject) ANOVA.

Hence, after Greenhouse-Geisser Adjustment/Correction using Epsilon = 0.604
Number by Colour: F(4.829,101.4) = 1.620, p = 0.164: : Mauchly's W= 0.045, Chi-Square (35) = 56.255, p = 0.015 which still indicates, despite attempt at correction, that the assumption of sphericity has been violated. Therefore, the sphericity assumption is not valid for this data. The p-value of well above 0.05 indicates that there is no statistically significant difference.[29]

These results show that the effect of colour on the (in-) correct perception of animals on a given panel does not tend to change when animal numbers are increasing on those panels. This is a great indication that no matter how many rock art animals are portrayed on a panel extend; the effect that colour repeatedly exerts on the viewers does not change this perception. This in turn illustrates that the **effect of colour as well as the effect of number are working independent of each other.**

[28] What is reported here are F (X = the between-groups df - degrees of freedom, then X= the within-groups df), after which the F statistic is accounted for and the level of significance.
[29] The performance of a repeated 2-way ANOVA means that no paired t-tests need to be conducted at this point.

6.4.6. Positioning superimpositions

Where do superimpositions occur on the panel?

For this section, all of the 72 panels have been analysed for the location of superimposed imagery. Taking a leaf out of the Upper Palaeolithic artist's book so to speak, to answer the question above as effectively and as visually as possible, panels with superimposed images will be superimposed on one another. The concept of superimpositioning is utilised in the aid for understanding overlap and their recurring choice of locations in a panel environment. For this, a layering software (in this case Adobe Photoshop) was utilised to mark the areas of overlap within the panels. A recording of a full panel extent serves as the backdrop to an 'invisible' overlapping layer onto which several markings are made (Fig. 6.4.18). The markings take the form of blue rectangles for panel extent, red rectangles for superimposed image extent and green stars for outlying, isolated motifs (the varying sizes of the stars are used to cover the extent of different animal yet are by no means representative and should not be regarded as illumination of sizing differences). The examples below show exactly this principle of denoting different regions of importance on the panel. The upper image is illustrative of how the rectangles and stars are featured. The lower image shows the layer of exactly these demarcations without its underlying panel (Fig. 6.4.19).

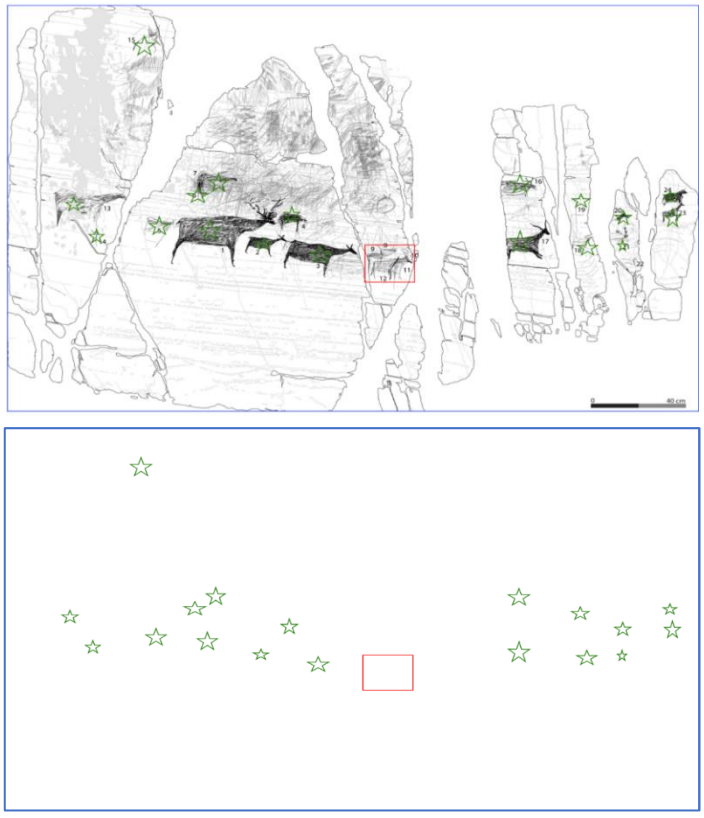


Figure 6.4.18.-6.4.19.: Recording of rock 16 of Vale de José Esteves with marked up squares and stars (top) (recording courtesy of Fundação Côa Parque). Transparent layer of rock extend (blue), area of superimposition (red) and individual motifs (red) (bottom).

The **blue rectangle** (in Fig. 6.4.18) indicates the physical rock extent dependent on all its orientations. A rectangle rather than tracing the actual outlining extent was chosen, first because it offers a better comparative strategy between panels and secondly and more importantly, it is able to indicate the physical availability of rock in front of the carvers' and viewers' eyes.

This idea plays on the fact that naturally, humans have the tendency to position themselves centrally in front of the subject under scrutiny (gaining a holistic overview of the scene) and subsequently move in closer or around the object to investigate areas of special interest (Bindermann, 2010). This is closely linked to a common central viewing bias amongst humans, which presents itself particularly "when an image of a visual scene is presented" to participants (ibid: 2579). Through this, it is possible to establish a central positioning of spectator and their level of line of sight (eye-level). One just needs to reminisce about entering an art gallery, an entire environment dedicated to the visual examination of art. One would naturally position oneself in a reasonable distance and parallel (i.e. at a 90° angle) towards the art under inspection to pay attention to all aspects in equal amounts. Subsequently, aspects deemed interesting by the observer are then often inspected closer up, with the accompanying label often consulted moments after this closer inspection (Serrell, 2015). This human tendency of viewing is taken into consideration for this study (see Judd *et al.* 2009). Furthermore, it is highly likely that pieces of rock that originally belonged to the panel have slightly shifted between the Upper Palaeolithic and now, due to river erosion and naturally occurring schist displacements (see Ch. 3 for more info). This factor needs to be considered, which is why a rectangular rather than a direct tracing system of panel denotation seems even more appropriate.

The **red rectangle** indicates the existence of superimposed imagery on an assessed panel. Again, the extent of all animals within their overlapped 'assemblage' is designated with a rectangle rather than an assimilating outline to their shape, for aforementioned reasons. The **green stars** denote singly occurring animals outside the realms of the superimposed motifs.

Existing panels are now being superimposed through these new marks of interest, in the form of the 'invisible' layers (without their underlying panel recordings)[30]. All of these layers are superimposed on top each other in the search for similar regions of superimpositioning. It quickly became clear that three general panel shapes occur in the Côa Valley. The first category

[30] This analysis is performed on panels that were available to the author at the time of writing (those that are also included in the *Engraved Species Database*). Naturally, as soon as new panels get discovered in future, the trends discussed in the following paragraphs need adjusting.

is comprised of squared panels[31], the second is comprised of horizontally aligned rectangular panels and the third category includes vertically aligned rectangular panel shapes. Once all the layers with their markings were created, the overall blue rock extend was then categorised into one of those three shapes. In each size category, all layers were adjusted to the same scale, in order to be able to objectively compare each rock category for their occurrence of superimposition. That meant that once layers were starting to be overlapped by each other, the different categories look as follows:

Squared

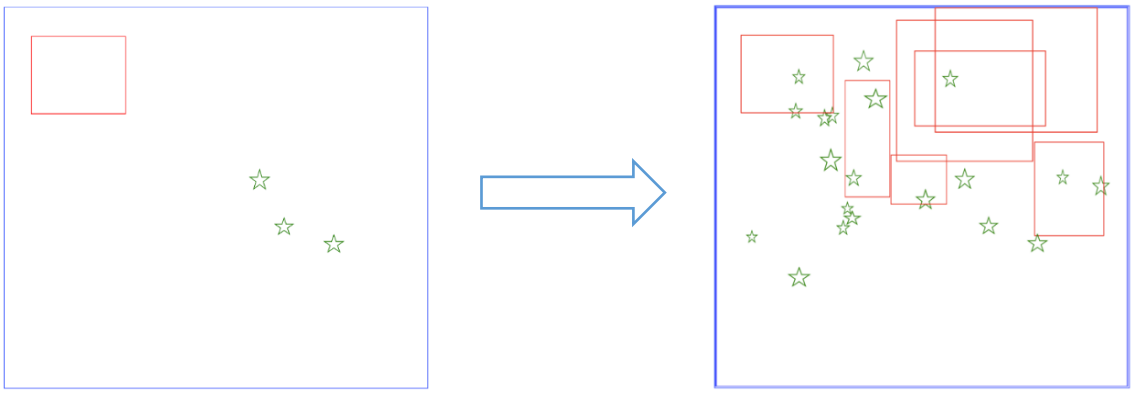


Figure 6.4.20.-6.4.21.: Transparent layer of rock extend on squared panels (left) and the subsequent overlap of transparent layers (right).

Horizontal

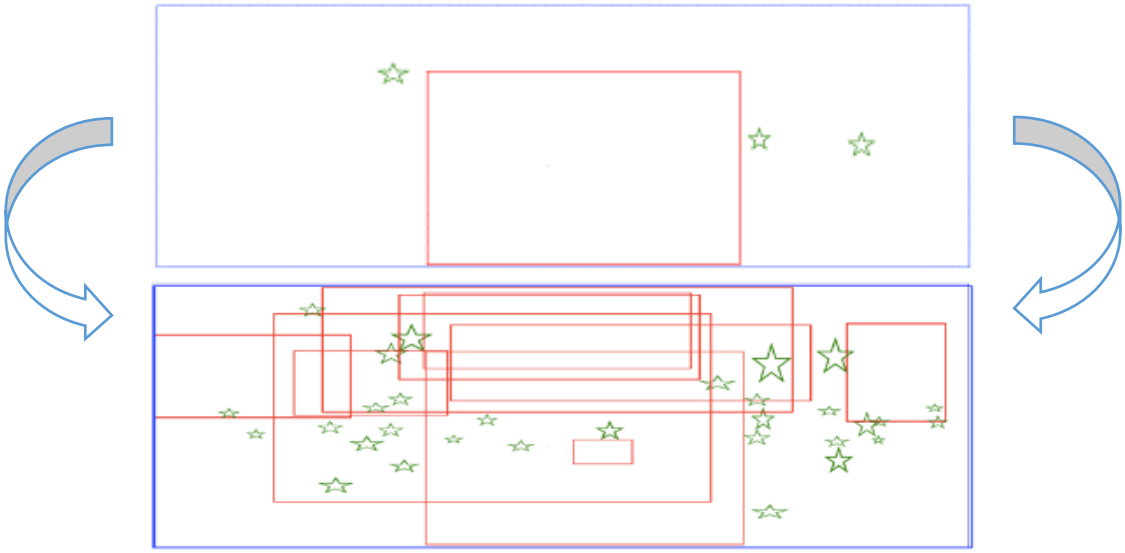


Figure 6.4.22.-6.4.23.: Transparent layer of rock extend on horizontal panels (top) and the subsequent overlap of transparent layers (bottom).

[31] Squared, of course, only in the sense that the rocks dimensions are similar in width and height, and not that the panel is literally a squared piece of rock. The same applies to the other categories.

Vertical

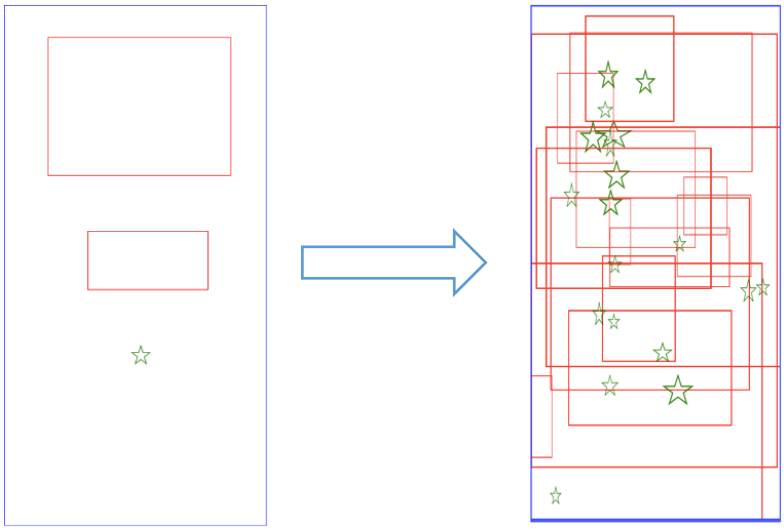


Figure 6.4.24.-6.4.25.: Transparent layer of rock extend on vertical panels (left) and the subsequent overlap of transparent layers (right).

The 'overlapping of overlaps' creates a powerful way to investigate common regions of interest on a panel (cf. Figures 6.4.20-6.4.25). Split between the three different aspect ratios (squared, horizontal and vertical) of how a panel portrays itself to an artist and its onlookers, the variety of generated overlap data is crucial in inspecting potential differences between these three types[32].

Although the superimposed overlaps already show certain trends as to where the majority of superimpositions on the panels lie, these observations seem too superficial and subjective to let them stand on their own as such. For that reason, each layer was subjected to a geo-referencing grid system, to numerically record the position of the red rectangles and green stars. A simple Eastings-Northings system served to collect data on the position of the markings within the different panel size categories. For the location of superimpositions on the panel (red rectangle), eastings were taken for each corner (E1 and E2) and so were the northings (N1 and N2). For the location of the single motifs (green stars), the central location within the star was taken and just one easting and northing reading was taken.

[32] For a sample databank on the marked overlap regions, please refer to Appendix D.

Readings were taken with a digital ruler and scaled to the size of each panel category under study. Hence, for the following panel, the process of measuring will have been undertaken like this (Fig. 6.4.26):

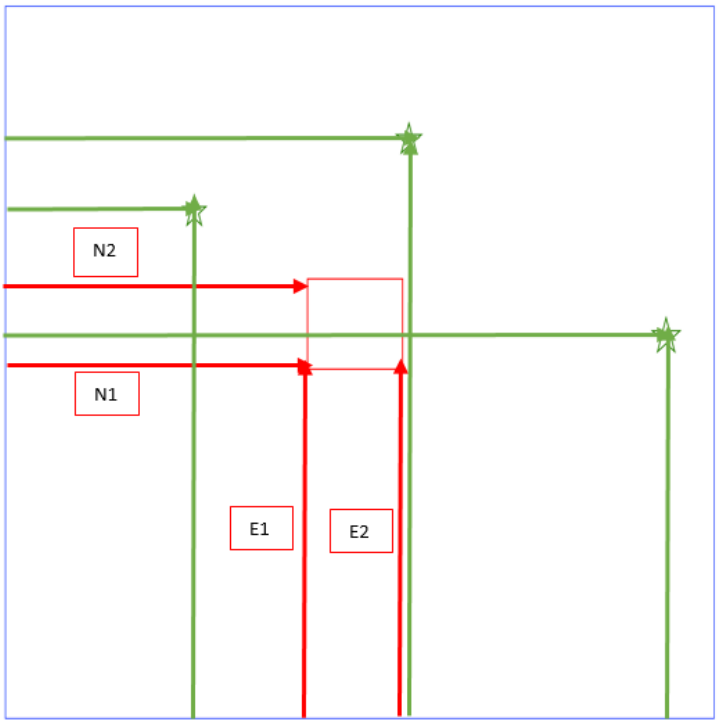


Figure 6.4.26.: Information on how the recordings of superimposition locations were conducted.

Overlap data – results and discussion

The four data points (E1, E2, N1, N2) collected for each superimposition rectangles were collated into one single data point through establishing the median value between E1 and E2 as well as between N1 and N2 to denote the centre of the 'box'. As illustrated below, this serves to simplify the way in which the reader will perceive the generalised locations of superimpositions in a panel environment.

The occurring locations of superimpositions on squared panel surfaces are investigated first:

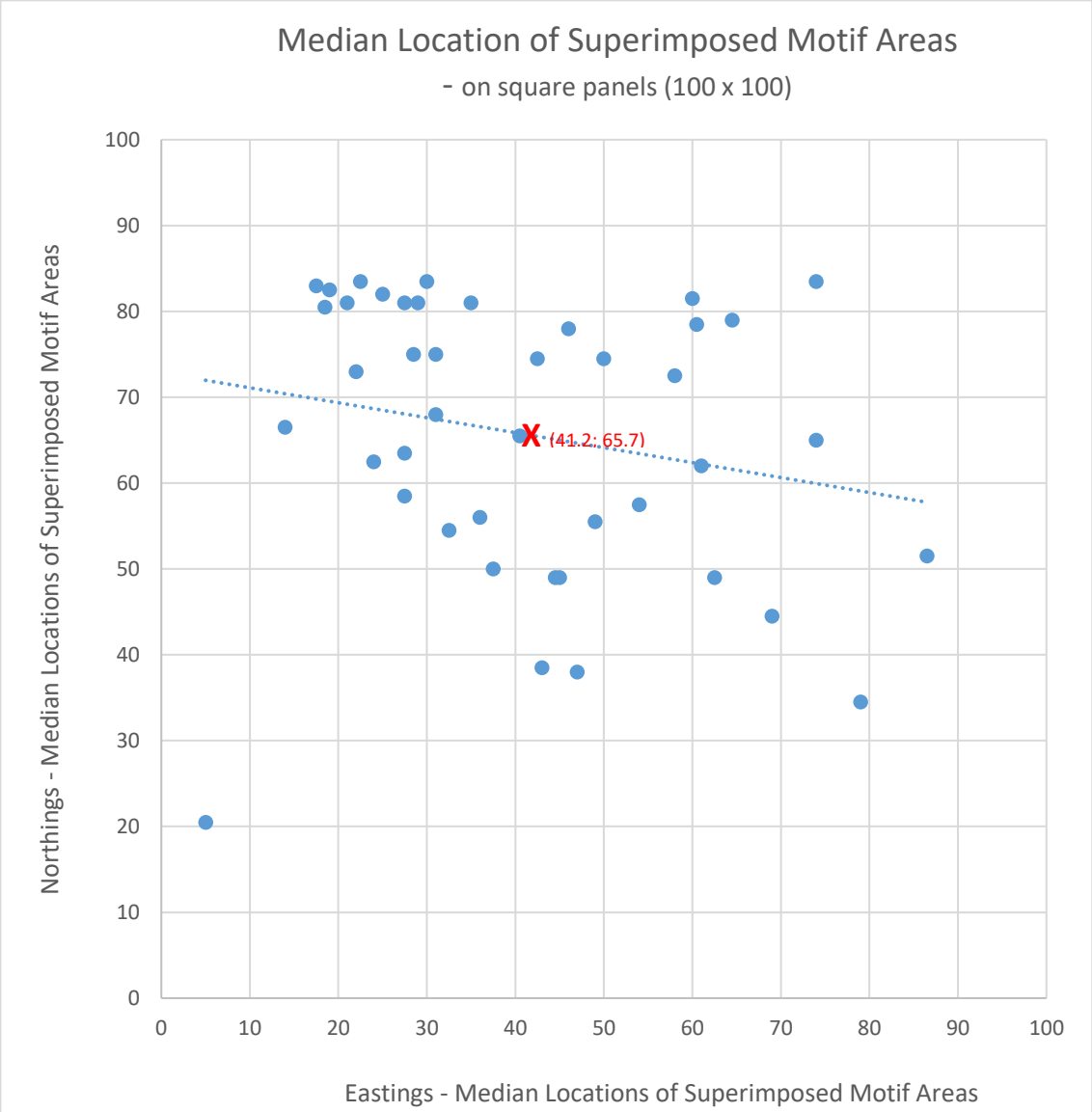


Figure 6.4.27.: Median location of superimposed motif areas on squared panels (the trendline indicates the general scattering of median values of superimposed areas, the red cross indicates the overall mean value of all superimposed locations on square panels).

Judging by the distribution of the median values of overlapped locations, an upper central inclination is noticeable. A few outliers such as the ones with a Northings reading of between 20 and 40 are intriguing incidences, which (given more time) would be worth evaluating further. Overall, then, as visible by the means of the linear trendline within graph (Fig. 6.4.27); a squared panel attracts most of its superimposed imagery in the upper half of the panel with a trend toward the upper left hand corner, also evidenced in the mean value of all superimpositions depicted (see red cross in the same figure). Thus, Upper Palaeolithic artists tended to overlap their depictions with a tendency towards the upper part of their initially blank canvases, particularly preferring left-sided superimpositions.

Why is there a preference for the centre-left?

Generally, when people inspect pictures of any kind (i.e. visual stimuli), they elicit a series of eye fixations, each one prompting the gaze to fixate and then move onto different visual locations in quick succession. This quick movement of both eyes between the fixation phases is psychologically termed *saccades.* The saccadic patterning of the eye is testable with eye-tracking equipment, enabling researchers to pinpoint particular fixations and saccades on visual imagery such as Renaissance art, facial expressions and marketing materials or for our matters it would even be possible on Upper Palaeolithic art. For some more general results on eye-tracking patters upon viewing works of art, the reader should refer back to chapter 3.2.2.

An eye-tracking survey conducted by Judd *et al.* in 2009 involved 1003 images being shown to 15 participants. It revealed an interesting trend in the way that fixations as well as saccades manifest themselves across different media. In fact, without going into the details of their specific psychological analysis, human fixations were averaged across viewers in a continuous saliency map (similar to what has been conducted for the *Bubbles* experiment, Chapter 5.4). This saliency map illuminates that 40% of fixations lie within the centre 11% of the image, with 70% of all fixations being positioned within the centre 25% of the image. This points to the fact that the middle part of the image attracts the most eye fixations, and not the peripheral areas, even though they often contained visually salient objects (Judd *et al.* 2009). Many researchers have however criticised this dataset and similar studies, because of something called strong *centre bias* due to experimental set-up. This is not surprising, since participants viewed their visual stimulus with their heads mounted to the eye-tracker and being centrally positioned in front of the computer screen (Tatler, 2007; Zhang *et al.* 2008). Furthermore, the photographs being shown will have naturally being taken with their chosen subjects as the central point of the photographer's composition, thus a tendency towards the middle therefore is inevitable (Parkhurst and Niebur, 2003; Tatler *et al.* 2005). Common ways to overcome this bias are to use a Gaussian blob to mask the centrally viewable objects of interest for the interpretation of fixations results (for further insights on this, the reader should refer to Zhang *et al.* 2008 and Judd *et al.* 2009).

Nevertheless, studies that not only adjust their images and results accordingly but also take the approach of letting participants *free-view* (without head-mounting) images, often come to similar conclusions on centre fixation tendencies. One such study by Bindemann in 2010 addresses some of the concerns caused by centre-bias laboratory set-ups, something that many visual psychologists especially link to viewing stimuli on computer *screens.* Not only does the

screen and focal position of the photograph play a role in potential centre bias, according to Bindemann, but also the centre effect that a fixation marker causes shortly before scene onset. A fixation marker aligns the participants' eyes just before a stimulus is presented, so that the eye saccades can be tracked equally between different sets of trials with different sets of stimuli (cf. Ruddock *et al.* 1995; Vincent *et al.* 2009). One might argue that this naturally forces the eyes to be primed for a centre-viewing position from the get-go. However, Bindemann and colleagues (2010) as well as Tatler's team (2007) have shown that even heavily peripheral fixation markers tend to swiftly bring participants eyes towards the centre, rather than elsewhere.

Moreover, the human tendency to look straight ahead (as described at the beginning of this section) might simply affect the way that the central-viewing bias comes about. Yet, a study by Vitu *et al.* in 2004 also dispelled this potential causation by setting up their screen left or right-centric dependent on the participant's central viewing position. Participants were still drawn to the scene centre, indicating that screen positioning does not affect this seemingly "systematic bias towards the centre of a visual display" (Bindemann, 2010: 2577). Lastly, to go back to the effect that computer screens and scene centres have on a central viewing bias, Bindemann's own experiment revealed that there was no interplay between these two. He offset the centre of a given visual scene to the left or right of the computer screen, for instance in the way that a person (naturally high in saliency in any given scene) is centrally or peripherally positioned on the screens. Again, a central viewing position was assumed from the scene onset (ibid).

After this rather lengthy theoretical discussion on how scientific studies measure and try to overcome or simply try to explain the tendencies for centre-biases, it now ought to be linked back to the visual displays of rock art. The previous experimental attempts have established that humans tend to naturally position themselves with a central viewing position towards the stimulus and then exhibit an initial central viewing bias within the scene extent itself. Therefore, it is now possible to relate this to the gathered data on superimpositions. In fact, a strong tendency for carvers to depict their overlaps goes towards the centre of a panel – very much in line with what the scientific community agrees upon with the help of eye-tracking. Hence, a clear **visual strategy by the Upper Palaeolithic artists as well as a clear central viewing preference by its audience underlines this phenomenon found within the established dataset. On a larger scale, the repercussions of such findings feed into a potential new function of the art, namely an art created for purposes of viewing, rather (or potentially coupled with) other mnemonic/shamanic/territorial/sensorial (amongst others) dimensions.**

Having recognised this natural predisposition for central fixations, the question remains as to why specifically the left-hand side of squared panels seem to be more populated with superimpositions than its counterpart.

It is commonly known that the left and right hemisphere of the brain have different attentional functions, which lead to dominances in either left or right visual fields, depending on perceptual processing tasks and influencing cultural factors (Abed, 1991). A technique called the *Divided Visual Field* Paradigm (Bourne, 2006) measures task performances once a visual stimulus is presented on either the left or the right visual hemifields (a hemifield is a 170-degree visual range observable by one eye). The initial reception of visual information by either the left or right cerebral hemisphere is then measured, giving rise to particular task advantages processed in either hemifield or hemisphere region.

A common phenomenon originally termed by Bowers and Heilman (1980) as *Pseudoneglect* indicates a left-visual field advantage (LVA) in the way neurologically normal participants bisect a horizontal line ("generally erring to the left of the veridical centre" (Jewell and McCourt, 2000: 95)). Brain damaged patients would respond differently, due to changes to the functions of their different hemispheres (see Soroker *et al.* 1997). Surprisingly, Śmigasiewicz *et al. (*2010) have established that this left-visual field bias also holds true across populations exhibiting different reading and writing directions. Their study presented alphanumeric stimuli (consisting of numbers and letters) to Germans (using Latin characters, reading from left to right), Israelis (using both Latin and Hebrew characters, reading from right to left) and to Taiwanese (using both Latin and Chinese characters, reading vertically). They hypothesised that if the left-visual field advantage was caused by learned native reading and writing directions, this advantage should manifest itself more in German than in Israeli or Taiwanese participants. However, it was broadly found that "a left visual-field advantage was always observed" (ibid: 2852). This shows that a left bias is not necessarily caused by reading direction but can be associated to the more general mechanisms of visual processes in the left and right hemispheric brain. For an additional study on Israeli participants possessing greater accuracy in the left visual field, the reader should refer to Braine (1968).

Furthermore, in a study by Kimura (1966), both verbal and non-verbal stimuli were presented to neurologically normal participants. Her results show that letters were "more accurately identified in the right visual field (...)" whereas the "enumeration of nonalphabetical stimuli was

more accurate when they appeared in the left field" (ibid: 275). Even though the other studies mentioned above already coincide with the data collected on an upper left bias of areas of superimpositioning, the result by Kimura underline the importance of a left-visual advantage for non-verbal material over verbal material, a result that fits nicely with that of the non-verbal nature of Upper Palaeolithic art.

Some studies even suggest that there might be an age-related loss in attentional lateralisation, meaning that the older a participant gets, the more biased they get towards a right visual field advantage. This in turn might indicate, with view on the dataset presented throughout, that the rock art was created by young artists who have not yet been influenced by this loss in attentional lateralisation (see Schmitz and Peigneux, 2011; Benwell *et al.* 2014). This idea should however be taken as highly speculative and too far-fetched from the dataset at hand. Moreover, no actual indication of the carver's age is available for open-air landscape art creation as of yet.

Overall, whilst all the studies above describe the analytical process of where the attentive fixations, and therefore the eyes, land when presented with visual stimuli, this can be indirectly and inversely applied onto how Upper Palaeolithic artists designed their artistic compositions. Whilst we do not have solid evidence for how exactly the art would have been viewed, the results from the data collected can indirectly give us information on how Upper Palaeolithic people subconsciously made use of these visual strategies, so highly dependent on the workings of our cerebral hemispheres. **Thus, the naturally occurring human visual tendency towards a central as well as left hemifield viewing bias, seems to have influenced the positioning of mark making in the past.** It seems likely that Upper Palaeolithic artists inspected their (in this case) squared panels, and due to this natural centre-left instinct, focussed their depictions in exactly these regions.

The following graph (Fig. 6.4.28) indicates the location of superimposed areas (in blue) and combines that data with motifs that appear in insolation (in cream). The linear trendline (here indicated in cream colour) generally reveals an even more central location of single motifs than that of superimpositioned areas (blue). In fact, it seems as if the motifs that singly occur on the panel generally assume a further reaching extent, yet still display a largely central-left attention bias. So not only do the centre-left arguments still hold true, what can be seen is that single motifs generally tend to accompany and supplement motifs that are overlapping.

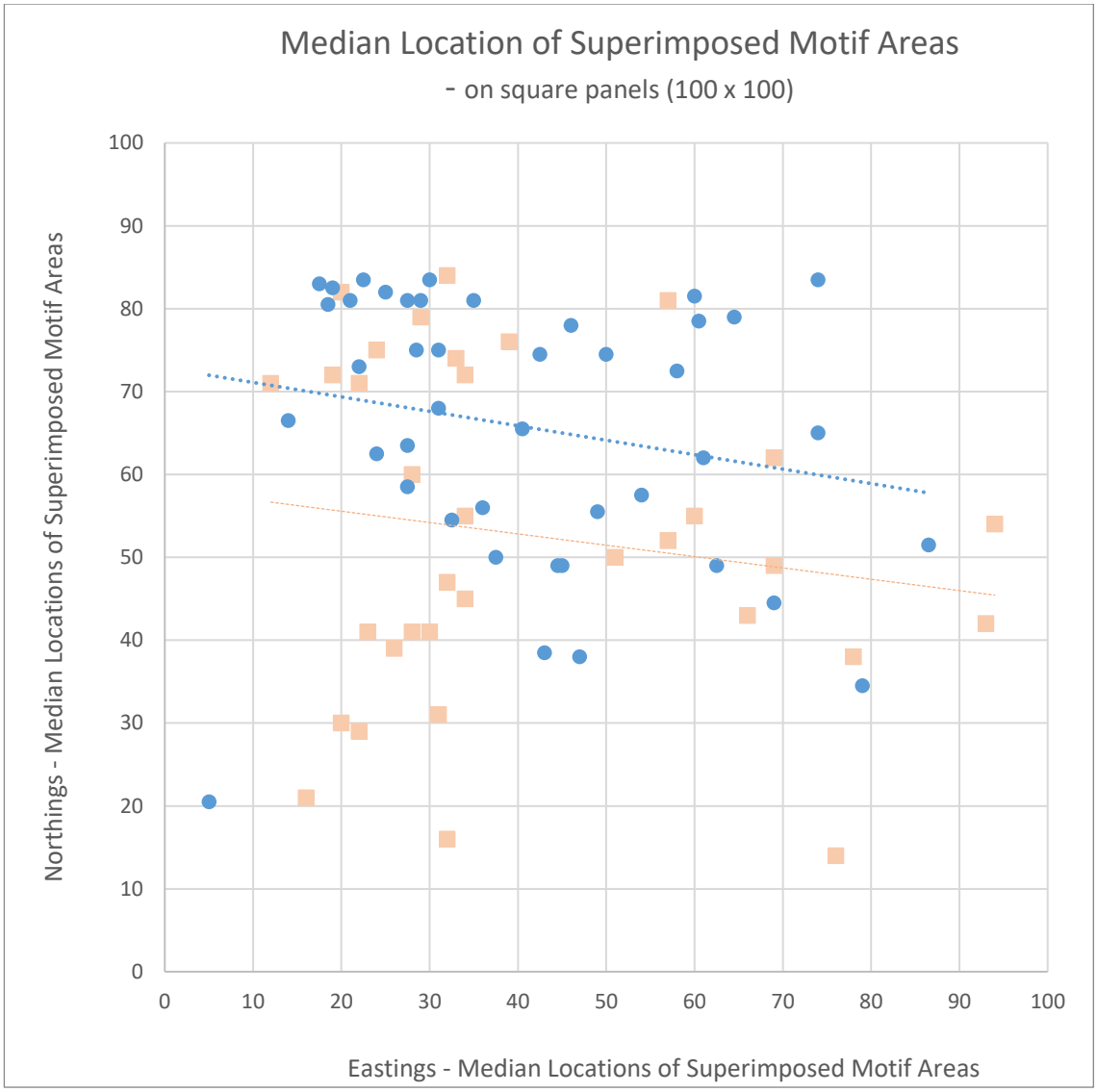


Figure 6.4.28.: Median location of superimposed motif areas (blue) and singly occurring motifs (cream) on squared panels.

Vertical panel compositions

After having considered panels that assume a squared (height similar to width) rock outline, panels that are of vertical nature (Fig. 6.4.29-6.4.30) will now be assessed. Again, as is visible in the following graph, a trend towards the centre-left is observable. The linear trendline included in the graph indicates a slight upper centre domination as well as a steeper alignment from top-left to bottom-right. This is not surprising once one imagines scanning a horizontal panel for motifs, one would naturally move one's eyes up and down the panel extent. This also nicely aligns with the overall mean value (red cross in Fig 6.4.29) of all superimposed imagery assessed. This is supported by a scatter of overlap areas across the whole of the vertical plane, yet still mimicking a centre-left visual attention bias. A similar trend to what can be found on squared panels with regard to the location of individual motifs is seen on vertical panels and a similar explanation is likely (see Fig. 6.4.33).

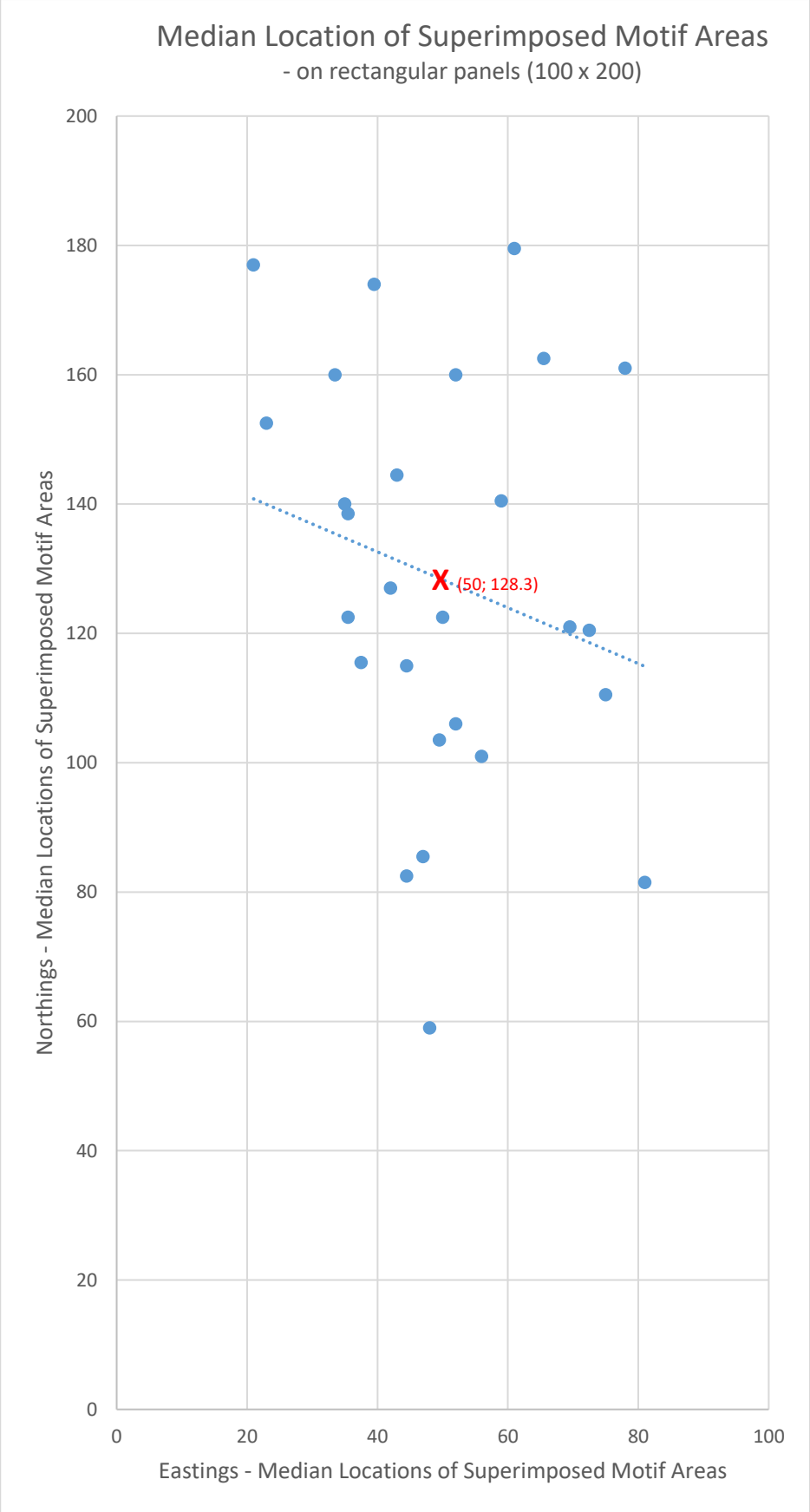


Figure 6.4.29.: Median location of superimposed motif areas on rectangular (vertical) panels (the trendline indicates the general scattering of median values of superimposed areas, the red cross indicates the overall mean value of all superimposed locations on those panels).

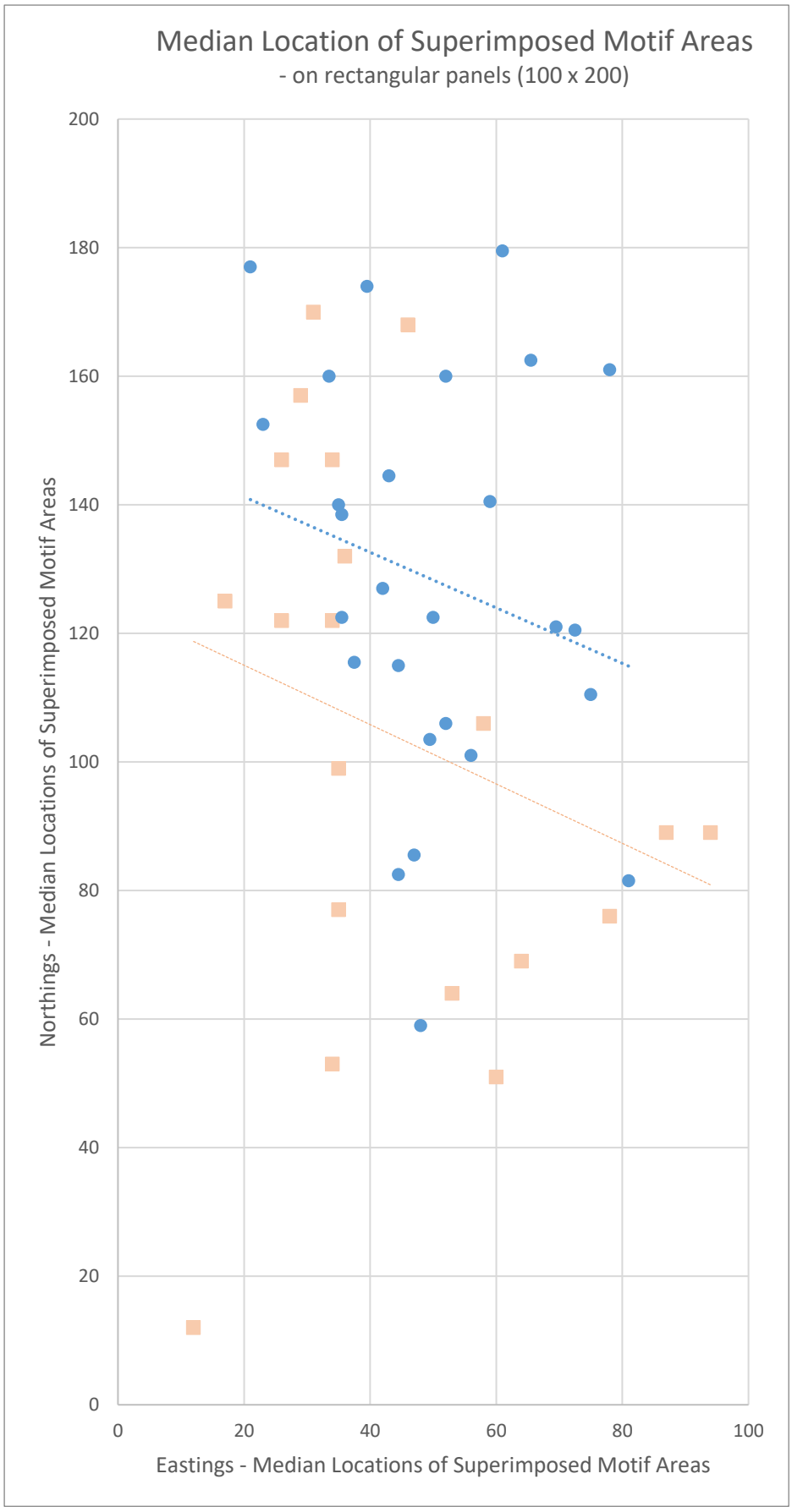


Figure 6.4.30.: Median location of superimposed motif areas and singly occurring motifs on rectangular (vertical) panels.

Horizontal panel compositions

As with the panels that follow a squared as well as vertical alignment, the inclination towards a centre-left focus on horizontally aligned panels is similarly visible (cf. Figure 6.4.31 and 6.4.32). The single motifs displayed in cream colour in the graph at the bottom of this page disperse across the full extent of the horizontal configuration. Again, this does not surprise if one reminisces about how the eyes work its way across the entirety of a canvas/stimulus, horizontally as well as vertically scanning for all the available visual data (with a starting point of the centre-left). The mean value (red cross in Fig. 6.4.31) nicely summarises this central bias. If readers are interested in general vertical and horizontal eye movement patterns, Baloh *et al.* (1983) and Rottach *et al.* (1996) serve as a good starting point.

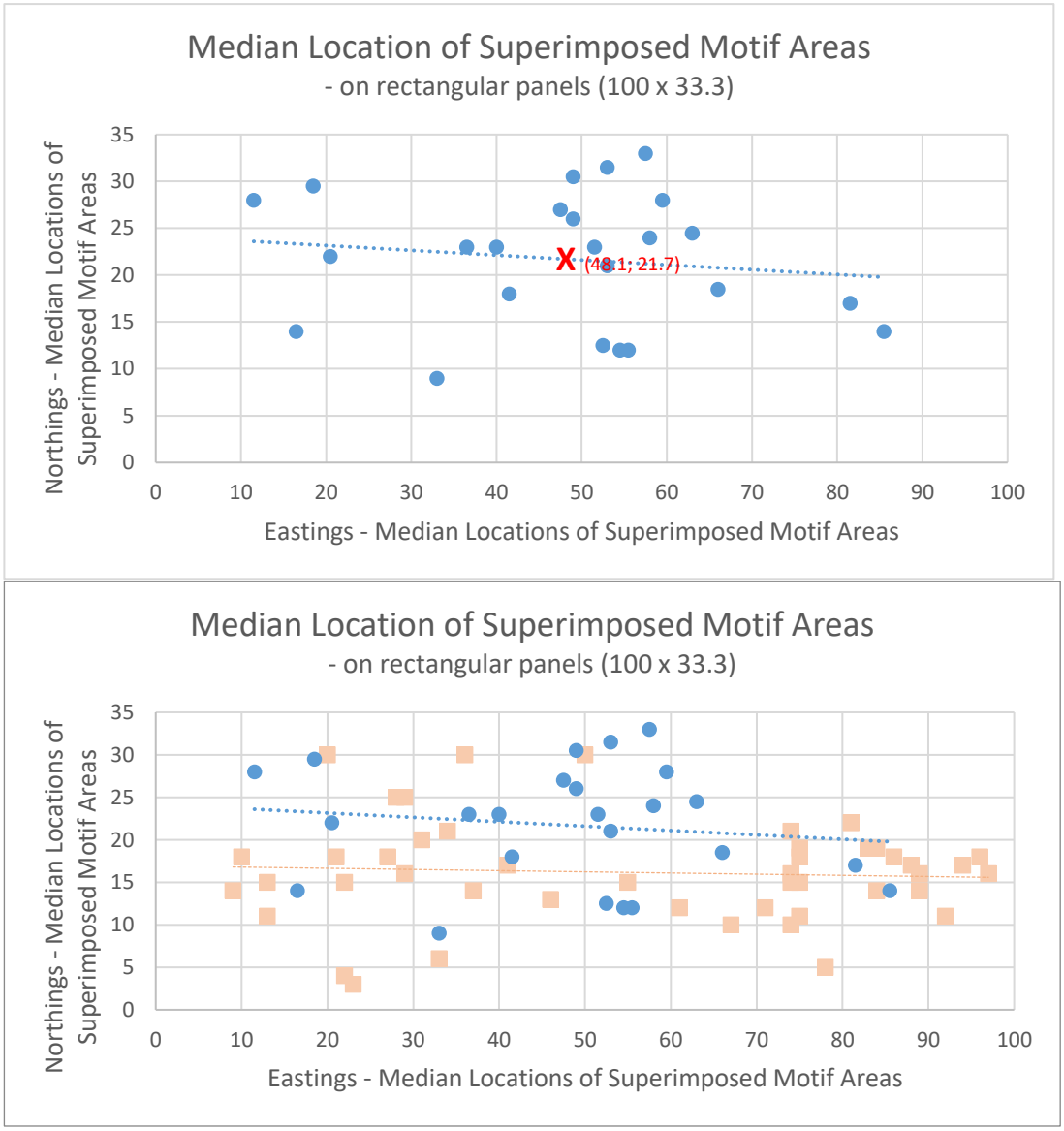


Figure 6.4.31-6.4.32.: Median location of superimposed motif areas (top with trendline and mean value of all superimposition locations) and singly occurring motifs (bottom) on horizontal panels.

Location of the different overlap categories

In addition to the plotting of superimposed motifs based on their location on differently aligned panels, the different categories of overlaps have also been considered separately and can be viewed in the following set of graphs. These graphs (Figures 6.4.33-6.4.35) display the split of basic overlaps and medium overlaps and their location on their respective panel alignments. A common trend between all the graphs shows that medium overlaps generally occur much higher up on the panels, whilst basic overlaps (i.e. those that have a maximum of three animals overlapping) tend to focus around the central fixation:

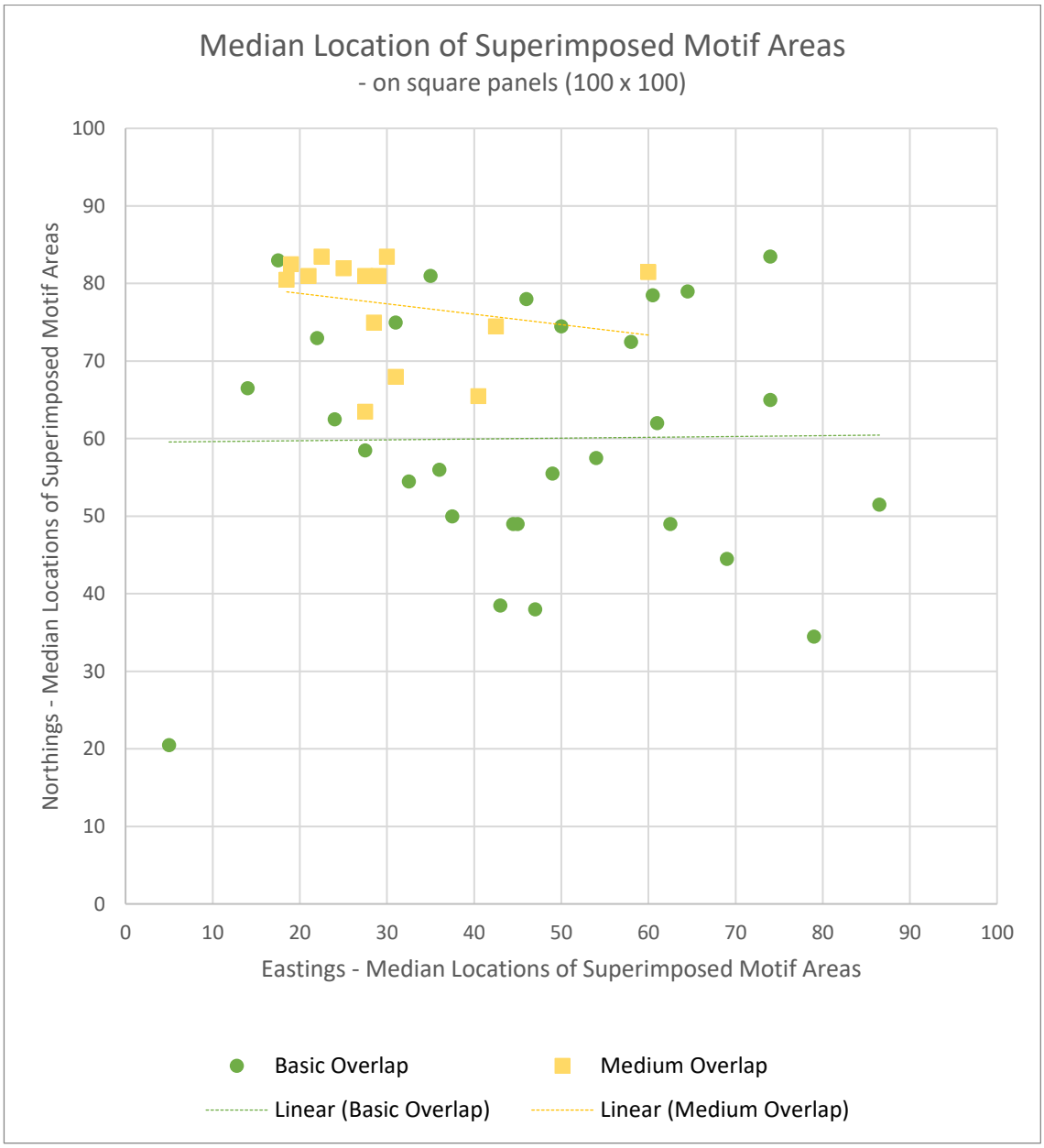


Figure 6.4.33.: Median location of superimposed motif areas on squared panels (split into basic and medium overlaps).

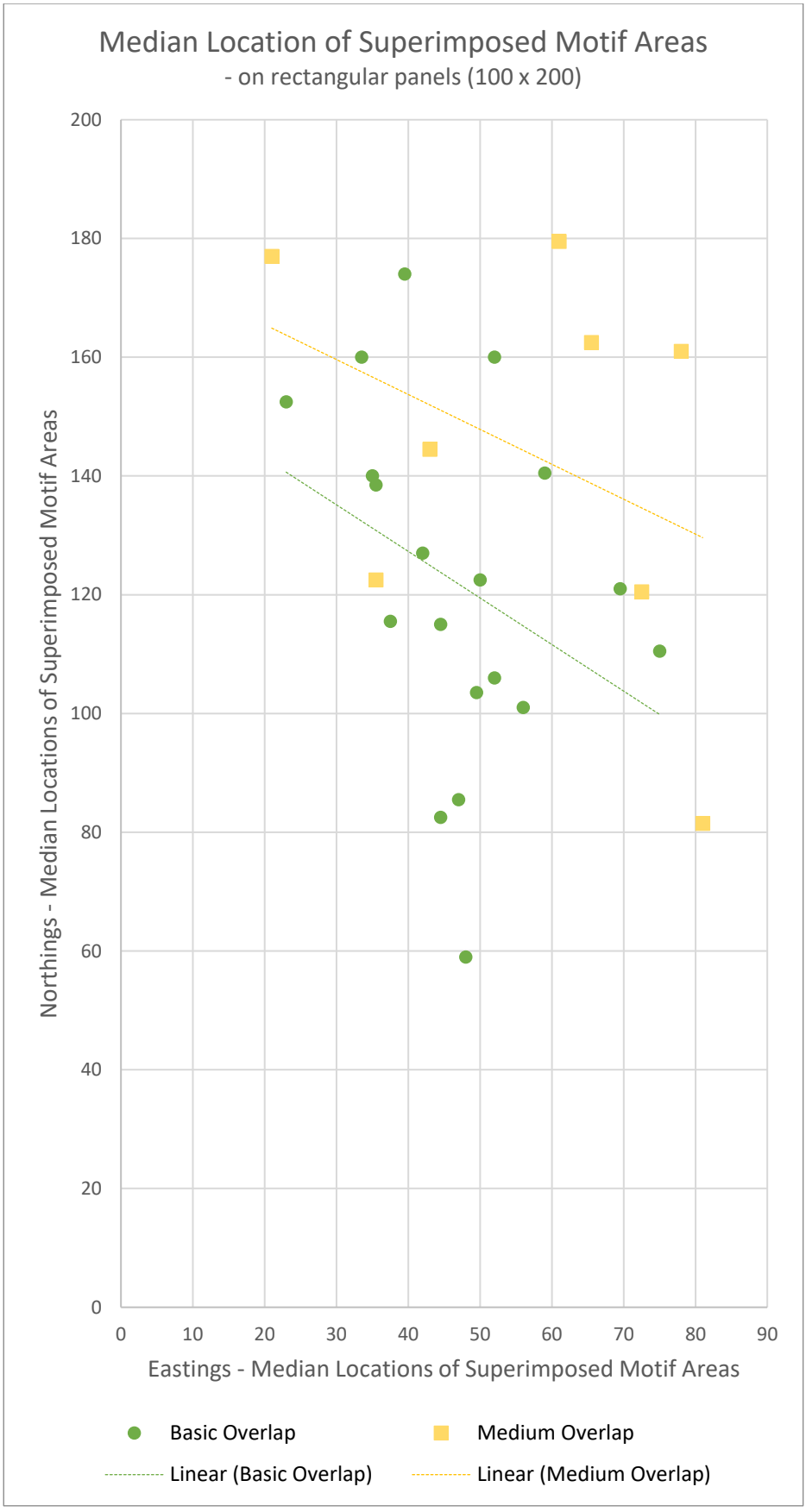


Figure 6.4.34.: Median location of superimposed motif areas on vertical panels (split into basic and medium overlaps).

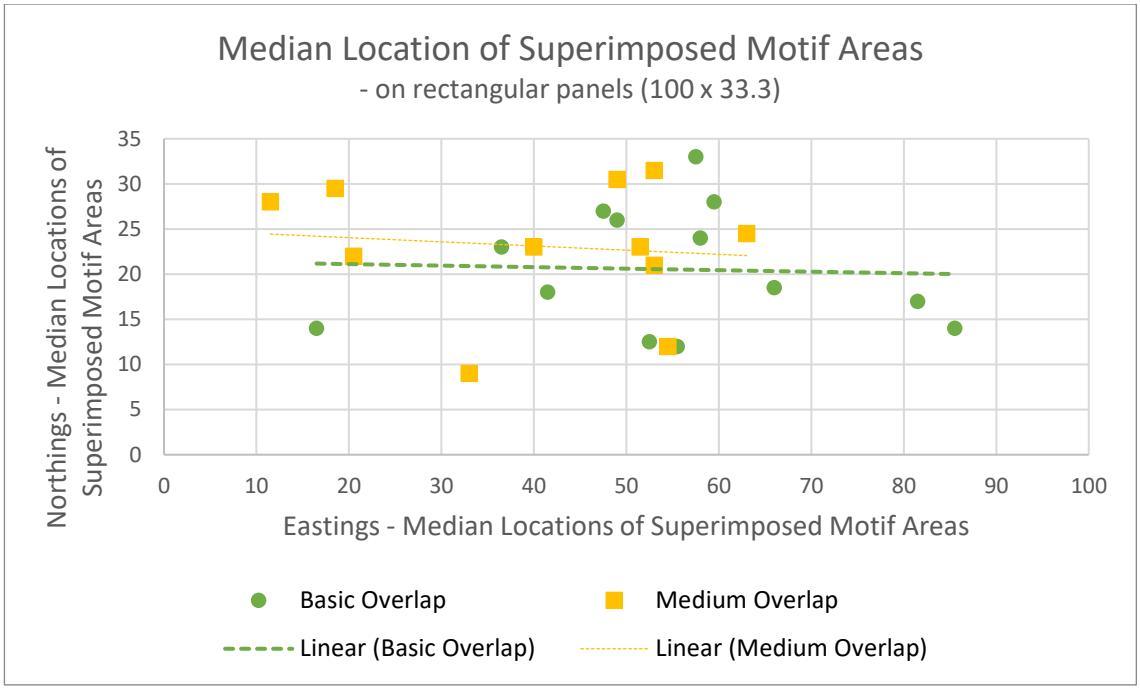


Figure 6.4.35.: Median location of superimposed motif areas on horizontal panels (split into basic and medium overlaps).

Intriguingly though, why might artists have wanted to portray heavier overlapped imagery further towards the top of panels, whilst less frequent overlaps tend to occur in central view? One aspect that might illuminate such pattern could be that these panels often span several metres in diameter, something that of course is not very easily conveyed within these graphs. If one regards humans standing centrally in front of the panel in question, there height and their level of eyes therefore will naturally align with the upper third of squared (Fig 6.4.33) as well as vertically (Fig. 6.4.34) aligned panels. The panels that adhere to a horizontal structuring (Fig. 6.4.35) will have required the viewers to look back and forth across their widths, thus their linear trendline is not surprising for both basic and medium degrees of overlap.

Furthermore, it is possible to add an analytical point of view on the part of the observer, especially with referral to the superimposition visibility study of the different categories described in the previous section. As was established earlier, it takes longer for observers to obtain information on medium overlapped areas than on basic ones. This, in turn, might also point to the fact why those types of overlaps (i.e. medium overlaps with a minimum of 3 and a maximum of 7 overlapping species) generally occur higher than the basic overlaps or the singly occurring features on any given panel.

The following illustrations, here termed *rock art heat maps*, summarise this data:

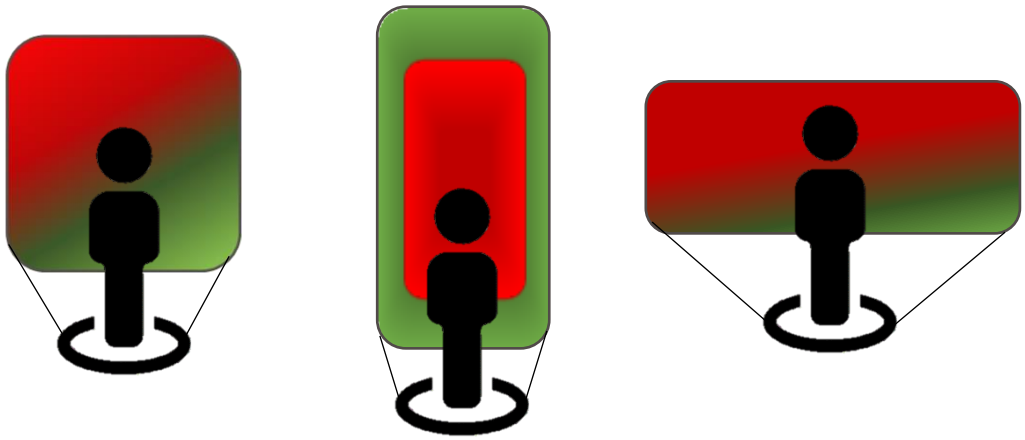


Figure 6.4.36.: Rock art heat maps based on superimposed motif areas on squared (left), vertical (middle) and horizontal panels (right) with an observer centrally standing in front of the panels.

Taking a leaf out of museum evaluation surveys, heat maps of particularly visited (red=hot) or neglected (green=cold) sites and glass cases are often performed to evaluate visitor behaviour (Fig. 6.4.36). The *rock art heat map* graphics above illustrate the hypothesised viewing behaviour across the three different alignments based on location of superimposed imageries. The areas in red are the ones frequented by superimpositions, the areas in green are those that are often neglected, both by panel composition creators and their audiences.

The location of heavy overlaps

Readers might now wonder about the locations of where the heavily superimposed panels fit in within the graphs that split up their overlapping nature (Fig 6.4.33-6.4.35). Whilst it was possible to split up the panels based on basic and medium overlap; the low quantity of rocks that possess heavy overlaps would not have resulted in any meaningful discussion. Therefore, the decision was to highlight heavy overlapped panels here and to discuss their superimposition placements on a case-by-case basis. The panels under review will be that of Piscos 24 and that of Penascosa 10, both located along the banks of the river Côa.

Nowadays, the original nature of panel Piscos 24 is preserved in an extremely fragmented fashion. The illustration of overlaps on top of original recordings (Figures 6.4.37 and 6.4.38) and the created transparent layers (Figures 6.4.39 and 6.4.40) show the extent of conservation. The panel has been recorded in several batches due to its fragmentation and size, yet the layers of the layout of the panel should be understood as one unit (extending towards the southeast). As can be seen on the layers below, several clusters of superimpositions can be found on just one panel alone:

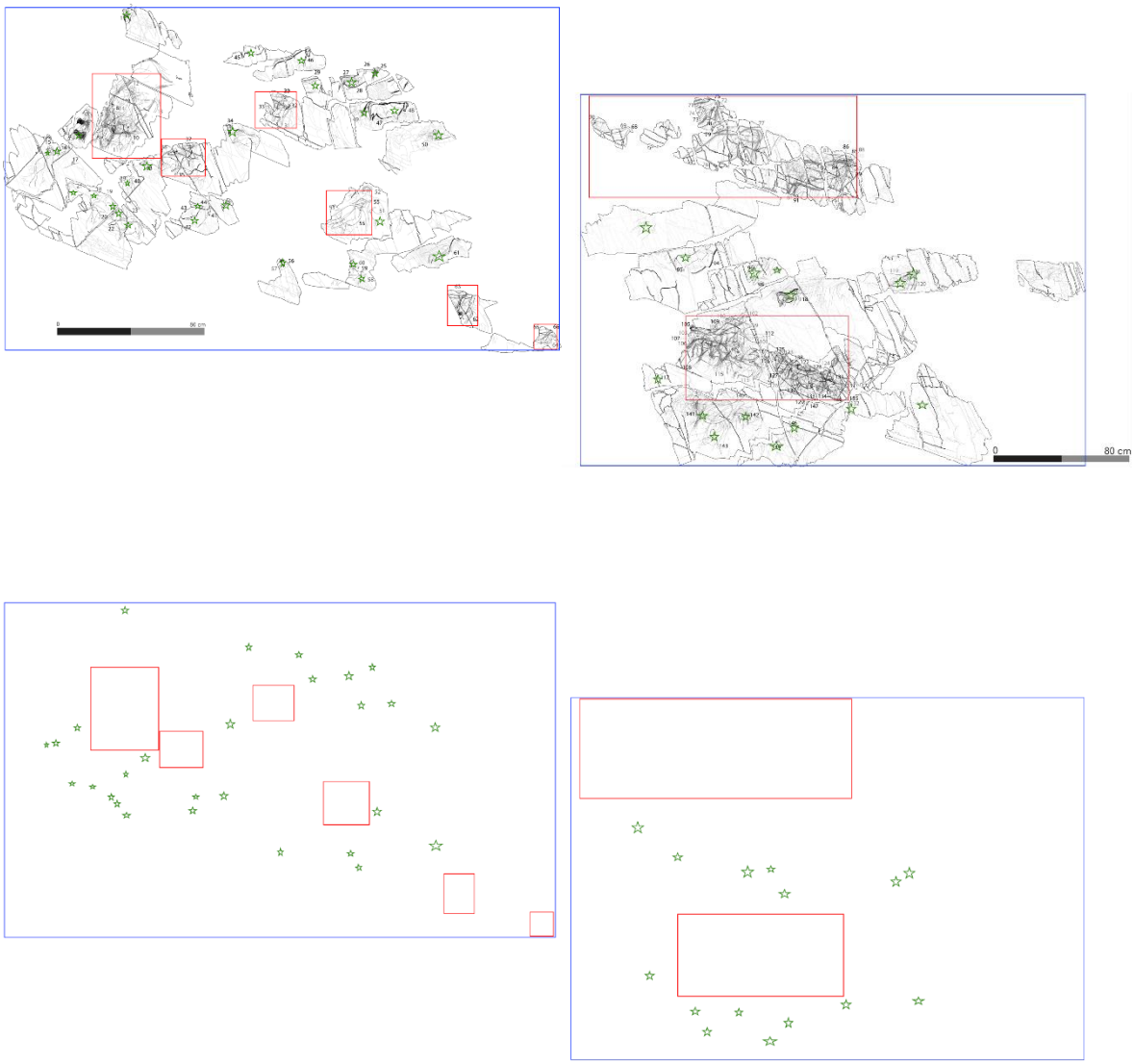


Figure 6.4.37.-6.4.40.: Recording of rock 24 of Piscos with marked up squares and stars (top two**)** (drawings courtesy of Fundação Côa Parque).
Transparent layers of rock extend of Piscos rock 24 (bottom two).

When the overlap data of Piscos 24 is compared to that of Penascosa 10 (Figures 6.4.41-6.4.42), a very similar pattern of a left-right alignment is emerging:

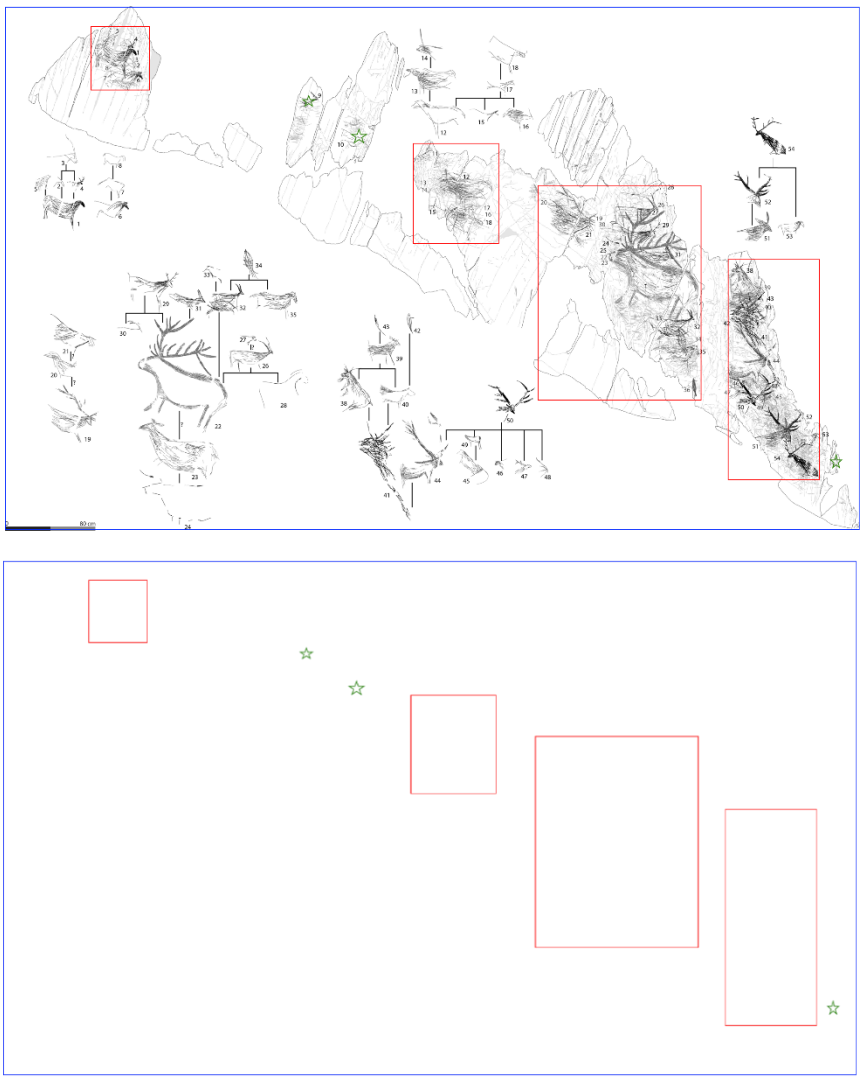


Figure 6.4.41.-6.4.42.: Recording of rock 10 of Penascosa with marked up squares and stars (top**)** (drawing courtesy of Fundação Côa Parque).
Transparent layers of rock extend of Penascosa rock 10 (bottom).

What can be extracted from this information is the fact that the overlaps on panels boasting heavy superimpositions, also conform to a top left to bottom right distribution of overlap clusters. This configuration mirrors the trend of the data points collected for squared and horizontal panel structures. A similar explanation of gaze direction, viewing onset and left advantage bias should also be considered in this instance. Once more, information gained from how heavy overlapped panels are configured only adds evidence to the standpoint that **Upper Palaeolithic artists intended to guide their audience through their compositions in a perceptually accommodating fashion.**

Predicting further rock art existence

In addition to the result that a central fixation with a tendency for a left hemifield is assumed in all of the panel shapes under study, another point can be made about the further implications this investigation can offer. If in fact it was the underlying strategy of the artists to play around with the areas of great visual attention, then this data can be extrapolated onto the possible former existence of additional rock art slabs relating to the panel. This idea will please those rock art investigators who are concerned that we are not seeing the whole picture, in other words, rocks have been severely altered both naturally and anthropogenically over time. This model of a linear trend from upper left to lower right can tell us if big chunks of rock are likely to be missing from the overall composition or not. So, for instance, if a rock panel has an obvious missing piece towards the upper right hand corner of an engraved panel (noticeable through fresh rock cuts, incomplete motifs or similar), the prediction of the model at hand would indicate that said area will have likely not borne any considerable pieces of rock art information (red marker in Fig. 6.4.43). If, however, a missing chunk can be identified in the upper left-hand corner of a panel alignment, rock art overlaps will have a much higher chance of originally having been part of the entire panel at the point of creation (green marker in Fig. 6.4.43). **Therefore, this model might be used as a helpful tool in conjunction with future rock art excavations and general predictions on what the original rock art landscape might have looked like in the past.**

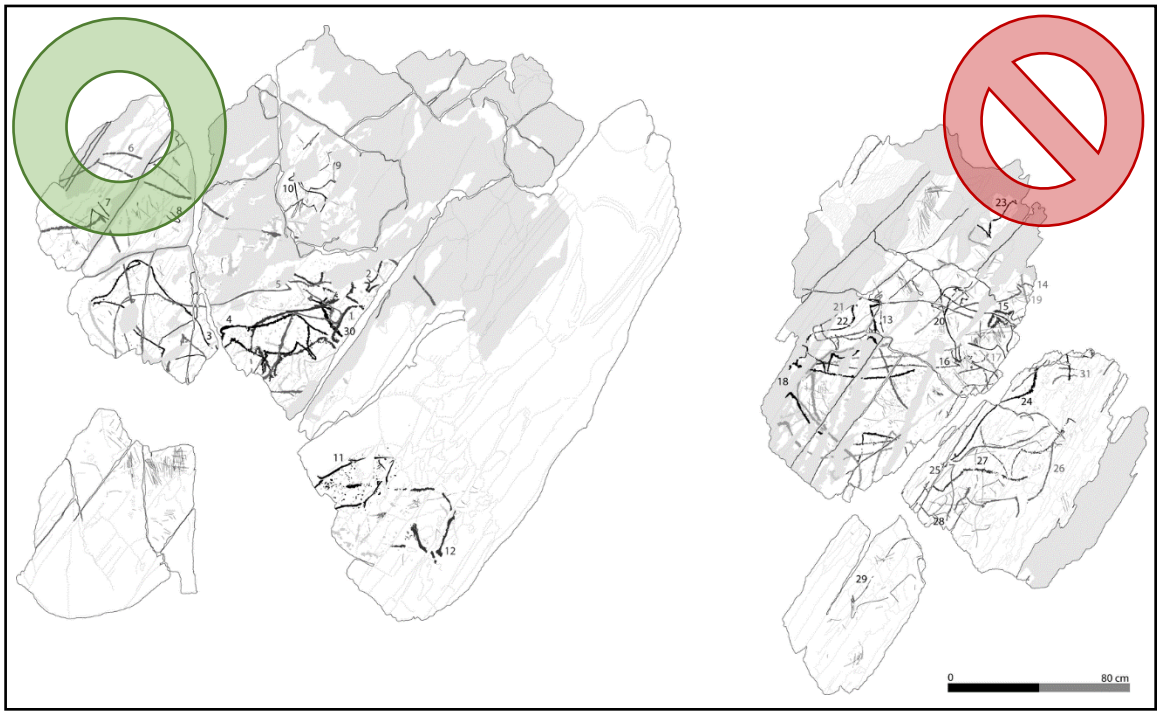


Figure 6.4.43.: Possible location of more motif areas on Rock 5 of Penascosa (drawing courtesy of Fundação Côa Parque).

6.4.7. Conclusions: Perceiving superimpositions

This section serves as a brief conclusion on selected findings for the questions that were asked at the start of the experimental set-up:

1) Why might artists superimpose their creations?

There are several potential reasons that are described in the introduction to this experiment that might illustrate why overlapping one's motifs is important: (a) Rejecting the Past; (b) Culture Jamming; (c) Aggregate Killing Site; (d) Deliberating Time; (e) Visibility; (f) others, or a combination of above.

2) Which motifs overlap each other and what are their related frequencies?

Against the expectation that motifs of similar nature would overlap, motifs tend to be overlapping with a variety of species, often with entirely different types altogether. For instance, horses are more often overlapped by aurochs than by their own species, indicating a true agglomeration of these species within single spots.

3) Are there different degrees of superimpositions?

Three different categories have been identified on a total of 127 inspected panels (albeit these categories are arbitrarily constructed for comparative analysis): a) Basic Overlap - max three superimpositions (n= 48); b) Medium Overlap – max seven superimpositions (n= 19); c) anything above b. (n=5); d) No Overlap (n= 50).

4) How visible are engravings with different degrees of superimposition and colour?

In terms of colour, participants perform best (i.e. mean of perceived number closest to actual animal number) on the darkest panels available, when the contrast between engraving and bedrock is at its highest. This also matches up with the amount of selected rocks with darker hues, which take precedence over lighter ones when it comes to engraving them. Additionally, results show that the effect of colour on the correct or incorrect perception of animals on a given panel does not tend to change when animal numbers increase on those panels. The effect of colour and the effect of number are working independently.

5) Where do superimpositions occur on the panel?

Three generalised alignments of panels have been identified within the Côa rock art panel corpus – squared, vertical and horizontal. It appears as if Upper Palaeolithic artists abide by a clear visual strategy to position their superimpositions in a central viewing position, with a tendency towards the upper left end of the panels' extents. This correlates with eye-tracking data derived from psychological studies independent of this current study. Implications of this approach might apply to new rock art discoveries, based on preferential focus on rock area towards the left of already superimposed panels.

Chapter 7 – Landscapes – The Environmental Level

7.1. Introducing the Landscape Level

This chapter investigates the art-landscape relationship and how hunter-gatherers at the time, visually, and therefore socially, converted their *spaces* into *places* of complex visual codes. As with the previous chapters, all 16 rock art sites, all 127 engraved panels as well as all 1117 motifs will be considered. The first experiment of this chapter (Experiment 5 in the sequence) considers the perceptual experience of stepping away from embellished panels and looking at them in their entirety. This experiment considers different field-aspects that are tested against different visibility parameters, so that factors such as possible pigmentation of motifs, effectiveness of engraving styles and influences of the underlying bedrock colouration are scrutinised. The last experiment integrates the findings from the aforementioned visibility study into a wider-arching GIS analysis, which will focus particularly on the (inter)-visibility of sites containing rock art and their relations to landscape settings, featured in the Côa Valley (Experiment 6). As before, the illustration below situates the experiments and their progression throughout this thesis, with to-be-discussed experiments circled in green:

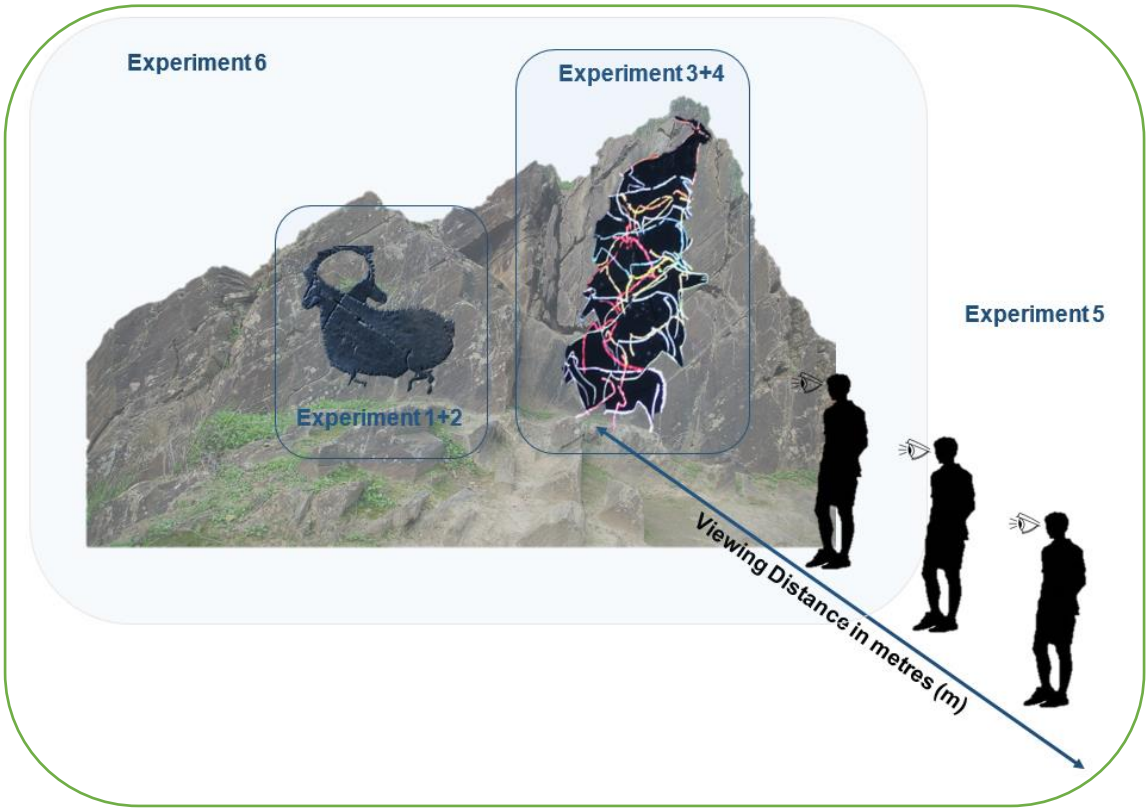


Figure 7.1.1.: The progression of experiments within this thesis. Accentuated here are the experiments under study in this chapter.

7.1.1. Studying landscape art

With the prey and panel characteristics analysed in chapters five and six, it is time to embed these two factors into their contextual settings. The outdoor factors of open-air rock art, such as differential lighting and weather conditions, variability in accessibility and its visibility from many different areas, influence the agenda for interrogation in vastly different ways to how cave-art studies are traditionally approached. Whilst the art is as spectacular as in the well-known contemporary caves (in the subjective opinion of the author), the art in the Côa Valley also benefits from those additional, external factors that can be studied and consulted in search for the art's biographical life and use cycles. Resultingly, the relationship between rock art and its landscape setting is very revealing. On one level, rock art is embedded in the landscape itself and on another, the landscape, in turn, creates different sets of meaning towards the engravings (Bradley *et al*. 1994; Ouzman, 1998). Conversely, the relationship between the artist and its audience, in close connection with its situated outdoor nature, adds another dimension. In fact, art is undoubtedly informed by its landscape surroundings, which in turn is shaped and influenced by its artists and audiences and vice versa and none of these aspects would be able to exist without one another. The following graphic (Fig. 7.1.2) illustrates this interconnectedness[33]:

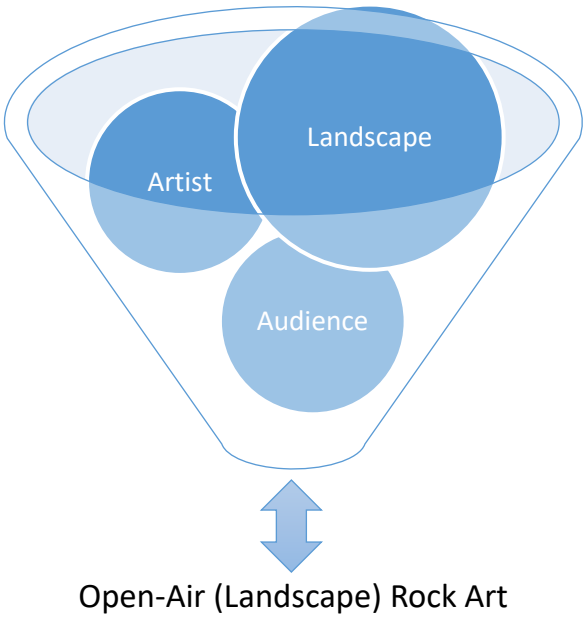


Figure 7.1.2.: Graphic illustrating the interconnectedness between landscape art, landscapes, artists, and audience.

[33] When viewing this graphic in conjunction with the Process, Practice, Product graphic from Chapter 1 - an interconnectedness between the chapters and progression of ideas is herewith created.

The natural, arbitrary formation of landscape settings means that artists had to work with the landscape as they found it (notwithstanding their ability to shape their spaces into places (cf. discussion in Ch. 2)). *Prima facie*, the selection of their art canvasses within the landscapes seem randomised, with some art locations even requiring certain degrees of athleticism to reach particularly hard-to-reach or high-up panels. If it was not for the limited availability of suitable rocks (schist outcrops are vastly abundant in the region), why else might artists choose particular locations for the display of their artistic creations over other ones? Why are some more suitable than others? This chapter, therefore, tries to come closer to an understanding of these overarching questions, by assessing particular motifs in particular spaces, and the art's visibility and the influences it bears on the landscapes thereafter (e.g. through viewsheds and inter-visibility calculations, least-cost paths, and slope determinations).

Recalling the discussion of how landscapes have been viewed and studied in the past (Chapter 1.3.2), a couple of theoretical frameworks have been more pronounced than others. Rock art within a structuralist framework is often associated with motif occurrence in specific combinations and topographies as well as intra-site motif structuration (e.g. Leroi-Gourhan, 1967). Beyond the level of site-wide analysis, theorists realised that this approach neglected the association of rock art in its wider surrounding landscapes, which is why many rock art studies experience the onset of processual archaeology coming in the 1980s. A few of those initial studies that regard the landscape and setting of the engravings as paramount are for instance Jochim (1983), Conkey (1984) and Schaafsma (1985). This approach, in turn, was heavily criticised by post-processualists like Ingold (1987), Ouzman (1998) and Tilley (1994). The latter pioneered the phenomenological inclusion of people-landscape experiential interactions based on people's perceptions, values and hermeneutical stances. Overall, whilst no strong affinity towards either theoretical side is taken, the wider concern with visual primacy in this thesis is akin to the idea that *spaces* are turned into *places* by social interactions with and through visual addition towards them. In other words, rock art landscapes are socially altered places fusing together in the following equations (see Ch. 1.3.2):

$$Human + Environment = Landscape$$

$$Human + Space = Place$$

7.1.2. Landscape-specific research questions

The research questions addressed in this chapter are reintroduced now, satisfying the overall research objective set out for this chapter: **Why are specific landscape locations chosen?**

Archaeological analysis

- Do human occupation sites equate to rock art sites?
- What can the palynological and palaeo-environmental record reveal about rock art visibility?
- Were animals, depicted on specific rocks, killed at these corresponding spots?
    - I.e. does the faunal assemblage match the rock art assemblage?

Psychological (experimental) analysis

Experiment 5: Rock Art Visibility – Distance Perception

- At what distances can viewers resolve the rock art?
- Did the addition of coloured pigments affect perception of these images?
- Do different engraving techniques influence visibility levels of rock art?
- Do the visibility levels withstand in real rock art terrain?
- Does sun exposure influence visibility levels of rock art?

These questions will be complemented and tied together within a landscape framework by the following enquiries using GIS and landscape surveys in the field:

Experiment 6: Integrated Rock Art Visibility – Distance Perception

GIS-specific analysis: Integrating all data: rock art features in the landscape

- What does the **distribution pattern** across the Côa Valley look like for:
    e) Individual Motifs?
    f) Incomplete/Complete Motifs?
    g) Engraving Techniques?
    h) Superimposed Imagery?

  I.e. Do these depictions appear in particular areas, or do they appear randomly distributed across the Côa Valley?

- How **visible** are different rock art panels?
    - From which specific points in the landscape are individual panels visible?
    - Can an inter-visibility between panels be noted?
    - Which kinds of viewsheds do panels create, with regard to
        - Resolution distances towards pecking/incision/Azilian depictions?
        - Legibility distances towards pecking/incision/Azilian-style depictions?

- What do visibility and locality tell us about the artists' **intentions**?

  I.e. Was every panel containing rock art to be seen by everyone in the community?

Landscapes - Research overview

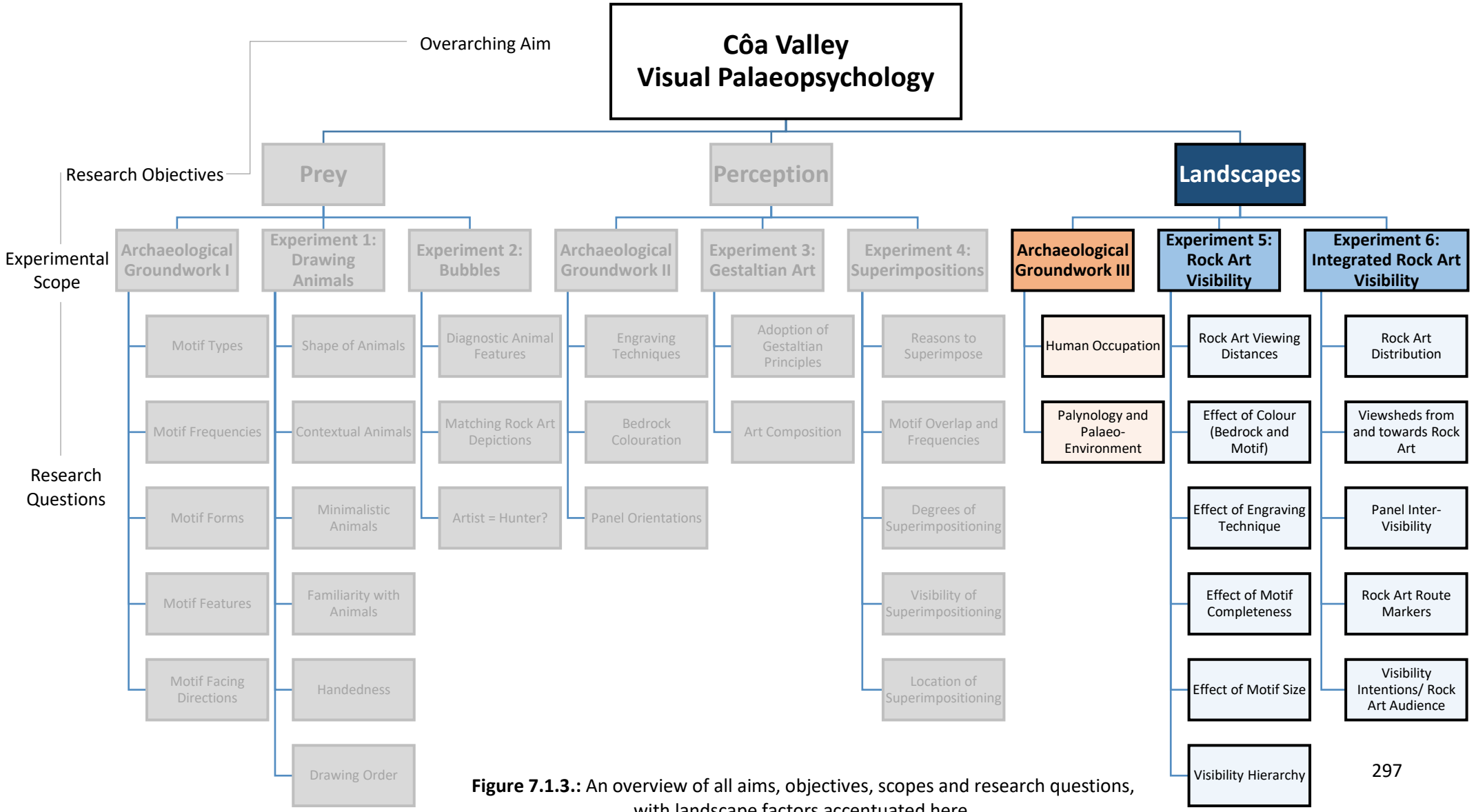


Figure 7.1.3.: An overview of all aims, objectives, scopes and research questions, with landscape factors accentuated here.

7.1.3. Landscapes, now and then

It is important to note that the way modern inhabitants would approach and perceive a landscape nowadays, does not necessarily (and most likely will not) translate in equal terms, into the ways of seeing of the people in the Palaeolithic. It is important not to presume that a prehistoric perception of a place equates to our concept of landscapes and places within them. When considering a rock art image of an isolated deer in the landscape, it should not lead us to hypothesise for instance that this was a particular spot were deer liked to rest or where deer were killed. Neither should a perfect example of a riverbed, with a particular grand opening of the mountain side with the sun shining through the cracks, mean that it would therefore be ideally suited for an elaborate depiction of that deer. It is tempting to portray our own modern cultural expectations such as "this remarkable overhang with an inspiring view across the whole valley is ideally suited for the location of rock art" onto the reasoning behind the arts' placement. However, studies that are employing an 'embodied' viewpoint, a view as to how ancient inhabitants of the lands will have experienced their surroundings and used their rock art, are harshly criticised by scholars who believe this to be a naïve, 'post-modern' venture (Chippindale and Nash, 2004). Chippindale and Nash (2004: 13) question the naïve confidence in this universal human experience: "for how is one to know that what strikes me today must have anything in common with what ancient people felt and found telling?" In the absence of any written records or reliable ethnographic encounters, it seems unlikely at this point in time to derive at a comprehensive understanding of the personal connections with these images. This thought, of course, is equally maintained within the often-times uniformitarian assumptions about other items of material culture.

Moreover, there may have been a totally different reasoning behind the placement of such depictions and thus it is highly important not to impose our modern euro- and ego-centric views onto the past. Indeed, if it were in fact the scenery and the placement of this particular spot that was of most importance to the ancient carvers, they could have just portrayed the scenery onto the rocks. Yet, this never occurs in Upper Palaeolithic art. Depictions of landscapes, rivers, clouds and skies never appear in the imagery. Perhaps they are incorporated into the art through the depiction of animals as an embodiment of nature and landscape and it is only our modern viewpoint that will not allow us to perceive landscapes in such forms. Another possibility could be the close connection between the medium of rock, the art and the interplay with the landscape itself. The art is situated in a static landscape setting anyhow, so why would one depict the landscape again? Why not depict something less static, something less predictable

and instead depict prey animals that graze these lands? Rock art cannot be moved away from the landscape, but animals can move themselves away from the art, thus worthy of depiction, to record what was once there.

Henceforth, a more objective approach on the landscape basis is that of formal variable measurements such as visibility ranges, angles of elevation and slope determination. The art's distances to prominent features in the landscape such as water sources or massive bedrocks (Hyder, 2004) can be determined and the factors such as motif displacement and stylistic change can be mapped over contextual widths across the valley. Related to this analysis, the mapping of social mobility patterns of humans and animals and the use of environmental spaces during the Upper Palaeolithic have been studied previously and can be drawn upon in this chapter. Hunter-gatherer landscape movements, according to Binford (1980), are guided by social knowledge of spaces and repeated experiences within similar environments (the reader should refer to 'landscape learning' studies for a greater overview of environmental settings having been utilised, revisited and reinvented by hunter-gatherers over time; e.g. Roebroeks, 2003). With these considerations in mind, it is now fitting to start this chapter's core work with an assessment of the available Upper Palaeolithic settlement sites and palynological and Palaeo-environmental data.

As for a potential change in the actual localities and the context of the rock art itself, the archaeological groundwork which follows next will give rise to the fact that surroundings will not have changed much since the Upper Palaeolithic. Even though Chippindale and Nash (2004: 9) argue that "the visibility both of a rock art site from its surroundings and of the surroundings from the rock art site (will have) decisively changed", when it comes to any rock art found and inspected nowadays, the physical landscape of the Côa Valley remains reasonably unaffected since the Palaeolithic and thus it is safe to assume that this aspect can be taken as a constant (see Aubry *et al.* 2002). However, it ought to be borne in mind that some parts of the Côa landscape, which we see nowadays, will have been transformed by modern impacts to the site, such as the river dam constructions forcing some rock art sites to be submerged under water.

7.2. Archaeological Groundwork

7.2.1. The engraved species database - contextual

A closer look at the *Engraved Species Database* (Appendix A, screenshot below in Fig. 7.2.1) reveals the georeferenced nature of all motifs under consideration within this study. From the onset of compiling the database, it was important to have a physical, geographical marker attached to each listed motif, to be able to easily situate and contextualise their features in the appropriate sections of this thesis. As this chapter pertains to the contextualisation of motifs and panels, the gathered data that has been addressed in the *Archaeological Groundwork* sections of the previous two chapters (i.e. motif types, their completeness, their individual bodily features, their facing directions, their associated engraving techniques as well as the panel's underlying bedrock colouration and complexity/degrees of associated superimpositions upon them) can now be integrated into their contextualised environments. This contextualisation will come to flourish once embedded into the analysis of the visibility data gathered from this chapter's experiments. As soon as rock art visibility ranges are determinable, the georeferenced nature of motif features then allows for the modelling of visibility characteristics across the entire Côa landscape.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Internal Num	Site Name	Panel Name	Panel N°	River Connecti	Rock Type	Rock Surfa	Rock Textu	Rock Colour	Facing Directi	LONG	LAT	ALTITUDE	Animal Num	Time Period
2	1	Foz Coa	FC	148	Upstream from th	Schist	Regular	Smooth	Orange-Brown	East South East	-7.10658	41.08024	160	1	Paleolítico; Id. Ferro
3	2	Foz Coa	FC_A (Fragment	1	Upstream from th	Schist	Regular	Smooth	Brown	Fragment	Fragment	Fragment	150	1	Paleolítico
4	3	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	1	Paleolítico; P-H. Recente
5	4	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	2	Paleolítico; P-H. Recente
6	5	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	3	Paleolítico; P-H. Recente
7	6	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	4	Paleolítico; P-H. Recente
8	7	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	5	Paleolítico; P-H. Recente
9	8	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	6	Paleolítico; P-H. Recente
10	9	Faia	Fa	6	Left Bank, Paralle	Granite	Irregular	Rough	Yellow	East	-7.09704	40.93659	199	7	Paleolítico; P-H. Recente
11	10	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	1	Paleolítico; Histórico
12	11	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	2	Paleolítico; Histórico
13	12	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	3	Paleolítico; Histórico
14	13	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	4	Paleolítico; Histórico
15	14	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	5	Paleolítico; Histórico
16	15	Canada do In	CI	1	Near Quota limit	Schist	Regular	Smooth	Brown	South East	-7.11241	41.0546	125	6	Paleolítico; Histórico

Figure. 7.2.1. Screenshots of the database in use for the establishment of animal features and their locations.

These topics will be addressed in this sub-chapter which fall within the remits of a landscape-wide consideration of rock art placement:

- Upper Palaeolithic Human Occupation in the Region (Chapter 7.2.2)
- Upper Palaeolithic Palynology and Palaeo-Environmental Data (Chapter 7.2.3)

7.2.2. Upper Palaeolithic (and earlier) human occupation in the region

When composing a chapter about the landscape setting in which the art is situated, it seems most sensible to address the state of human presence in the area first. Despite the fact that this has been addressed in chapter 2, this chapter begs for a more in-depth consideration of such material. In ideal circumstances, physical human presence in any defined region is matched with surviving human bone assemblages, yet preservation issues often prevent such existential analysis. As this is the case in the Côa region, human presence can only indirectly be confirmed by the material culture (and visual culture if one regards the art) that is left behind. For the Côa Valley, lithic assemblages are able to provide specific information on the nature of human occupation and their stratigraphic sequencing now allows for a relative chronology to be established for the different Upper Palaeolithic settlement phases. Earlier Middle Palaeolithic remains, such as Levallois technologies, have also been uncovered in areas such as Olga Grande 4 (layer 4) and remains from Cardina's Middle Gravettian level 4b and Early Upper Palaeolithic layer 5 illustrate the region's continuous settlement use (Aubry *et al.* 2016; Aubry *et al.* 2019).

In Zilhão *et al*.'s (1997) initial synthesis surrounding factors contributing to the Côa Valley rock art, two sites (further upstream in the Alto Douro region) are described, that bear artefacts attributable to Acheulian industries (>100 000 BP), namely that of Quinta da Granja and Quinta do Vale do Meão. Further excavations at lower fluvial levels confirm human presence during the Upper Palaeolithic by means of two camp sites (Salto do Boi/Cardina[34] (25 mas) and Quinta da Barca (6 mas)). At Cardina for instance, curved backed points associated with the final Magdalenian and Noailles burines as well as backed and truncated bladelets attributable to the late Gravettian, give rise to its Upper Palaeolithic inhabitancy (Zilhão *et al.* 1997). Since the first excavation season at Cardina in 1995, in excess of 30 human occupation sites have since been identified in the entire region (based on technological and typological lithic overlaps), including sites such as Quinta da Granja, Quinta da Barca, Quinta da Barca Sul, Ínsua, Fariseu and Olga Grande (4, 13, 14). Thermoluminescence (TL) dating carried out on 19 burnt quartzite pebbles that were uncovered at Cardina 1, Quinta da Barca Sul, Olga Grande Sula and Fariseu further establish a Gravettian to Magdalenian occupation span (31.0±2.5 ka - 11.0±1.1 ka BP) (Valladas *et al.* 2001; Mercier *et al.* 2001; Mercier *et al.* 2006, Aubry 2009). When assessing the localities of the majority of the sites with dense lithic assemblages pointing to human occupation during the Upper Palaeolithic, it becomes clear that the rock art locations, for the most part, are not in close vicinity to sites where humans tended to dwell. Habitation sites tend to be located at

[34] During the spring of 2018, the author was part of the excavation team exploring further human occupation evidence (including Middle Palaeolithic examples) at Salto do Boi/Cardina I (cf. Aubry *et al.* 2019: 64).

plateau locations whilst rock art sites, very often featuring directly at the riverbanks, tend to concentrate in the valley bottoms (Zilhão *et al.* 1997). Through deduction, this differential distribution in itself provides insights into the production and consumption of rock art on a larger scale, especially now that the human habitation patterns have been established, suggesting that household activities carried out at the camp sites were clearly distinct from art locations and related actions. The following map (Fig. 7.2.2) indicates (with the help of the coloured boxes) the location of many of the rock art and settlement sites mentioned in the previous paragraphs. An interesting avenue to explore would have been to determine if certain rock art sites (for example those that are more viewable/public) are closer to occupation sites, yet the clear separation of these red and green areas below would not yield effective results.

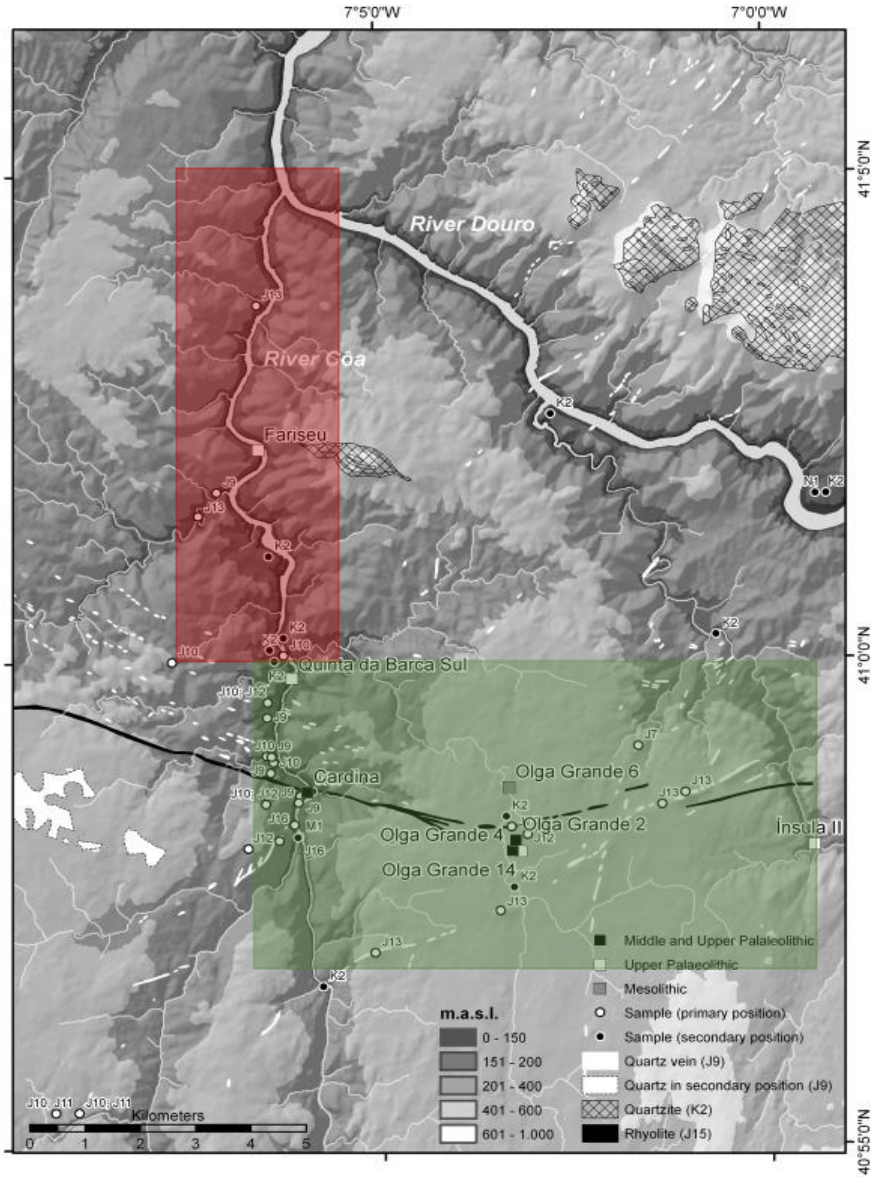


Figure 7.2.2.: Map showing the interrelationship between rock art sites (demarcated in red by the author) and excavated settlement sites (demarcated in green by author) (Basemap by Aubry *et al.* 2012a).

The map overleaf reveals that neither the production of rock art nor the consumption of rock art seemed to have been at the same location as the actual living spaces that Upper Palaeolithic inhabitants occupied. Based on current understandings of stratigraphic data, it remains hypothetical whether humans stayed in the valley on a permanent basis throughout the year, yet the presence of such a multitude of occupation sites points to the "recurrent occupation of the Côa Valley by small-sized human groups" (Zilhão, 1997: 18). The high acidity of the soil within the Côa region, however, unfortunately yields very few well-preserved organic materials such as charcoal or animal remains. Still, the large presence of a variety of stone tools for use in different scenarios might suggest that tasks such as hunting, fishing and the processing of animal carcasses and their hides will have been carried out throughout the region as a whole. The scarcity of animal remains in the region means that, as it stands, no comment can be made about whether animals depicted on panels were also killed at these corresponding spots.

Speaking of which, not only can human presence in the area be determined by their settlement sites, but also raw materials being moved by human agents can point to a wider network of land and material usage. Unlike most lithic assemblages uncovered from the European Upper Palaeolithic, the Portuguese Upper Palaeolithic sequences show a "systematic and profuse use of quartzite and quartz" (Pereira, 2010; Aubry *et al.* 2012b: 530). Yet, a variety of other types of lithic tools uncovered from some of the aforementioned settlement sites can both be diagnostically used for establishing a chronostratigraphic occupation framework, and for establishing their exotic make-up (absence from regional geological contexts), often implying long-distance raw material movements towards these sites. This in turn, as Aubry and colleagues suggest, points to (social) connections and mobility patterns between the Côa Valley and central parts of Portugal and Spain. In fact, exotic raw materials such as flint has been analysed to have originated at sites based in the Northern Meseta and the Portuguese Estremadura, with distances towards the Côa Valley of up to 250 km from procurement source to eventual use site in the Côa region (Aubry *et al.* 2012b). This large-scale and far-reaching exploitation of exotic raw materials points to a number of socio-cultural models, with the authors describing the following model as likely:

> "Territory sizes, distances travelled, the archaeological record, and the presence of rock art in this natural geomorphological boundary suggest that the Côa Valley could have been an aggregation area, where dispersed bands would seasonally come together to fulfil their economic, social and cultural needs" (ibid: 543).

The model proposed by Aubry and colleagues further suggests that the Côa functioned as a seasonal meeting ground for raw material exchange, during which rock art production and consumption would take place (ibid).

7.2.3. Upper Palaeolithic palynology and palaeo-environmental data

The combination of the uneven, mountainous terrain and the acidic soil conditions are not conducive to great archaeological preservation. Hence, both faunal and macro-botanical remains are poorly preserved and consequently understood for the region as a whole. In a personal comment between Figueiral and Aubry (2002), the former claims to have identified three species amongst a very poorly-preserved set of charcoal fragments found in the interlacing schist sediments of Cardina 1, namely *Quercus ilex*, *Juniperus* and *Fraxinus*, with the first two likely to be intrusive (Aubry *et al.*2002). Despite this speculative comment, the palaeo-environment as a whole is not able to be reconstructed from surviving plant nor faunal remains.

Nevertheless, based on data from deep sea cores, glacial deposits from the Serra de Estrela mountain range as well as pollen sequences extracted from mountain lakes, Zilhão (1997) proposes a more nuanced schema to reconstruct the Portuguese Palaeo-environment. Generally, well-established data from Portuguese continental margins indicate wide-spread climatic fluctuations throughout the duration of the Upper Palaeolithic (Lebreiro *et al.* 1996; Shackleton *et al.* 2000; Skinner and Elderfield, 2007). Extracted cores from these margins indicate major Heinrich events every 7000-10000 years, whose interstadial cycles release major parts of northern hemispheric ice-sheets, resulting in abrupt and severe weather and environmental changes (Heinrich, 1988; d'Errico and Sánchez Goñi, 2003; Roucoux *et al.* 2005). According to Zilhão's 1997 assessment of the available pollen records, the Portuguese region in question here would have featured "scot pine forest mixed with open herbaceous scrublands and patches of temperate deciduous and Mediterranean forest" (ibid: 13 ; Aubry *et al.* 2001). Consequently, at altitudes of 700 metres, so-called "compressed" (Mateus and Queiroz, 1993) zones would have featured alpine, sub-alpine as well as boreal and temperate vegetation. At any altitude below this threshold, as indicated by the low count of arboreal pollen for the duration of the Heinrich events, a steppe environment with herb and shrub species would have been flourishing (Zilhão, 1997).

Additionally, geomorphological data from the aforementioned Serra de Estrela Mountains in central Portugal reveal that large glaciers (~70 sq. km at >1600 m altitude) will have created frosty temperature ranges (<0° from December-March) and strong westerly winds during winters (Daveau 1971; Ferreira, 1993; Aubry *et al.* 2002). Snow-cover will have been likely during this period, yet both Ribeiro *et al.* (1995) and Zilhão *et al. (*1997) suggest that, contrary to typical snow and ice alimentation hydrological regimes, the snow would have discharged during

warmer spring periods, leading to increased temperature and increased water levels of the rivers and tributaries in the valley bottoms (see also Aubry *et al.* 2002).

A micro-morphological survey conducted at Olga Grande 4 by Sellami (2009) indicates a high likelihood of water-accumulating depressions based on hydromorphic data collected, which suggest frequent intervals of melting snow and freezing grounds. This pattern might therefore also shed light onto the choice of settlement sites on granite plateaux at higher altitudes and selective herbivore movements towards seasonal water availabilities in these depressions (see Aubry *et al.* 2002). This, in turn, might give rise to the specialised placement of rock art alongside the Côa River. Chapter 7.4 will see the introduction of the environmental spaces that a variety of the depicted animals on the Côa rocks are likely to have occupied, with data on specific prey ethologies (i.e. their behaviour in landscape settings) helping the reader navigate the chapter.

7.3. Psychological Experiment 5: Distance Perception and Rock Art Visibility

7.3.1. Introducing the experiment and research questions

Rock art visibility can be studied in terms of relations between the depicted art and bedrock features such as cardinal orientation (N, E, S, W etc.), inclination (acute, obtuse etc.), micro-topography (overhang, horizontal wall etc.) as well as surface morphology (convex, concave, flat etc.). Certain features of rocks, such as downwards orientated overhangs, naturally do not lend themselves to being particularly favourable for image visibility over distances. For instance, the whole panel of Penascosa 6 in the Côa Valley nowadays tilts forward by 30 degrees and is additionally situated on an extremely steep slope to its surrounding areas (for the DEM slope map, see Appendix F). Viewing such a tilting visual canvas requires special knowledge and commitment to appreciate it in all its extent. The following image (Fig. 7.3.1) illustrates the placement of rock art motifs and a variety of factors that have an impact on their visibility. The yellow enhanced figures are illustrative of the different variations such as size, rotation (alongside their X, Y, Z-axes) and choice of location on the rock itself, such as on convex, flat or concave parts of the panel, on inclined wall overhangs or on particularly coloured or eroded rock parts.



Figure 7.3.1.: Illustrative yellow motifs indicating the various possible placements of rock art within their panel environments (photograph and markings by author).

However, since not all panels recorded for the database were accessible for this project's related fieldwork, such as assessment of their slopes and tilting on site, these particular bedrock data points (including inclination, topography and morphology) could not be obtained. An alternative plan to study visibility had to be devised, consisting of factors other than bedrock constitutions. After the realisation that the contrast between rock engravings and rock background plays a pivotal part in our ease of rock art detection (as previously established in the visibility of superimposed imagery on different bedrock colours), this section will delve deeper into the effect colour and engraving techniques have on general visibility. Henceforth, rock art visibility is analysed in terms of colour contrast between bedrock and motifs, creation style (i.e. engraving technique; motif density etc.) in addition to other external factors. This sub-chapter comprises of a set of experiments testing visibility levels of a variety of rock art depictions within an open-air landscape environment. They consider a number of variables relating to the carvings themselves and their corresponding outdoor localities. The experiments within this outside environment are primarily concerned with how we nowadays view and how people in the past would have viewed the rock art that spans the regions of the Côa and Douro rivers. A theoretical approach, adopted from literary typography (Tracy, 1986) and elaborated on in the discussion section, is being advanced here allowing for rock art to be analysed in terms of their resolution, readability, legibility and comprehension levels. Moreover, this particular investigation is aimed at satisfying one of the main objectives of investigating the rock art's potential colouration in the past and whether that might have influenced visibility levels.

To the author's knowledge, the unpublished undergraduate dissertation by Jorge Ferreira in 2003 entitled *"A phenomenological study of landscape settings of the Palaeolithic Rock Engravings in the Côa Valley, NE Portugal"* first introduced an experiment testing the visibility of different pigments within the art's region. Yet, despite its obvious merits, many of its shortcomings, such as the use of entire cardboard squares denoting different colours, as opposed to single animal depictions, are being remedied here. Following on from this, a thought-provoking and more cohesive approach to a rock art visibility by Aubry and Luís (2012) and subsequently by Luís *et al*. (2015) regard readability and viewsheds as modes to test visibility of rock art in the Côa Valley. For their studies, the authors physically engraved simple short lines with different techniques onto schist bedrock located in the Côa Valley itself (see Fig 7.3.2). They tested if different engraving techniques and associated colours would affect visibility levels.



Figure 7.3.2.: Sample images from the visibility study by Aubry and Luís, 2012.

Yet, a couple of shortcomings of their study will be addressed with this new attempt at studying visibility of rock art in a landscape setting. The first shortcoming is that the viewing of the marks was made by the same (presumably three) people that also made the carvings in the first place. Therefore, the location of the carvings is known from the onset, which will have significantly skewed their results. For, if someone knows where to look for engravings and what in particular to look out for, the brain is already so primed to only seeing those depictions, that a much larger distance range is going to be recorded. This leads to another point of participant sample size, which is significantly increased in this new study. Furthermore, in their original study, rock engravings were only made in the form of simple short lines. Naturally, however, viewing a full-bodied depiction of an animal will of course impact visibility on a different scale. Viewing lines as opposed to viewing motifs is, of course, going to influence the distances at which they are distinguishable, i.e. legible/readable. Additionally, whilst the study by Luís and colleagues was only conducted with one particular schist background, this present study will address the variability of bedrock colouration to test its impact on visibility levels.

The following research questions will be addressed:

- At what distances can viewers resolve the rock art?
  (Chapter 7.3.1-7.3.5)
- Did the addition of coloured pigments affect perception of these images?
  (Chapter 7.3.1-7.3.5)
- Do different engraving techniques influence visibility levels of rock art?
  (Chapter 7.3.1-7.3.5)
- Do the visibility levels withstand in real rock art terrain?
  (Chapter 7.3.6-7.3.9)
- Does sun exposure influence visibility levels of rock art?
  (Chapter 7.3.6-7.3.9)

To make these overarching questions manageable, these sub-questions are devised:

Petroglyphic typography:

1) How far does one have to stand away/how close does one have to be in order to make sense of the images?

- More specifically, over what distances and at what orientation/angle can viewers resolve (identify) the art?
  - What is the legibility distance?
  - What is the readability distance?

Engraving factors (anthropogenically-influenceable):

- Does the …
  - Colour of the engraving
  - Size of the engraving
  - Engraving technique (pecked, incised, scraped) + boldness (thin vs. thick engraving)
  - Animal type
  - Animal completeness (part of the animal, detail of the animal)

  ... influence visibility (resolution/ legibility/ readability) levels?

Field factors:

- Do other factors such as …
  - Colour of the schist
  - Type of rock location
  - Weather and lighting conditions (sunny, overcast, rainy, foggy; time of year/time of day)

  … influence the visibility (readability/legibility) levels of the rock art?

Limiting factors

Location with all variables

For a study that takes all concerned variables into account, it was hard to find an original rock art site at which all these conditions are met. First, in terms of availability of all rock art animals, techniques and sizes, but secondly also in terms of extendable visibility distances. A neutral setting that bears all the necessary landscape features is therefore preferred and will function as the ***control study***. Hence, for this study to be conducted as accurately and unambiguously as possible, a standardised location has been found at which the to-be-tested factors are present. The control study environment is thus able to provide enough distance to the art to test wide ranges of visibility. What was however not obtainable, was a control study that also included a variety of rock features such as sheltered/hidden vs. open/conspicuous panels, small/unassuming vs. large visible rock surface in combination with considerable and measurable distances. It would have been intriguing to examine whether participants, viewing the art at different angles and from above/below, respond differently when asked about their visibility levels. Yet, the control-study environment, similar to the conditions mentioned before, does not allow for such testing. These variables were therefore cut out of this experiment yet are important to consider in future examinations of such kind. Furthermore, time-constraints of a PhD and access to different (often privately-owned) areas suitable for a control-study made the search for an alternative location difficult. Nevertheless, these variables would be desirable to test and should be embedded and repeated in any other further study of similar nature. Yet, the area that was eventually chosen for this preliminary study provides ample opportunity for analysis of how people view different art variables at different distances. As will become apparent when reading the next pages, a total of 162 rock art and field-factor variables were shown to participants during this study. Despite this rather large number of testable depictions and circumstances, it is hoped that this methodology leaves no question on possibilities not accounted for and that the results reflect this accordingly. Furthermore, after conducting the control study, a simplified study will be undertaken at an ***in-situ*** panel and art-rich ***original rock art location*** to test for visibility levels in the art's original environment.

Image availability

For different engraving techniques to be tested, the limiting factor for image selection was their physical availability within the recorded rock art corpus, as it was decided to utilise only real rock engravings and no images anthropogenically fabricated by the experimenter. Nonetheless, a sufficient number of images were found to cover all necessary variables.

Weather and lighting

The weather conditions will need to stay constant between different colour and technique trials. Seasonality can also influence visibility. Whilst it is desirable to test rock art visibility in different seasons (i.e. with different light conditions at different times of day), PhD constraints particularly pertaining to time, restricted this holistic consideration. In the thesis' proposal this part stated that "if time, the study can be conducted in different lighting conditions, i.e. direct sunlight, overcast, foggy, rainy", yet these conditions were hard to bring about during the actual field sessions undertaken. The effect that lighting has on the visibility of rock art engravings will have played a key role in the resolution attempts by audiences in the Upper Palaeolithic, just as they play an essential role nowadays, especially in evaluation of this present set of experiments. Hence, whilst different lighting conditions will have undoubtedly played a deciding factor in the visibility of engravings throughout different times of the day and of the year, it was decided that this present set of tests had to have lighting set as a constant and not a variable. Since it is the objective of this experiment to test for visibility of colours, engraving techniques and motif completeness (head/full body) the lighting conditions had to remain as constant as possible to eliminate distracting biases throughout and within datasets. Hence, the visibility experiments at the control study site ran over a period of six consecutive days (12 participants, two participants each day) **to ensure all participants were tested at the same time of day, with similar lighting conditions and sun orientations** towards the to-be-tested rock surfaces.

Pigment usage in the Côa Valley

One limiting factor, for a study such as this, is the actual presence/absence of pigments in association with the rock art at hand. Although traces of pigments (red and yellow ochre as well as manganese) have been found within the area during archaeological investigations (Zilhão *et al.* 1997; Zilhão and Trinkaus, 2002), this was not in connection with the art. Yet, the evidence of the use of pigments at Faia (albeit a granite engraving) give rise to the potential for a more widespread use of pigments, in the form of colouring of freshly pecked engravings or within other (perhaps ritualistic) tasks. In fact, several scholars (Zilhão, 1997; Baptista, 2001; Bahn, 2001; Diez and Aubry, 2002) have expressed their belief in the possible use of colour to accompany the engravings of the region. Nonetheless, their lack of survival nowadays needs not exclude the actual use of pigments on these surfaces in the past. Hence, the experimentations in the chapter aim to scrutinise this belief.

7.3.2. Theoretical background – literary and petroglyphic typography

A particular theoretical stance will be implemented here. For this, the concept of typography will be adapted in order to understand the different factors influencing our way of processing what we see in presented images. This is an important new step in developing a methodology for rock art visibility that goes beyond merely asking at what distances people first notice rock art on surfaces. It delves into levels that are more comprehensive, since participants will be asked when they first see things and what they can specifically and contextually identify.

Based upon the study of literary typography, legibility measures the clarity of the letters and readability measures the ease to read words and phrases. The final test within typography lies within its comprehension, by which one deciphers whether the reader understands the meaning of the letters that make the words and the words that make the sentences (after Tracy 1986):

Literary typography

Literary resolution:	Ease to acknowledge textual presence.
Literary legibility:	The clarity of the letters.
Literary readability:	The ease with which to read words and phrases.
Literary comprehension:	Understanding the meaning of the letters that make the words and the words that make the sentences.

Here, these two notions are slightly extended and applied to the way one is able to *read* rock art in its original context, in an overarching concept called petroglyphic typography. The following four visibility types: (1) rock art resolution; (2) rock art legibility; (3) rock art readability and (4) rock art comprehension are appropriated in the following manner (accompanied with a graphic illustrating the procedures of viewing, Fig. 7.3.3.):

Petroglyphic typography

Rock art resolution: Ease to acknowledge a panel, i.e. that it contains a rock art engraving (akin to *detection* in the *Bubbles* software).

Rock art legibility: Ease to identify the motif, i.e. Clarity of the rock art motif; Ability to decipher what motif is displayed (akin to *discrimination* in the *Bubbles* software).

Rock art readability: Ease to read the panel, i.e. that it contains scenes (superimpositions or freestanding motifs).

Rock art comprehension: Ease to understand the panel, i.e. that it bears specific meaning.

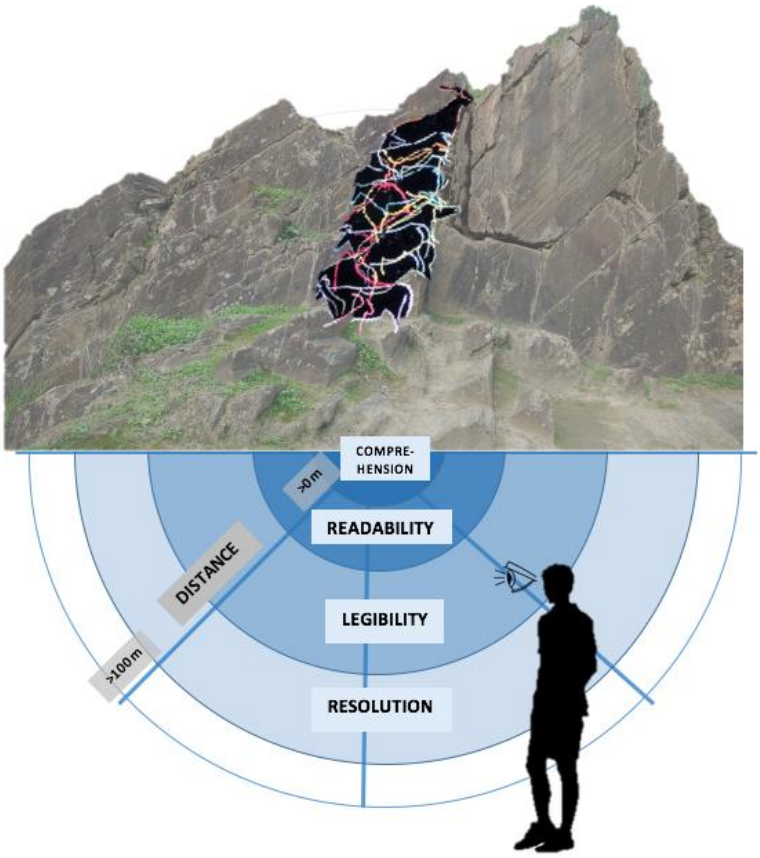


Figure 7.3.3.: Graphic illustrating the mechanisms of how this experiment will be carried out.

Within the results section of this chapter, different scalar models on all the different typographical types relating to rock art viewing distances will be revealed. Hence, once applied to the realms of rock art, the notions of resolution, legibility, readability and comprehension compare as follows to the study of literary typography (Table 7.1):

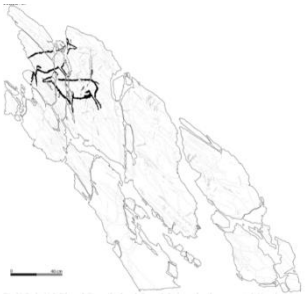
	Literary Typography	Example	Petroglyphic Typography	Example
Resolution	LETTER Size, Font, Colours → Contrast (e.g. black on white)	R	ENGRAVING Size, Carving Technique, Colours → Contrast (e.g. engraving on rock)	
Legibility	WORD Shorthand/Abbreviations Full words	Researching	MOTIF Partially complete figures Completeness	
Readability	SENTENCE Text with: Plainspoken words, Reading levels (e.g. 12th grade) Length of words and length of sentences	Researching rock art is a universal endeavour.	COMPOSITION Rock with: Freestanding motifs vs. Superimpositions Level of motif detail	
Comprehension	MEANING Terms and concepts within the sentences familiar to the audience to facilitate comprehension	E.g. Our 'modern' conceptual understanding of 'rock art', 'universal', what 'researching' involves etc.	MEANING Reoccurring motifs, 'scenes' and superimpositions	? - to be investigated. 

Table 7.1.: Table explaining the differences between literary and petroglyphic typography, with associated examples for both types.

7.3.3. The control study: experimental methodology

This methodology has been designed for the purposes of a comprehensive study that is able to encompass multiple factors influencing visibility. It contains two parts: a) a control study; b) a situational *in-situ* study within the actual rock art location. The initial control study took place at an open-air location with availability of different coloured schists and enough space to test sufficient visibility distances (the procedure of measuring those distances is explained later under participant instructions). In line with an ethical conduct, every part of this study is carried out under the premise not to alter or harm the environments in which this study is taking place. Therefore, no real engravings are made or coloured for the purpose of this study. Instead, real-sized images from the Côa Park Foundation's archives are traced onto transparent sheets of film (plastic pockets) with different colours, engraving techniques and animal types. The collage of images (Fig. 7.3.4) shows the use of these transparent films used on the rock surfaces:



Figure 7.3.4.: Image collage representing the material set-up in the control-study environment.

The control study was set out to take the following factors into account (Fig. 7.3.7). In line with the research question set out at the start of this experiment, there are engraving factors (i.e. those manipulated by Upper Palaeolithic artists) and field factors (i.e. those that can be controlled by the experimenter). However, due to the limiting factors described earlier (Table 7.2), only the boxes shaded in blue are assessed within this control study. That means different rock types, angle positions and weather conditions have been omitted from this research.

ENGRAVING FACTORS	FIELD FACTORS
Colour of the engraving • White (mimicking the colour it will have been after initial pecking) • Red (Manganese, Ochre) • Black (Charcoal)	Colour of the underlying schist • Light (Yellow) • Medium (Red) • Dark (Black)
Size of engraving • 10-170cm • Original size of engraving (50%, 100%, 200%)	Location of the rock • Hidden 'shelter' • Small, unassuming rock • Large rock face
Engraving technique • Pecked • Incised • Azilian Style	Distance • Arm's reach to 180 metres
Animal type • Horse • Deer • Aurochs	Angle • Frontal view • From side angles
Animal completeness • Head • Full Body	Weather conditions influencing visibility • Direct sun • Misty • Rain • Seasonality (?)

Table 7.2.: Table setting out the engraving (internal) factors and field (external) factors under scrutiny within this experiment.

The above engraving and field factors have been collated into several experimentation charts of which one can be consulted overleaf (Fig. 7.3.5) for a general understanding of the parameters under study. This chart exemplifies the images being made and evaluated on yellowish schist bedrock (with dark/black and red bedrock charts to be found in Appendix E).

Example experimentation chart (yellow schist)

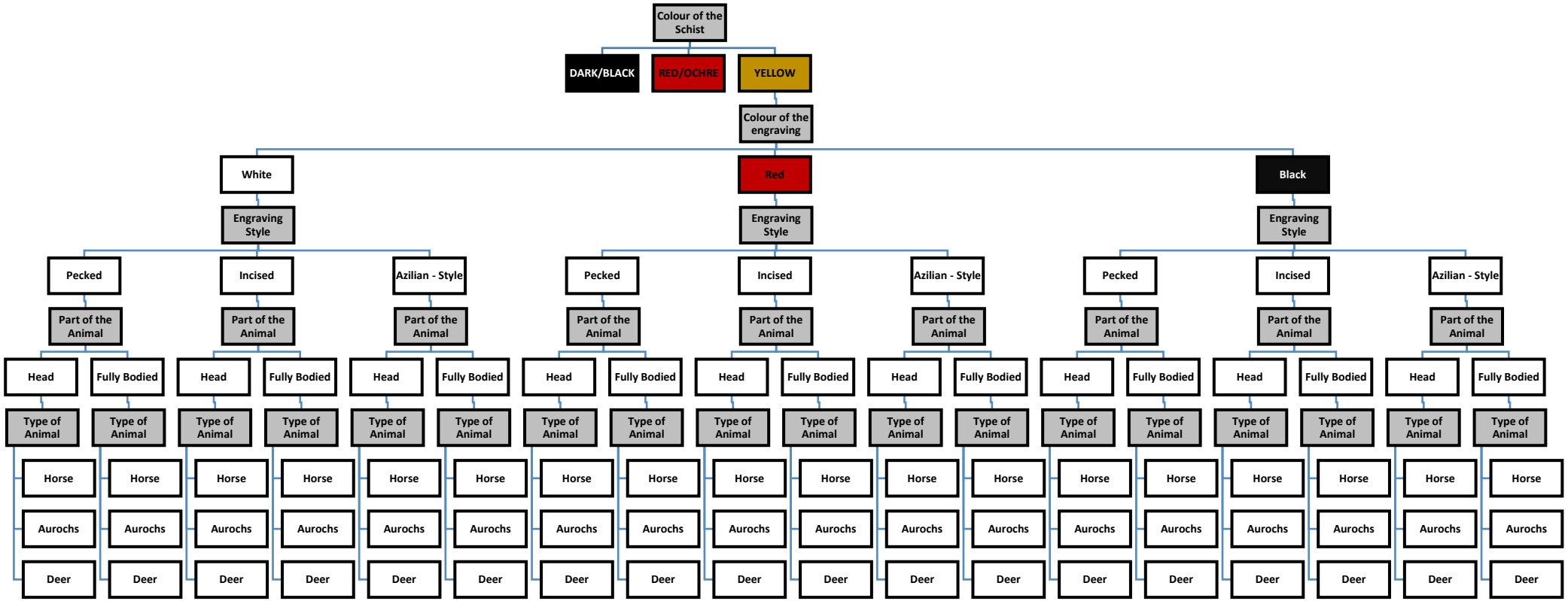


Figure 7.3.5.: Experimentation chart explaining what types of images are reproduced for later testing within the specified control-study environment.

Image selection and preparation:

In consultation with the chart overleaf, white engravings (to elaborate on one example) were prepared in the form of the following variables:

Pecking:

(1) Pecked Horse Head; (2) Pecked Aurochs Head; (3) Pecked Deer Head

(4) Pecked Full Body Horse; (5) Pecked Full Body Aurochs; (6) Pecked Full Body Deer

Incision:

(7) Incised Horse Head; (8) Incised Aurochs Head; (9) Incised Deer Head

(10) Incised Full Body Horse; (11) Incised Full Body Aurochs; (12) Incised Full Body Deer

Azilian-style:

(13) Azilian Horse Head; (14) Azilian Aurochs Head; (15) Azilian Deer Head

(16) Azilian Full Body Horse; (17) Azilian Full Body Aurochs; (18) Azilian Full Body Deer

The same set of transparent engraving sheets were made in a red (n= 18) and dark black colouration (n= 18). This meant that a total n=54 (3 x 18) tracings were prepared. These n=54 images were subsequently subjected to different environmental conditions such as colour of the underlying schist. This meant that a total of n=54 depictions were set up to overlay a red schist background, n=54 depictions were overlaying dark/black schist bedrocks and n=54 were attached to yellowish rocks, equalling a total of n=162 recorded data. Each variable in its to-be-tested, situated landscape was then measured and recorded according to different viewing distances.

Engraving techniques

In order to investigate visibility of a variety of rock engravings, it is essential to test the visibility of various and most importantly strongly contrasting techniques. This meant that incised (fine lined incision), pecked (deeply hammered marks) and Azilian style engravings (motifs that are not just outlined but fully striated in its midst) were singled out within the rock art corpus for subsequent use in this visibility experiment and in later comparative analyses. Whilst it would also be desirable to test different levels of boldness (i.e. thick and thin engraved lines), and their impact on visibility, this factor needs to be assessed in a future study due to the already outlined limitations. Of course, this discussion of actively selecting variables to be tested against each other also applies to the other categories. For instance, it was established that a multitude of different bedrock colourations exist in the Côa Valley, yet for purposes of this experiment only the three most contrasting base colours were selected, in the hope for conclusive results, yet more inclusive studies of all bedrocks colours, all pecking techniques, all animal types (etc.) should be conducted in future studies.

Sizes of engravings

There is, of course, no ambiguity in assuming that larger engravings will be spotted much quicker (i.e. from further away) than smaller engravings placed on the same background surfaces. However, if this study also took into account a variety of sizes, the amount of times participants and the experimenter would need to carry out the distance measuring, would have been in excess of 100 times (n=162; when considering original size (n=54, 100%), half size (n= 54, 50%) and double size (n=54, 200%)), which would not have fitted into the field working day schedule, since between all trials, the sun would considerably change the lighting conditions.

Instead, the first tracing of a horse head and a full-bodied horse (in all three colours) were re-created according to exact measurements of the originals (images of original tracings when the rock art was recorded obtained from the Côa Park Foundation archives). Sizes of engravings in the Côa Valley were recorded in the *Engraved Species Database* and thus it was easy to establish that the engraving sizes for the control-study had to be the average of the original engraving sizes produced in the region. From then on, all engravings drawn on the transparent films were scaled to exactly the same measurements as the initial horses, so that the effect of differential sizing could be eliminated from the influences on visibility ranges.

Methodological procedure

The overall three-step methodology (Fig. 7.3.6) and an experimentation chart explaining the testable factors are presented below:

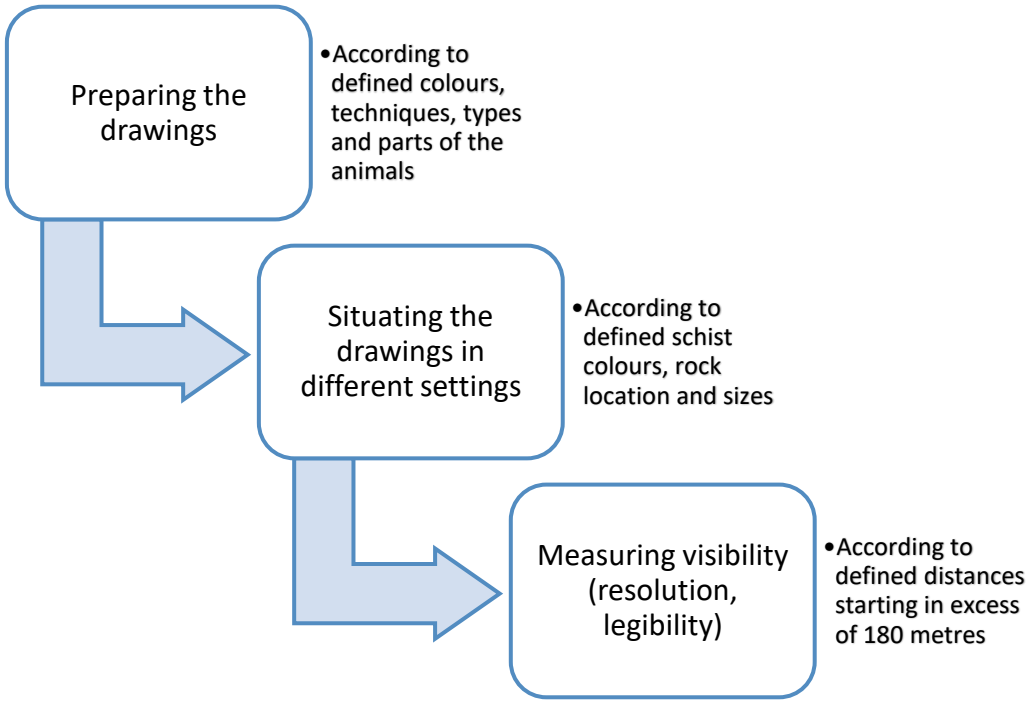


Figure 7.3.6.: Three-step methodology for conducting the visibility study set out in this chapter.

Example experimentation chart (all prepared coloured engraving films being subjected to different variables)

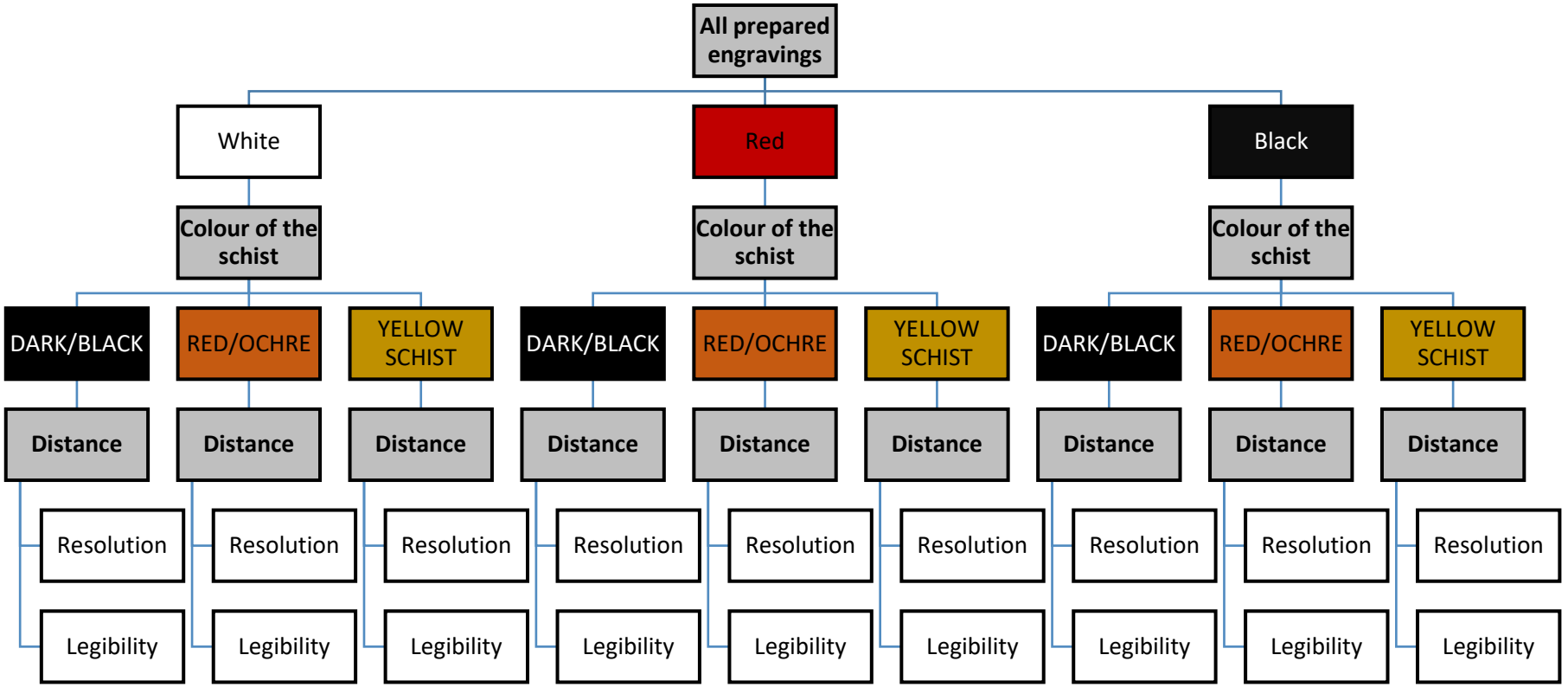


Figure 7.3.7.: Experimentation chart explaining how the different types of images will be subjected to different tests within a control-study environment.

In consultation with the chart (Fig. 7.3.7) overleaf, all prepared engravings (n=54) are subjected to the following variables:

18 White engravings:

(1) Dark Bedrock (2) Red/Ochre Bedrock (3) Yellow Bedrock

(4) Measurable Distances (Resolution and Legibility)

18 Red engravings:

(5) Dark Bedrock (6) Red/Ochre Bedrock (7) Yellow Bedrock

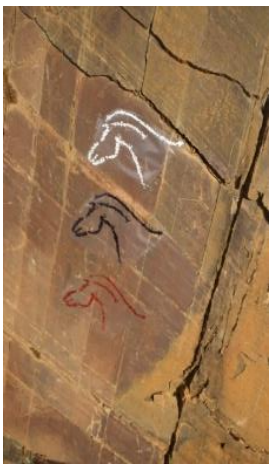
(8) Measurable Distances (Resolution and Legibility)

18 Black engravings:

(9) Dark Bedrock (10) Red/Ochre Bedrock (11) Yellow Bedrock

(12) Measurable Distances (Resolution and Legibility)

In order to eliminate participants knowing where rock art is likely to be positioned between different trials, each prepared variable (i.e. engraving technique, animal head/body, animal species) was conducted with all three assessed pigment colours at once (cf. Figures 7.3.8 and 7.3.9). In other words, all three engraving colours were simultaneously attached to the different bedrock colours. This ensures repeatability and appropriate conduct of the experiment, saves time and does not influence the judgement and potential prior bias of the participant between trials. This meant that 18 sets of three colours were attached to different bedrock colourations and their distances were measured accordingly. Furthermore, when it comes to evaluating distance perception for different colours, it is ensured that all will have been set under the same conditions:





Figures 7.3.8.-7.3.9.: Three differently coloured drawings attached to different bedrocks.

Participant information:

For a statistically meaningful outcome, a certain number of participants had to take part in the experiment. All participants had to have normal (or corrected-to-normal) eyesight at the point of the experiment. The control study with anonymised, voluntary participants took place at the study location where they were asked for the resolution and legibility (according to different distances and angles of viewing) of the images presented to them.

Overall participant summary:

- 12 participants
- Age range between 17-64 years
- 5 women, 7 men
- 9 with normal eyesight, 3 with corrected-to-normal eyesight

Participant instructions:

1) Participants were positioned in excess of 180 metres from the rock art trial under study. No specific path was instructed, yet the path alongside the street was unavoidable and thus directed. A guided marker system (denoting metres) on the floor guided the experimenter (unlikely to have been visible by the participants, as markers were set into natural surroundings). Participants were instructed that rock art could be found *anywhere in front* of them within a 180-metre[35] vicinity. Furthermore, participants were instructed that between trials, rock art would occur in different locations. This was to ensure that participants were unbiased between trials and that they would not just simply look alongside a pre-specified route and find the rock art in question through simple deduction.
2) For each trial, participants were asked for their resolution and legibility levels as they approached their perceived rock art motifs. There was no interference by the experimenter if participants indicated incorrect features.

[35] 180 metres was chosen, purely on the basis of available space towards a particular rock art feature and was deemed sufficient in the initial pilot study carried out in October 2016.

The following set of images (Fig. 7.3.10) highlights a typical run-through of an experimental trial (in this case three coloured horse heads on a reddish bedrock:

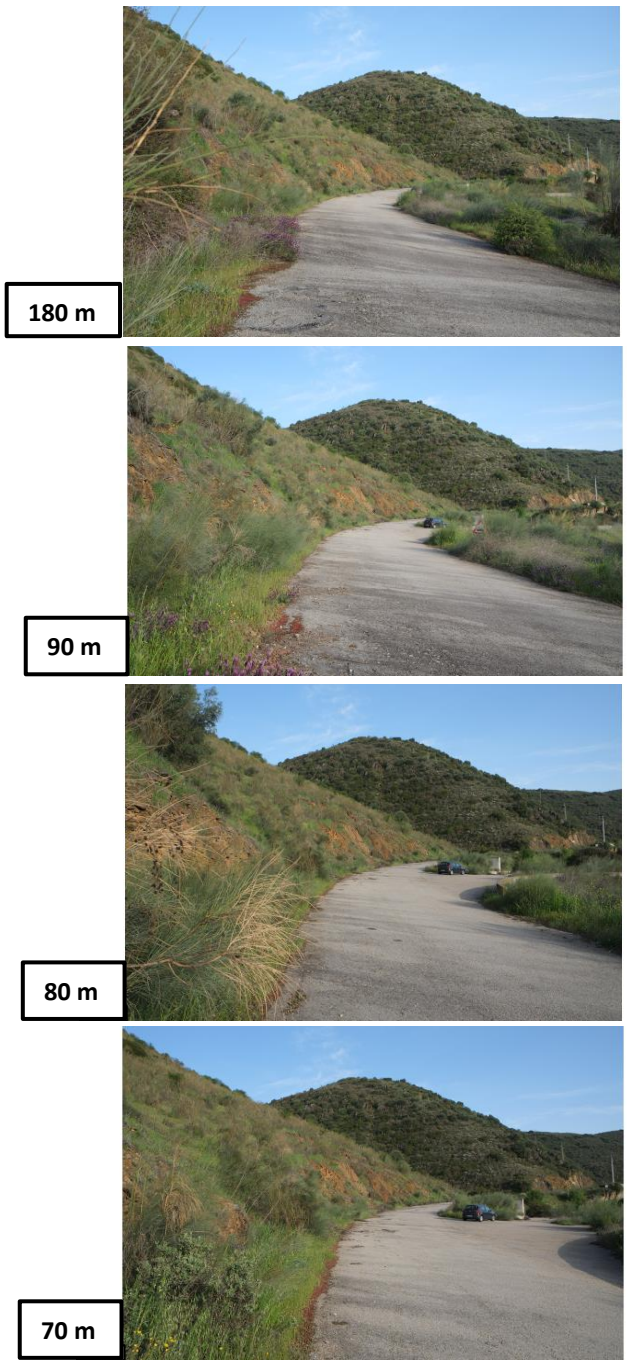


Figure 7.3.10.: Collage of trial set-up viewing differently coloured horse heads with measurable distances (starting at 180 metres and ending in arm reach) attached to the left of each image.



Figure 7.3.10.: Collage of trial set-up viewing differently coloured horse heads with measurable distances (starting at 180 metres and ending in arm's reach) attached to the left of each image.

7.3.4. Results and analysis of the control study

A selected range of sub-variables will be presented in more detail, after which a more generalised pattern of visibility will be explored. The experimentation chart from earlier is re-purposed below (Fig. 7.3.11) to illustrate the results that will be revealed first (intensified in red).

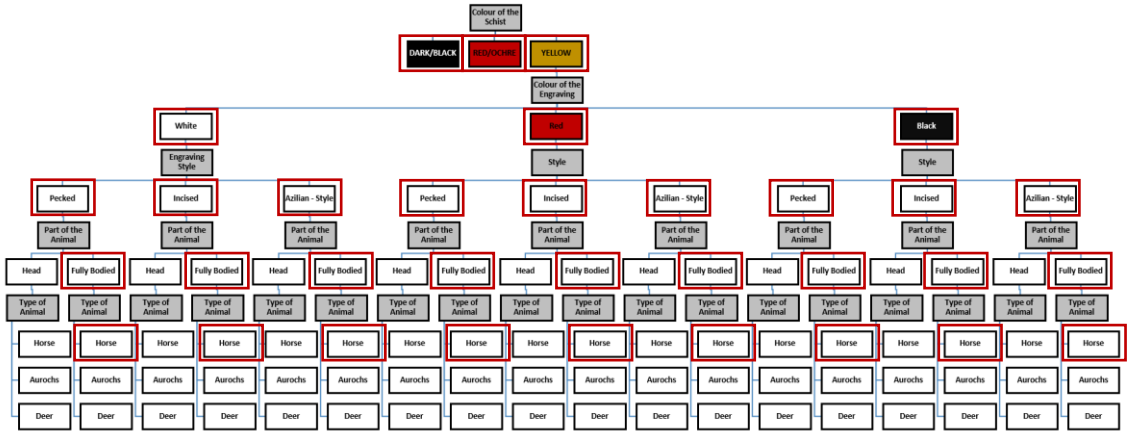


Figure 7.3.11.: Repeat of the experimentation chart with the author's indication (red squares) of which results will be presented as an illustrative example on the next couple of pages.

The results displayed here are those for participants' *resolution* of full-bodied horses tested with all the different carving techniques (Pecked, Incised, Azilian) and on all of the differently coloured bedrocks (Dark, Reddish, Yellow). The following sets of results are based on 9 out of the 54 engravings available (n=9; 17%). Accordingly, the result charts represented below indicate the distance ranges that occurred for the tested environments in the control-study (Table 7.3–7.5). These charts represent the first step in the petroglyphic typography – namely simple *resolution* (i.e. noticing that a motif (in this case a full-bodied horse) is present on a rock).

This analysis focuses on one set of results (full-bodied horses), yet readers are able to apply the same means of analysis onto other parts of motifs by extrapolating results from the summary figures (Fig. 7.3.12 and 7.3.13), if they wish. In addition, a discussion of general observations will be pointed out which reveal visibility trends of a variety of rock art features.

Viewing distances (resolution) for dark engravings of full-bodied horses

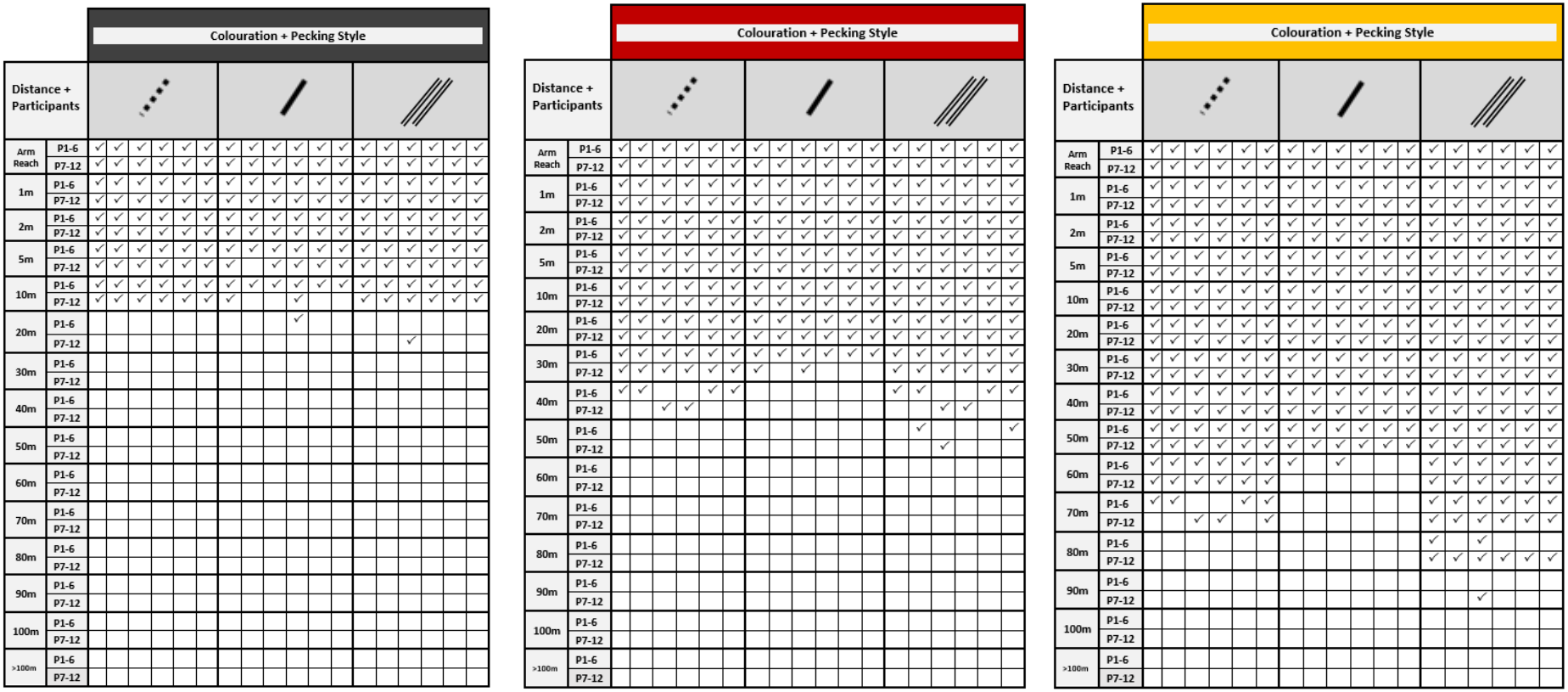


Table 7.3.: Result charts illustrating the perceivable resolution distances of darkish/blackish engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Viewing distances (resolution) for red engravings of full-bodied horses

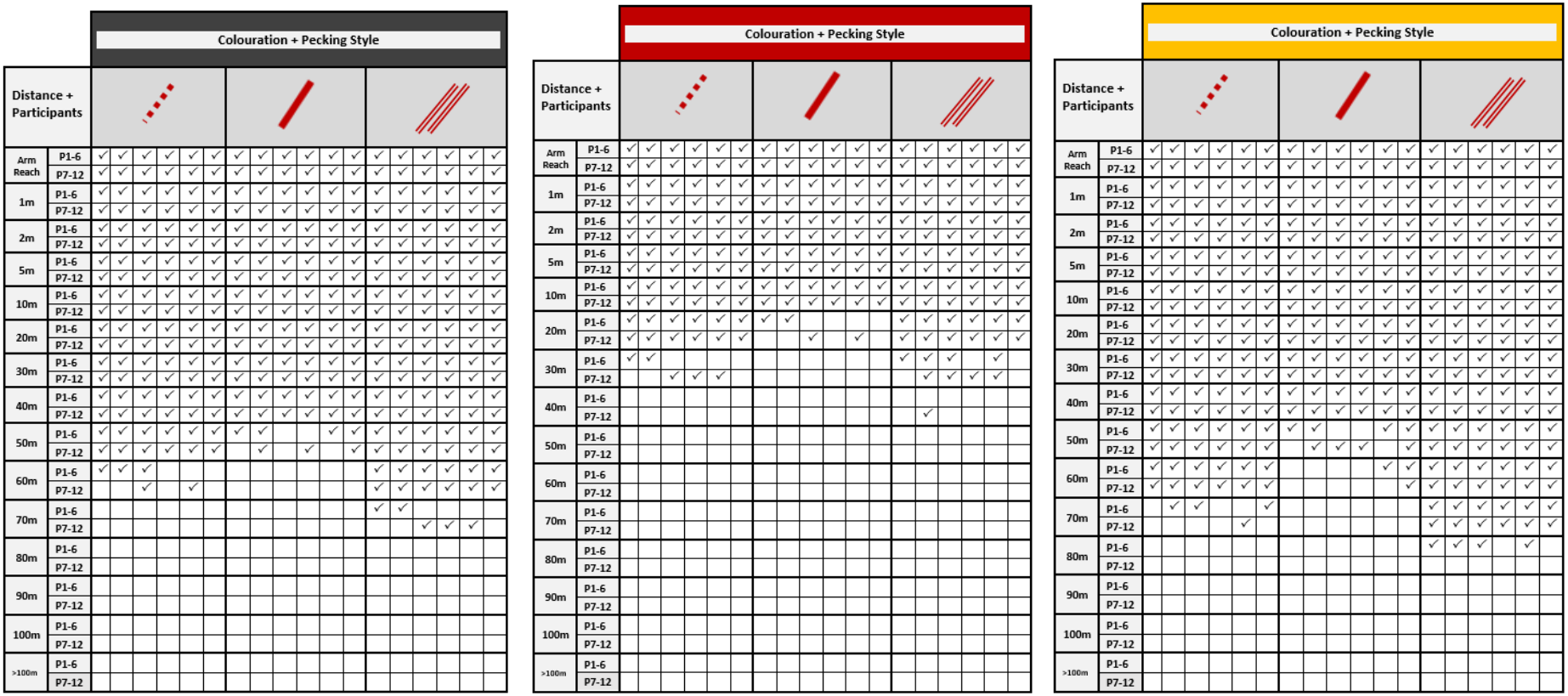


Table 7.4.: Result charts illustrating the perceivable resolution distances of ruddily engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Viewing distances (resolution) for white engravings of full-bodied horses

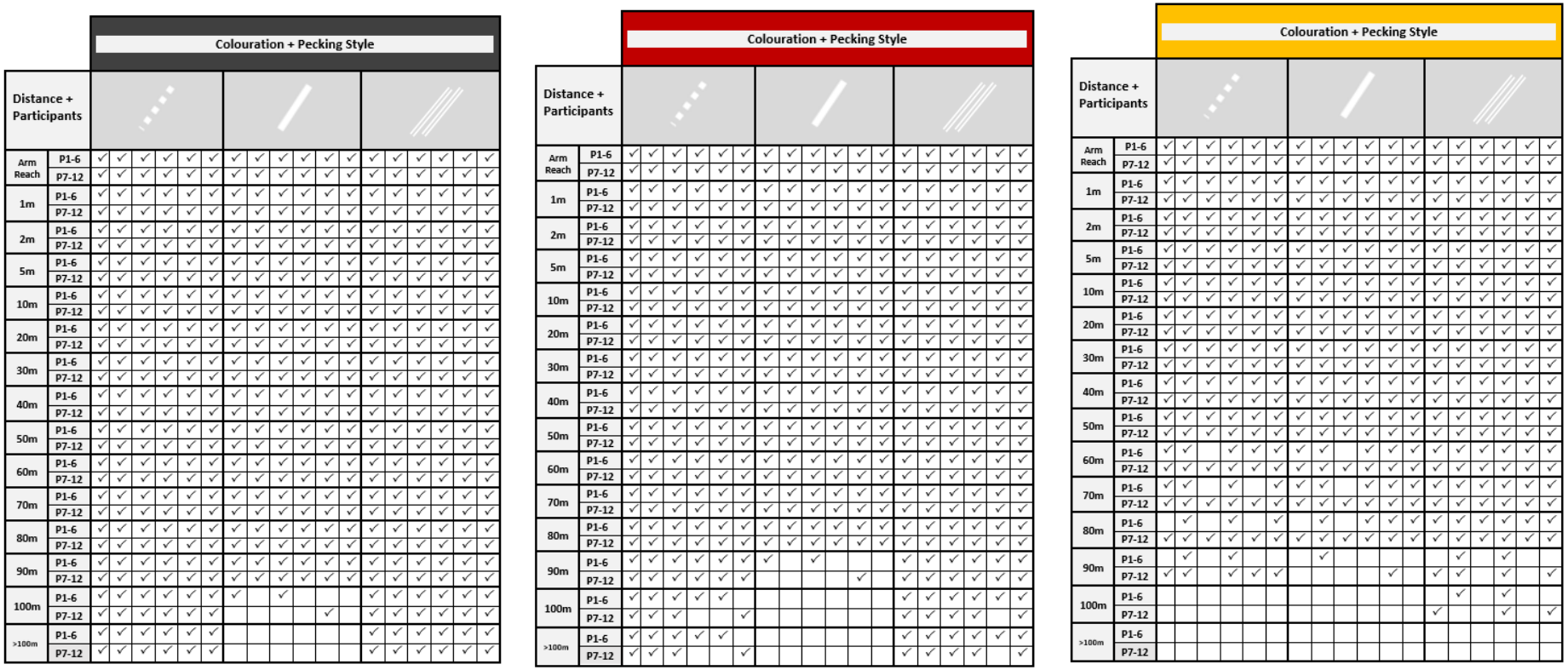


Table 7.5.: Result charts illustrating the perceivable resolution distances of whitishly engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Analysis of results – resolution

The previous three pages offer the results obtained for the (resolution) visibility of full-bodied horses on three differently coloured schist backgrounds, made with three different engraving types and with three different pigments. Again, a series of repeated ANOVA's would function well with this dataset, especially since there are generally three colours, set against 3 colours and engraved in three different ways. However, the sheer quantity of all the different tests and the resultant planned post-hoc tests to be carried out for statistically significant results, as well as the large amount of reporting will defeat the general idea of what is trying to be achieved in the first place. The data was collected for researchers and readers of this thesis to understand at what point participants are able to resolve certain types of depictions. Hence, it would make most sense to understand, in simple terms, what exactly these thresholds are within the different settings. Whilst the ANOVA's from the perception task on superimpositions (Chapter 6.3.5) have already revealed several statistically significant results with regard to the perception of engraved 'colours' and underlying bedrock colours, these results are incorporated into the discussion of these present datasets. Simple descriptive statistics will be reported here to conclude this mass of data collected for this experiment.

Resolving full-bodied horses

In consultation with Table 7.3, for engravings pigmented in dark on the different rock colours, it can be concluded that dark horses are best visible on yellowish backgrounds, with dark horses hardly perceptible on dark rocks and slightly more visible on red rocks. For reddishly pigmented horses (Table 7.4), there seems to be a general trend averaging ~60m for the resolution of engraved features on dark and yellow surfaces, with the average for red background surface rocks falling considerably behind (~25 metres). For horses pigmented in white (Table 7.5), participants started noticing an engraved feature on a dark surface as far away as 148 metres (in the cases of 2 participants). Both red and dark/black surfaces were particularly prone to early sightings (i.e. at large distances) of white marks (red surfaces ~ 97 metres), with yellowish surfaces and white engravings averaging around ~80 metres. Hence, when comparing all three results charts, an obvious visibility trend emerges, namely that **white engravings have a much larger impact on visibility (resolution) levels than red or dark engravings on similar surface backgrounds.**

Resolving all engravings

Instead of boring the reader with yet another chart of recorded distances, the following graphic (Fig. 7.3.12) represents the average distances of all resolution results across all types of engraving colours, engraving techniques and levels of motif completeness[36]:

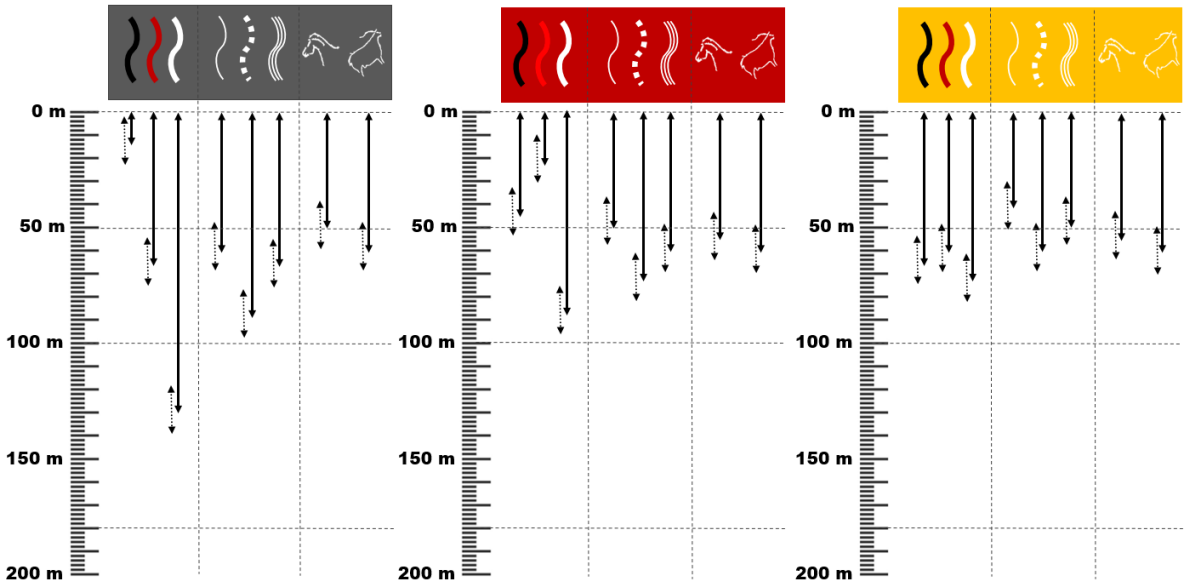


Figure 7.3.12.: Average distances recorded for the resolution of different engraving colours, techniques and motif completeness based on responses by 12 participants.

The graphic is divided into three different parts, illustrating the three different bedrock colours (from left to right [darkish grey; reddish; yellow]). Each bedrock denoting chart is further divided into three different sets of results (from left to right – engraving colours [dark, red, white]; engraving techniques [incision, pecking, Azilian] and motif completeness [head, full body]).

The data analysed and summarised above exposes a striking trend on which types of coloured rocks and which engraving colours are (on average), utilised for best resolution of engravings in a landscape environment. Across all bedrock colouration sets, the **whitely pigmented engravings, the technique of pecking and full-bodied animals rather than heads only attract earliest resolution levels**. Especially dark bedrocks in association with white engravings (∑ = 135 metres[37]) produce a considerably positive effect for visibility (i.e. increases visibility over distances) of any engraved patterning, meaning **the starker the contrast, the better the resolution.**

[36] This graphic is an adapted and updated version of the distance representation from Aubry and Luís (2012) and Luís *et al.'s* 2015 paper.
[37] ∑ = average sum of.

The results for engravings attached to reddish and yellowish background colours are very similar in nature, with the exception of engraving colours, which is strongest for white on red and weakest for red on red.

Interestingly, yet not an unexpected outcome, engravings that are portrayed in their full extent (i.e. full-bodied engravings) are spotted ~10 metres prior to representations of heads only. This is most likely due to more engraving marks necessary when making a full body as opposed to making just a head. **Largely, more engraving mass equals better resolution.** It will be intriguing to compare this figure to the result obtained from the legibility levels (i.e. at what point participants are able to tell what motif it is), especially whilst bearing in mind the discussions and experiments carried out previously surrounding the saliency of animal features (cf. *artistic minimalism* and *Bubbles*).

Therefore, the next step is to figure out at what point participants are able to tell what it is that they are seeing, rather than just seeing unidentified engraved marks. Hence, the following three charts summarise the results of participants' *legibility* data, again based on a full-bodied horse displayed in three different engraving colours on three different background schist colours (Tables 7.6-7.8). For easy comparison, the distances recorded for the resolution levels are retained in light grey within the next charts.

Viewing distances (legibility) for dark engravings of full-bodied horses

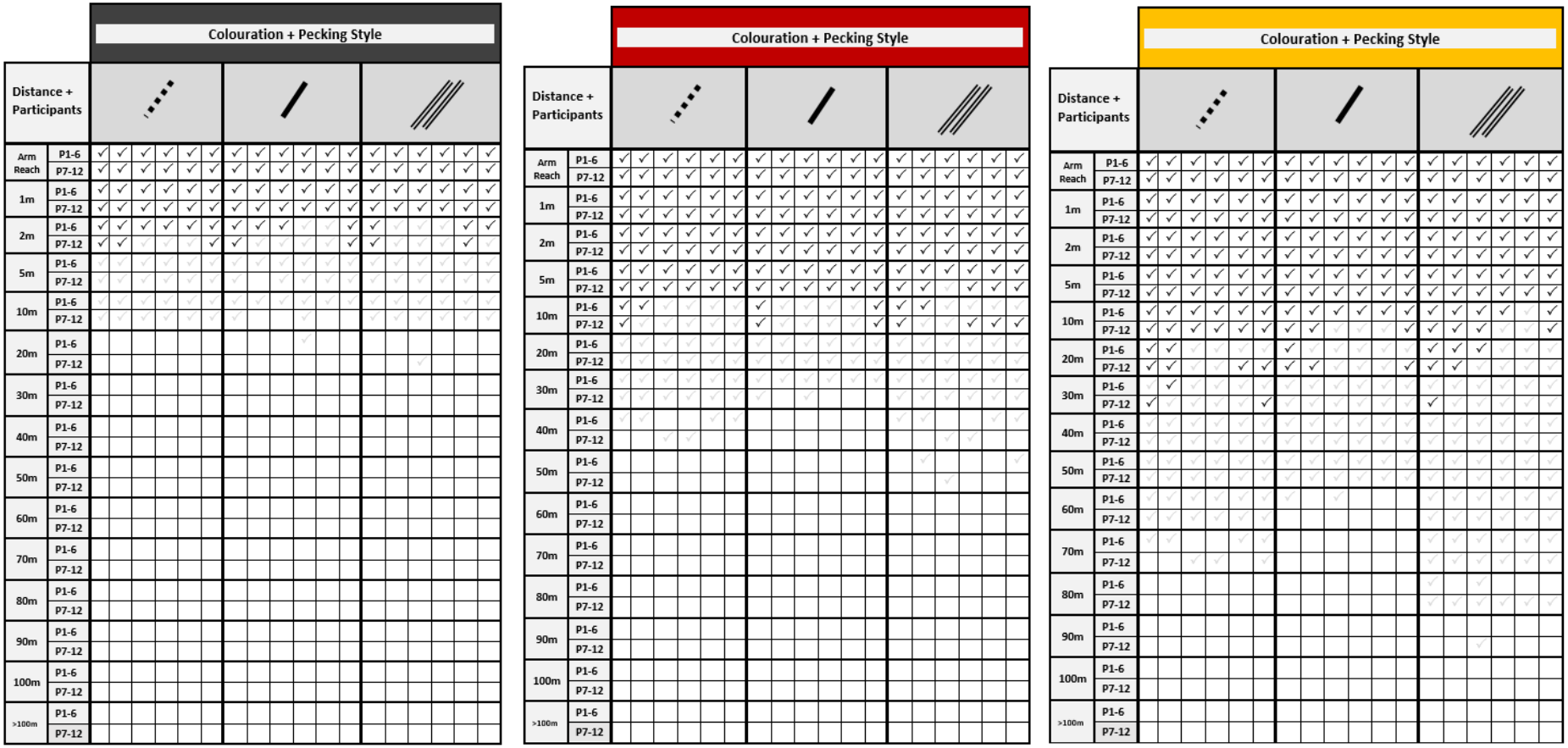


Table 7.6.: Result charts illustrating the perceivable legibility distances of darkish/blackish engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Viewing distances (legibility) for red engravings of full-bodied horses

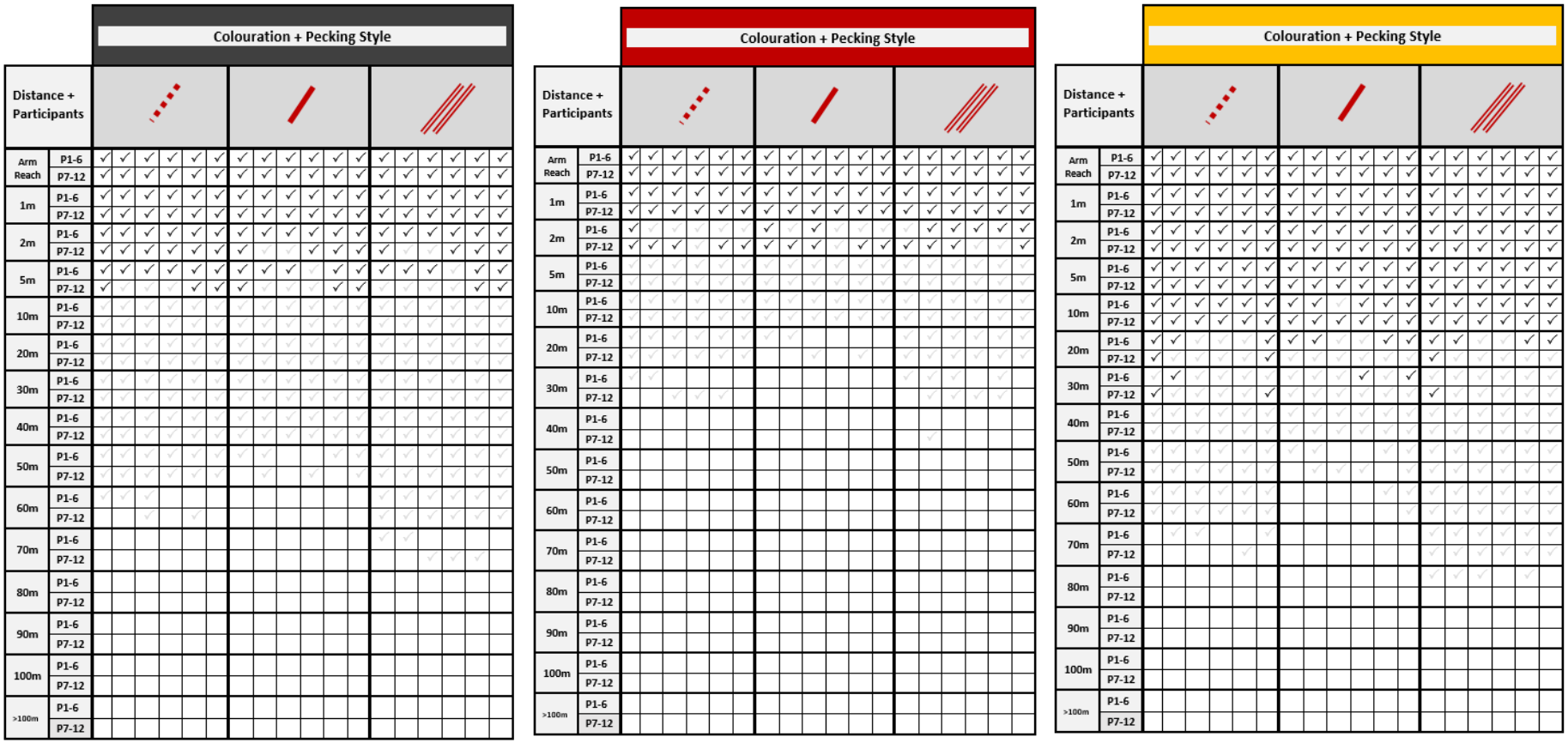


Table 7.7.: Result charts illustrating the perceivable legibility distances of ruddily engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Viewing distances (legibility) for white engravings of full-bodied horses

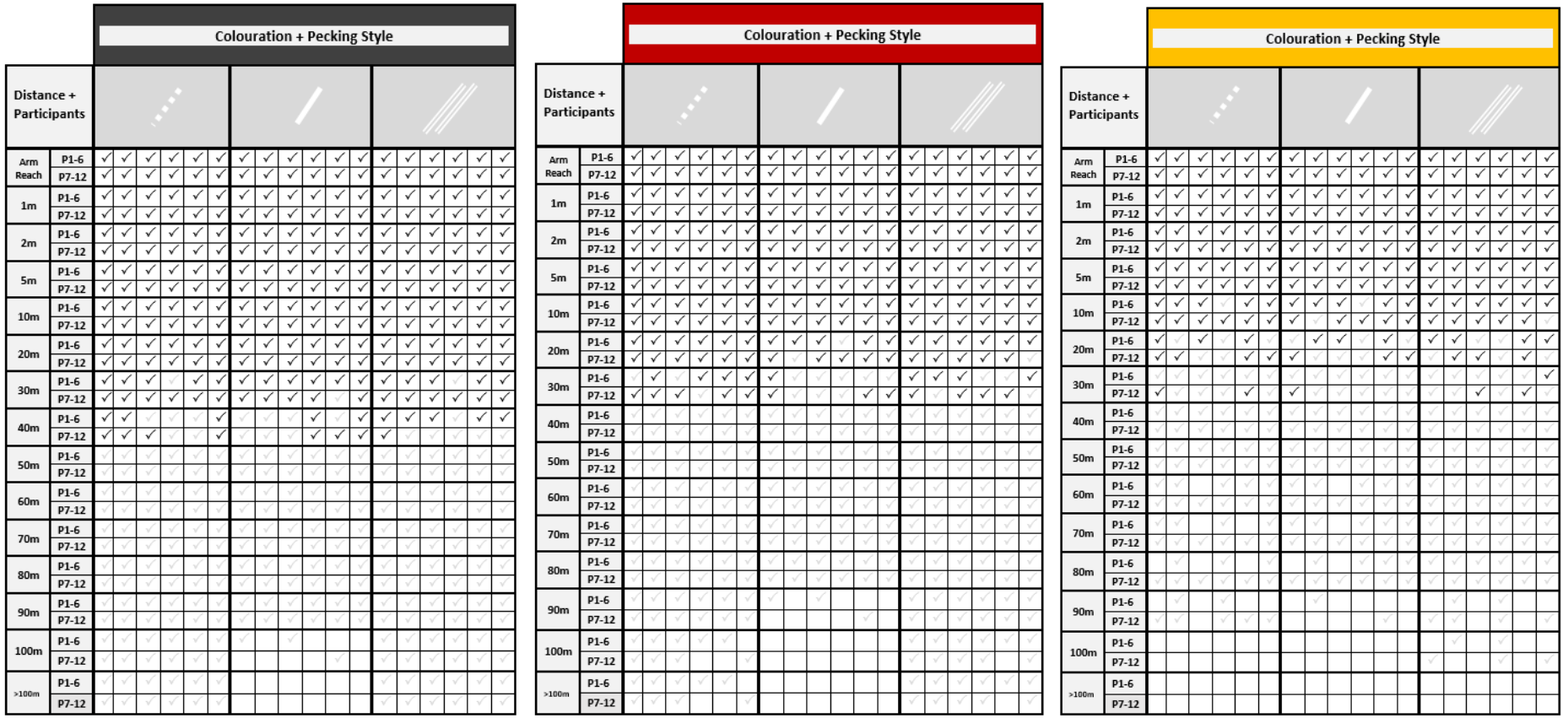


Table 7.8.: Result charts illustrating the perceivable legibility distances of whitishly engraved full-bodied horses on three different bedrock colours (left dark, middle reddish, right yellow).

Analysis of results - legibility

The previous three pages offer the results obtained for the (legibility) visibility of full-bodied horses on three differently coloured schist backgrounds, made with three different engraving types and with three different pigments.

Legibility of full-bodied horses

To begin with, horses pigmented in dark attached to the three different background colourations are analysed (Table 7.6). In fact, it appears that whilst black pigments on black backgrounds are *resolved* at ~10 metres, participants are able to reach the *legibility* level only at ~1.5 metres distance from the depictions. Dark pigments on red backgrounds are *legible* as specific motifs at ~8 metres whilst dark pigmented horses on yellowish bedrock are *resolved* at around ~65 metres and *legible* at only ~18 metres. This means that it takes participants to walk on average ~47 extra metres to finally identify what is depicted on the (yellowish) rocks.

Similar results can be found for reddish pigments (Table 7.7) on dark bedrock, with the average of all engraving techniques for red horse *legibility* being ~4 metres. Red pigment on red bedrock reveals only a *legibility* distance of 1.5 metres, accounting for ~23.5 metres between *resolution* (~25 metres) and *legibility* levels. The average *legibility* distances for red pigmentation on yellowish bedrock reads ~24 metres, compared to their associated *resolution* data averaging ~60 metres.

Results for whitely pigmented horses on the three different bedrock options (Table 7.8) seem to concentrate around the ~30 metre *legibility* levels, with white on dark being ~36 metres, white on red averaging ~27 metres and white on yellowish bedrock measuring ~ 18.5 metres. This result is surprising, as original *resolution* levels were recorded as being between ~135 and ~ 80 metres distance away from the engraving. Bearing in mind that participants are then able to focus on just that one specific mark on the rock, the motifs only start becoming much clearer and identifiable at around the ~36 metre mark. This leads to a discrepancy of roughly 100 metres between both extremes, indicating that long distances are necessary to provide participants with enough identification ability in the first place. However, the **striking equivalence of white engravings tending to require a roughly ~30 metre (averaging all recorded distances for white engravings) *legibility* leeway on any given bedrock** will be explored further in the discussion section which follows next in this sub-chapter.

Legibility of all engravings

In the same presentation style as the *resolution* data, the following graphic (Fig. 7.3.13) represents the averages of all *legibility* results across all types of engraving colours, engraving techniques and level of motif completeness:

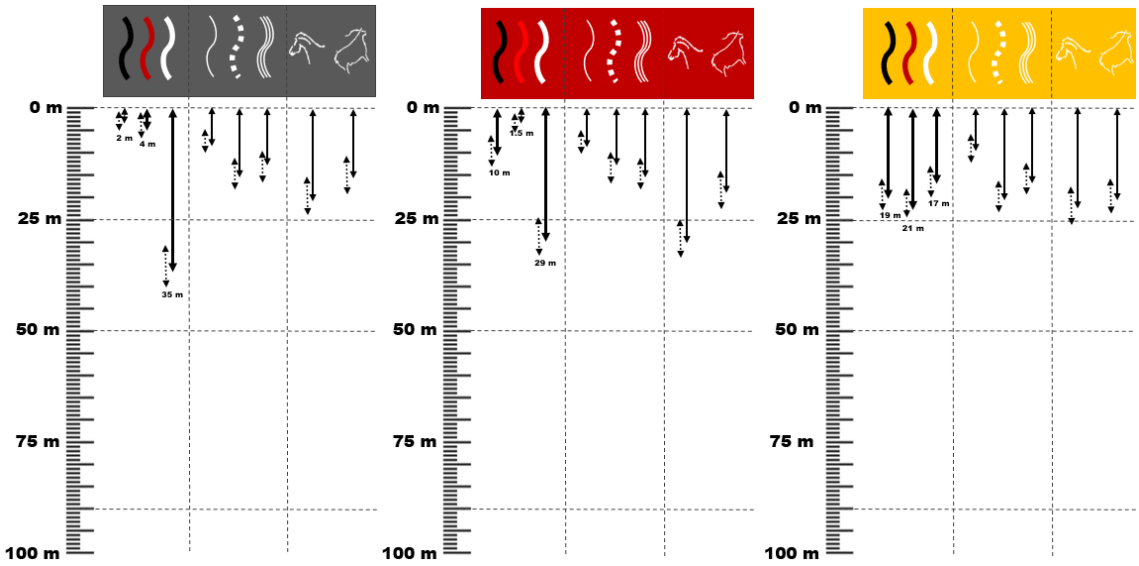


Figure 7.3.13.: Average distances recorded for the legibility of different engraving colours, techniques and motif completeness based on responses by 12 participants.[38]

As before, the graphic is divided into three different parts, illustrating the three different bedrock colours (from left to right [darkish grey; reddish; yellow]). Each bedrock denoting chart is further divided into three different sets of results (from left to right – engraving colours [dark, red, white]; engraving techniques [incision, pecking, Azilian] and motif completeness [head, full body]).

Again, across the dark and red bedrocks, participants show a particular high success rate of identifying the motifs on display from furthest away when displayed in white (dark bedrock ~35 metres; red bedrock ~29 metres). For the yellow bedrock panels, there was a close tie between all engraving colours on its surfaces, as the distance ranges for black on yellow (~19 metres), red on yellow (~21 metres) and white on yellow (~17 metres) all fall in close proximity to each other.

When it comes to the ease of identifying the nature of a specific motif, it is now worth taking a closer look at the legibility levels of different engraving techniques and different levels of motif

[38] Readers should note the change in scale on the left-hand-side of each chart, reduced from 200m to 100m to allow for better comprehension at legibility scale.

completeness. This consideration is especially valuable at this point as it serves as a retrospective on the earlier discussions on the types of techniques and motif features that bring about easiest identification within the drawing experiments and *Bubbles*.

To start with the engraving techniques, it is plausible to suggest that the clearer a motif is depicted in terms of its engraving method into the bedrock, the better the legibility levels are likely to be (i.e. greater distances). In other words, simple incision might not be as legible as the deeper marks of a pecked engraving, which in turn might be more visible than the outwardly more clustered engravings made with Azilian-style striations. In reality, the data reveal that motifs that have been pecked into the bedrock result in greater legibility ranges, than incised or Azilian style depictions. However, it is distinguishable that the Azilian style motifs are roughly as legible in the case of dark and yellow bedrocks (just a few metres behind pecking in each case), and if not more legible in the case of red bedrocks. This illustrates that **motifs that are not just outlined but striated within the inside of their bodies are as legible as purely outlined motifs**, perhaps as alluded to earlier, this might be due to the sheer mass of lines inside the depictions aiding in quicker identification. As expected, single line incisions used for marking out all important features of a motif are not as legible as the techniques previously assessed.

Continuing with the level of motif completeness, it is plausible to suggest that the more a motif is adorned with salient features for easy identification (i.e. horns, particularly shaped backs, ears, head shape etc…), the better the *legibility* levels are likely to be (i.e. greater distances). In fact, the heads that have been portrayed onto the control study rocks exhibit the majority of these salient features, especially if one bears in mind the discussion from the previous chapter of 'cutting' animal motifs in half and still being able to identify their nature by their heads only. By deductions, the rest of the body is therefore just an accessory for completeness, rather than an essential and defining characteristic. With this in mind, the logical way to analyse the *resolution* data was to suggest that the additional lines that full-bodied animals, as compared to head-only animals, possessed, led to their greater success in the *resolution* part of the study. However, when it now comes to their *legibility* assessment, the opposite outcome is hypothesised. In fact, within all three bedrock varieties, **animals that are represented by their heads only exhibit a much larger legibility distance than their full-bodied counterparts** (in the case of the red bedrocks, there is a difference of ~10 metres between heads and full-bodied legibility, which in view of the overall recorded scale at this visibility level is highly significant).

7.3.5. Discussion of the control study results - visibility of pigmented engravings

To date, only one engraving site within the Côa Valley, namely Faia, has been found to contain (red) pigments. As mentioned previously, Faia is also the only known site with engravings on granite rock and its engravings are contained within a sheltered outcrop environment. Due to absence of pigments on schist, one might be inclined to argue that the combination of engravings and pigments was confined to granite rocks only, especially since granite also requires a completely different engraving force than schist. In any case, there is currently no evidence suggesting the use of pigments on vertical schist panels to colour in the freshly engraved marks. Alternatively, there is also no evidence that suggests that Upper Palaeolithic artists pigmented the entire rock for subsequent engraving over the top. However, the absence of colour does not equal absence of such practices all together and it should be pointed out that the vertical conditions of the schist surfaces lend themselves to rapid weathering processes meaning that these preservation issues might compromise their longevity.

Yet, in alliance with the fact that no pigments have been found on Côa schists as of yet, the conducted visibility experiments reveal that **engravings coloured in white (i.e. akin to those that were freshly engraved) yield best rock art visibility** at both resolution and legibility level. By extension, it can be argued that **the addition of colours such as red or dark pigments to the rock, other than the naturally occurring white pigmentation of fresh engravings, reduces visibility over increasing distances** within an open-air rock art landscape complex. Hence, detection ability of colour within open-air rock engravings reduces with increasing distances. Crossing borders, within the prehistoric rock art examples of Zimbabwean animals, white paint is sometimes visible, which was used to bring out distinctive changes within the animals' coats: "white stomachs or undersides of some antelopes, light stripes on a kudu's back" (Garlake, 1995: 20). During the Upper Palaeolithic in the Côa region, the natural occurrence of white 'pigmentation' and its excellent stand-out visibility will have likely been used for similar effects and intentions in mind. Relatedly, **colouring in rock art engravings was not a necessity for easy perception but rather a stylistic choice.** In other words, if it were the intention of the artists to colour in their creations, they would have done it because of stylistic preferences rather than perceptual necessity. In fact, for all we know, the addition of pigments might have been the key to the meaning of rock art. Without it, it might have only meant half its intended purpose. Nevertheless, without delving deeper into the underlying motivations, the results from this experiment suggest that **if the function of the Côa Valley art was its general visibility by passers-by at varying distances, colour will have impeded on that aim.**

Visibility of engraving techniques

Without repeating all the different characteristics of each engraving technique found within the Côa rock art repertoire (see Ch. 6.2), the three types chosen for purposes of this experiment offer the greatest ranges of variety – pecking, incision, Azilian-style/fully striated motif cores. The engraving technique that was **consistently better perceived (i.e. resolved and legible) by participants of the study, is that of *pecking*.** This is not surprising since pecked marks, deeply hammered into the schist's surfaces, take away much of the top layer of the chosen rock whilst also deeply piercing the surface and leaving behind visible alterations to the bedrock. In contrast to pecking, Azilian type engravings tend to be more visible than engravings created by pure incision into the rock surfaces.

Furthermore, another way to think about pigmentation in relation to technique goes back to the white residue left behind when artists utilise any of these three engraving methods. Motifs are being brought into existence by pecking/incising something superficially into the bedrock. This results in a stark contrast between the initial intact bedrock area and the now-manipulated area being engraved. Zilhão *et al.* (1997: 25) describe this effect fittingly as "a kind of reverse painting in which pigment was removed instead of added".

Visibility of engraving sizes

Although not carried out with the entirety of the participant pool, during the initial pilot study in 2016, one set of engravings with a variety of scales was trialled. As such, three originally pecked horse heads (100%) were scaled to half their size (50%) and double their size (200%). One engraving colour (i.e. white) and one bedrock colouration (i.e. dark) were considered. The aim was to test whether the increase or decrease of motif size has impact upon visibility levels. As would be expected, larger engravings were seen (resolved) from further away (~155 metres) and smaller engravings were spotted later (~70 metres) than the original size of the engraving (~120 metres). This signals that **larger depictions are visible from further distances and that the smaller a depiction gets, the closer the audience needs to get to the rock to view and understand the markings.** Thus, differences in scales of depiction bear significant implications for the ways in which the images will have been viewed. It appears that small depictions could only be deciphered at close quarters, and due to this, the depictions were perhaps small in order to guard them from public scrutiny, as Bradley (2009: 54) reflects: "in a sense they codified "secret" knowledge". This, in turn, has further implications for the theoretical rock art audience debate, which will be discussed in the second experiment towards the end of this chapter.

Visibility of motifs with different completeness

Similar to what has been described in the previous section on motif sizes and their visibilities, an interesting trend can be observed when comparing the resolution and legibility of motif heads versus those for full-bodied motifs. **On the resolution level, full-bodied animals are resolved quicker than animals with heads only, yet on the legibility level, the reverse is true, namely, head-only motifs produce better legibility than their full-bodied counterparts.** Again, on a resolution basis, it is most plausible to suggest that mass and size increase resolution levels. On a legibility level, it occurs sensible to look into the saliency factors established in chapter 5, resulting in the potential link between the clarity and minimalism of the motif and its better legibility range when compared to motifs that have more 'baggage' of non-salient features attached to them.

Resolution, legibility - what about readability and comprehension?

The two levels of visibility within the established petroglyphic typography, that follow on from *resolution* and *legibility,* are *readability* and *comprehension*. Yet, due to the fact that these two levels require a contextual surrounding for their assessment, the control study results and their analysis end here. For, *readability* requires participants to indicate whether they see superimposed images (perhaps even scenes) or simply motifs in isolation. Since only single motifs were hafted onto the rocks at the control study, an *in-situ* site would be better suited for the required testing of *readability* levels. The last level with the petroglyphic typography – *comprehension* – is arguably very subjective and hard to evaluate in a numerical manner. It requires participants (i.e. viewers of the art) to understand the panel and illustrate that it bears specific meaning. This goes back to the emic and etic perspectives on rock art (see Ch. 2), as it is impossible for modern rock art researchers to adopt the emic mind-set of Upper Palaeolithic carvers. All they have left us are engravings, rendering the *comprehension* level within the typography relatively speculative. To interrogate all typographic levels, however, the *in-situ* study, outlined next, will provide further insights.

7.3.6. The *in-situ* study of visibility at original rock art locations

Now that the different visibility ranges have been established for the selected variables on neutral, control-study grounds, the following paragraphs will highlight the outcomes from situating the 'pigmented' art in its actual landscape setting. To start with, it was important to have tested the variables for their ability to withstand several hundred metres of distance (and firmly establish the upper most visibility ranges) as was possible at the control-study location. Now, it is of equal importance to regard the rock art in its authentic setting in appreciation of the often-times crowded, obscured or less accessible panel nature. This will give insights into the actual workings of the established visibility distance ranges and will set up the parameters for the next experiment which will integrate viewing distances into GIS models, featuring the rock art distribution maps, generated and discussed previously. In particular, the following two questions are addressed in this sub-chapter: Do the visibility levels withstand in real rock art terrain and does sun exposure influence visibility levels of rock art?

7.3.7. The *in-situ* study: experimental methodology

Site selection

The site of Penascosa (in particular rocks 3, 4, 5 and 6) was selected for the conduct of the *in-situ* study. The site not only offers great distances to be walked aiding in testing wide possible ranges of visibility, but also offers a number of panels containing rock art that lie in close proximity to one another (see Fig. 7.3.14 for a photograph taken above one of the rock art panels overlooking the landscape underneath and beyond). The river location nowadays is a mere ~40 metres away from the majority of the panels (near the location of the trees and the bottom of the mountains in the photograph of Fig. 7.3.14).



Figure 7.3.14.: Penascosa, situated in the heart of the Côa Valley, image taken above rock art to show extent of the site (Image: Museu do Côa).

Image selection and preparation

As with the control study, the tracings were made according to exact measurements of the originals (images of original rock art recordings/tracings were obtained from the Côa Park Foundation archives, see Fig. 7.3.15-7.3.19). Yet, for a range of sizes and engraving techniques to be tested, the limiting factor was engraving availability at the *in-situ* site. However, enough engravings were found to cover the variabilities and to even add more variety in animal species.



Figure 7.3.15-7.3.19.: Collage of images showing the engraving sheets that were attached to rock 5 (top two images) and rock 4 (bottom 3 images) at Penascosa.

Limiting factors for *in-situ* studies

Location

For purposes of this research, there are a number of conditioning issues that prevent the research being undertaken at original rock art locations at a large scale:

1. Accessibility: Many rock art sites are difficult to access and require special visits with guides and land ownerships permissions.
2. Water Location/Submerged: Whilst the general course of the river has remained the same, the finer turnings of it cannot be guaranteed to be in its original location. Thus, the distances from the sites will not be able to be measured, as one would nowadays need to step into the river, for wider visibility distances.
3. Lichens and sediment built up at sites, due to heavy weathering effects and rainfall.

Lighting conditions

Due to the fact that there was only limited amount of time available to conduct this experiment at the rock art sites themselves, the experiment was conducted in one sitting (i.e. in one day) and thus the lighting conditions are likely to vary slightly between photographs (cf. Ch. 7.3.9).

Use of material

Photographic and videographic materials were obtained for later consultation during the analysis and write-up phases, for use as 'on-screen testing' in the Undergraduate teaching module "Advanced Skills – Experimental Approaches to Understanding Upper Palaeolithic Art" and for readers to be able to have access to in Appendix E of this thesis. The video material was obtained for the integration into an eye-tracking software, for testing whether participants would be attracted to certain features more than others and to establish their fixations and saccades (as introduced in Chapter 6.4). Unfortunately, the material was not as accurate as was hoped, which was further hampered by time and lighting constraints at the site itself and thus did not allow for further pursuit of such undertaking. Its potential impact, however, is likely to be very revealing and the transparent engraving sheets should be reutilised and taken out to the same site in future to allow for proper conduct of this new experiment.

Participant Information

It is for the aforementioned reasons pertaining to site accessibility that the *in-situ* study was not carried out by any formally recruited participants. Instead, the author made note of any inter-visibility of sites once all recreated engraving sheets were attached to the panels under scrutiny. Resolution and legibility levels were additionally confirmed by the Côa Parque Archaeological Team (five archaeologists at the time), who carried out excavations at the site of Penascosa at the same time as the *in-situ* visibility study was installed and conducted.

7.3.8. Results and analysis of the *in-situ* study

The following table (Table 7.9) shows the results of the panel appearance once the different transparent layers were attached to the original rock, each colour-coded within the different columns of the table. The reader will likely experience the impact that the different colours have on the rocks, when visually examining the table from left to right. The table offers insights into how individual motifs and their colourations are perceived *in-situ*. This allows the reader to appreciate whether any large discrepancies are emerging. The table features resolution and legibility distinctions, and its information is further enhanced by a subsequent consideration of how terrain and light exposure impacts visibility ranges. The motif's height (situation on panel, measure above ground level (ag)) is recorded (central point within the motif measured), which puts the ranges into perspective, as lower down features and features at eye-sight level are perceived at different distances towards the panel. Furthermore, engraving techniques are mentioned, and comments are provided. The site of Penascosa offers great degrees of panel structures, resulting in the ability to test visibility of more secluded panels as well as more open panels.

The bedrock colouration of the rocks in the table are not indicative of how they once appeared in front of the engraver when first attempting to engrave, so should only be taken as a proxy. The unnaturally light colouration of the rock in the images stems from sediment built-up, due to a particularly rainy season, causing river flooding and general sedimentary shift to occur around the panel locations. Prior to the adhesion of the prepared transparent films onto the rock, the author, paired with the Côa Parque Archaeological Team, attempted to sustainably clean most debris from its panel surfaces, yet a sandy film remained. Henceforth, distances were measured with the status-quo of how the bedrock was 'coloured' when conducting this visibility survey. This however also means that during particular seasons of the year, visitors to the site are only able to inspect the rock art with an obscured lens (i.e. sandy layers, weather-induced patina, etc.), leading to potential wider-reaching misinterpretations, which ought to be corrected (potential by means of a more tourist-geared version of this visibility survey).

	Black Motif Colouration		Red Motif Colouration		White Motif Colouration	
Rock 4 of Penascosa: **Ibex Motif**						
Visibility Ranges	Resolution: 9.32 m	Legibility: 8.02 m	Resolution: 13.98 m	Legibility: 11.90 m	Resolution: 26.14 m	Legibility: 23.50 m
	Height: 70 cm (ag)	Technique: Pecking	Height: 70 cm (ag)	Technique: Pecking	Height: 70 cm (ag)	Technique: Pecking
	Comment: This part of rock 4 is at a slighlty tilted angle to the rest of what is depicted underneath (see 3 headed horse below). This meant that differential features were detected at different times, pointing to the importance of panel features such as angles and reliefs and their contribution towards rock art visibility.					
Rock 4 of Penascosa: **3-headed Horse Motif**						
Visibility Ranges	Resolution: 12.37 m	Legibility: 08.05 m	Resolution: 16.01 m	Legibility: 12.14 m	Resolution: 18.67 m	Legibility: 14.30 m
	Height: 40 cm (ag)	Technique: Pecking	Height: 40 cm (ag)	Technique: Pecking	Height: 40 cm (ag)	Technique: Pecking
	Comment: This part of rock 4 disappears from sight with increasing distances. The full extent becomes legible at 14.30 m with first resolution levels detectable at roughly 19 metres (see white colouration and read discussion on terrain impact in Ch. 7.3.9).					

<table>
<tr><th></th><th colspan="2">Black Motif Colouration</th><th colspan="2">Red Motif Colouration</th><th colspan="2">White Motif Colouration</th></tr>
<tr><td>Rock 5 of Penascosa:

Fish Motif</td><td colspan="2">  </td><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td rowspan="3">Visibility Ranges</td><td>Resolution: 24.11 m</td><td>Legibility: 19.02 m</td><td>Resolution: 25.46 m</td><td>Legibility: 19.00 m</td><td>Resolution: 27.10 m</td><td>Legibility: 20.23 m</td></tr>
<tr><td>Height: 57 cm (ag)</td><td>Technique: Pecking</td><td>Height: 57 cm (ag)</td><td>Technique: Pecking</td><td>Height: 57 cm (ag)</td><td>Technique: Pecking</td></tr>
<tr><td colspan="6">Comment: Within its current terrain (i.e. river sediment heigh levels etc.) and location of large hoizontal schist slabs in front of panel nowadays, the fish still holds sightings almost as far as 30 m away, making it look as if the fish is emerging from the anterior rock slab (likely a modern setting, rather than some-thing persisting from the Upper Palaeolithic).If the anteriror slabs were gone, visibilty ranges would likely improve, cf. Rock 5 in Ch. 7.3.9 for terrain). As for its location on the panel, its ground level situatedness requires the viewers to look around the panel more to attract attention (cf. disucssion on location bias of superimpositions towards the centre/upper left in Ch. 6.4).</td></tr>
<tr><td>Rock 5 of Penascosa:

Female Deer Motif</td><td colspan="2">  </td><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td rowspan="3">Visibility Ranges</td><td>Resolution: 19.85 m</td><td>Legibility: 7.44 m</td><td>Resolution: 22.08 m</td><td>Legibility: 07.80 m</td><td>Resolution: 23.32 m</td><td>Legibility: 8.09 m</td></tr>
<tr><td>Height: 60 cm (ag)</td><td>Technique: Incision</td><td>Height: 60 cm (ag)</td><td>Technique: Incision</td><td>Height: 60 cm (ag)</td><td>Technique: Incision</td></tr>
<tr><td colspan="6">The rock slabs mentioned above that obscure visibility to the entirety of the panel partially affects the depiction of this female deer. Eventhough a natural opening within the foreground slabs offer glimpses towards this depiction and thus create long resolution ranges, the viewer is required to come very close towards the rock to make sense (legibility) of what is on display (cf. Rock 5 in next section for terrain). Its incised nature, contrary to the examples portrayed above, also contributes to this lower visbility effect.</td></tr>
</table>

	Black Motif Colouration		Red Motif Colouration		White Motif Colouration	
Rock 5 of Penascosa: **2 Female Deer Motifs**						
Visibility Ranges	Resolution: 19.50 m	Legibility: 5.16 m	Resolution: 21.57 m	Legibility: 7.22 m	Resolution: 24.20 m	Legibility: 8.98 m
	Height: 180 cm (ag)	Technique: Incision	Height: 180 cm (ag)	Technique: Incision	Height: 180 cm (ag)	Technique: Incision
	Comment: This feature of the two female deer is ideally situated to be viewed when positioning oneself in a straight line of sight towards it. This is due to the fact that it is neatly situated at about eye-level of an adult observer (measuring 180 cm above groundlevel). Its rather small scale size, however, requires the obsrever to come quite close to it (roughly 5 metres) to make sense of what is being depicted. Size might play a role in this, as might its superimposed overlap, adding confusion as to where the motif starts and ends. As for participant visibility ranges, the uneven nature of the rock at this part created a slight glare once the sun hit the transparent film, likely resulting in skewed data here.					

Table 7.9.: Table illustrating the visibility effects of the differently coloured motifs of rock 4 and rock 5 at the site of Penascosa situated in the Côa Valley.

7.3.9. Discussion of the *in-situ* study results

Situating the coloured rock art sheets in its original place of creation revealed two major aspects that influence their visibility, aspects which have not been addressed as such during the control study. The first was that actual rock art sites are not to be (and cannot be) compared to the even-grounded 'perfect' control study environment. Each site, each panel, each individual stroke on the rocks are so different to each other, making generalised assumptions about their visibility difficult. Often times, the terrain in front of a panel obscures major aspects of rock art, which in return is able to reveal aspects about its possible intended audiences. The second facet, which was heavily regulated at the control study site (by setting it up at the same time with matching cloud cover for every participant trial), is that of lighting conditions heavily influencing visibility levels. Therefore, to illiuminate these two aspects further, the following sets of images illustrate the impact that terrain (7.3.9.1) and light exposure (7.3.9.2) have on visbility.

7.3.9.1. The effect of uneven terrain and obscured places on visibility

Serving as examples, the following four panels bears witness to the creation of restricted visibility the further its observers step away from it:

Rock 3 of Penascosa

Distance towards rock:

1.91 metres



13.27 metres



27.56 metres



Figure 7.3.20.: Collage of images taken at different distances towards Panel 3 at the site of Penascosa, Côa Valley (photographs by author).

Rock 4 of Penascosa

Distance towards rock:

0.96 metres



2.43 metres



16.37 metres



22.94 metres



Figure 7.3.21.: Collage of images taken at different distances towards Panel 4 at the site of Penascosa, Côa Valley (photographs by author).

Rock 5 of Penascosa

Distance towards rock:

1.53 metres



5.37 metres



10.72 metres



27.21 metres



Figure 7.3.22.: Collage of images taken at different distances towards Panel 5 at the site of Penascosa, Côa Valley (photographs by author).

Rock 6 of Penascosa

Distance towards rock:

1.12 metres



10.99 metres



21.05 metres



29.53 metres



Figure 7.3.23.: Collage of images taken at different distances towards Panel 6 at the site of Penascosa, Côa Valley (photographs by author).

As already indicated within Table 7.9 and discernable from the preceeding four examples, there are several landscape features that obscure clear visibility of the rock carvings. Rock 4 (Fig. 7.3.21) for instance is partly covered by terrain, partly exposed once observers walk away from the panel. It requires close inspection to gain view of its full extent. A similar scenario is observable for rock 5 (Fig. 7.3.22). The partial coverage of the rocks with anterior topographic features might also be due to excavation biases, meaning that oftentimes, the full rock extent was excavated leaving lower lying rock art features in the ditches without excavating the surrounding areas. This needs to be borne in mind when viewing the modern topography of sites, yet it is equally feasible that other natural features obscured certain imagery in the past.

Furthermore, the top image for rock 6 (Fig. 7.3.23) in section 7.3.9.1 was taken only about a metre away from it, yet its general elevation within the site's formation requires observers to climb up towards it (now possible via steps built for tourists) to make sense of the images on display.

Overall, the adhesion of coloured rock art motif films revealed that these two landscape features influence the effectiveness of rock art visibility, both now and in the Upper Palaeolithic: (1) Rock slabs or other natural features such as vegetation concealing rock art behind and (2) rock art elevation necessitating degrees of athleticism to reach a panel's full view. As a method to go about overcoming the shroudedness of rock art due to natural features in front of it, changing the angle of walking towards the art is often times required, which suggests that **when the terrain requires, observers would not have walked a seemingly conventionalised route (i.e. in straight line towards it), but rather manouvered around the sites at angles to locate its containing features.** The same principles can be applied to higher lying rock art, which will have likely attracted adventurous observers in the search for more demanding rock art quests. In fact, whilst conducting this experiment, three tourist groups (each containing around 20 visitors) were led around the site and exactly this walking and climbing pattern was observable.

7.3.9.2. The effect of sunlight on visibility

These images reveal the impact that sunlight and cloud over-cast have on the visbility of panels and their contained rock art (Fig. 7.3.24). The top image was taken at 11.57 am, the middle one at 12.57 pm, whilst the last image was taken at exactly the same spot on the same day but three hours after the first (14.57 pm). All images feature the same white engraving films attached to the rock. In the process of the differential light coverage on the panels, observers who spent several hours at the site will experience **the 'lighting up' of different panel parts with the wandering sun, a sensation that will not have gone unnoticed by Upper Palaeolithic artists and their audiences.**

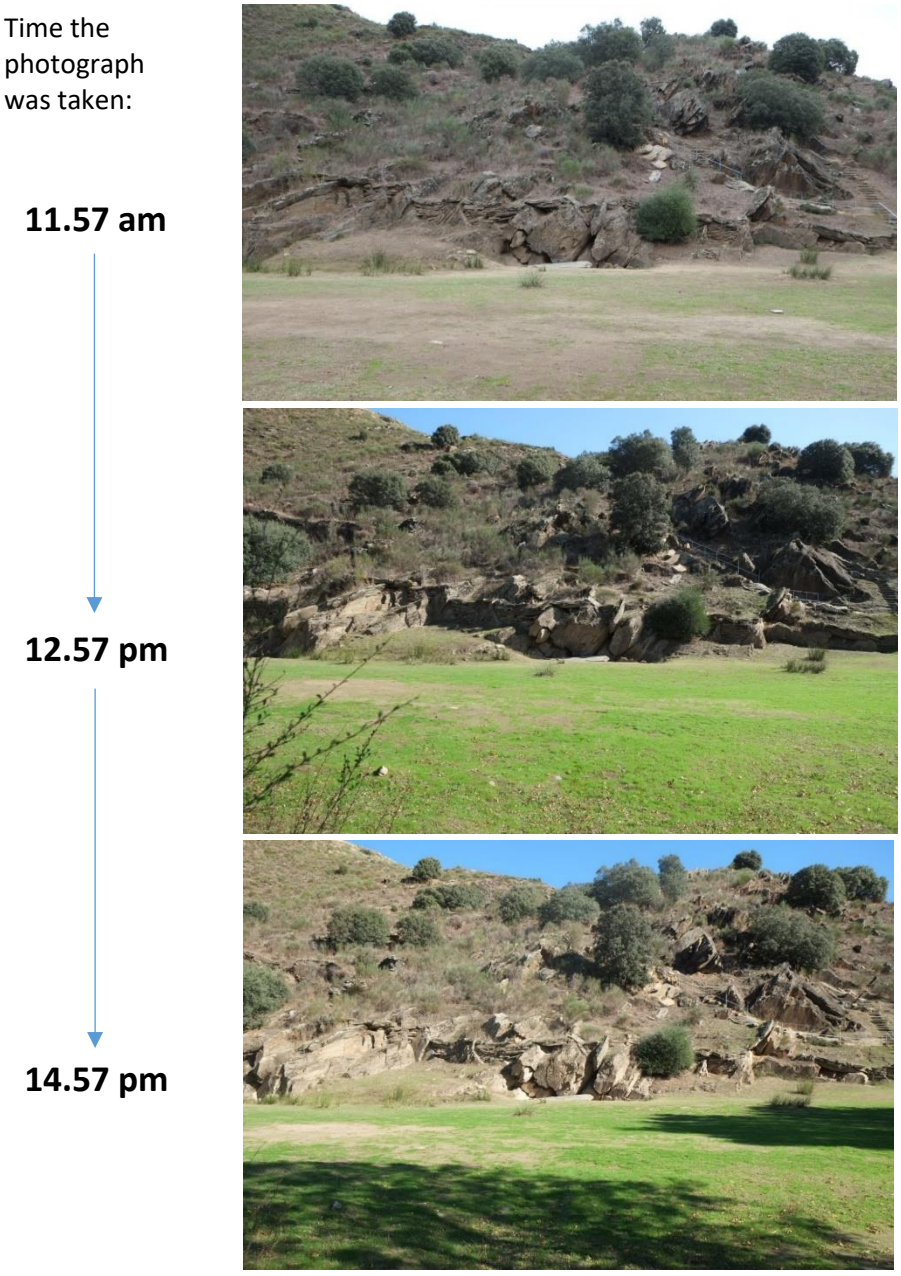


Figure 7.3.24.: Collage of images taken at different times of the day showing the impact sunlight has on the visibility of rock art at the site of Penascosa 5 (photographs by author).

7.3.10. Evaluating the *in-situ* study results

It is worthy of note that this *in-situ* study and its results should be taken as a preliminary pilot for more extensive studies to be conducted in the future. Furthermore, whilst it would be visually appealing to create another distance chart of visibility, with resolution and legibility attached (similar to Fig. 7.3.13), for the *in-situ* study, it has to be questioned what additional value it would bring. This is especially due to the fact that the *in-situ* study has not been formally conducted by participants but was merely assessed through the partaking of a few separate archaeologists independent to the authors judgement. Thus the sample size and averages would not be reflective of a statistically sound methodology (with more iterations of this needed at more sites too) and subsequent presentation of results. As already touched upon, a side by side comparison between the control and *in-situ* study would also be subjected to pitfalls as the parameters for testing resolution and legibility were vastly different in both settings, with weather conditions and objects such as boulders and trees in the way able to obscure results. Nonetheless, it already offers new insights into site usage by different audiences. Furthermore, it is hoped that the images created here are to be used by the Côa Parque Museum Guides, for illustrative purposes of how the rock art will have looked in a variety of different forms (i.e. colour, location, etc.) and that perhaps more permanent transparent films are to be created that can be taken into the field and overlain on top of the rock features to aid in a more cohesive and educational visitor experience. The varied and unique nature of each panel location make *in-situ* visibility studies inherently more difficult. When visiting the Côa Valley, one will quickly realise that a certain degree of athleticism is needed to reach certain panels, that long-distance walking is often required to gain access to certain panel locations and that river crossings are frequently necessary to reach rocks that are otherwise difficult to access by modes of transport. In fact, even entire panels are often-times not highly visible when first entering new terrain environments. Many panels seem to be secluded from direct line of sight, which in turn might imply that they were not to be seen by the masses. This does not mean that they were not to be seen by anyone, but rather by a select group of people who were in the know about its location. Reflections on likely audiences based on visibility patterns will feature in chapter 7.4.

Readability and comprehension

Readers have been pre-warned that understanding the visibility ranges for readability and comprehension, borders onto entering the realms of speculations. Nevertheless, one might circumvent this by attributing these last two steps within the typography, likening their status to visual patterns that have been previously tested (Ch. 6). As such, readability levels might be interrogated when combining these with results from the superimposition study, whilst comprehension levels might be linked to the incorporation of 'Palaeolithic' Gestaltian principles.

Rock art readability

As a reminder, rock art readability refers to the ease of reading the entirety of a panel - i.e. that it contains scenes with superimpositions versus freestanding motifs. Moreover, the results from chapter 6.3.5.2 revealed that (1) the more superimposed a panel becomes, the harder it is for participants to detect individual species and that (2) the stronger the contrast between bedrock and motif colouration, the better the detection. This provides us with a method for interrogating whether specific rock art panels were constructed with *readability* as its purpose. In fact, artists who hew motifs into panels with increasing amounts of overlap allow for the decrease in readability levels. The lower the amount of overlap a panel exhibits, the more readable it becomes. Conversely, panels that exhibit large amounts of overlap certainly attract longer resolution ranges, due to the mass of motifs on display that aid in their quick detection. Yet, panels that bear just a few motifs scattered around the panel result in poorer resolution ranges but better readability levels. To illustrate this interrelationship, the following graph (Fig. 7.3.25) initially presented to the reader in chapter 6.3.4, is repurposed here:

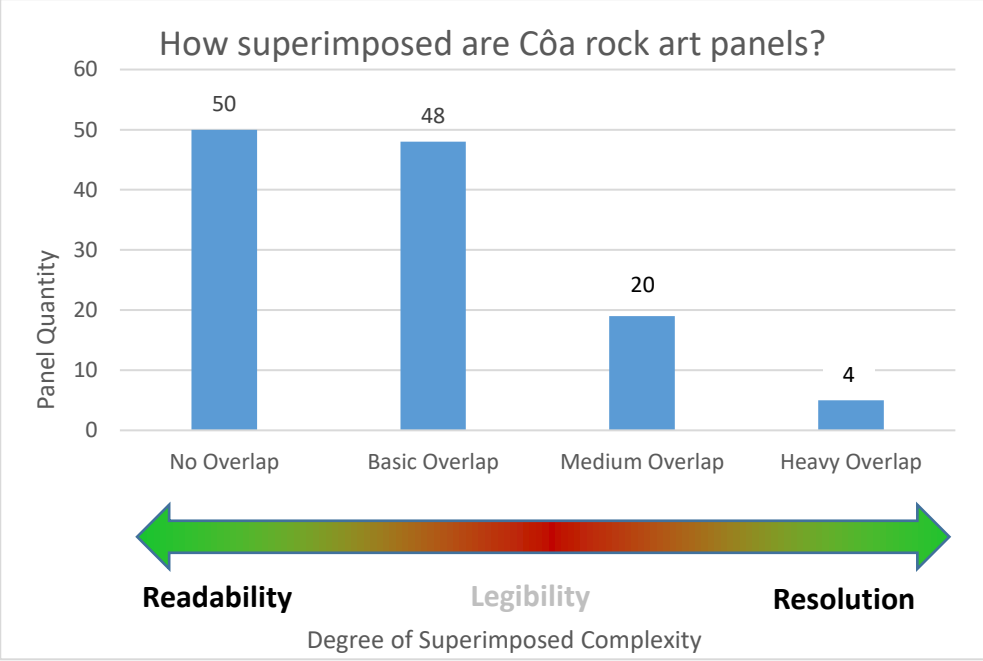


Figure 7.3.25.: Repurposed graph featuring the quantities of the different degrees of overlaps and their connection to readability and resolution levels.

Therefore, the quantities of the different panel complexities indicate the potential underlying reasons for creating the rock art. Was it easy readability or was it easy resolution over large distances? The large quantities of the left-lying overlap bars in Fig. 7.3.25 (no overlap or basic overlap) would point to a greater likelihood of the former. The panels at the right end of the spectrum will be localised in the GIS-part of the next experiment to test if these exhibit certain commonalities between them, which can point us in the direction of their potential purpose.

Rock art comprehension

Rock art comprehension denotes the observer's ease to understand the panel, i.e. that it bears specific meaning. Of course, this is a particularly difficult endeavour in the absence of any emic insights. One way, however, to arrive at a more nuanced understanding of why motifs are the way they are and why they are there in the first place, is to go back to the Gestaltian principles that were discussed in chapter 6.2. The discussion of these principles yielded in the construction of a visual hierarchy of perceptual grouping in the observers' minds:

1) Motif Technique

2) Motif Similarity

3) Motif Proximity

With this in mind, a comprehension of the following (randomly selected) rock art panel (Canada do Inferno 36) might become slightly more nuanced (Fig. 7.3.26):

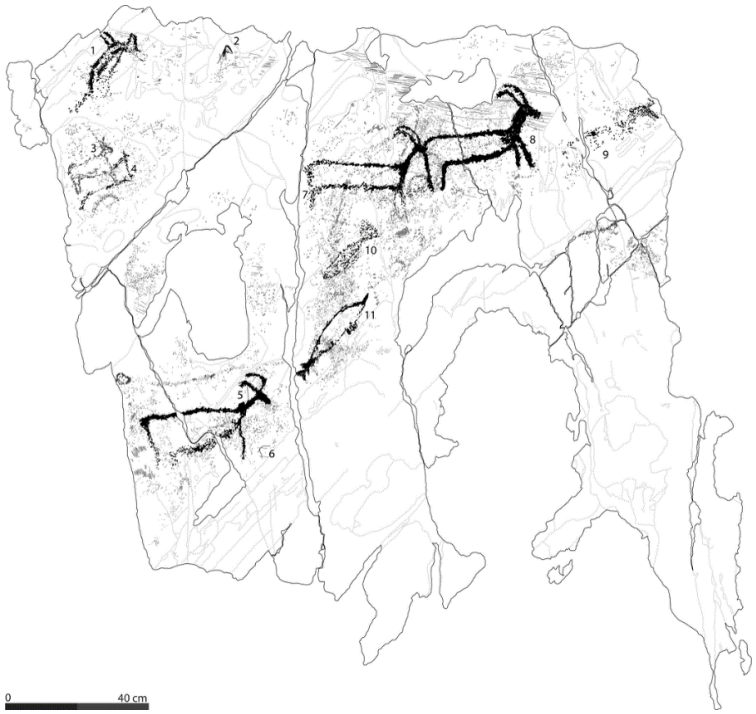


Figure 7.3.26.: Can we comprehend rock art? Rock 36 of Canada do Inferno (drawing courtesy of Fundação Côa Parque).

From the onset, observers will undoubtedly be attracted to the parallels between engraving techniques of certain features within the panel (ibexes, fish, etc.). Next, similar motif types are likely to be grouped together, after which the two top lying male ibexes will be connected, due to the proximity, as forming a cohesive union. These deliberations in the observers' minds are ultimately linked to their comprehension of the presented stimuli in front of them, likely forming storylines on what is happening in the presented scenes. This, in turn, links the minds of the artists to those of the observers, both subliminally and/or consciously implementing the principles of Gestalt established earlier in this thesis.

7.3.11. Wider research impact of the visibility study

Preference of shape over colour and texture…

The fact that the addition of colour was not necessary for purposes of easy detection of the engravings, adds even more weight to the implications stated in chapter 5, namely that the artists wanted to put more time into the development of their outline depictions rather than what goes into them. Psychologically speaking, the processes of detection and discrimination of visual stimuli, in this case of prey in the landscape, are very much interrelated, as they are utilising the same base of sensory information but apply different decision processes. In other words, the two processes are linked by a common dependence on how the "visual system encodes or forms neural representations" of visual scenes (Thomas, 1985: 1457). With regard to the detection of animals within their natural habitat, Thorpe *et al*. (1996) have shown that neural signals emerge within 150 msec of the stimulus onset and that eye gazing towards an animal target is initiated within a similar timeframe (Kirchner and Thorpe, 2006). This highly rapid response rate suggests that the visual mechanisms producing such speed are quite simple and 'feedforward' (non-iterative and non-recurrent).

Yet, little is known about which particular cues make up the determining factors for such speed. Cues such as colour, texture, luminance as well as shape therefore need to be considered. Previous empirical studies such as the investigation of ultra-rapid categorisation of natural scenes between monkeys and humans by Delorme and Fabre-Thorpe (2000) and Fei-Fei *et al.*'s (2005) study on natural and synthetic stimuli, provide evidence that colour as a cue for rapid detection can be eliminated from the equation. Indeed, eliminating colour cues from the selected stimuli, i.e. either natural or synthetic scenes, had very limited effect on the average categorisation performance. This was observed for both monkeys and humans.

Additionally, the study by Elder and Velisavljevic (2009: 7) aimed to estimate the importance of "proximal cues to the presence of animals in natural scenes" and to elaborate on the specific mechanisms needed for rapid detection. Natural scenes were systematically manipulated to create stimuli that would select for cues such as colour, texture, luminance as well as shape that were then tested against each other. After cross-validating the findings that colour as well as luminance cues have a minor impact upon detection, they found that animal detection is largely dependent upon shape and texture cues. Shape cues require only 12-17 msec of "backward-masked stimulus exposure" in order to yield the relevant information, whilst texture required longer exposure (ibid). Furthermore, as mentioned previously, it seems plausible that whenever

a camouflaged environment conceals colour and texture of an animal, its shape must be of primary importance (Hodgson, 2013). Interestingly, no differences can be observed either in reaction-time, accuracy, or latency, if the stimulus is presented through the means of either coloured photographs or line drawings. Neither Biederman and Ju (1988) nor Davidoff and Ostergaard (1988) found an improved object recognition performance with one stimulus over the other. Within the few studies that contradict these findings, their stimuli are based on colour effects for objects that always appear in one colour, such as lemons. Hence, "colour benefits categorisation only if it is diagnostic of the object category" (Humphrey *et al*. 1994: 19; Tanaka and Presenell, 1999). The predominance of rock art animals that are depicted in a pure outlined fashion, entailing no traces of colour or indication of texture, therefore suitably corresponds to the findings from these perception studies.

Tendency for a 30-metre legibility range (for white engravings)

It seems plausible to hint at a potential connection between the effective 30-metre close hunting ranges when prey animals are exploited in close quarter hunting (Cattelain, 1997).[39] Cattelain draws upon a series of studies (mostly ethnographic/experimental) in which projectile distances have been recorded and concludes that:

> "The effective distance of projectiles shot with a spearthrower seems to be limited to a maximum of 45 m, but, in general, a precise shot does not exceed 20 to 30 m. (…) The hunter attempts to approach game as closely as possible. Contrary to the expectations of most archaeologists who are not hunters, the above information indicates exactly the same values for distances of shots with bows (…) however, a bow allows for regular contact with a smaller target than a spearthrower". (ibid, 1997)

If we liken the act of being able to kill prey species at 30 metres distance and the mechanisms that play a role in this, especially hand-eye coordination, we might be able to explain why rock art seems to start becoming legible at a distance of roughly 30 metres, too. Are we seeing artists deliberately constructing their motif with appropriate sizes, placements, colourations, and bedrock choices to mimic killing range actions and to facilitate the training of the eye? Is the rock art's purpose deliberately linked to what hunter-gatherers needed to sustain themselves with, i.e. hunting? The fact that rock art starts to become legible at around the 30 metre mark might then point to similar events once animals start appearing to come into sight, which according to Cattelain will have likely yielded in successful kills at such distances.

[39] The idea for this connection came about through a conversation with the author's primary supervisor, Professor Paul Pettitt, who suggested this avenue upon initial reflection of the resulting visibility data.

The following photographs of a rock with a depiction of a (very faint) undeterminable prey animal (Fig. 7.3.27) near the site of Canada do Inferno appears to bear marks right in the midst of its torso (Fig. 7.3.28). The outline of the animal is akin (almost assimilating) to the shape of the rock (head on right, rear on left) and bears an anthropogenic alteration near the location of its heart, which might be used in conjunction with this theory. The Côa Parque Team had been unaware of its existence, which is why this find was an especially exciting addition to the mark repertoire of the Côa Valley. In fact, in widening out this 30-metre rock art visibility and hunting range theory, this rock art example also adds to the idea that rock art may have been used to train hunters on how to successfully hunt and where to point their weapons onto.[40]



Figure 7.3.27-7.3.28.: Rock art – a training ground for close quarter hunting? Top image showing the full extent of the rock and its 'killing' spot. Bottom image reveals a close-up of the anthropogenically-altered rock (Photographs taken by author in 2018, rock incision was cleaned with water for further inspection).

[40] Aspects of this observation have to be accredited to Mr. Jake Newport, who assisted during this field visit.

7.3.12. Conclusions: Rock Art Visibility

This section concludes the questions that were asked at the start of the experimental set-up:

1) Over what distances can viewers resolve and identify the rock art?

Depending on a variety of interlinking factors such as engraving size, colour and bedrock colouration, a multiplicity of different visibility ranges was recorded (between ~12-135 metres for resolution and ~1.5-35 metres for legibility). Certain combinations of colours and engraving techniques and size are more conducive to better visibility than others:

Visibility hierarchy

Based on the findings summarised above, it is now possible to establish a hierarchy of features pertaining to the engravings and the rocks that offer best/worst visibility. The established order can be viewed below. Each column demarcates the assessed variables and are to be read as top equals most visible and bottom equals least visible in both resolution and legibility scenarios. The illustrations underneath (Fig. 7.3.29) offer an insight into the combination of these variables to derive at the best (left) and worst (right) rock art visibility scenario (which can be determined by reading the columns in a criss-cross manner, as illustrated by the underlying blue arrows).

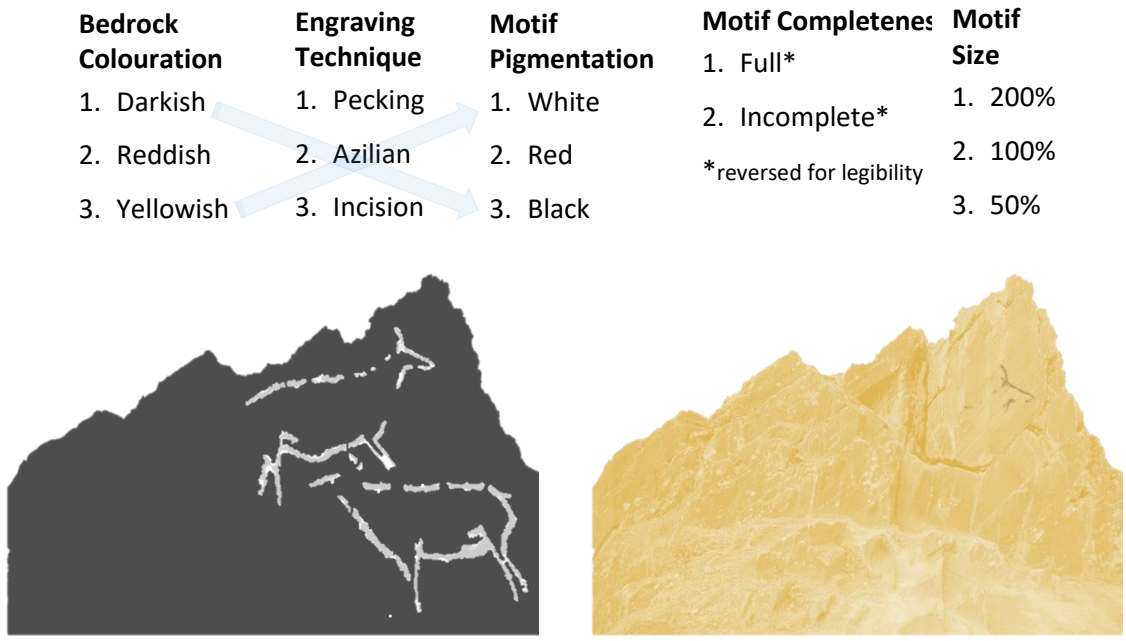


Figure 7.3.29.: Rock art visibility hierarchies and associated visibility scenarios offering best and worst visibility at resolution and legibility levels.

2) Did the addition of coloured pigments affect perception of these images?

Yes, but in a negative (i.e. counter perceptive) way. The addition of pigments tends to obscure what is actually on display, whereas the naturally occurring white residue when freshly engraved is most visible even over large distances. Hence, colour reduces visibility over increasing distances and should merely be regarded as a stylistic choice, not a perceptual aid.

3) Do different engraving techniques influence visibility levels of rock art?

Yes, certain engraving techniques yield larger distance ranges when visibility is tested. The stronger a motif is hewn into the rock, the more visible it becomes. This makes the technique of pecking more likely to be perceived over larger distance when compared to incisions. When it comes to the first typography step (resolution), the more mass an animal possesses (i.e. the more detailed body lines are attached), the better it is resolved, meaning that Azilian features are also quicker resolved than incisions. At legibility level, the mass effect does not apply.

4) Do the visibility levels withstand in real rock art terrain?

The examples that were set in an area without any natural topography in its way of sight (i.e. motifs on rock 4 and 5 in Table 7.9) exhibited similar visibility ranges to those established at the control study site. Visibility ranges for rock features that were, however, obscured by anterior rock slabs or that were only reachable after an elevated climb, did not compare to results from the control study site, yielding much shorter distances for both resolution and legibility. This indicates that rock art terrain certainly has a huge part to play in the rock art's overall visibility, and its placement is likely a result of specific planning and specific regard for its intended viewership (more on this in Chapter 7.4).

5) Does sun exposure influence visibility levels of rock art?

As was revealed in the series of photographs (Fig. 7.3.27), the effects that sun exposure, cloud cover and general weather conditions have on the visibility of rock art is immense. A motif might appear in plain sight at a particular time of day and ten minutes later the same motif becomes largely invisible. Best conditions for the broadest spread of visibility across all panels is that of cloud-overcast, which gives an even lighting tone, suitable for good visibility of the inspected areas and prevents different rocks illuminating at different times of day. This is, however, not to say that specific rock art depictions were deliberately placed on rocks facing the morning or evening sun, rewarding them with importance as the come in and out of light and sight.

7.4. Psychological Experiment 6: Integrated Rock Art Perception and Visibility

7.4.1. Introducing the experiment and research questions

In many places alongside the Côa River and its tributaries, a clear inter-visibility between sites can be experienced (see Santos, 2017). Rock art motifs are practically seen from one site to the next, almost as if intending to maintain active eye-movements (i.e. saccades) and to lead audiences on a path of new rock art discoveries. Baptista (2006) and Santos (2008) have, therefore, described the Côa as being an important congregational area during its peak time, a "sanctuary [of sorts] complete [with] pilgrimage paths" (Batarda Fernandes, 2018: 283). As already mentioned in the previous chapter, the movement of exotic raw materials underlines the argument for a cultural aggregation locale (cf. Aubry *et al*. 2012b) and thus the Côa will have likely served as a repository for mark making and ideas exchanges. Henceforth, this sub-chapter will map rock art motif, panel and landscape specific features such as areas in which individual motifs and superimposed images are situated. It will be questioned whether all rock art panels lend themselves to great visibility. The end goal of this sub-set of mapping is to come closer to an understanding of the target audience for these depictions, by entering a public versus private audience debate for a hypothesised use and functionality of these early depictions.

The following research questions will be addressed:

- What does the **distribution pattern** across the Côa Valley look like for:
    i) Individual Motifs?
    j) Incomplete/Complete Motifs?
    k) Engraving Techniques?
    l) Superimposed Imagery?

  I.e. Do these depictions appear in particular areas, or do they appear randomly distributed across the Côa Valley? (Chapter 7.4.3)

- How **visible** are different rock art panels? (Chapter 7.4.4)
    - From which specific points in the landscape are individual panels visible?
    - Can an inter-visibility between panels be noted?
    - Which kinds of viewsheds do panels create, with regard to
        - Resolution distances towards pecking/incision/Azilian depictions?
        - Legibility distances towards pecking/incision/Azilian-style depictions?

- What do visibility and locality tell us about the artists' **intentions**?

  I.e. Was every panel containing rock art to be seen by everyone in the community? (Chapter 7.4.5)

Many of these questions will be complemented and tied together within a landscape framework, tackled using landscape survey data and GIS processing tools.

7.4.2. Using GIS to contextualise rock art depictions

Whilst the Côa rock art has never been subjected to visuo-psychological experimentations related to its visual formation and conception, its embeddedness into analysis of scale and geographies especially with regard to GIS toolbox component analysis is highly advanced. Hence, before generating any kinds of visibility viewsheds or distribution maps of Côa rock art features, based on findings from previous chapters, the following review and images contextualise the current state of research. This is an important step in making sure this thesis contributes a novel aspect to our understanding of how rock art features are situated, and not just generates more GIS-based maps that essentially show old data and established viewsheds.

An influential study, bringing together a number of previously recorded aspects, is that of Aubry *et al.* (2012) and ought to be mentioned first, as it covers the utilisation of a range of GIS-provided tools in the mapping of rock art. Besides the simple mapping of known rock art locations (Appendix A.F.1.), the team also recorded rock art in relation to its geological setting (Appendix A.F.2), mapped 'enforced' rock art placements due to fractural and kinetic forcing (Appendix A.F.3), indicated slope-topography related to fracture orientations of rock art (Appendix A.F.4), designated areas of particular aspect, slope and cost-weighted[41] distances to water sources (Appendix A.F.5), and mapped natural solar radiation and lichen built-up influencing rock art conservation (Appendix A.F.6), all in preparation for a culminating model termed the Côa panel formation and preservation model (CPFP). Their comprehensive analysis puts current researchers in great stead for the development of new ideas based on this initial wide-ranging groundwork.

Furthermore, founded upon meticulous analysis of stylistic changes correlating to motif overlaps, of sedimentary palimpsests and of location diversity, scholars, most as part of the Côa Parque Archaeological Team (from its early beginnings pioneered by Zilhão in 1997 to Eastham in 2000 and more recent work by Santos in 2012, Aubry *et al.* in 2012 and Luís *et al.* in 2015), have been able to understand a prospective sequence of rock art creation. The image below shows their established distinctions between three different rock art phases noticeable over the spread of the Côa region (Fig. 7.4.1). Phase A, datable to a pre-Magdalenian chronology, thanks to Fariseu's panel discovery, correlates to a predominance of ibexes, horses and aurochs, all featuring two legs (no hooves), naturalistic head depictions, rounded hips, rounded bellies and outlined carvings (ibid). Phase B comprises of depictions that can largely be attributed to Leroi-Gourhan's style IV, with Magdalenian stylistic parallels to be found in northern Spain (Bernaldo

[41] For this analysis, the cost was derived from the slope value.

de Quirós and Lasheras, 1994). Human figures start to appear in specified places in this phase. Phase C predominantly encompasses depictions of heavily striated, geometric forms of red deer, ibexes and horses, with aurochs appearing more sparsely. The finds of 76 portable slabs containing these rock art characteristics, within Fariseu's Azilian Layer 4, now give Phase C an Azilian chronological embeddedness (ibid) and also gives the name to the third engraving style tested for visibility throughout this chapter. Accordingly, panels with different phase attributions and viewsheds have been mapped within GIS and can be consulted below:

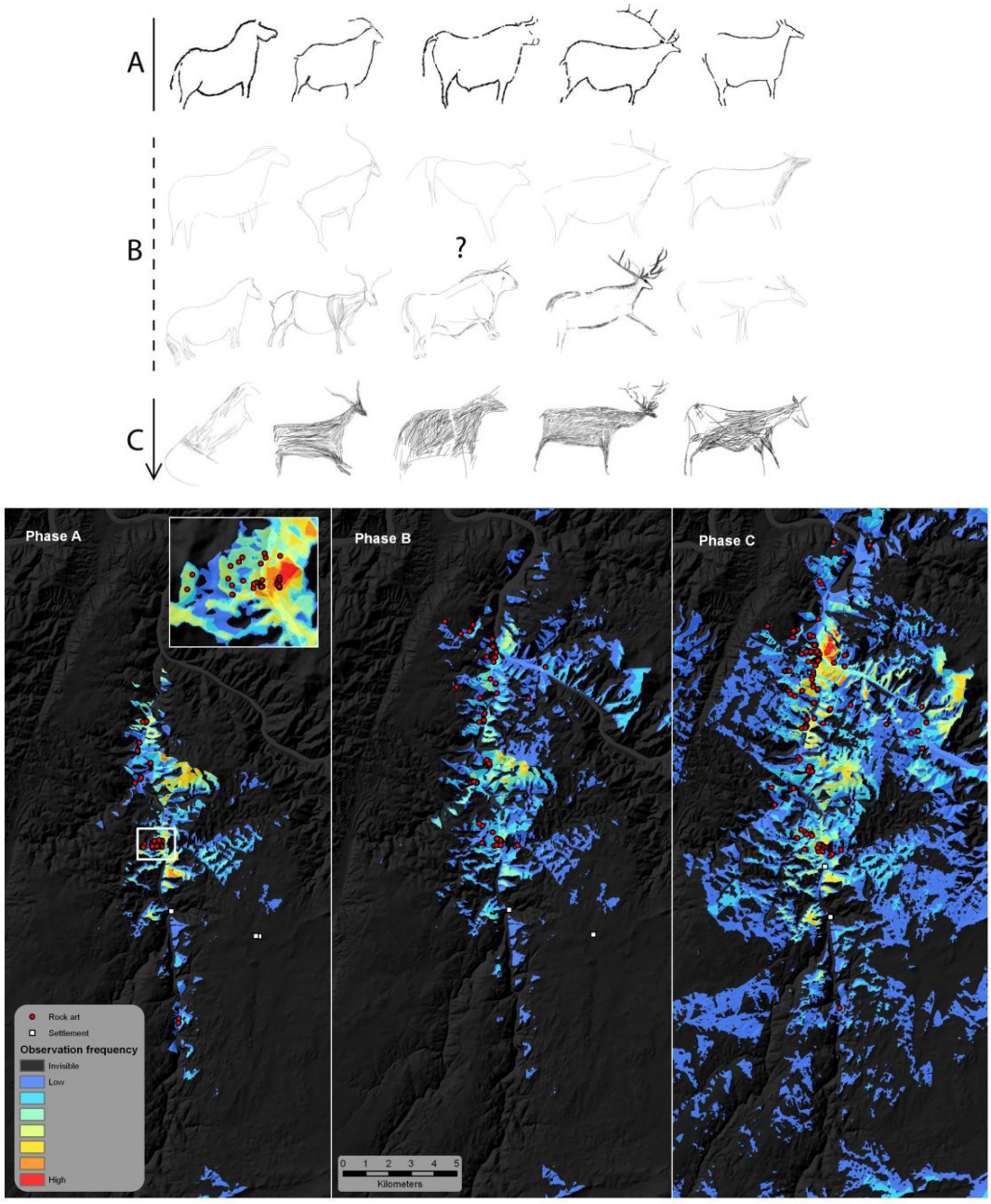


Figure 7.4.1.-7.4.2.: Phase progression of rock art motifs (top) and their landscape embeddedness (bottom). Graphic produced by Luís *et al.* in 2015.

Methodological procedure - mapping the collected data

The sheer effort that has gone into these highly elaborate studies indicate that understanding the connection between external landscape features and rock art depictions, is an important step in the endeavour to understanding why and where rock art occurs in the valley around the Côa River. The natural schist formations, with their fracture lines and natural topographic slopes towards the waterline will have 'indirectly' enforced rock art production in certain areas and on certain rocks (such as on NW and SE facing slabs) and will have guided a huge part of the artists' efforts to portray rock art in particular areas. Henceforth, this chapter complements the current dataset and state of research on geographical situatedness of rock art based on the previous findings, particularly those relating to superimpositioning and visibility.

The data used within this section is obtained from various sources. For the underlying digital elevation models (DEM), which are terrain maps/models created with "arrays of regularly spaced elevation values referenced horizontally" (USGS, 2020), a broadly encompassing 30m resolution DEM was downloaded from the freely available EarthExplorer section of the U.S. Geological Survey governmental website[42] and a more refined 10m resolution DEM was kindly provided by the Côa Parque Archaeological Team (courtesy of the *Fundação Côa Parque)* whilst working with them during a 6-week placement in early 2018.[43] For the locational data of the rock art depictions, Mário Reis, archaeologist at the *Fundação Côa Parque,* has been instrumental in offering access to the geo-referenced nature of this data and needs to be acknowledged here (cf. Reis, 2012; 2013 and 2014 for insights into his work).[44] For data on the content, context and association of the sites (such as orientation, motif types, engraving techniques, panel interconnectedness etc.) André Santos' (2017) PhD thesis on the state of the art and parts of Batarda Fernandes' (2012) PhD thesis on natural processes and conservation of Côa rock art proved to be invaluable. As for what is to be mapped now, especially in view with what has already come before, a collaboration of all data gathered for this thesis, dispersed amongst the previous chapters, will now find a place within the geographical contextualisation generated by GIS.

[42] The website used is https://earthexplorer.usgs.gov/ (correct as of January 2020), which provides DEMs obtained from SRTM (Shuttle Radar Topography Mission). Whilst other DEM 30m resolution providers such as ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) are available, the former provider uses radar observations (whose beams are able to penetrate tree canopies to achieve detailed topographic coverage) to extract DEMs. The latter utilises slightly less accurate stereo imagery and sun-radiating reflections for photogrammetry to create DEMs (cf. Nikolakopoulos *et al.* 2006).

[43] The 10m DEM was originally generated by Luís Luís based on 1/10.000 vector maps provided by Direção Geral do Território, and on aerial photogrammetrical contour lines (pers. comm. Luís, 2020).

[44] Due to the fact that knowledge of the geographical nature of all known rock art engravings is an important national treasure, and to inhibit large masses (protection against vandalism amongst other reasons) to access the GPS coordinates for all rock art sites, this data has been blocked out of the database.

7.4.3. How are individual motifs distributed across the Côa Valley?

The act of mapping motifs separated by their intrinsic characteristics bears wide-reaching values. Hence, with the current dataset it is possible to map the location of all analysed 1117 motifs, for instance a map that bears motifs having been made using the engraving technique of incision (Fig. 7.4.3). Similarly, if the reader was, hypothetically, interested in the location of all deer depictions walking towards the right that are also associated with depictions of anthropomorphs, made by incision and only present on dark bedrocks, even that specific request would be feasible to map with the gathered info and geo-referencing available for each data point. Yet, it needs to be questioned what is really to be gained from expending efforts on mapping and discussing each motif type, as well as their associated carving characteristics and a random set of data combinations such as the made-up example above, especially in view of what this thesis aims to achieve. Which is more informative: to achieve a geographical classification of the different motifs and features, or to investigate the contexts in which these are found? The latter is favoured here, yet the former approach will briefly be touched upon, utilising maps that display singly occurring motifs events. These maps are merely indicative of the type of distribution patterning of motif variability arising in the Côa Valley, set to a background of a GIS offered *imagery* basemap (satellite-based data). Four motif categories (deer, anthropomorphs, bird and fish) and one engraving type category (incisions) illustrate such scattering (see collage on the next page Fig. 7.2.3) and can be regarded as '*animalising the Côa*' of the past.[45]

Motif/Panel/Landscape associations

One question arising for motif maps is whether depictions appear in certain areas or in randomly scattered locations. From what can be seen in the top left map (Fig. 7.4.3), depictions of deer (both male and female) occur over the entire stretch of the analysed region, whereas anthropomorphs (top right) tend to congregate in the bottom half of the region, interestingly mirroring (and perhaps pointing towards) the location pattern of the more southerly placed Upper Palaeolithic habitation sites, too (cf. Fig. 7.2.2). Whilst these maps convey a general sense of motif scattering, another reason for the rather unhelpful use of these maps is the fact that the dots denoting the motif locations do not indicate quantities. When consulting the constructed database, a total of 27 anthropomorphs can be detected across the region, split between 7 different sites, with one panel in particular (Piscos 24) exhibiting 74% (n=20) of all those cases. For these reasons, a more nuanced quantitative mapping approach is delved into deeper next (cf. Fig. 7.4.4 ff).

[45] Contrary to the commonly phrased 'peopling' of places. More rock art feature maps are available in Appendix F.

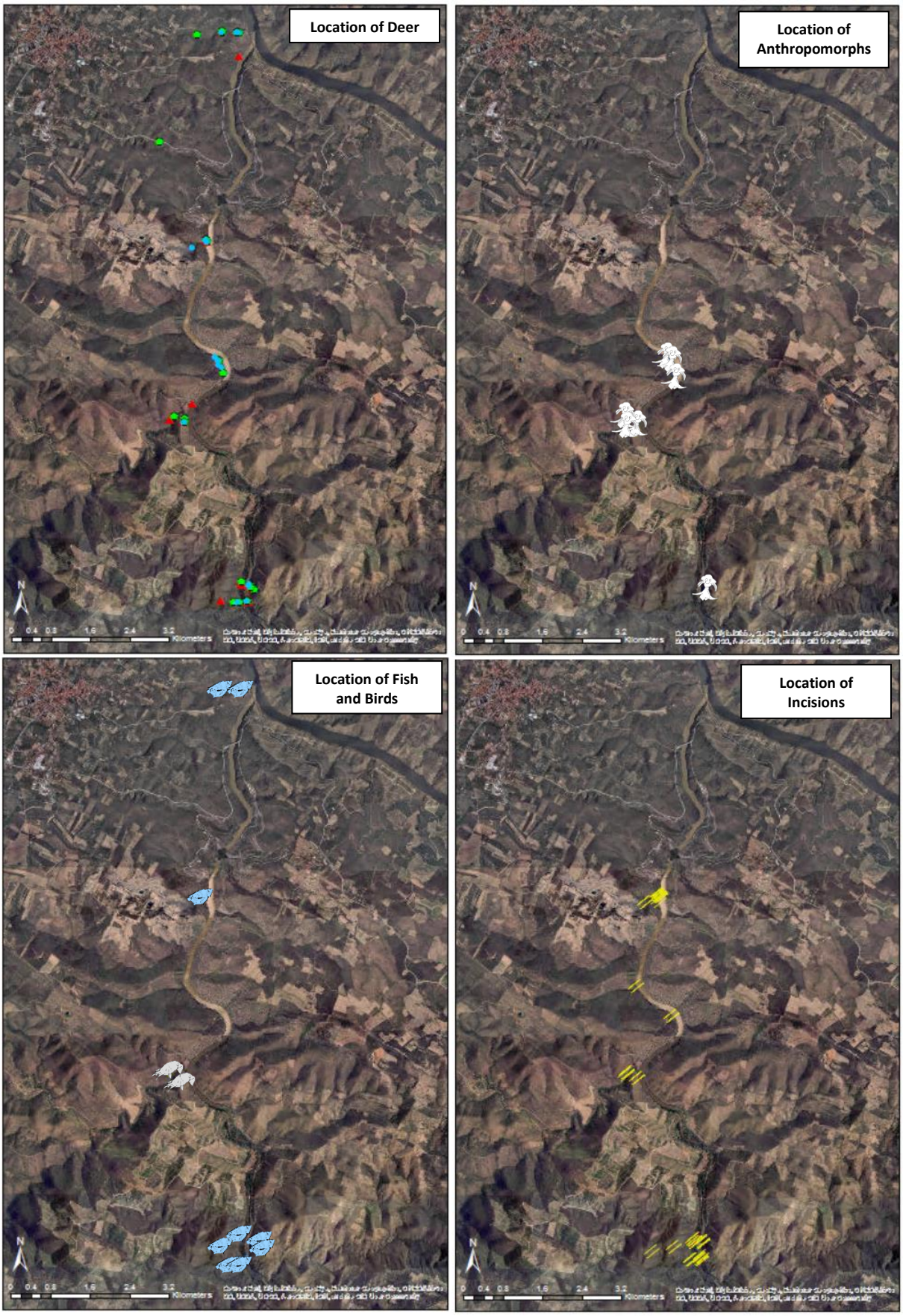


Figure 7.4.3.: Collage of distribution maps bearing individual locations of motifs and engraving techniques.

What does the distribution pattern across the Côa Valley look like for (a) individual motifs (b) incomplete/complete motifs and (c) engraving techniques?

Chapter 5 saw the introduction of the quantities of available motifs and the level of their completeness (i.e. full-bodied versus incomplete depictions) within the wider Côa region, whilst chapter 6 attributed the motif's engraving techniques and bedrock colourations in a quest for how certain motifs can be attributable to certain panel features. This section of the chapter will combine both lines of evidence, by specifically positioning entire rock art sites (that might contain a multitude of panels) and their quantities of selected attributes that are contained within them. Whilst it was enough for the enquiries within chapter 5 to ask for simple quantities of overall motif counts within the Côa as a whole, this part digs deeper and attributes these quantities towards specific regions/sites within the Côa Valley.

Hence, the following tables and resulting maps show the relationship between (1) Motif Count per Rock Art Site in the Region (Table 7.10, Fig. 7.2.4); (2) Completeness Status per Rock Art Site in the Region (Table 7.10, Fig. 7.2.5) and (3) Engraving Techniques per Rock Art Site in the Region (Table 7.10, Fig. 7.2.6).[46] A close look at site and panel structures and their internal workings will provide insights into how certain areas of the region were utilised and whether authorship might be determinable. For, if certain panels bear specific quantities of the attributes in question, such as one panel attracting particular kinds of animals or carving techniques, it might be suitable to suggest different creation and consumption scenarios, linking authorship with viewership. After the maps have been displayed, a couple of observations on their patterning will be made.

[46] For the purposes of mapping, sites with just one reliably obtainable motif count (i.e. Red0r do Porco, Vale de Casa, Vale de Videiro and Vermelhosa) have not been mapped, especially since the intended purpose for the creation and consumption of these maps is the comparative visualization of data, rather than the mapping of all rock art available.

Site Name	Motif Type										Σ	Motif Completeness		Σ	Engraving Technique					Σ
	Anthropo-morphs	Aurochs	Bird	Deer	Dog (?)	Fish	Ibex	Horse	Muste-lid	Undeter-minable		Full-Bodied	Incomplete		Pecked	Incised	Azilian	Mixture	Abraded	
Canada do Inferno	0	51	0	36	0	9	42	51	0	47	**236**	104	132	**236**	98	85	8	45	0	**236**
Canada do Moreira	0	3	0	2	0	0	0	0	0	0	**5**	3	2	**5**	0	5	0	0	0	**5**
Faia	0	5	0	0	0	0	0	1	0	1	**7**	1	6	**7**	0	0	0	0	7	**7**
Fariseu	4	24	0	17	0	0	31	36	0	19	**131**	57	74	**131**	89	40	1	1	0	**131**
Foz Côa	0	0	0	1	0	0	0	1	0	0	**2**	1	1	**2**	0	1	1	0	0	**2**
Penascosa	1	26	0	34	0	7	33	38	0	41	**180**	72	108	**180**	69	73	0	38	0	**180**
Quinta da Barca	0	41	0	21	0	4	49	49	0	60	**224**	79	145	**224**	151	39	0	34	0	**224**
Redor do Porco	0	1	0	0	0	0	0	0	0	0	**1**	1	0	**1**	0	1	0	0	0	**1**
Rego da Vide	0	1	0	0	0	0	1	3	0	4	**9**	3	6	**9**	8	0	0	0	1	**9**
Ribeira de Piscos	22	63	2	15	0	0	21	27	1	57	**208**	63	145	**208**	14	186	1	7	0	**208**
Vale de Casa	0	0	0	1	0	0	0	0	0	0	**1**	1	0	**1**	0	0	0	1	0	**1**
Vale de Cabrões	0	3	0	9	0	0	6	2	0	3	**23**	19	4	**23**	2	18	0	3	0	**23**
Vale de Figueira	0	8	0	0	0	0	2	0	0	7	**17**	4	13	**17**	13	3	0	1	0	**17**
Vale de José Esteves	0	4	0	20	1	2	14	8	0	17	**66**	36	30	**66**	0	28	33	5	0	**66**
Vale de Moinhos	0	1	0	1	0	0	1	0	0	2	**5**	3	2	**5**	1	0	0	4	0	**5**
Vale de Videiro	0	0	0	0	0	0	1	0	0	0	**1**	1	0	**1**	1	0	0	0	0	**1**
Vermelhosa	0	0	0	0	0	0	1	0	0	0	**1**	1	0	**1**	0	0	1	0	0	**1**
Σ	**27**	**231**	**2**	**157**	**1**	**22**	**202**	**216**	**1**	**258**	**1117**	**449**	**668**	**1117**	**446**	**479**	**45**	**139**	**8**	**1117**

Table 7.10.: Table quantifying motif types, motif completeness and engraving technique per panel region in the Côa Valley.

(a) Motif Counts per Rock Art Site in the Côa Valley Region

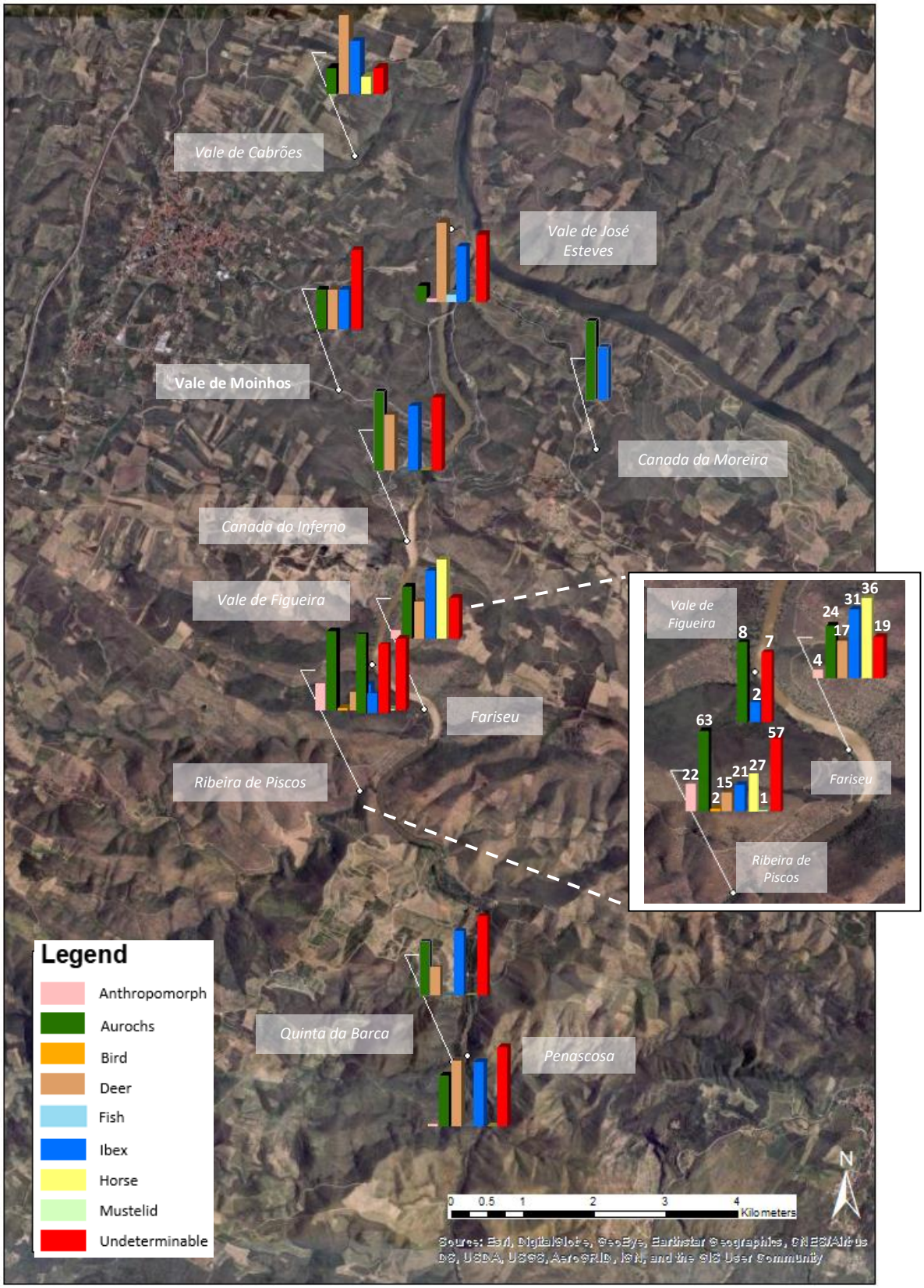


Figure 7.4.4.: Regional map revealing the different quantities of motifs split up by sites/panels for individual visual comparison (see zoomed-in box for more info (due to their clustered vicinities) on quantities for panels at Fariseu, Ribeira de Piscos and Vale de Figueira).

(b) Motif Completeness per Rock Art Site in the Côa Valley Region

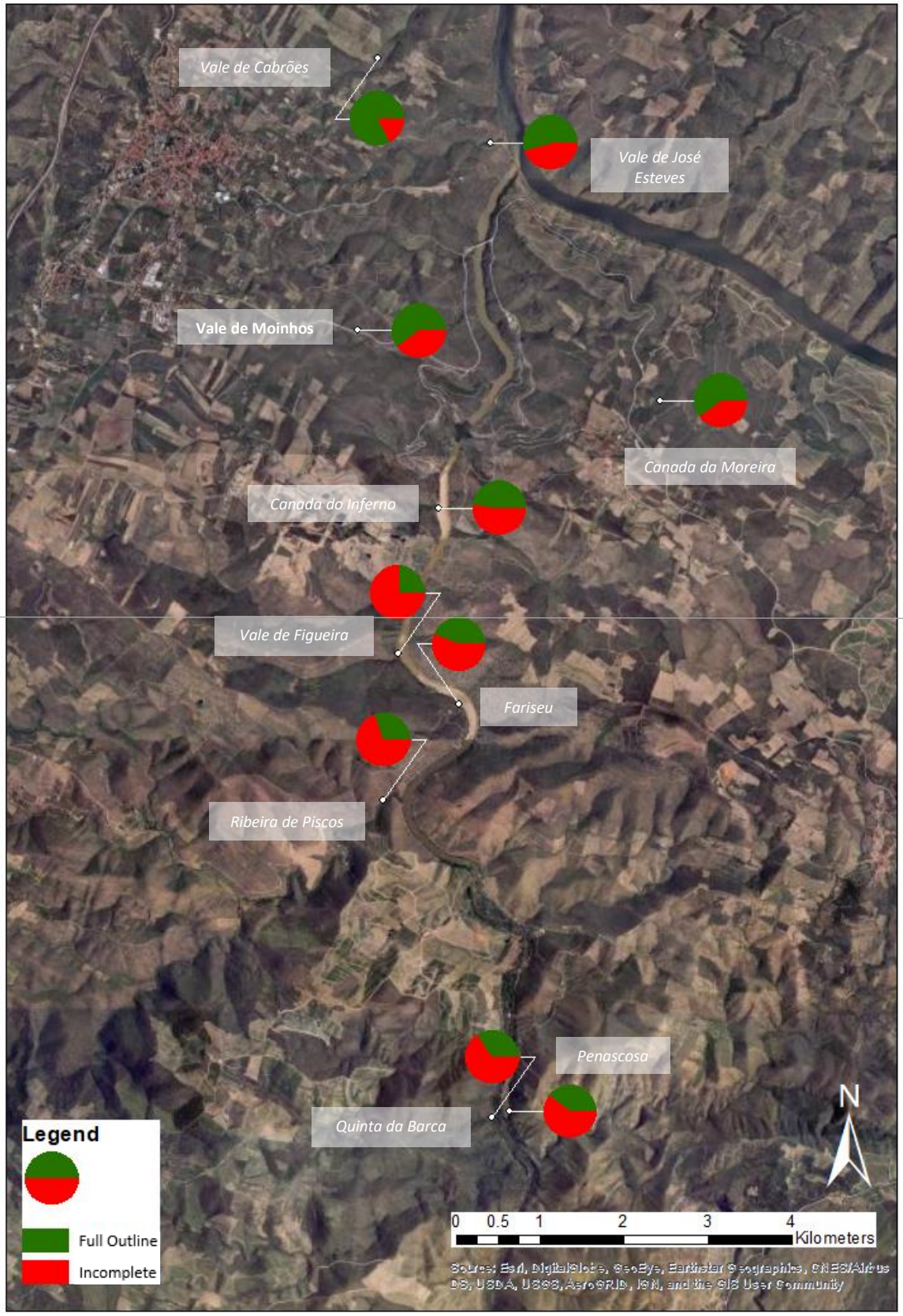


Figure 7.4.5.: Regional map revealing the level of motif completeness split up by sites/panels for visual comparison.

(c) Engraving Techniques per Rock Art Site in the Côa Valley Region



Figure 7.4.6.: Regional map revealing the different engraving techniques split up by sites/panels for visual comparison.

Observations on motif counts/completeness status/engraving techniques

1. Motif counts per rock art site in the Côa Valley region

As can be observed on the map (Fig. 7.4.4), aurochs are prevalent throughout the whole region and that in large quantities. In fact, three colours/species dominate the scene: green for aurochs, blue for ibexes and red denoting the location of undeterminable species. Deer tend to occur in large numbers on panels where the Côa River meets the larger Douro River towards the top of the map. A similar position is obtained for depictions of fish (n=2), which can be observed on the panels of Vale de José Esteves, close to where the Côa meets the Douro. Fish are also depicted towards the middle of the map at Canada do Inferno (n=9) and towards the bottom, featuring seven fish at Penascosa. This shows that the depiction of fish is widespread across the entire extent of the Côa rock art corpus, hypothetically informing us that fish were widely exploited, not just alongside the larger Douro river.

Panels with horses are strikingly localised, with large horse quantities (n=36) occurring at Fariseu, located in the midst of the Côa meanderings, an area which was perhaps particularly fruitful for the exploitation of horses. During the Upper Palaeolithic, horses inhabited various open habitats (Mihlbachler *et al.* 2011) and when in wider open territories would have formed large free-roaming herds (Bignon *et al.* 2005). It is believed that evidence of horse hunting from the Lower Palaeolithic shows cooperative work (Stiner *et al. 2009)* oftentimes characterised by ambush hunting (Stiner, 2002) and associated spear finds from for instance Boxgrove GTP17 (Roberts and Parfitt, 1999) and Schöningen (Conard *et al.* 2015). In more restricted areas, such as the meanders of the Côa and its confluences, it appears likely that horses would have been drawn into water-rich areas for resting and drinking, which on the other hand creates increased vulnerability as these places also form easy killing spots (cf. Brown *et al.* 2017). If the rock art mirrors real life events at these sites, an increase in horse depictions at these sites could be explained. Incidentally, the same region also features the majority of the region's anthropomorphs. A coincidence? Likely not. The interplay of horses and anthropomorphs at sites near water is strongly reminiscent of close-quarter hunting episodes.

2. Motif completeness per rock art site in the Côa Valley region

Upon inspection of completeness trends on the generated map (Fig. 7.4.5), a fascinating divide between the north and south ends of the Côa River is noticeable. A signifying horizontal split on the map just above the site of Vale de Figueira (grey line) will illustrate this pattern to the reader. The five sites above the line reveal a majority of full-bodied, fully outlined individual motifs. The pattern is reversed for the five sites below this line. This bears a significant implication on spread of motif variations and the willingness to form full outlines by artists in the region. Why is there such a strong trend towards a more completed image, the further north one travels? In fact, the more and more north one inspects, the more complete the motifs tend to be. From another perspective, the closer the panels get to the larger Douro River, the more complete the containing motifs get. Comparing this trend to Fig. 7.4.2, the more northerly areas near the Douro correlate to more engravings of Phase B and particularly of Azilian Phase C (Luís *et al.* 2015). It seems that with elapsing time, artists complete motifs more frequently. This data might also reveal trends in a northwards population movement and potential population (artists and observers) growth throughout time in the valley itself.

3. Engraving techniques per rock art site in the Côa Valley region

The distribution of different engraving techniques appears scattered across the region and even across single sites (Fig. 7.4.6). Three localities stand out, which primarily bear just one engraving type: Vale de Figueira (Pecking); Canada da Moreira (Incision) and the site of Vale de José Esteves leaps out to the viewer due to its (relatively) large occurrence of Azilian-style engravings (Incisions n=28, Azilian n=33, Mixture n=5). The distribution of engraving techniques will aid in the contextualisation of Côa rock art visibility ranges (Chapter 7.4.4).

How are panels with superimposed imagery distributed across the Côa Valley?

The map below signals the distribution of panels with the established degrees of motif overlap. At first encounter, a colourful mix of dots illustrates the interwoven nature of panels with a variety of overlaps scattered throughout the valley's full extent. This, on a broad scale, means that **artists did not deliberately place particularly full or empty panels in specific regions** and that populating panels with overlapping motifs was a widespread phenomenon. Thus, results from the superimposition study (Chapter 6.4.5.) can be imposed upon the entire region.

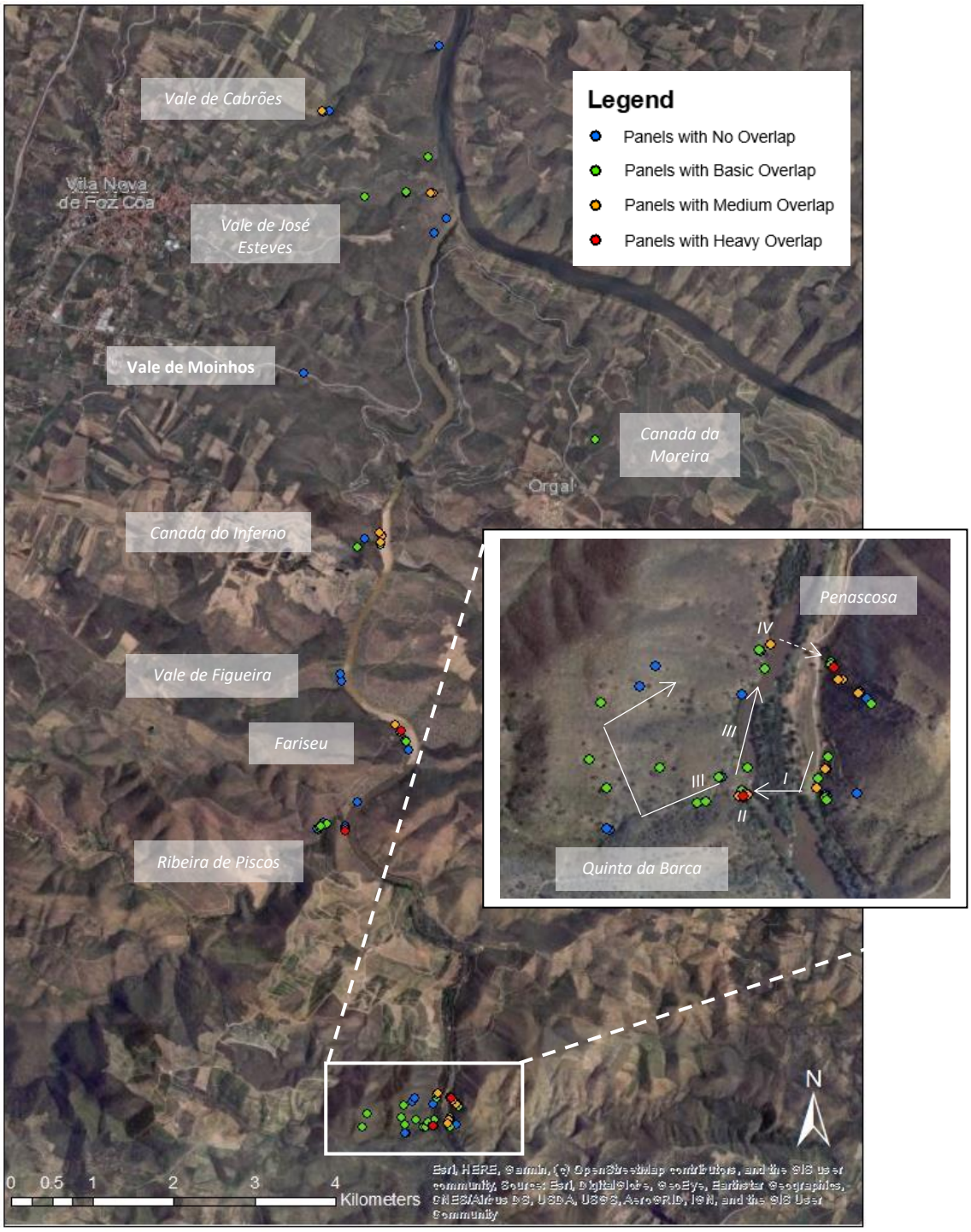


Figure 7.4.7.: Regional map revealing the different degrees of superimposed imagery in the Côa Valley.

Upon closer inspection, this map further illustrates the co-existence of panels with no overlap in the vicinity to panels with extremely heavy overlap, such as at Fariseu. It is, therefore, not the case that at rock art and panel-rich locations, all panels are similarly structured. The heavily worked-on panels (indicated in red) are situated towards the bottom half of the map, with the top end towards the Douro, agglomerating many none-to-basic overlapping motif panels. When viewing this trend in combination with the completeness distribution pie charts (Fig. 7.4.5), an interesting pattern emerges. Not only do motifs become more and more complete, the further north one 'travels', it also seems that, largely, artists tend to obey to a more resolvable structural layout of panel compositioning. This is done, in line with findings from the superimposition study in chapter 6, by not overbearing the viewer's resolution and legibility levels with heavily overlapped motifs on schists, but rather with motifs that are minimally touching others. This combination throws up a thought-provoking insight into how the combination of motifs and the construction of panel compositions can convey revealing visual messages over the spread of the valley. It appears, as if artists working on panels of Vale de Figueira and above did so with great care for swifter resolution and general visibility, judging by the fact that lesser crowded panels and more complete figures are attracted to the more northern parts of the valley.

Additionally, the further in-land one gets from the riverbanks, the simpler the layout of the panels tend to be (see for instance sites around Vale de Jose Esteves, Canada do Inferno, Ribeira de Piscos and Quinta da Barca). Panels located in very close vicinity to water appear more complex/interwoven in their structural layouts, with artists seemingly awarding different significances to water and land localities. An example of this entwined structure is offered in the zoomed-in box of Fig. 7.4.7, focussing in on the panel sites of Penascosa and Quinta da Barca and their different degrees of superimposed imagery. These two examples offer a stimulating perspective into the mind-sets of the carvers at these more southerly sites. The Penascosa sites towards the east of the Côa, bear a good mix of all types of superimpositions, whereas the Quinta da Barca panels directly opposite on the western banks largely comprise of none-to-basic overlapping motif panels, except for a few medium ones (orange) and the heavy overlapped panel (red) of Quinta da Barca 1 (both close to the water's edge). Why this pattern?

For a potential answer, it appears fruitful to consult Baptista *et al.* 2006, but specifically the 2010 paper by Baptista and Santos, who consider the age of the engravings on the individual panels alongside a hypothetical ancient walking route of art discovery, between Penascosa and Quinta da Barca. As indicated in the zoomed-in box of Fig. 7.4.7, based on panel orientations and engraving technique visibility, there plausibly appears to be a circuit that will have likely been

taken by people in the past in search of rock art at these sites. People would start at the Penascosa panels at point I, containing highly visible Phase A (Solutrean-Gravettian) peckings, then cross the river to find a heavy and a couple of medium overlapped panels (II) to then move on either upwards onto the mountain terraces with singly-occurring and barely overlapping pecked motifs or to follow the riverbank northwards on a trail of rock art discovery. The panels at IV are of the later Magdalenian Phase B, characterised by fine-line incisions and as established are not as noticeable/visible as the earlier utilised peck marks. So if people went as far as discovering the incisions at point IV and looked across the river, they would be equipped with the right viewing angle to spot the other heavily-overlapped Penascosa panel and would likely spot the other incised panels behind this site, too (here added as a dashed arrow as this route was not conceived of by Baptista and Santos). All rocks in the more northerly formation at Penascosa and surrounding marker IV are engraved with Phase B incisions, whereas rocks near I, II and III mostly comprise of pecked marks.

Whilst Baptista and Santos (2010) took into consideration the perceived engraving ages and panel fracture orientations in their path establishment, the localisation of the new superimposition data adds even more weight to this pattern. Furthermore, it signals the importance of the more densely overlapping motif panels in the establishment of route creations and guiding directions, hence the creation of active eye-movements amongst audiences. Besides, it is possible that a particular narrative or particular design was divided into several separate panels, making it necessary for viewers of the art to move around the landscape to get a sense of the whole scene and story (cf. Kaul, 1998 for a similar account of rock art imagery in Scandinavia). Overall, it seems, based on the occurrences at these two sites, that the existence of the heavily occupied panels are important indicators, one could even go as far as calling them waypoints, in guiding the visual experience of their audiences, combining *humans* with *spaces* to create *places* of special significance.

7.4.4. The interplay between looking in and out

How visible are different rock art panels?

This section utilises the same set of data as employed for the mapping of motif features in the landscapes a few pages ago, with the addition of visibility distances generated for experiment 5 (Ch. 7.3). There are a number of possible avenues that can be taken to investigate visibility of rock art in the Côa area and for this final contextualisation of the data, two separate methodologies will be employed to **(a) visualise visibility distances by observers** (Observer Feature Points) and **(b) demarcate areas signalling visibility of panels** (Panel Feature Points). Initially, an observer will be positioned within the landscapes adjoining the rock art sites looking *inwards* towards the rock art panels and their contained motifs. A viewshed from an observer point then delineates the visible area from that particular spot, determining whether a collective of panels at a rock art site can be viewed from one spot alone. This can be matched by associated rock art visibility distances, established in the experiment prior to this. Subsequently, entire rock art panels will be identified that possess a variety of engraving techniques and motif/bedrock colourations bearing a relatively wide-reaching walkable visibility distance leeway. This data is then to be inserted into an analysis addressing the *outwards* visibility from the panel surface (into the landscape), rather than an observer looking *inwards* (towards the panels) (Fig. 7.4.8). This will determine all of the places deemed ideal for defined visible distances within defined radii. These viewshed calculations are then able to locate observers in the ideal resolution and legibility spots to view particular rock art features.



Figure 7.4.8.: Photograph visualising the difference between the two methodological approaches to viewshed creation (a) Inward Observer Feature Points and (b) Outward Panel Feature Points (photograph and annotations by author).

7.4.4.1. Viewshed mapping methodology

Apart from the simple mapping of motif locations, a more multifaceted procedure is adopted for the generation of viewsheds from specified points in the landscape. In order to create a viewshed raster, the software *GIS* (version ArcMap 10.5) and specifically its integrated *Spatial Analyst Tool* within the *Arc Toolbox,* is selected to produce viewsheds of specified input, based on the Côa Valley 10m *DEM* and on the georeferenced points of interest.

a) Inwards observer feature points: observers looking in…

For the creation of diagnostic viewsheds, signalling visibility distances of particular observer points *inwards*, the following information (Table 7.11) is added to GIS:

'Experiment' Data Input	GIS-Input Feature Name	Description
Rock Art Locations	XY Data Input	GPS data - Longitudinal and Latitudinal Coordinates of Rock Art Locations at a particular site.
Observer Location	Observer Feature/ XY Point for Viewshed	GPS data - Longitudinal and Latitudinal Coordinates of Observer looking at rock art panels at a particular site.
Visibility Distances	Buffer Zones	The various recorded distances for resolution and legibility within different radial buffers based on a set of different parameters.
Observer Feature Height	OFFSETA	This value corresponds to the average height of an observer's eye-height, which is set to 1.75 m for purposes of this research (based on data obtained from Hermanussen, 2003 and Ruff *et al.* 2012). This value is termed 'observer feature height'.

'Experiment' Output: **Inwards Observer Viewsheds**



Table 7.11.: Description of data input for 'inwards' observer viewshed outputs.

b) Outwards panel feature points: panels looking out…

After an initial trial of buffering multiple radii in association with different motif features and their related visibilities, it became apparent that a more nuanced methodology is necessary that considers aspects such as panel orientations and a match of actual visible areas relating to rock art localities. For, all too often a radius from an observer point is drawn (Fig. 7.4.9), taking into account a 135 metre (white engraving style) resolution radius, yet the viewshed does not indicate that panels are actually visible in the first place (see panels at the left outer rim of the radius not marked as visible (green) from that viewpoint). Whilst a radius around an observer is useful in showing the hypothetical resolution and legibility ranges, and will reveal a multitude of panels within that observer's view, in a real rock art landscape setting, this only works in an analytical way if panels are actually visible from the observers perspective (i.e. the cardinal direction of the rock is actually facing the observer). For, what is the point of a hypothetical visibility radius if panels face the wrong way.

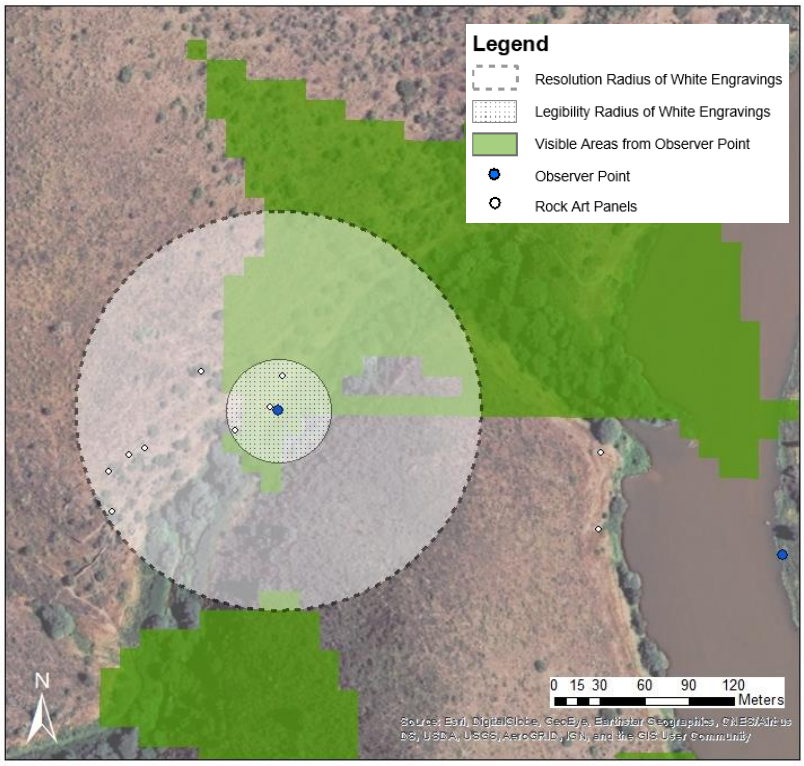


Figure 7.4.9.: Often, the creation of buffers creates radial distances that do not encompass actually visible areas. (GIS viewshed and 135m resolution buffer at Ribeira de Piscos).

Hence, a reverse process of viewshed creation, to the one outlined above, is applied for the next methodological step. For the creation of diagnostic viewsheds which signal visibility distances outwards from panel locations, with particular rock art features added (e.g. colour, engraving technique and motif completeness), the following information (Table 7.12) is inserted into GIS (normally optional input for general viewshed creations but essential for creating specific viewsheds as required for purposes of this analysis):

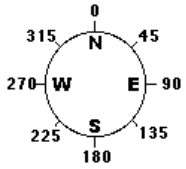
'Experiment' Data Input	GIS-Input Feature Name	Description	'Experiment' Output
Rock Art Location	**Observer Feature/ XY Point**	GPS data - Longitudinal and Latitudinal Coordinates of Rock Art Location.	**'Outwards' Panel Feature Viewsheds**
Visibility Distances	**RADIUS2**	The various recorded distances for resolution and legibility based on a set of different parameters.	
Panel Facing Direction	**AZIMUTH 1 (A1)**	Depending on the cardinal alignment of the panels, a viewshed can be created that limits the horizontal angle for its outlook. This makes sense since rock art cannot be seen behind the panel and thus no viewshed is necessary for these angles. Due to fractural forcing of panel alignments, the Azimuth values are likely to be between A1-180 and A2 – 360 (to be read in a clockwise manner on the compass below): 	
	AZIMUTH2 (A2)		
Rock Art Panel Feature and Observer Height	**OFFSETA**	This value corresponds to the location of rock art on a specific panel. By utilising the drawings prepared by the Côa Foundation, an average height of the depictions will be calculated for each inspected site and will here be called 'panel feature height'.	
	OFFSETB	In accordance with the results obtained in the super-imposition study (i.e. centre/top-left bias), it is being assumed here that the majority of rock art tends to be viewed on eye-level height. A vertical distance is added to the height value of each DEM cell eligible for the viewshed – the 'height of the observer's eye'. The average observer eye-height is set to 1.75 m for purposes of this research (based on data obtained from Hermanussen, 2003 and Ruff *et al.* 2012).	

Table 7.12.: Description of data input for 'outwards' panel feature viewshed outputs.

A set of preliminary steps that prepare the data for viewshed creation and that combine all these features within GIS can be viewed in Appendix F.

This image (Fig. 7.4.10) visualises the required data input into GIS, modelled on a photograph taken during fieldwork at Penascosa in late 2018:

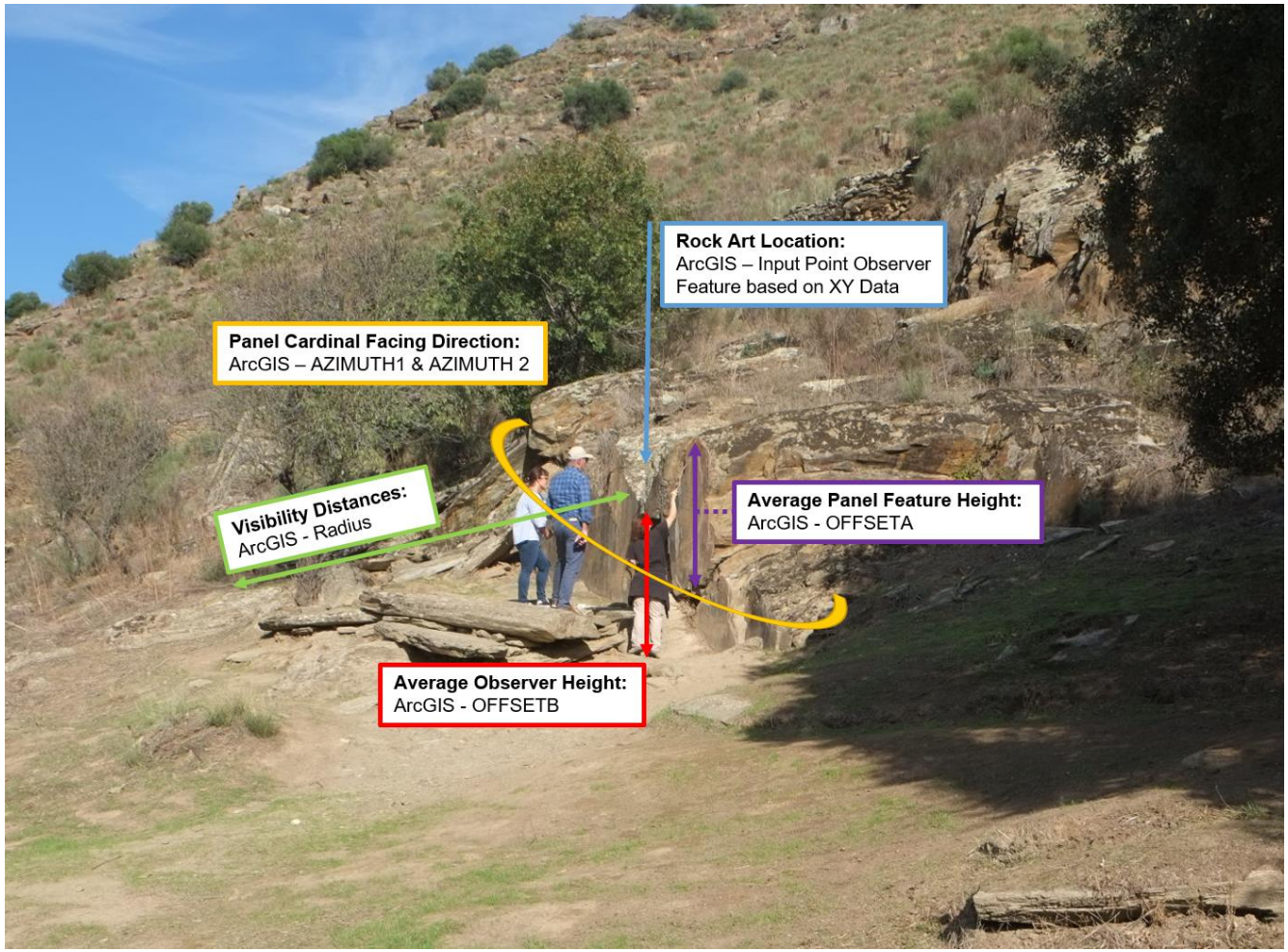


Figure 7.4.10.: Illustration of how all the research parameters fit together in their combined input into GIS (Photograph and annotations by author, 2018).

Input of visibility distances

A more specified look at the values that will be inserted for visibility distances (termed in GIS as 'Radius2') can be found in the table below (Table 7.13). The values are to be read as the average distances recorded for each parameter within the control study setup. Of course, each parameter is dependent on others being present or not, such as 'white' pecking of fully-outlined motifs on black bedrock, yet the values presented below are purely demonstrative of their averaged nature when all aspects are being taken together and a white motif colouration (as concluded to be most visible in the last sub-chapter) is assumed. Differential motif colouration is again being put to the test to try to rule out (on a geographical landscape basis) if pigmentation was indeed being used or not.

Visibility Parameters		Visibility Distances - Resolution			Visibility Distances - Legibility		
Bedrock Colouration **(colour in the cells to the left indicate engraving colouration)**	Black/Dark	135 m	12 m	65 m	35 m	2 m	4 m
	Red/Ochre	88 m	44 m	21 m	29 m	10 m	1.5 m
	Yellow	72 m	65 m	60 m	17 m	19 m	21 m
Engraving Technique*	Pecking	72 metres			15 metres		
	Incision	50 metres			7 metres		
	Azilian-Style	63 metres			10 metres		
Motif Completeness*	Full-Bodied	58 metres			17 metres		
	Incomplete	51 metres			24 metres		

Table 7.13.: Summary of averaged visibility distances for resolution and legibility ranges (*based on white engravings, bedrock colouration – all values are averaged. The data used for the data contained within this chart can be found in Fig. 7.3.12 and 7.3.13).

Rock art site selection

The visibility from and onto a total of 6 rock art sites will be analysed in detail now, with wider viewshed analyses being performed for the entirety of the valley later on (Tables 7.14 and 7.15). To be suitable for a viewshed analysis for purposes of this research, the to-be-selected sites have to bear a number of qualifying features:

- Considerable distances when looking towards (and outwards from) the panels,
- Recorded data features within the *Engraved Species Database* for:
  - GPS coordinates,
  - Bedrock colouration,
  - Motif Type / Engraving technique / Completeness,
  - Panel cardinal facing direction
- Panels have to be located in a clearly *distinct* landscape (i.e. different rock art locations along the Côa River and their inherently different cardinal directions).

Selected case studies

Case Study	Name	Panel N°	Cardinal Direction	Bedrock Colouration	Engraving Technique(s)	Motif Types	Motif Facing Directions	River Connection
1	Penascosa	3	North West	Brown	Mostly Pecking (very few incisions)	6x Ibex, 2x Horse, 5x Aurochs, 6x Undeterminable	Left, Right, Downwards	132m alt One of the very few rock art sites with panels to the east of the river meanders
2	Quinta da Barca	3	South East	Reddish-Brown	Perforated and Abraded – (here assimilated to pecking)	3 Ibexes	Juxtaposing	142m alt On the opposite riverbank to the Penascosa site
3	Ribeira da Piscos	1	South East	Grey Brown	Pecking	2 Horses	Juxtaposing	129 m alt Alongside a small tributary arm of the Côa River
		24	South East	Brown	Overwhelmingly filled with incisions	20x Anthrop., 7x Deer, 11x Ibex, 14 Horse, 53x Aurochs, 43x Undet.	Right, Left, Frontal Upwards, Downwards	131 m alt Situated a few hundred metres away from Piscos 1, but overlooking the main Côa riverbank
4	Canada do Inferno	14	South East	Orange Brown	Mixture of Incisions, Azilian-Style Striations and Pecking	8x Deer, 4x Ibex, 6x Fish, 11x Horse, 3x Aurochs, 8x Undeterminable	Right, Left, (Fish are Upwards & Downwards)	144 m alt
5	Canada da Moreira	7	South East	Orange Brown	Incision	2x Ibex, 3x Aurochs	Right, Left, Downwards	300 m alt 'Inland' in between the merging land of the Côa and Douro rivers
6	Vale de José Esteves	16	South West	Orange Brown	Overwhelmingly filled with Azilian striations and a few incisions	6x Deer, 6x Ibex, 1x Fish, 2x Horse, 3x Aurochs, 5x Undeterminable	Right	186 m alt

Table 7.14.: GIS relevant information for the six different case studies under consideration.

Visibility distances of white engravings for selected case studies

Case Study	Name	Panel N°	Bedrock Colouration	Engraving Technique(s)	Resolution Distances Pecking	Legibility Distances Pecking	Resolution Distances Incision	Legibility Distances Incision	Resolution Distances Azilian-Style	Legibility Distances Azilian-Style
1	Penascosa	3	Brown	Pecking, Incision	**69 m**	**14 m**	**47 m**	**8 m**	-	-
2	Quinta da Barca	3	Reddish-Brown	Pecking	**74 m**	**12 m**	-	-	-	-
3	Ribeira da Piscos	1	Grey Brown	Pecking	**80 m**	**14 m**	-	-	-	-
		24	Brown	Incision	-	-	**55 m**	**8 m**	-	-
4	Canada do Inferno	14	Orange Brown	Pecking Incision, Azilian-Style	**67 m**	**16 m**	**46 m**	**9 m**	**55 m**	**15 m**
5	Canada da Moreira	7	Orange Brown	Incision	-	-	**46 m**	**9 m**	-	-
6	Vale de José Esteves	16	Orange Brown	Incision, Azilian-Style	-	-	**46 m**	**9 m**	**55 m**	

Table 7.15.: GIS relevant information pertaining to the visibility ranges (resolution and legibility) for the six different case studies under consideration. The specific range data is extracted from the underlying data used to make Fig. 7.3.12 and 7.3.13.

Limitations

There are a couple of limitations that have to be borne in mind when consulting this study and its results. First, the obtained DEM has a resolution of only ten metres, meaning that some of the more intricate results of the visibility study (those <10m such as legibility values) will not be able to be displayed accordingly. Hence, this restricts the mapping of most legibility distances, but for this to be done in the future a finer resolution DEM will need to be used. Furthermore, the 30m DEMs obtained for this survey also include modern vegetation cover and are thus not entirely representative of past visibility in front of and surrounding the panels in question (a LiDAR model would be more useful for this, which, to the authors knowledge, does not exist for this stretch of land as of yet). The 10m DEM is based vector maps provided by which are not inclusive of vegetation data. Whilst the vegetation coverage will have been likely consisting of low-lying shrubs in the Upper Palaeolithic (similar to how it is nowadays (cf. Aubry *et al.* 2002)), this is not of a major limiting factors, yet its implications need keeping track of.

What is more, the visualisation modelling considers the cardinal direction into which the panel surfaces face and thus a viewer would need to be facing the opposite direction to see the extent of the panel. So, for instance, if a panel was to face into a south-easterly direction, the GIS azimuth values would lie between 45 and 225 degrees, in other words those are the angles that a panel exhibits and utilises in its extent of visibility, since it physically cannot cast visible features beyond those angles as they would lie 'behind' the panel.

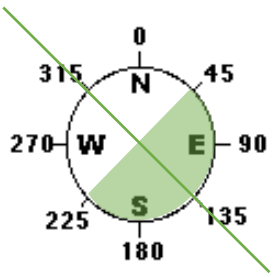


Figure 7.4.11.: Illustration of azimuth determination.

An observer, however, does not possess such a wide-angle viewing range and would require to change positions to see the entire panel. As such, an observer standing at 45 or 225 degrees would likely not be able to see the entire panel since the angle of observation would be too obtuse/straight. A study looking into observer angle positioning would be required to make this modelling even more accurate. However, since this model processes information on how wide-reaching different parameters are, when looking outwards from the panel, this degree of information is not essential.

7.4.4.2. Results and analysis of the GIS visibility study

The map below provides the reader with a general overview of the individual viewsheds for each of the six case study sites. As can be seen by the extensive areas that their viewsheds cover, a wide stretch of the region under scrutiny is therefore being inspected and included in this study.

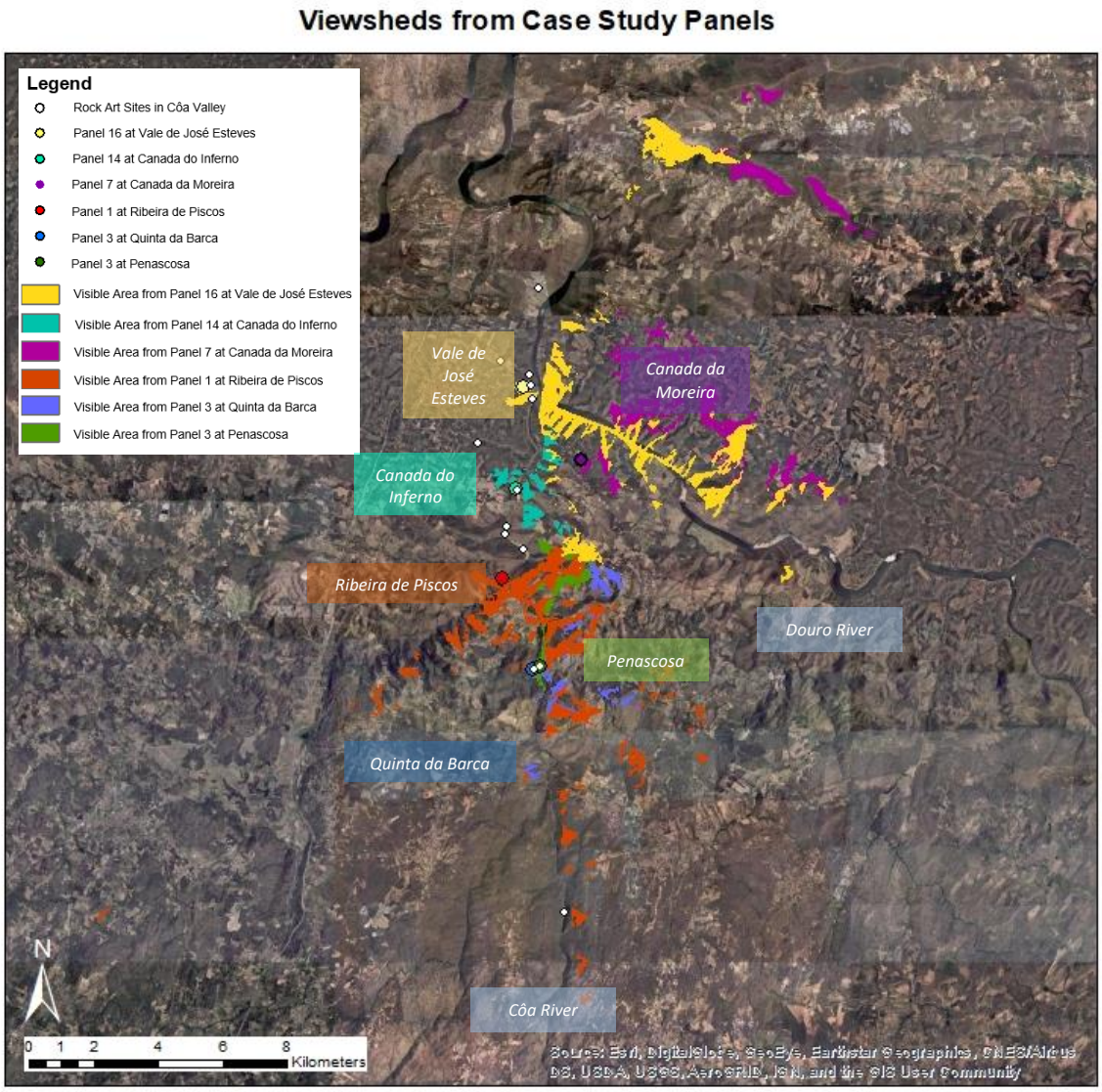


Figure 7.4.12.: The location of the selected case studies and their viewshed extents, all marked in a different colour to distinguish between sites.

What will follow next is the analysis of the individual case studies, with a visually rich and textually sparse illustration succession (almost like an exhibition catalogue) being utilised here for the reader to grasp their specific visibility ranges in quick progression.

Each case study consists of:

(1) An overview of the **visual layout** of the selected panel
(2) An **overall viewshed** from the rock art site under study
(3) One or more inwards **observer feature points**
(4) A visualisation of the **resolution and legibility levels** for different engraving colours

Case Study Site 1: Penascosa 3

(1) The panel's visual layout:



Figure 7.4.13.: Panel 3 of Penascosa (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Penascosa 3:

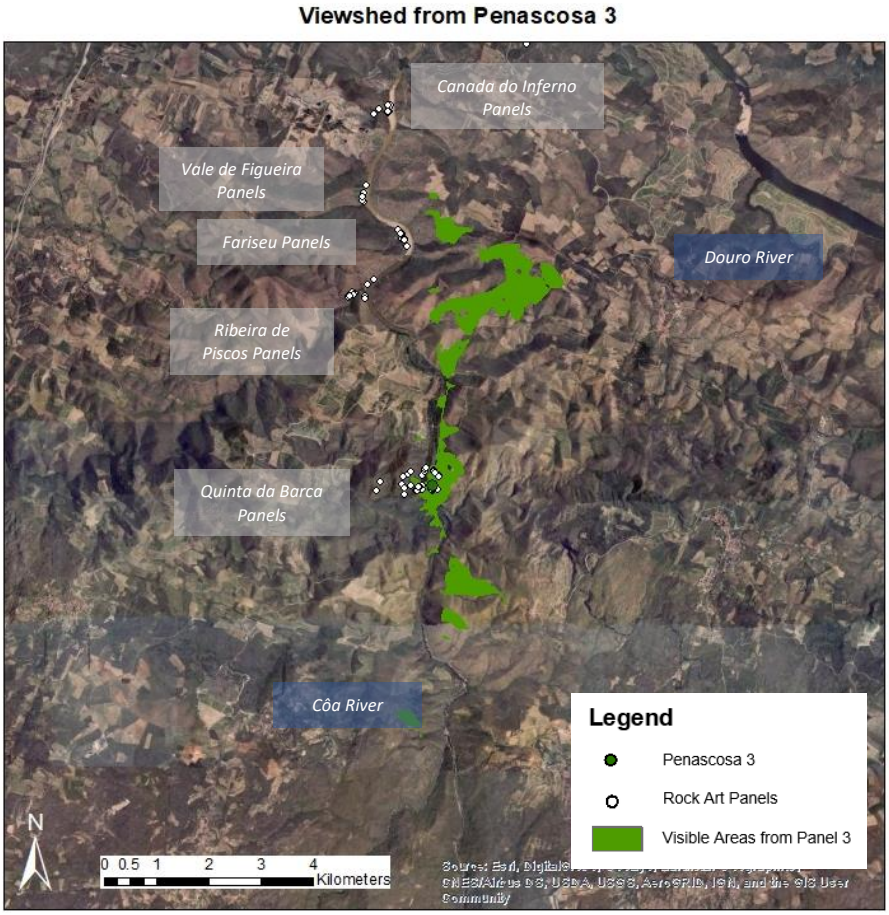


Figure 7.4.14.: The location of case study 1 (Penascosa 3) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature points – observer 1+2:

The blue dot implies the standing location of a rock art observer, able to turn 360˚as is illustrated by the surrounding radii. Each radius represents a different visibility range (see legend).



Figure 7.4.15.-7.4.16.: Observer Feature Point 1 at Penascosa 3 (top) and Observer 2 (bottom) with their respective radii enveloping different rock art features at the site.

The impact of movement around the landscape and features coming into one's sights is clearly perceptible in figures 7.4.15 and 7.4.16. In those figures, observer 1 is slightly further north from observer 2, illustrating nicely how moving through the landscape brings different rock art aspects into one's view (radius of visibility). As became quickly apparent in previous analyses on visibility of the different engraving colours, the resolution of engravings in a white residue is by far better than those in red or black. As such, this is reflected in the colour of the observers' surrounding radii. Hence, when inspecting the bottom figure (Fig. 7.4.16), the location of the observer lends itself to offering a great resolution of the highly visible Phase A (Solutrean-Gravettian) pecking panels (cf. Ch. 7.4.3), a majority of which would also be resolvable if they were painted in red. Legibility ranges of white engravings incorporate three sites, the ones closest to the standing location of the observer. So, the observer would be able to identify features from this distance on three panels and acknowledge the existence of more features on at least another eight surrounding sites.

This selected location of the observer seems to be the most inclusive location to gain oversight over as many sights as possible in this locality. Any further away would obscure many resolvable and legible panels all together. Ideal observer points are determined, which is the case for all observer points in subsequent case studies, by a trial-and-error method of locating various GPS points in the landscape and determining which ones best encompass overlapping rock art sites with viewsheds, almost as if mimicking how rock art observers in the physical landscape would, by trial-and-erroring rock art visibilities. Furthermore, if we reminisce about this location's actual geological compositioning, the panels touching the outer rim of the red resolution radius are only accessible by climbing a series of natural steps to get close to the rock art in the first place (cf. Fig. 7.4.8). Once on this natural incline closer towards those sites in question, the other sites below or above would come out of sight. This example illustrates how Palaeolithic (and modern) art audiences need to be able to navigate their landscapes by **maintaining a close look** at schist outcrops falling into their view, keeping up **active/rapid eye-movements** for more rock art sites to appear and exerting a certain **degree of athleticism,** to get towards specific sites that are not in even-grounded walkable vicinities.

(4) Resolution and legibility viewsheds for Penascosa 3:

As indicated in the introduction to the methodology, there are benefits but also obvious flaws in showing the reader visibility ranges from an observer's point of view with the help of buffers/radii. Hence, the following figures show the novel methodological procedure of selecting a location, in this case that of the Penascosa 3 panel and specifically aligning its bespoke viewsheds, which have been tailored to show the visible ranges clipped to the panel's facing (cardinal) direction and its specific metre ranges for the visibility of white and coloured engravings. In the figures that follow, the white area, for instance, is the extent an observer is able to stand in and still resolve the engravings on the panel in question. The red area, by extension, shows the resolution distances for red engravings tailored to this particular panel.

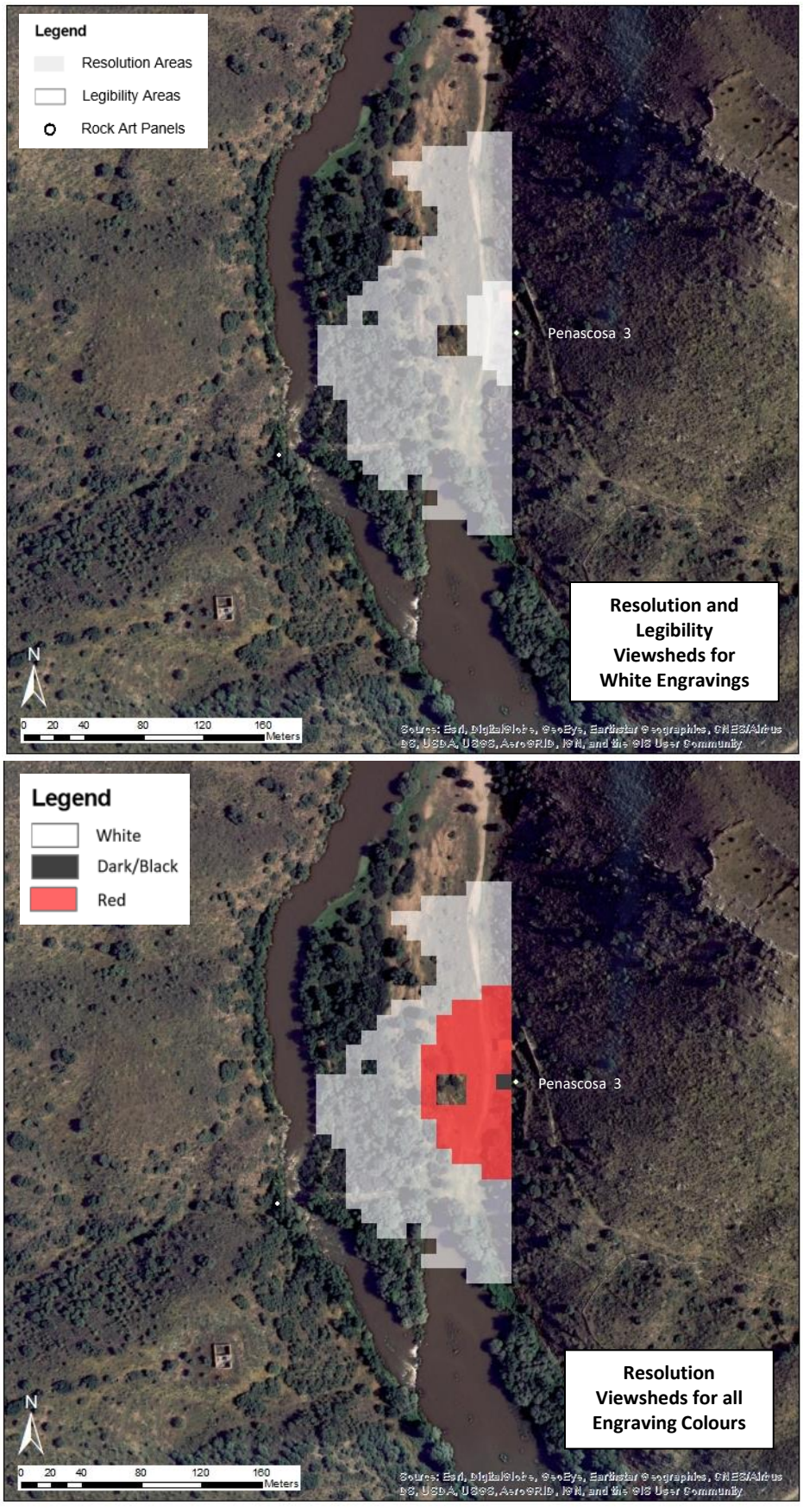


Figure 7.4.17.-7.4.18.: The created viewsheds for the established resolution and legibility ranges for white engravings at Penascosa 3 (top) and coloured engravings (bottom).

Case Study Site 2: Quinta da Barca 3

(1) The panel's visual layout:

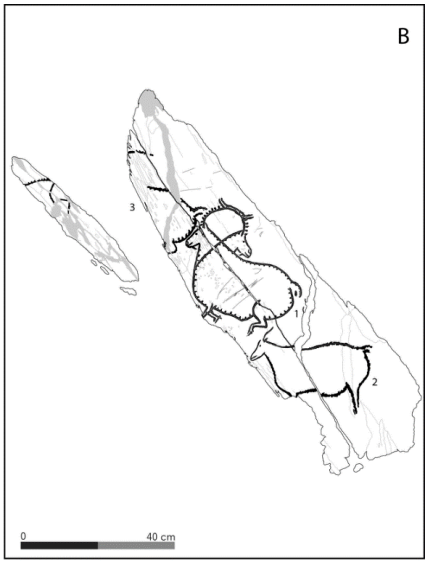


Figure 7.4.19.: Quinta da Barca 3 and its unique ibex(es) (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Quinta da Barca 3:

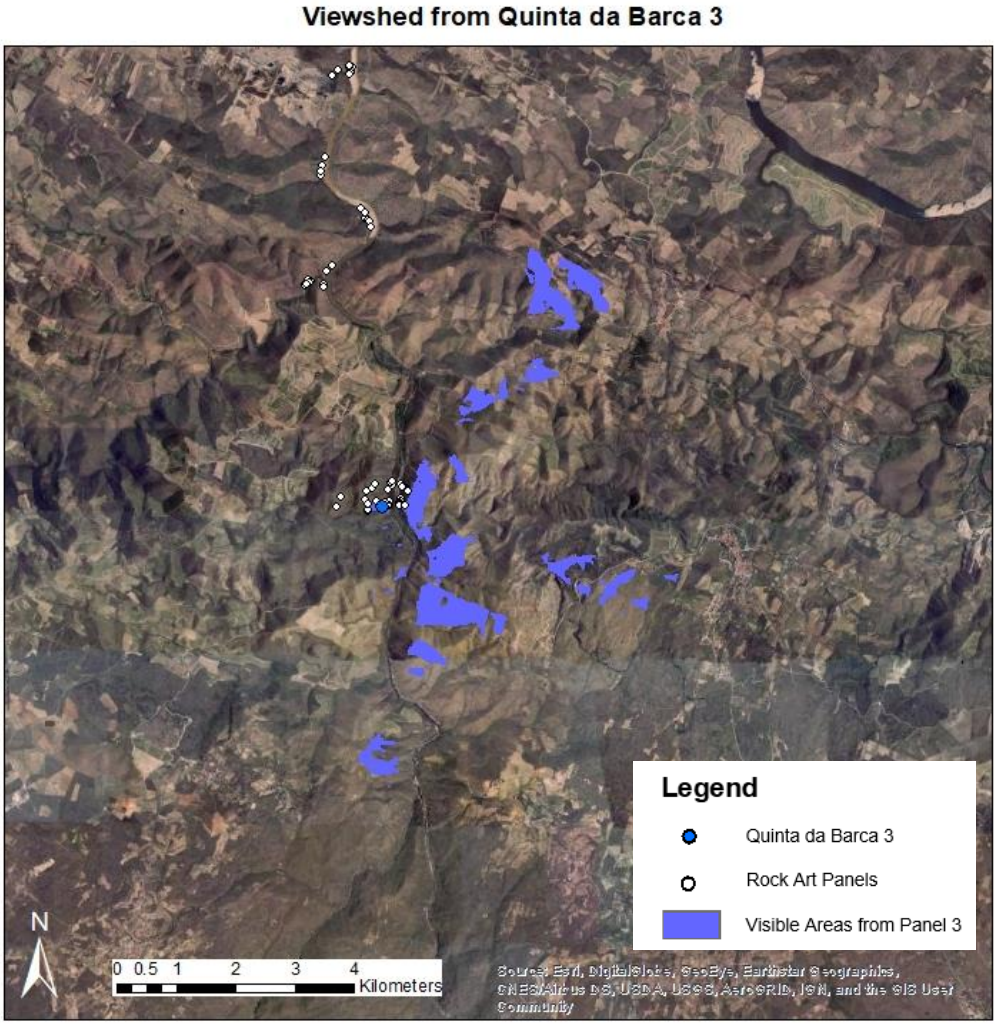


Figure 7.4.20.: The location of case study 2 (Quinta da Barca 3) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature point:

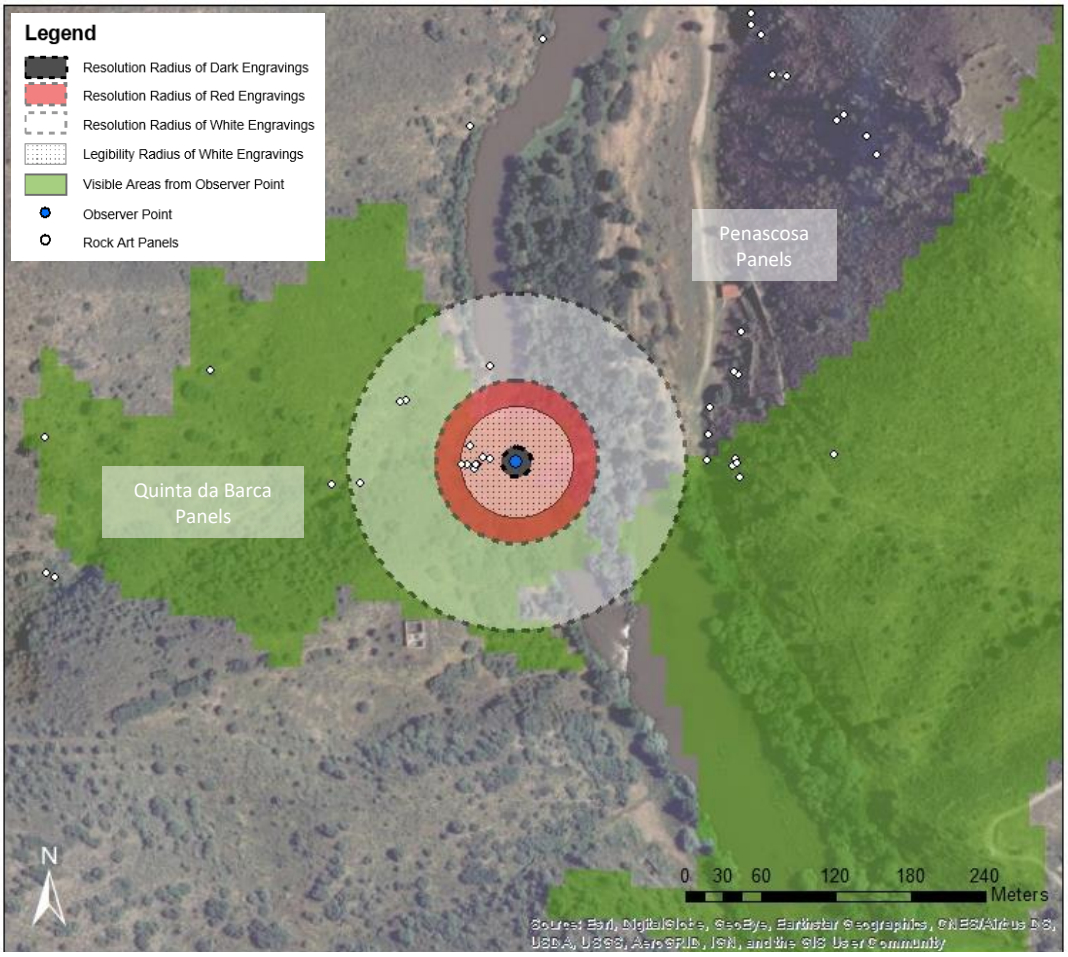


Figure 7.4.21.: Observer Feature at Quinta da Barca with its respective, calculated radii.

The observer is situated just after having crossed a slim stretch of the river coming from the direction of Penascosa. Again this location was determined as the best match for overlap of viewshed and rock art sites. Yet, of course, the location of an observer slightly to the left or right of this current selection would be possible and would yield a slightly different visibilty scenario. Many of the lower lying sites are in legible distances, with four more resolvable sites in its 135 metre white resolution radius. An interesting trend here, is the bare visibility of the actual river from this location, with most of what is to be seen (green viewshed area) lying in the wider terracing system surrounding the site. Besides, since the panels are naturally facing the river at this site, an observer would be standing with their back to the river in order to detect rock art here. This is an important facet to bear in mind when thinking about the wider visuality people would experience at rock art sites in general. Consuming rock art comes at a detriment to taking in its wider surroundings and its allegedly omnipresent river locations. These latter components only come into play once an observer reaches a rock art site, processes what is on display and turns around, knowing what is depicted, to then view its embeddedness in nature. This creates a **constant dialogue between the art, the artist, the observer and the landscape**, which nicely goes back to the chart in chapter 1 that describes their interconnectedness (Fig. 1.1.2).

(4) Resolution and legibility viewsheds for Quinta da Barca 3:

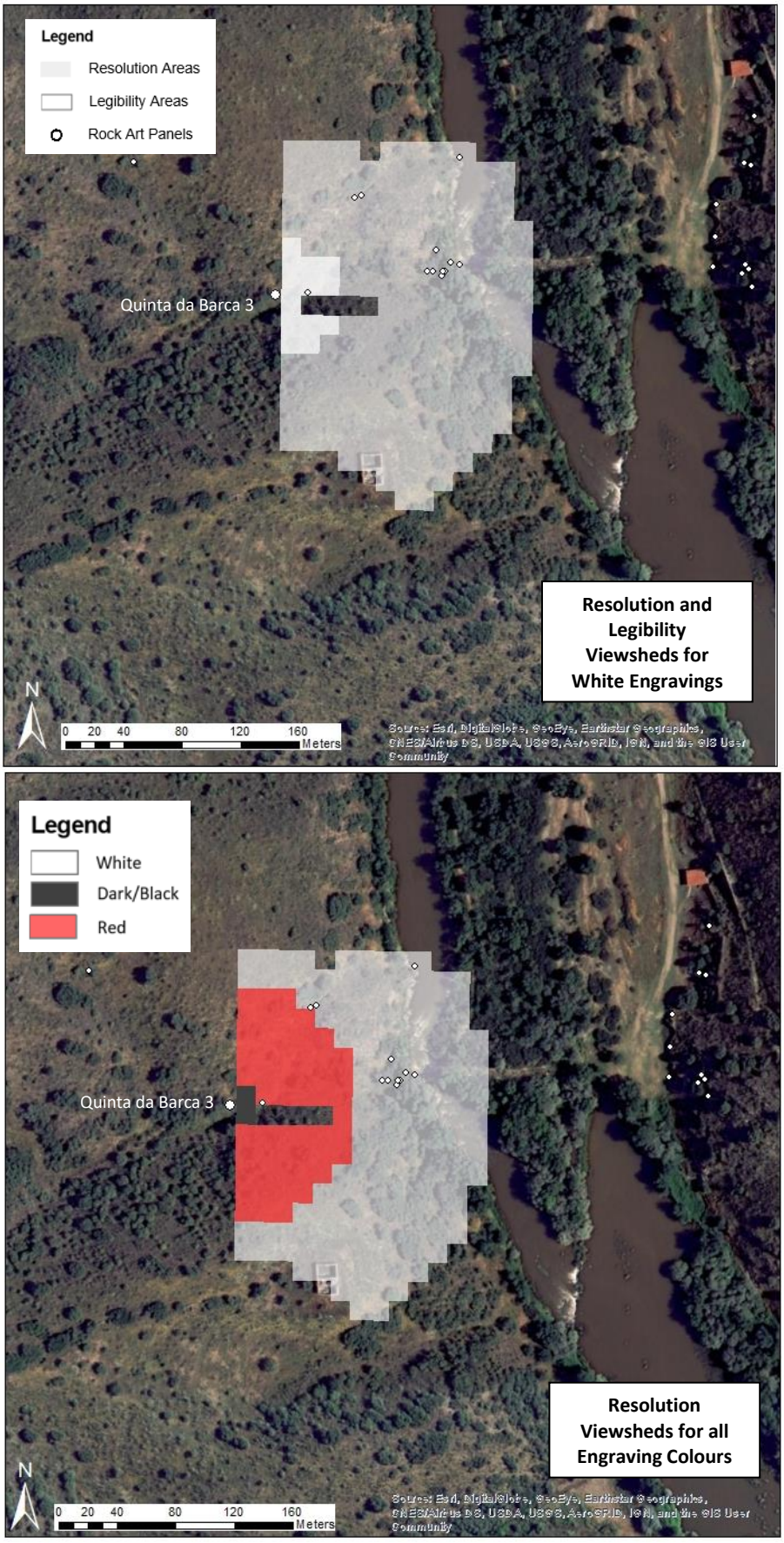


Figure 7.4.22.-7.4.23.: The created viewsheds for the established resolution and legibility ranges for white engravings at Quinta da Barca 3 (top) and coloured engravings (bottom).

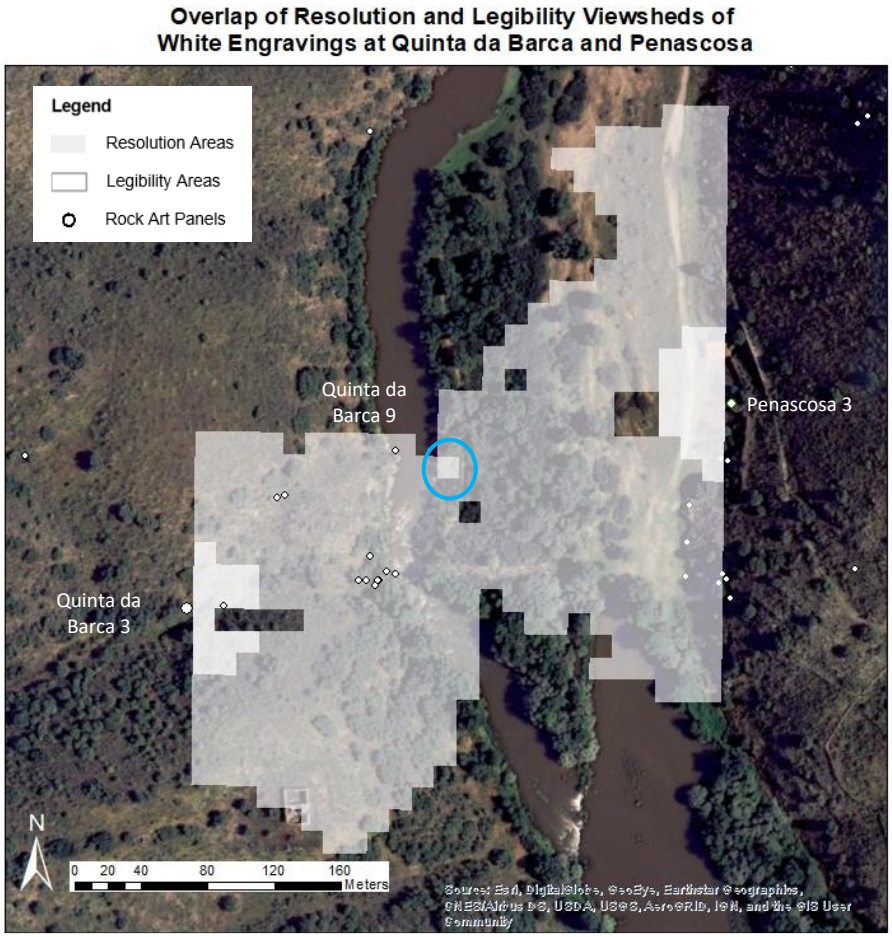


Figure 7.4.24.: The overlap area of the created viewsheds for Penascosa and Quinta da Barca.

An interesting feature appears in the event above, when both viewsheds from these close-by, yet mirroring sites are shown as overlapping in the same figure. In fact, there is one particular spot within this overlap, at which an observer would be able to stand and resolve the art on both panels (circled in blue). This spot is located at the riverbank of Penascosa, from which also another adjacent panel (Quinta da Barca 9 with six depictions including aurochs and ibexes) across the river would easily be visible. Again, the careful manoeuvring of landscapes will bring different sites into ones view at different times and locations. The **intricate knowledge** of spots at which a multitude of panels become visible will have likely been **reserved to observers spending a considerable amount of (conceivably recurring) time** at these sites.

It might be worth at this point, to refer back to what the panel of Quinta da Barca 3 actually displays – an intertwined one bodied, two-headed ibex pointing towards the left and right. It might be plausible to link this two-faced nature to the two possible walking routes as established in Fig. 7.4.7, one which would lead an onlooker into the landscape and one down towards the river, almost as if, upon one's departure, this panel suggests multiple routes to its audience. Moreover, its wide-bearing, fan-like viewshed is indicative of its public visibility.

Case Study Site 3: Ribeira de Piscos 1 and 24

(1) The panels' visual layouts:

Ribeira de Piscos 1

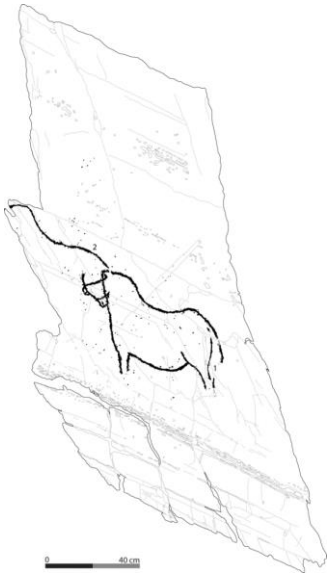


Figure 7.4.25.: Panel 1 of Ribeira de Piscos (drawing courtesy of Fundação Côa Parque).

Ribeira de Piscos 24

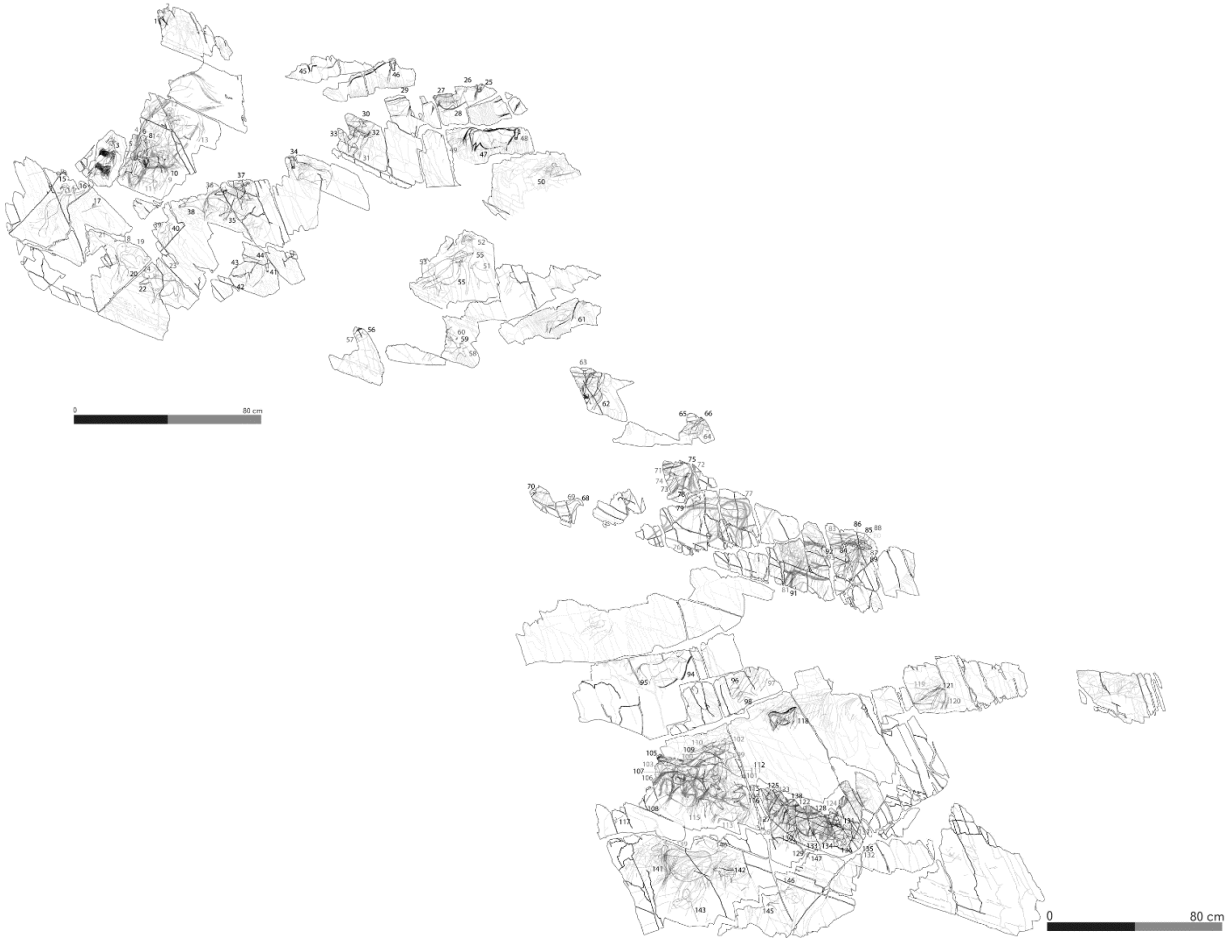


Figure 7.4.26.: Panel 24 of Ribeira de Piscos (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Piscos 1 and Piscos 24:

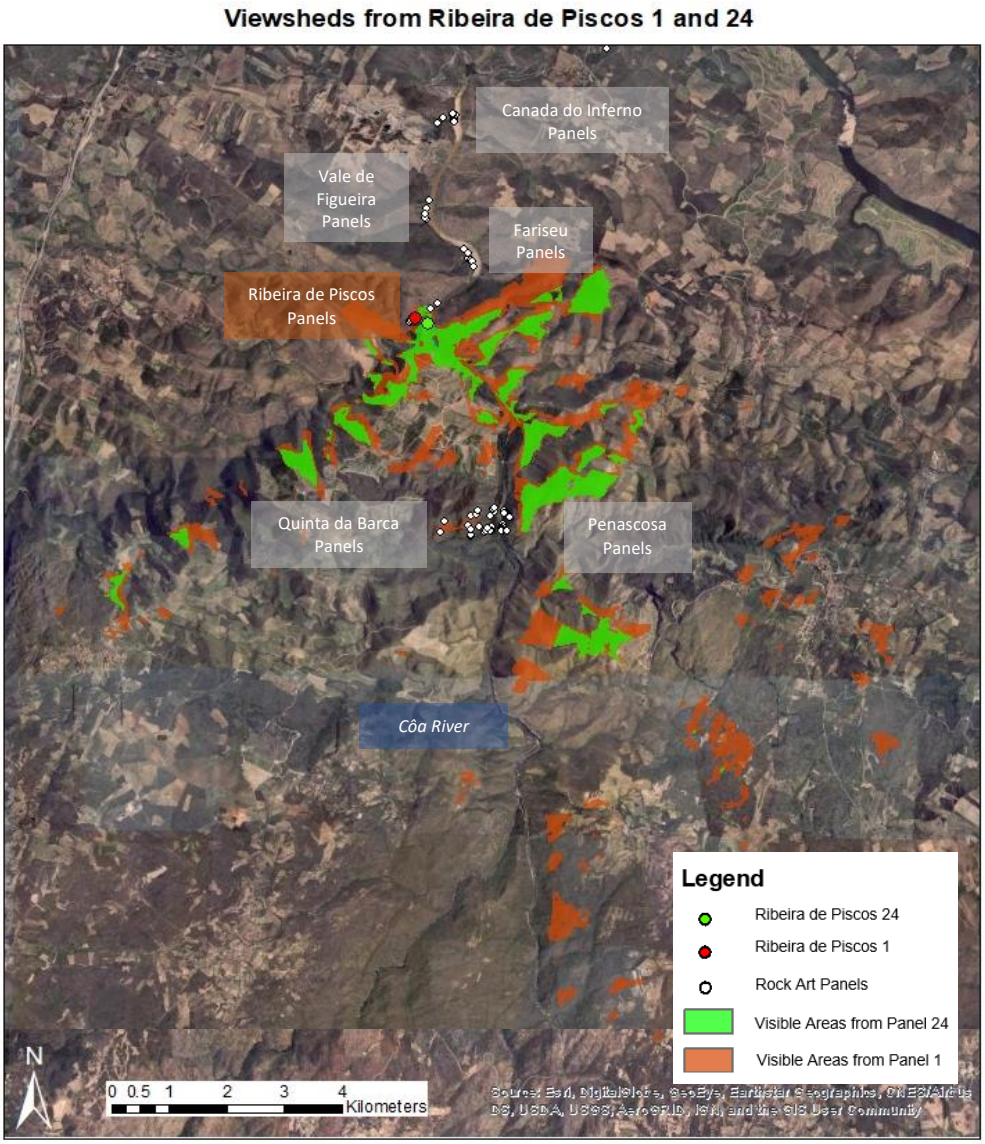
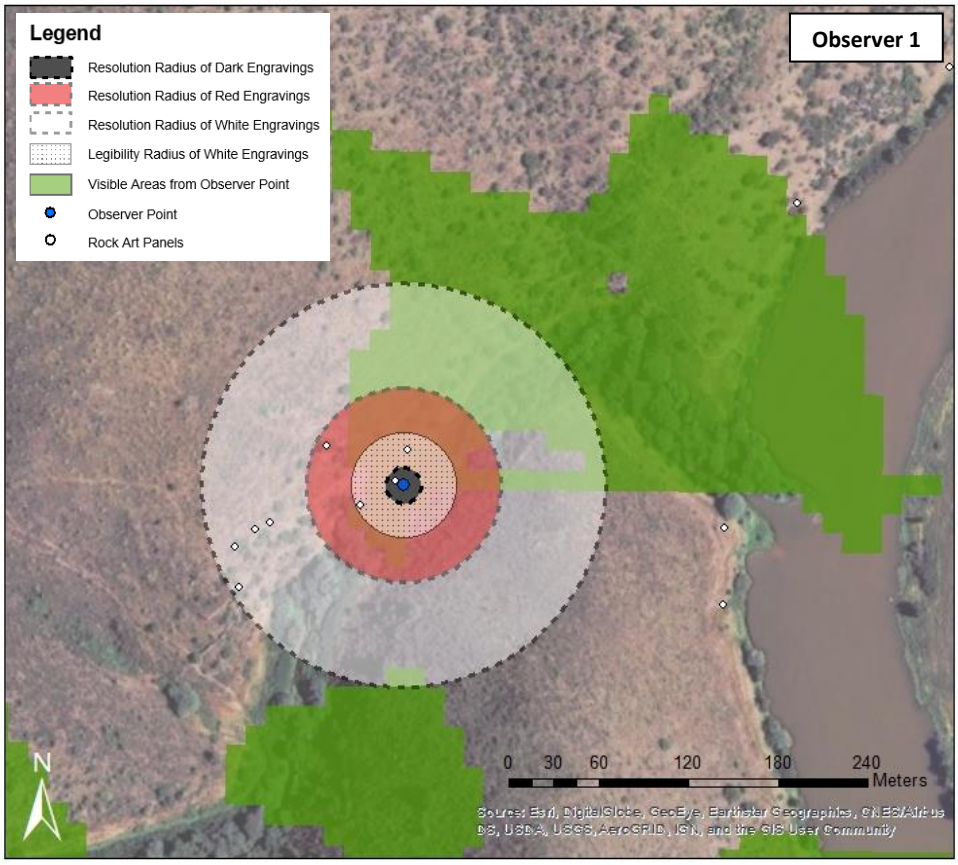


Figure 7.4.27.: The location of case study 3 (Ribeira de Piscos 1 and 24) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature points – observer 1-4:

The site of Ribeira de Piscos begs for a careful consideration of its surroundings. This is due to its spread-out location, incorporating panel locations at a tributary to the Côa (Piscos 1 in Fig. 7.4.32) and panel sites at the banks of the Côa itself (Piscos 24 in Fig. 7.4.32). As previously mentioned in chapter 2.1, the course of the river and its associated meanderings into the landscape will have stayed very similar between the Upper Palaeolithic and now. The panel-rich nature at this site and its merging water setting will not have gone unnoticed in the past either. In terms of the observer locations and their significances, the dual nature of these two different panels at the same site begs for the placement of more than just two observers in the area.



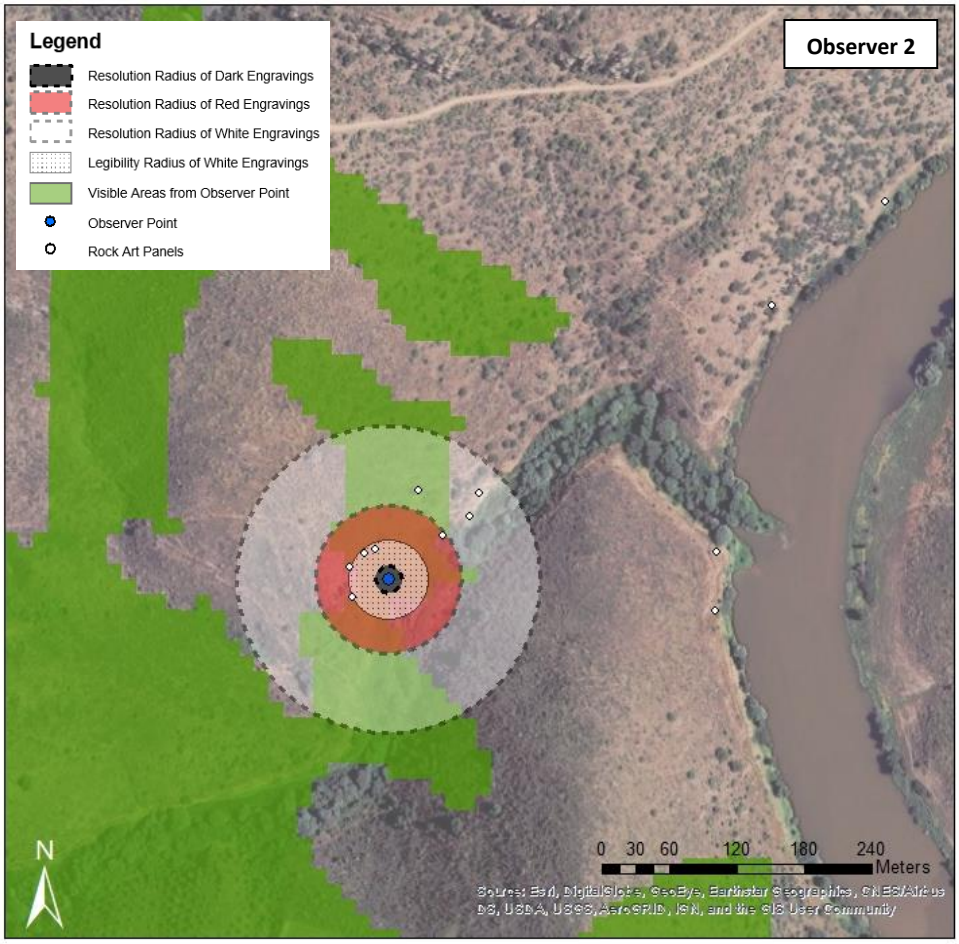


Figure 7.4.28.-7.4.29.: Observer Feature Point 1 near Piscos 1 (top) and Observer 2 (bottom) a few hundred metres south with their respective radii enveloping different rock art features at the site.

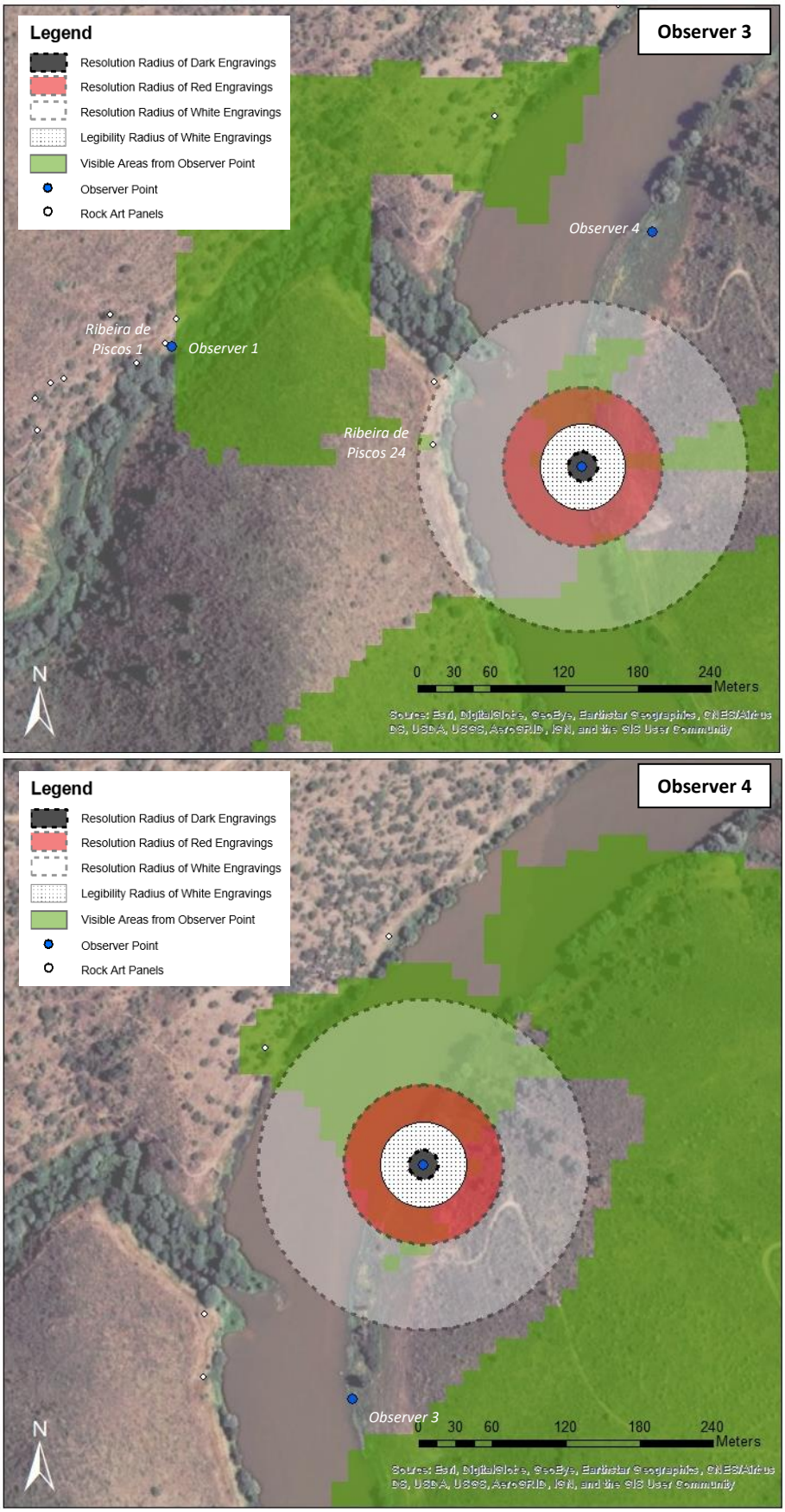


Figure 7.4.30.-7.4.31.: Observer Feature Point 3 and 4 near Piscos 24 with their respective radii enveloping different rock art features at the site.

Hence, two observers were placed in the area of the Côa tributary (Observers 1+2) and two more on the opposite bank to the Ribeira de Piscos site (Observers 3+4). Again, their location is based on best possible yields when rock art sites and viewsheds are combined. Starting with the former two observers, by moving through the adorned panel areas lying away from the actual Côa River, rock art audiences (in this case observers 1 and 2) would be able to bring certain aspects of the engravings in and out of sight. Here, readers are invited to notice the 'actually' visible areas from both (blue) spots marked with a green viewshed. Although their radii indicate that engraving colours would be visible, the (rather limited) overlap of green viewsheds with these buffers, is what counts in the end in determining a site's visuality. Observer 3 (Fig. 7.4.30) is situated opposite to the Ribeira de Piscos site, on the adjacent shore. In this particular position, an observer would be able to view (with the white engraving visibility calculations from earlier) right across the river and just make out marks on panel 24 (also green and visible in the observer's viewshed). Observer 4, on the other hand, who is standing a little further north from observer 3, might be able to view the other riverbank (as indicated by the green viewshed), yet its white resolution radius does not reach that far. These examples illustrate **the importance of understanding the mechanisms for successfully viewing rock art.** To reiterate, it is the combination of a **viewshed at a standing location** being present, coupled with the **necessary adjustments for the different visibility distances** towards rocks of different engraving techniques and possible colours, which creates good conditions for being able to spot rock art in the Côa Valley. It ought not to be forgotten that these external factors need to be matched by the facets that were mentioned earlier, namely the **maintenance of close viewing and the upkeep of active eye-movements** and a willingness to exert a certain degree of **athleticism.**

(4) Resolution and legibility viewsheds for Ribeira de Piscos 1 and 24:

The following images show the viewsheds for both panel 1 and 24, tailored to fit their pecked (Piscos 1) and incised (Piscos 24) nature. Remarkable for the former panel, which depicts two 'kissing' horses, is its watercourse constricted viewshed and its relatively long-stretched view towards the Côa opening (white viewshed line across the landscape), almost as if **the kissing horses mimic the meeting/kissing of tributary and river.** An important art location which will not have gone unnoticed by its creators and consumers. Panel 24 exerts a more rounded, fanned viewshed, illustrative of a wide opening with plenty of locations that the panel will have been visible from. This might indicate a more public resolution approach (even from across the river), yet once one gets closer, the intricate motif incisions (cf. Fig. 7.4.26) draw audiences in to spend considerable time studying the panel. One could liken this approach to an initial public outreach event, with the successive intention to retain audiences long-term.

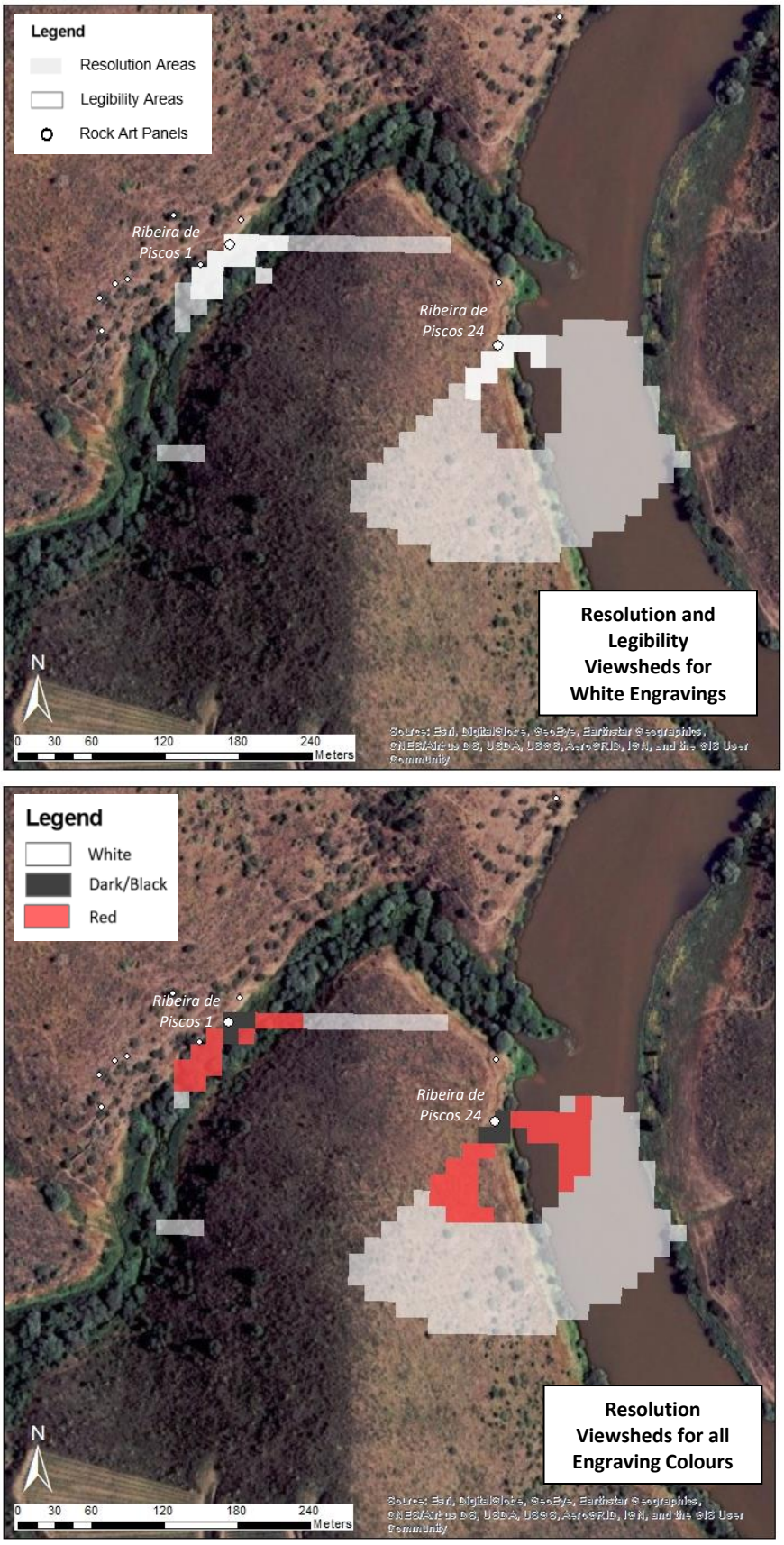


Figure 7.4.32.-7.4.33.: The created viewsheds for the established resolution and legibility ranges for white engravings at Ribeira de Piscos 1 and 24 (top) and coloured engravings (bottom).

Case Study Site 4: Canada do Inferno 14

(1) The panel's visual layout:

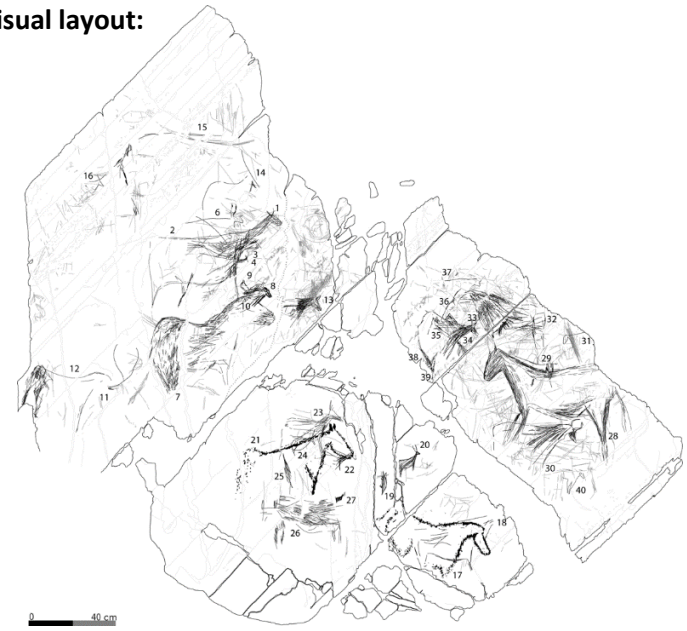


Figure 7.4.34.: Panel 14 of Canada do Inferno (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Canada do Inferno 14:

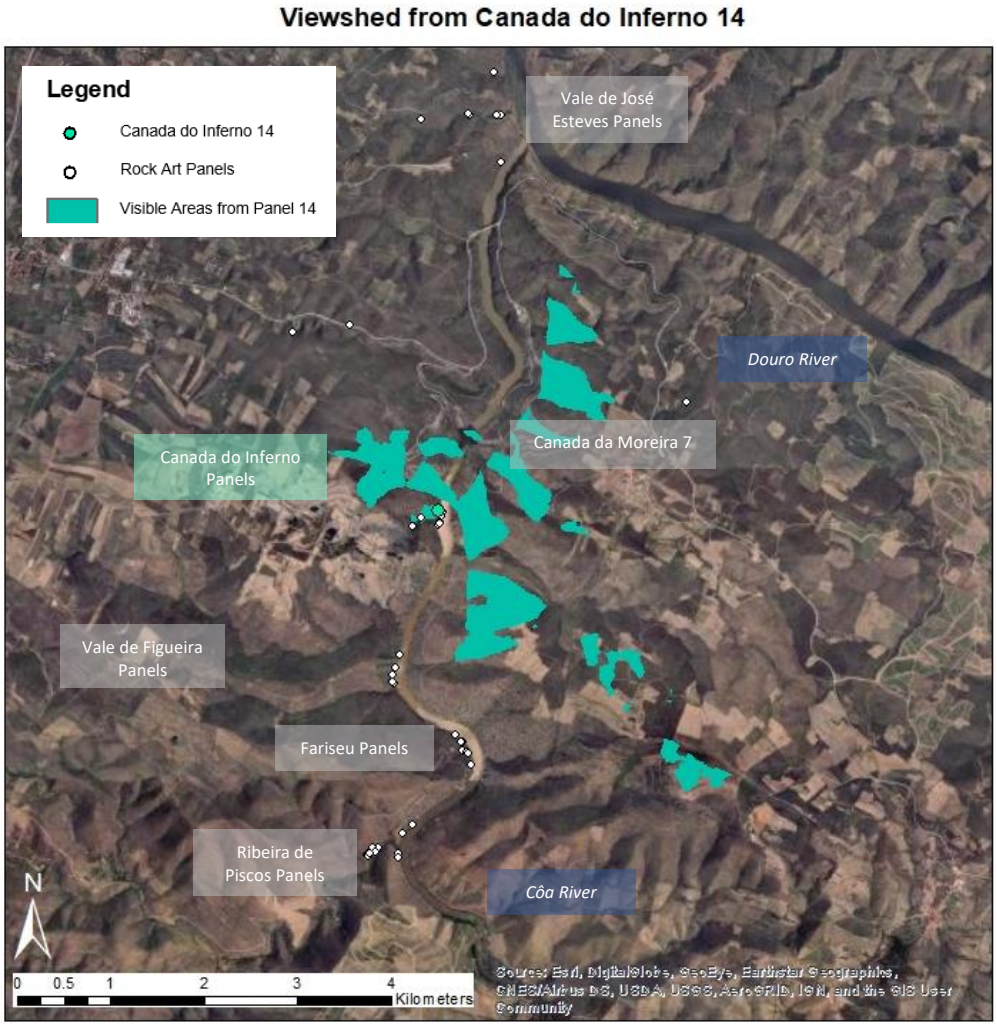
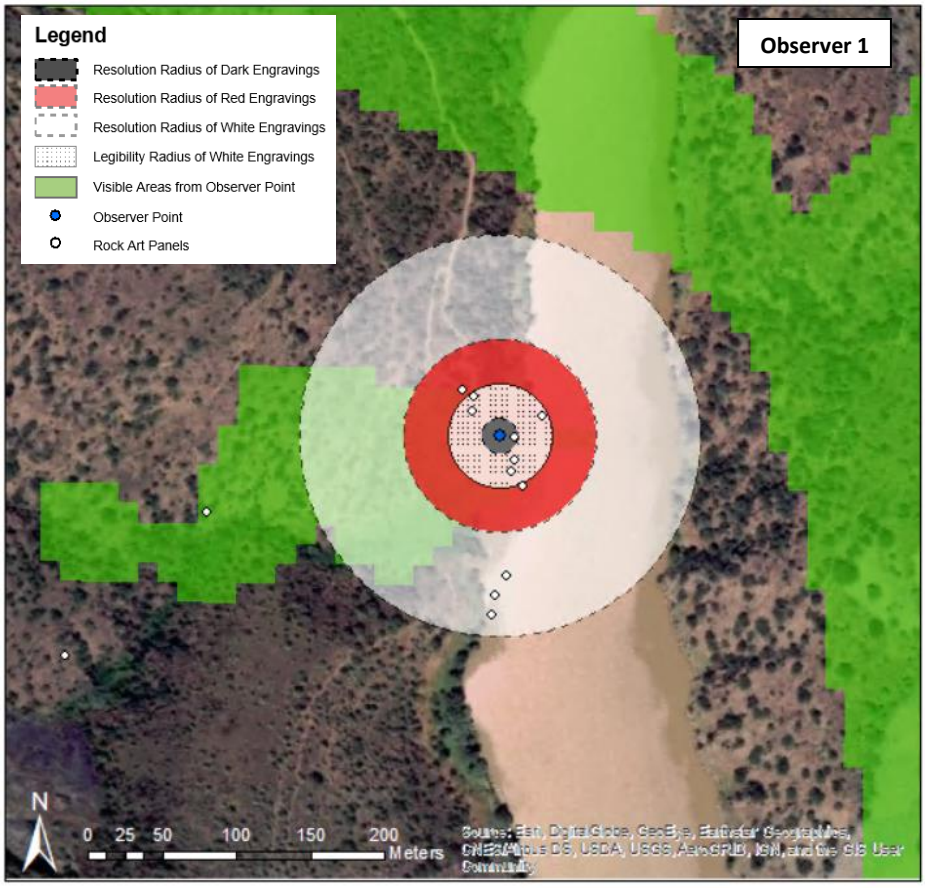


Figure 7.4.35.: The location of case study 4 (Canada do Inferno 14) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature points – observer 1+2:



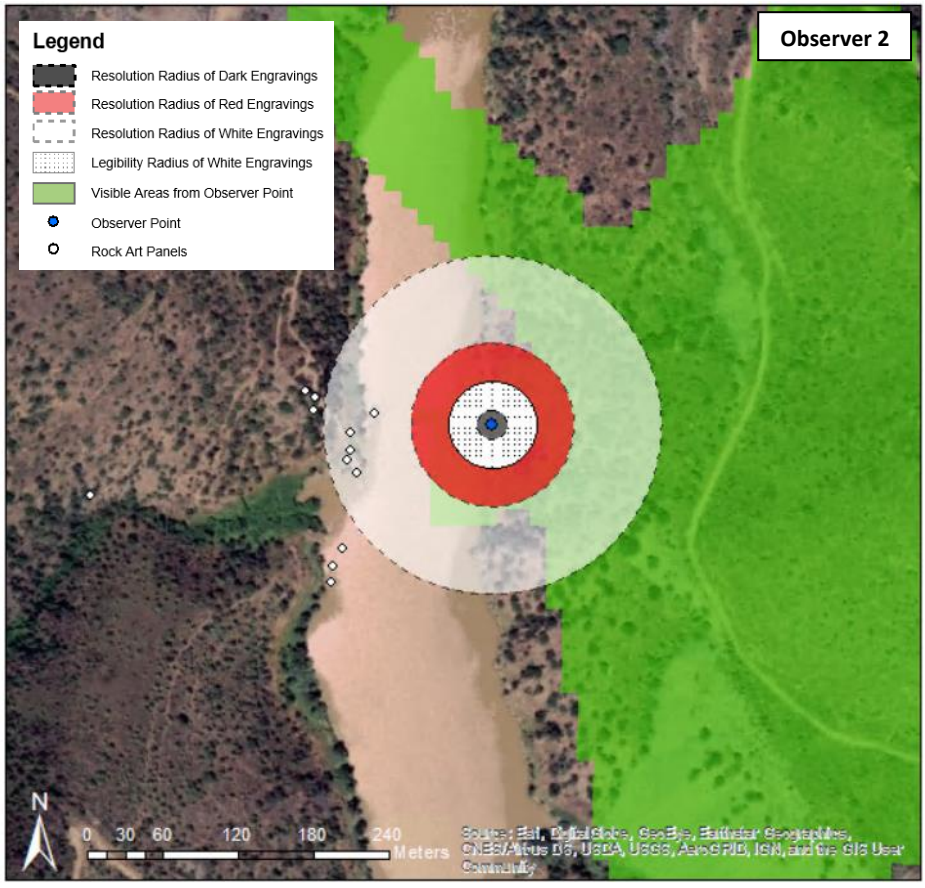


Figure 7.4.36.-7.4.37.: Observer Feature Point 1 at Canada do Inferno (top) and Observer 2 across the river (bottom) with their respective radii enveloping different rock art features at the site.

Observer 1 is situated amongst most of the panels present at Canada do Inferno. Yet, despite its interjacent location, the visible area does not align very much with the established visibility radii in this area. Several other observer point viewsheds have been trialled at adjoining locations, all yielding very similar viewshed patterns. This can also be seen when looking at observer 2, who is stationed on the opposite bank of the river, supposedly looking towards the opposite Canada do Inferno sites by the way the white resolution radius falls, yet its indicated green viewshed does not physically allow for such an extended view. Judging by the difficulty to find suitable viewsheds to cover the panels in question at the site, it seems reasonable to suggest that this site was utilised with a more private character in mind, something which is also reflected in the visual layout (cf. Fig 7.4.34) of panel 14, for instance. The reader might recall the discussion of the same panel during its Gestaltian analysis in chapter 6. The law of similarity plays a big role in the creation of Gestaltian visual cohesion, with the two pecked horses and their incomplete nature towards the bottom of the panel, standing out in particular.

This careful construction of panel layouts will have demanded the artist's time, but likewise demands time from the consumers in order to intricately study its component parts, beyond what appears visually striking (and Gestaltian) at first sight. It is for these reasons, perhaps, that the site of Canada do Inferno barely issues far-reaching viewsheds and is populated with panels of visual complexity, fostering a more private relationship with its audiences. Furthermore, the panels' very close connection to the river means that this relationship is extended to include the significance of water, too. So much so, that many of the panels that used to be originally present at the site are now submerged as a result of the dam constructions, which modern visitors and researchers at the site need to bear in mind when assessing its full visual impact.

(4) Resolution and legibility viewsheds for Canada do Inferno 14:

A similar pattern to what was just described can also be perceived in the following tailored viewsheds being exerted from panel 14. One viewshed part appears on the opposite bank of the river, yet when considering its rather acute angle towards the actual alignment of the panel's cardinal direction, this will, in reality, likely not translate to great visibility.

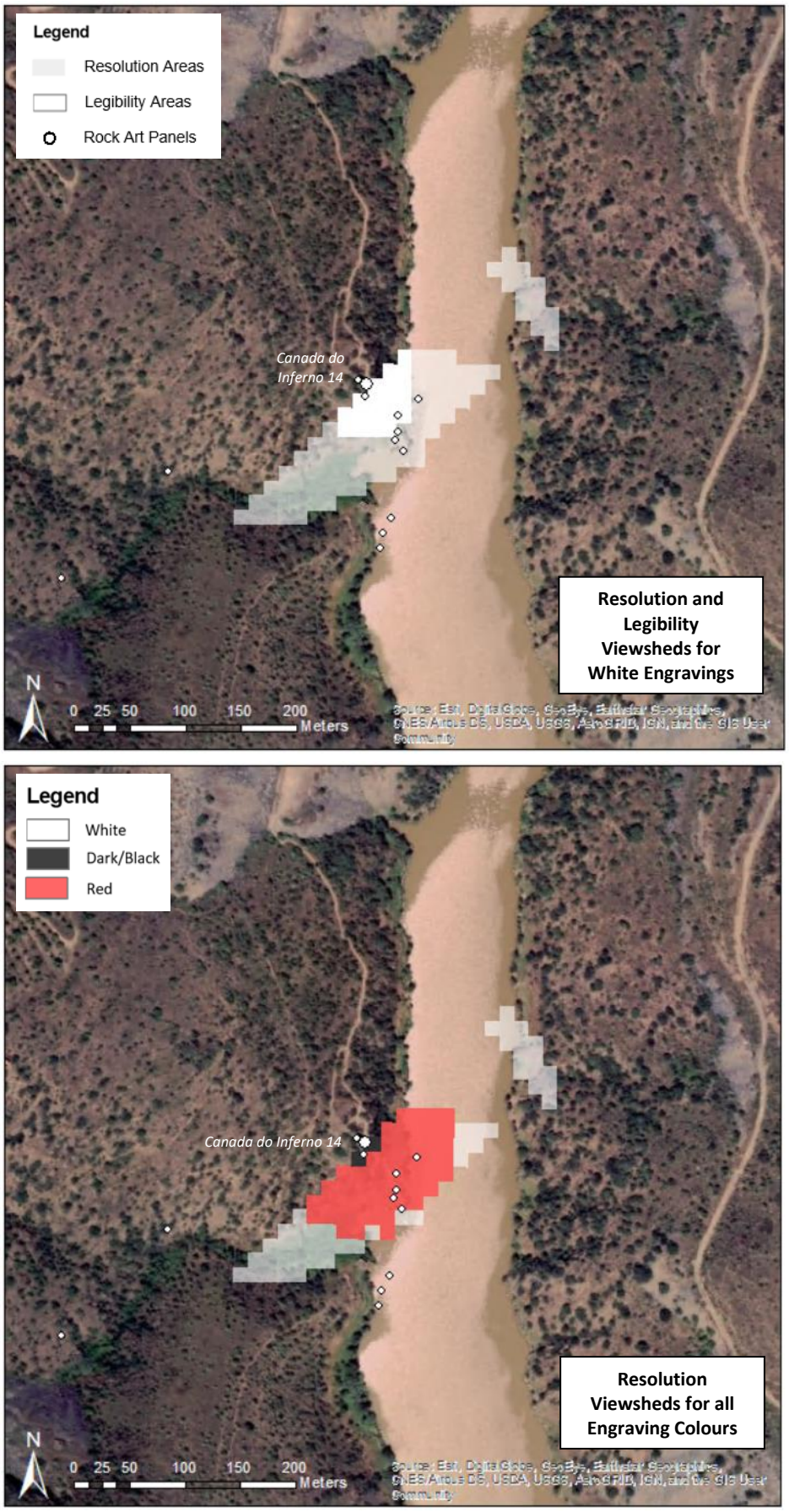


Figure 7.4.38.-7.4.39.: The created viewsheds for the established resolution and legibility ranges for white engravings at Canada do Inferno 14 (top) and coloured engravings (bottom).

Case Study Site 5: Canada da Moreira 7

(1) The panel's visual layout:

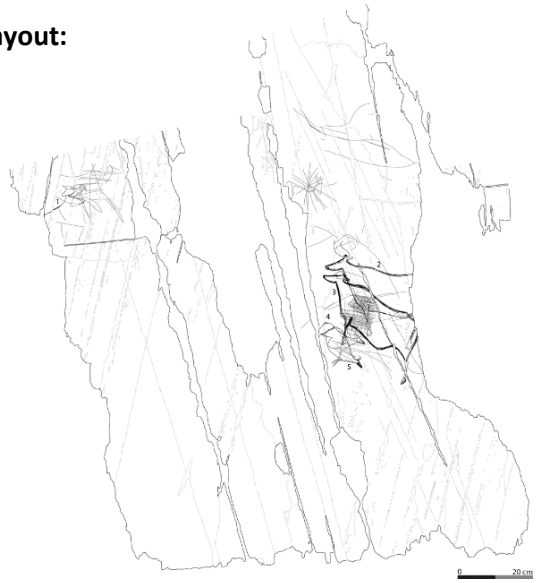


Figure 7.4.40.: Panel 7 of Canada da Moreira (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Canada do Moreira 7:

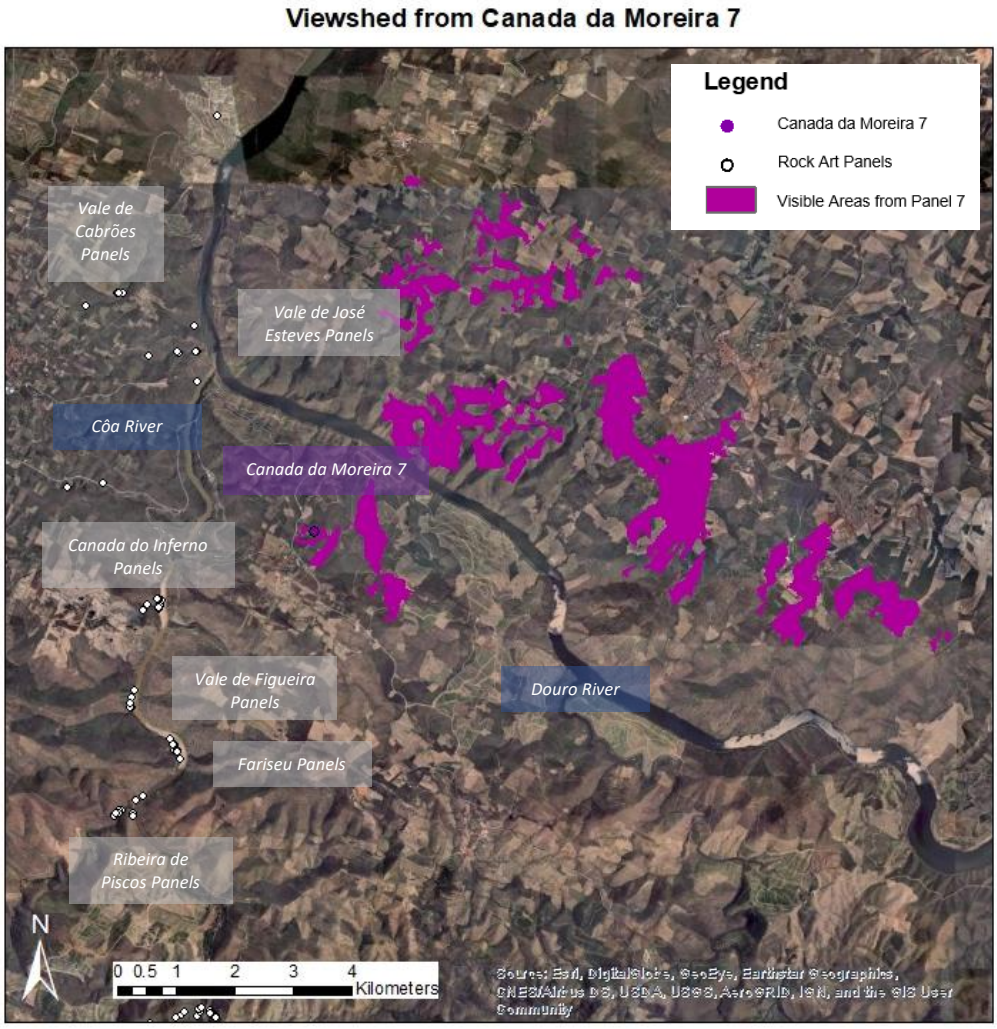


Figure 7.4.41.: The location of case study 5 (Canada da Moreira 7) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature points – observer 1:

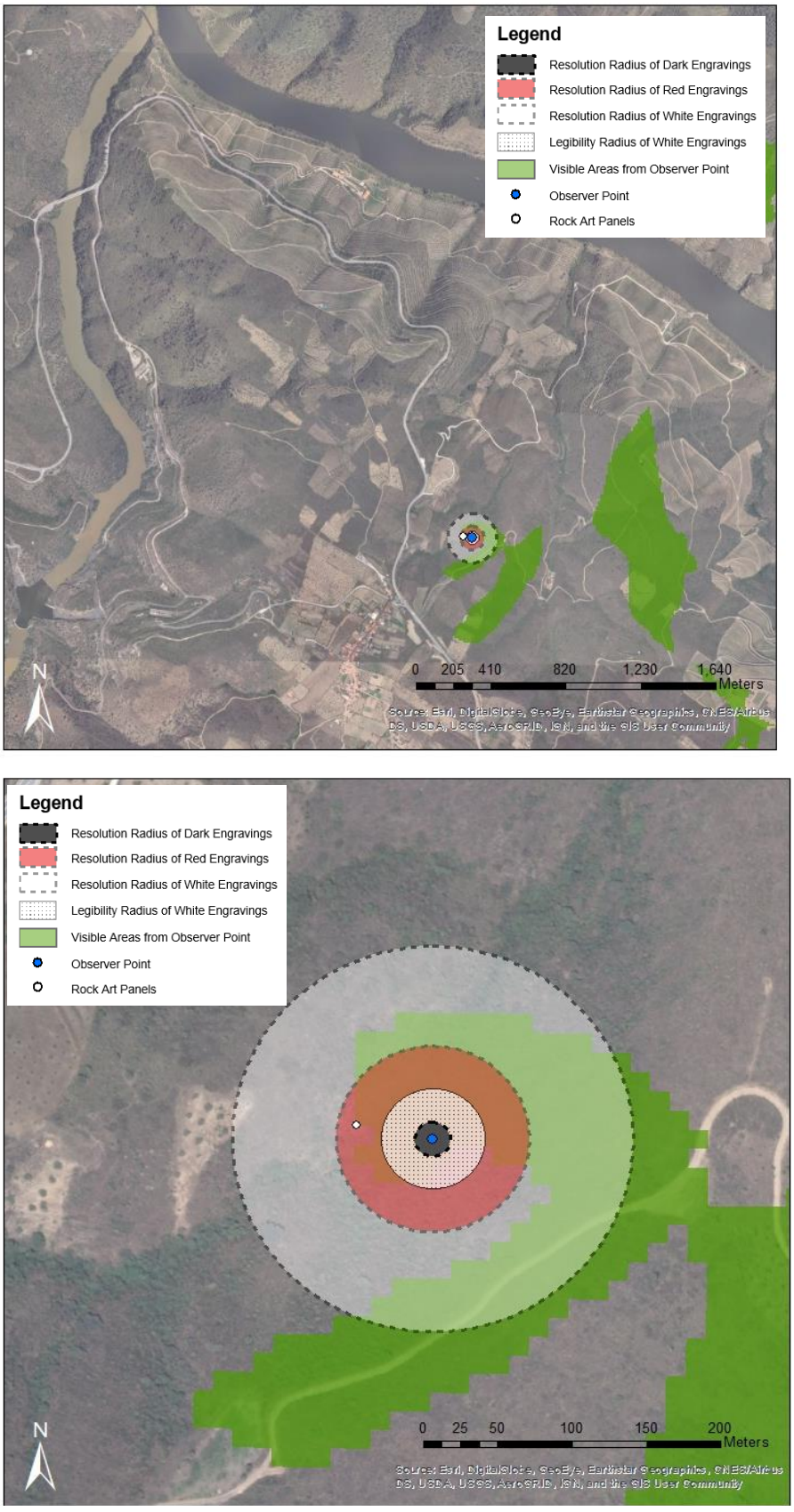


Figure 7.4.42.-7.4.43.: Observer Feature Point at Canada da Moreira. The top figure is a zoomed-out version of the bottom figure to show its embeddedness between the two rivers.

The rather unique location of the site of Canada da Moreira, in between the Côa and the Douro river, quite far away from any water edges (Fig. 7.4.41), begs for a close study. The green viewshed at the situated observer throws a sickle-like shape, which is also visible in the tailored resolution viewsheds in Fig. 7.4.44 on the next page. This shape allows viewers to stand at a peripheral position to the site and resolve it and legibly identify motif types at close quarters. Any locale in between these two visibility levels would obscure one's view of the panel. This again points to a specific movement pattern of audiences trying to navigate this location. In inspecting the visual layout of the panel, the isolated two converging deer motifs are reminiscent of the converging two rivers further north.

In line with this thought, the panel's facing direction is into the south-east, which would align audiences to point their gaze in the opposing north-westerly direction. This nicely aligning with the same direction as the uniting rivers. However, when taking this information together with Figure 7.4.41, the viewshed from the site does not direct peoples' attention to the merging waters, but rather towards to more north-easterly lying landscapes, across the larger Douro. So, whilst the panel might point audiences towards the location of where the Côa meets to Douro, the actual viewshed does not allow people to physically see this particular event. Instead, the viewshed diverts the attention towards wider mountainous ranges.

(4) Resolution and legibility viewsheds for Canada da Moreira:

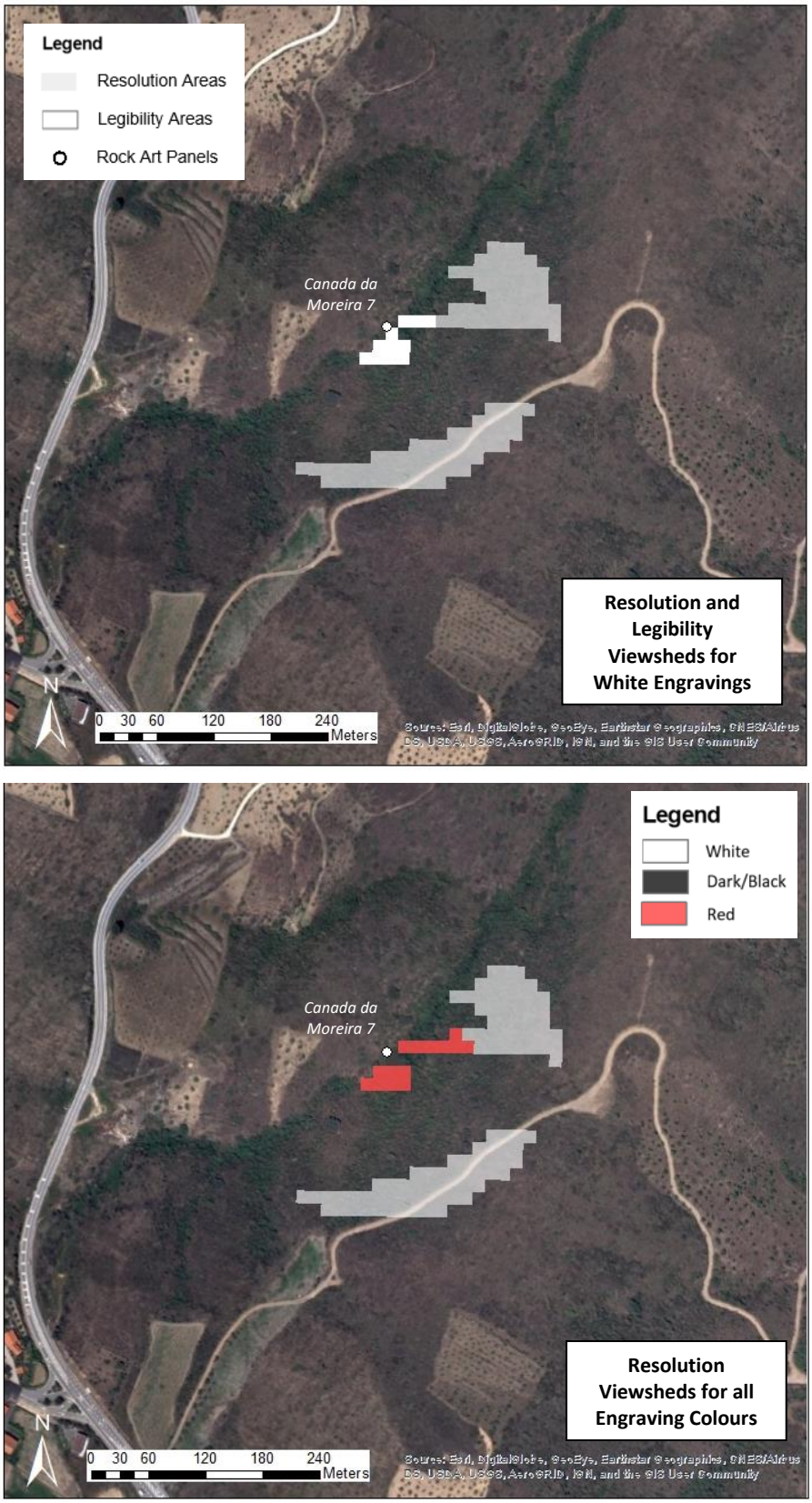


Figure 7.4.44.-7.4.45.: The created viewsheds for the established resolution and legibility ranges for white engravings at Canada da Moreira 7 (top) and coloured engravings (bottom).

Case Study Site 6: Vale de José Esteves 16

(1) The panel's visual layout:



Figure 7.4.46.: Panel 16 of Vale de José Esteves (drawing courtesy of Fundação Côa Parque).

(2) The overall viewshed for Vale de José Esteves 16:

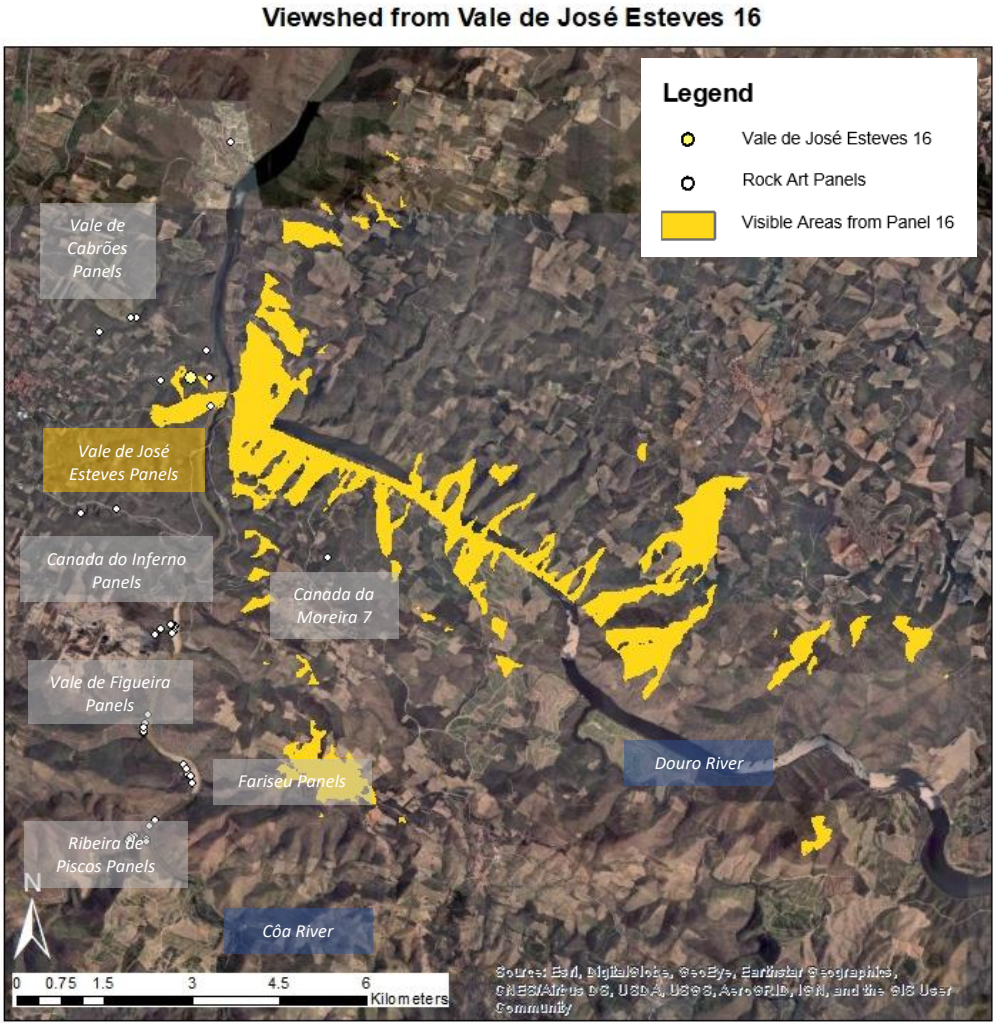


Figure 7.4.47.: The location of case study 6 (Vale de José Esteves 16) and its viewshed extent with surrounding sites marked for orientation.

(3) Inwards observer feature points – Observer 1:

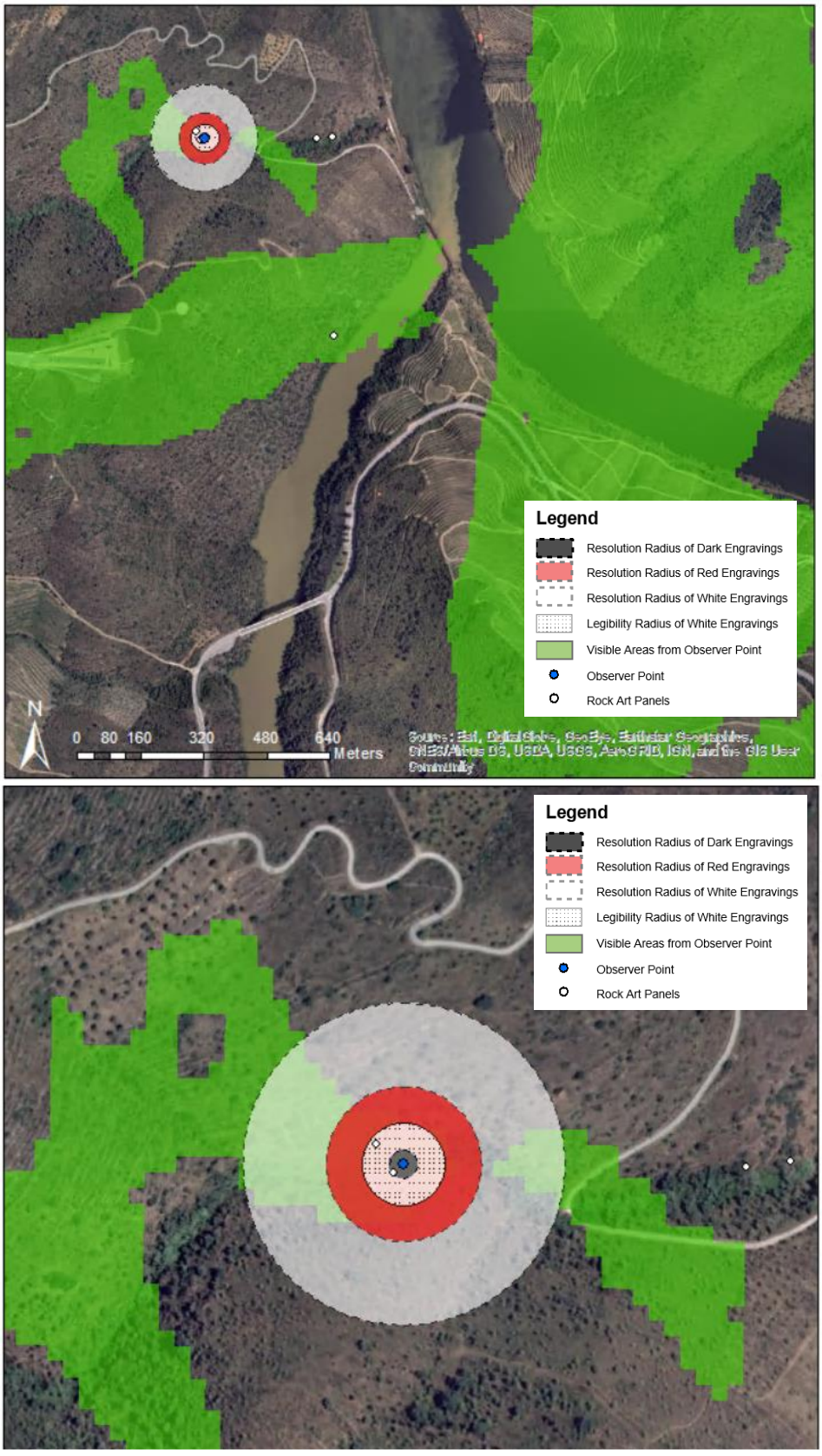


Figure 7.4.48.-7.4.49.: Observer Feature Point at Vale de José Esteves. The top figure is a zoomed-out version of the bottom figure to show its embeddedness between the two rivers.

(4) Resolution and legibility viewsheds for José Esteves 16:

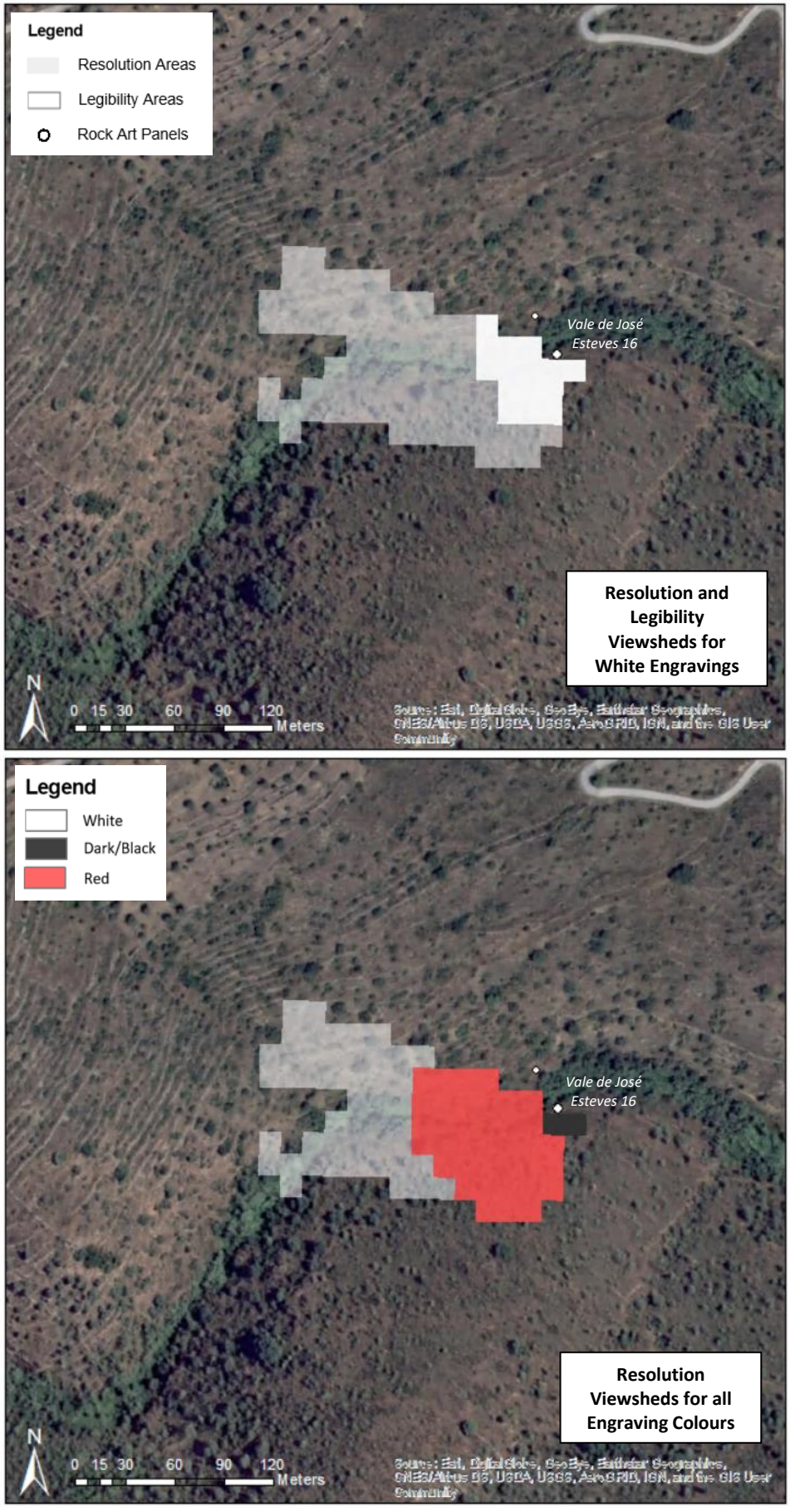


Figure 7.4.50.-7.4.51.: The created viewsheds for the established resolution and legibility ranges for white engravings at Vale de José Esteves 16 (top) and coloured engravings (bottom).

After inspecting the resulting figures generated for overall viewsheds, observer points and the resolution viewsheds, the most striking visual anomaly for this case study is the long stretched viewshed (yellow) which forms around the course of the Douro river (Fig. 7.4.47). As far as eyesight permits, an elongated stretch of the river will be visible from the location of Vale de José Esteves, which is a site, as it appears in Fig. 7.4.48-7.4.49, alongside a small tributary arm of the Douro. The panel choice for this case study depicts a deer herd (also described in Gestaltian Chapter 6), moving into a single direction, which might indicate that herd movements could have been visible from this site in the past, paralleling its sprawling (yellow) visibility extent.

Concluding the six case studies of this section

This section started with a description of viewsheds at Penascosa and Quinta da Barca, which illustrated the need for artists, art and audiences working in unison to maximise the best visual strategies to view these opposing sites. The consultation of two panels at Ribeira de Piscos offered a glimpse into how different viewsheds can be, even at a relatively tight-knitted rock art locale, with the 'kissing horse' panel 1 offering a very localised viewshed and panel 24 offering a broad-ranging fan-lie visibility range. Here public versus private dimensions were discussed, with a broader discussion on this debate following towards the end of the chapter. The next three case studies, located at Canada do Inferno, Canada da Moreira and Vale de José Esteves bore smaller ranging viewsheds and in each case, the visual displays on the panels seem indicative of what kind of audience it favours and what is to be viewed beyond the panel itself.

A few **active steps** have crystallised throughout the analysis process which seem to be **of advantage for the successful viewing expedition of rock art** in the Côa Valley, both in the past and nowadays:

1. Realising that Côa Valley rock art is connected through an intricate network of visibility.
2. Maintaining a close look at what is visible in one's vicinity.
3. Keeping up active/rapid eye-movements (saccades) across rock outcrops and throughout the landscape.
4. If applicable, exerting a degree of athleticism to reach rock art.
5. Bearing the geographically possible viewsheds and visually-possible resolution and legibility parameters in mind.
6. Allowing for an adjustment in dwelling time (depending on how pronounced the Gestaltian features appear) and visibility ranges at the more public and private sites.

Attentional selection

There are broadly three schools of thought when it comes to elucidating how people are attracted by visually salient stimuli. One such school, headed up by Posner in 1980 proposes that attention is *space-based,* akin to something like a theatre spotlight, whose beam moves through space with moving centres of interest as the scenes progress. On the other end of the spectrum lies a theory by Neisser (1967), that regards the attention of humans as being *object-based*, grounded in the idea that humans move through a "preattentive segmentations of visual scenes" in a way that jumps between familiar objects (ibid: 4). Another school of thought, pioneered by Baylis and Driver in 1992, is that of *feature-based attention.* That assumes that attention is connected to a particular feature of the things being viewed, for example in the form of a specific colour.

If applied to the way rock art would likely have been explored and viewed, facets of each approach seem to apply. Audiences scan their spaces for the initial availability of rocks for art (space-based), scan suitably-looking rocks based on factors such as materiality like schists and their alignments like a vertically facing surface (object-based) and then apply a feature-based attention approach to actually try and detect what is on display, with the likely help of the white residues left in the engravings. Hence, it seems wise to take a medium stance between these three attention mechanisms. Conversely, in a landscape already more familiar to observers, which we can assume to be applicable to Upper Palaeolithic hunter-gatherers, the *space-based* approach starts to become less important, since observers would simply start by looking for known objects rather than start by looking for more general features. Going back to the equation of *human + space = place*, relating this particularly to the knowledge base of Upper Palaeolithic inhabitants, one might want to term this approach *place-based attention.* Further testing, especially in combination with eye-tracking would be beneficial to rule out or move forward certain selection procedures.

7.4.4.3. Rock art visibility pixels across the entire study region

After the exposition into how these six different sites offer a variety of visible ranges from the point of a situated observer (inwards) and/or from the panel location (outwards), a further step is taken here that will quantify the visible ranges across a multitude of sites in the region. Whilst the previous sites offered an in-depth insight into distances towards rock art, pertaining to site-specific parameters such as their orientation and their present day bedrock colouration, and to engraving-specific parameters such as colouration of motifs and engraving techniques, this next step provides an empirical approach towards quantifying viewsheds from a much wider range of panel locations.

<u>Methodology – counting pixels</u>

The same methodological steps that were applied for the outwards panel approach are repurposed here. Yet, instead of presenting a specific symbology for each viewshed, merely the pixels that each viewshed creates, are being counted for a comparative analysis and are visually presented in the results section. Below is a screenshot from ArcMap 10.5 showing the data generation process, here specifying the pixel count (n=43) for the viewshed of resolving incisions on the nowadays greyish-brown panel of Penascosa 5:

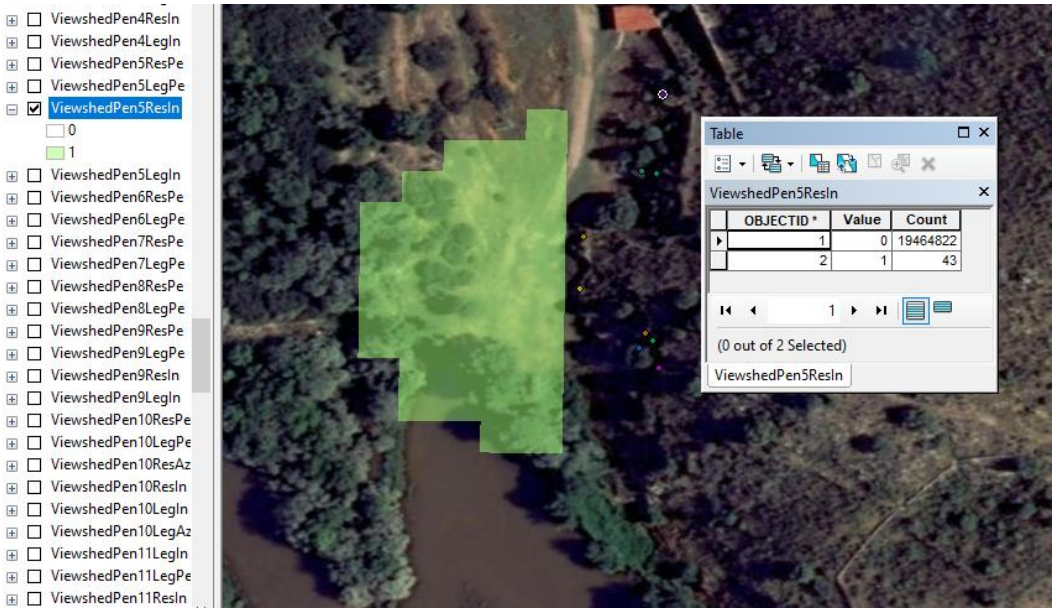


Figure 7.4.52.: A total of 43 pixels are counted at Penascosa 5, which are compared to the tailored viewshed pixels at 303 other sites, gaining an overview of visibility poor and rich areas in the Côa Valley.

Again, both an assumed 'past-grey' colouration and the bedrock colourations we find nowadays are being compared against each other, which will aid in further investigating whether the preservation of rocks and the conservation of their contained art and its visibility is noticeably changing over time. A note of caution has to be addressed here again similar to that given in

Chapter 6. 4.3, relating to our understanding of the actual colouration of the rocks in the past. Whilst a grey colouration is assumed for rock art slabs at the time, relating to the way rock Cambrian schist slabs get formed in the Desejosa formation (Meireles, 1997), it still is useful to understand how the colouration is able to change associated visibility distances and place making. Even if further research concluded that the rocks of the past were in fact similar to how we have them in front of us at present, this research will have touched upon all eventual potentialities, with no result suddenly becoming redundant due to new research advances.

Site selection

All sites described in Santos' thesis (2017) are being consulted, with the exception of sites for which (a) no GPS coordinates were available through Mario Reis; (b) the panel drawings were inconclusive about the panel's respective height off the ground deeming OFFSETA undeterminable; (c) the panel's engraving technique did not match those for which visibility ranges have been tested; (d) the panel's bedrock colouration was not noted. After the deduction of sites that fell into these exclusions, a total of 94 sites were left, a considerable number of cases which will yield a sufficient amount of data for an empirical comparison. A total of 304 viewsheds are created for the original bedrock colourations of the panels ranging from brown to reddish and yellow. Of these, there are 67 viewsheds for the resolution of pecking, 67 viewsheds for the legibility of pecking, 56 viewsheds for the resolution of incision, 56 viewsheds for the legibility of incision, 29 viewsheds for the resolution of Azilian-style depictions and 29 viewsheds for the legibility of Azilian-style depictions. One of the objectives for this chapter comprises of the factors surrounding visibility of rock art now and in the past. As has already been established in previous chapters and as the excavation of the 'fresh/*in-situ*' Fariseu panels indicate (Aubry and Sampaio, 2008), the colouration of the schist will have likely been much darker in the past when comparing it to the colourations of bedrock we are able to see nowadays. This leaves this section to investigate the change in rock colouration and its impact on visibility. This is further attended by the question of how quickly the rock art in itself degrades and fades, similar to what has been discussed in the analysis to the rock art superimposition study in chapter 6. Hence, the viewsheds for each site are being performed twice – one with their presumed original dark colouration and one with the colouration it adopts nowadays. This leads to a comparative analysis of such feature changes. Therefore, the same set of 304 of the earlier viewsheds are further generated assuming that the rocks will have been much greyer in the past, to learn more about the degradation of visibility over time. Hence, a total of 608 viewsheds are being generated, from which their individual pixel counts will subsequently be of comparative interest.

Input of visibility distances

The subsequent table (Table 7.16) houses the visibility distances recorded during fieldwork, for specific resolution and legibility levels of white engravings, made by pecking, incision or in Azilian-style, on a variety of background colourations as well as the ubiquitous grey schist colour of the past. Whilst the previous case studies examined how visible differently coloured pigments would be in their respective locations, this overall viewshed and pixel modelling, only bases its results on white residual pigmentations, as it was deemed to be most visible and likely solely used in rock art creation, unless of course, colour was part of a specific artistic strategy.

Visibility Parameters		Visibility Distances based on Engraving Technique		
		Pecking	**Incision**	**Azilian-Style**
Resolution of White Engravings on specified Bedrock Colouration	Brown	**69 m**	**47 m**	**55 m**
	Grey-Brown	**80 m**	**55 m**	**63 m**
	Orange-Brown	**67 m**	**46 m**	**55 m**
	Reddish-Brown	**74 m**	**47 m**	**57 m**
	Grey	**90 m**	**60 m**	**68 m**
Legibility of White Engravings on specified Bedrock Colouration	Brown	**14 m**	**8 m**	**16 m**
	Grey-Brown	**14 m**	**8 m**	**13.5 m**
	Orange-Brown	**16 m**	**9 m**	**15 m**
	Reddish-Brown	**12 m**	**8 m**	**15 m**
	Grey	**15 m**	**7 m**	**12 m**

Table 7.16.: GIS relevant information pertaining to the white visibility ranges (resolution and legibility) for all the pixel counting sites under consideration.

7.4.4.4. Results and analysis of the visibility pixels

Below is a screenshot (Table 7.17) of a selection of sites (here Penascosa has n=11 out of the total 304 site calculations) for which data on pixels has been gathered:

OBJECTID	SITENAME	FEATURE	RADIUS2	OFFSETA	OFFSETB	AZIMUTH	Pixel Count Then	Pixel Count Now	Pixel Difference	PD%
113	Penascosa 1	ResPe	90	0.9	1.75	180	115	64	51	44.3478
115	Penascosa 2	ResPe	90	0.8	1.75	180	120	70	50	41.6667
117	Penascosa 3	ResPe	90	0.85	1.75	180	121	71	50	41.3223
121	Penascosa 4	ResPe	90	0.7	1.75	180	115	89	26	22.6087
125	Penascosa 5	ResPe	90	1.7	1.75	180	120	94	26	21.6667
129	Penascosa 6	ResPe	90	1.8	1.75	180	130	76	54	41.5385
131	Penascosa 7	ResPe	90	0.3	1.75	180	120	82	38	31.6667
133	Penascosa 8	ResPe	90	1.2	1.75	180	122	96	26	21.3115
135	Penascosa 9	ResPe	90	1.5	1.75	180	124	84	40	32.2581
139	Penascosa 10	ResPe	90	2.8	1.75	225	95	68	27	28.4211
145	Penascosa 11	ResPe	90	1.5	1.75	270	75	52	23	30.6667

Table 7.17.: Data outputs for pixel counts then (during the Upper Palaeolithic based on grey colouration) and pixel counts now (the shade of the schist nowadays).

These results lend themselves nicely to simple statistical tests performed to understand the differences between resolution and legibility levels in different areas of the Côa, as well as the difference that engraving techniques have on wide-spread visibility. In fact, the collected data offers opportunities to discuss how different variables act in each other's company, which when averaged, reveal their influencing behaviours. Hence, the following graphs group a set of variables, average them and assess their interconnectedness. To begin with, there are a couple of acronyms used throughout the next written analysis, which are clarified below:

Pixel calculations:

Pixel Count (PC) Then – Pixel Counts based on Upper Palaeolithic Bedrock Colouration

Pixel Count (PC) Now – Pixel Counts based on Modern Bedrock Colouration

PD – Pixel Difference

Visibility parameters:

Res/LegPe – Resolution or Legibility Distances of Pecked Engravings

Res/LegIn – Resolution or Legibility Distances of Incised Engravings

Res/LegAz – Resolution or Legibility Distances of Azilian-Style Engravings

The *PC Then* range stretches from 0-134 across all visibility parameters, whilst the *PC Now* range features pixels from 0-106. The following Box and Whisker plots (Fig. 7.4.53-54) summarise this data (Table 7.18):

	Pixel Count Then	Pixel Count Now
Minimum	0	0
Q_1:	2	2
Median:	7	7.5
Q_3:	54	41.5
Maximum:	134	106

Table 7.18.: Data input for overall visibility box and whisker plots for pixel counts now and then.

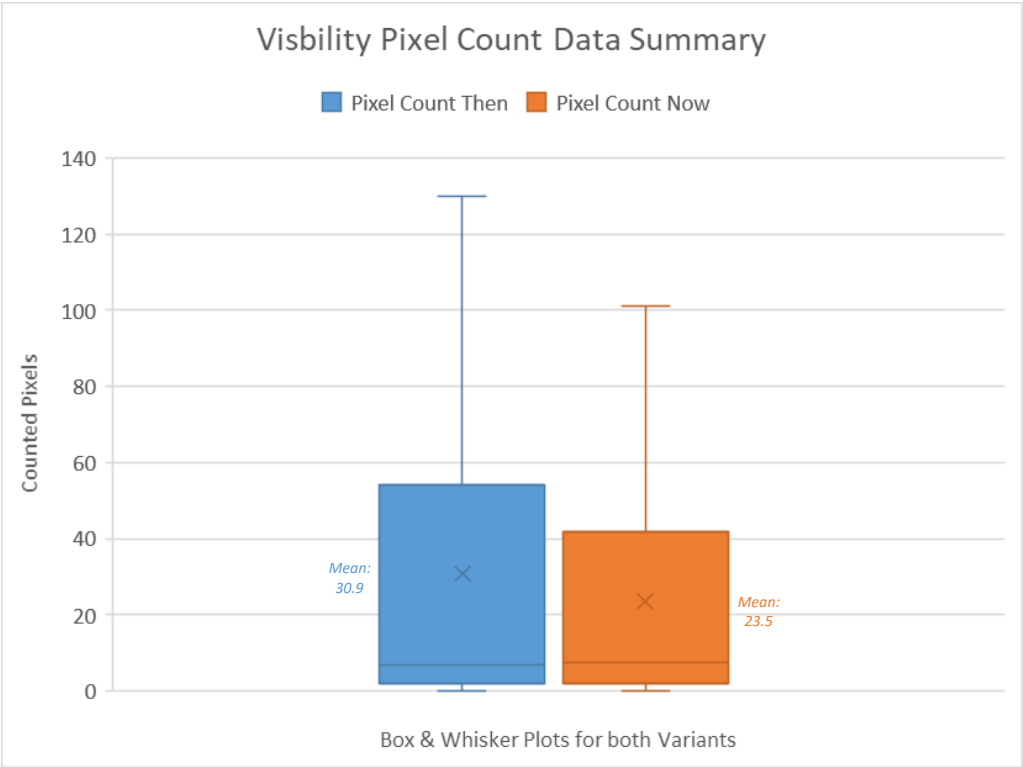


Figure 7.4.53.: Box and whisker plots summarising the range of pixel calculations now and in the Upper Palaeolithic.

The boxplots below delve deeper into the pixel counts (now and then) separated for each of the different engraving types. This allows to assess the differences in overall technique visibility independently of individual sites.

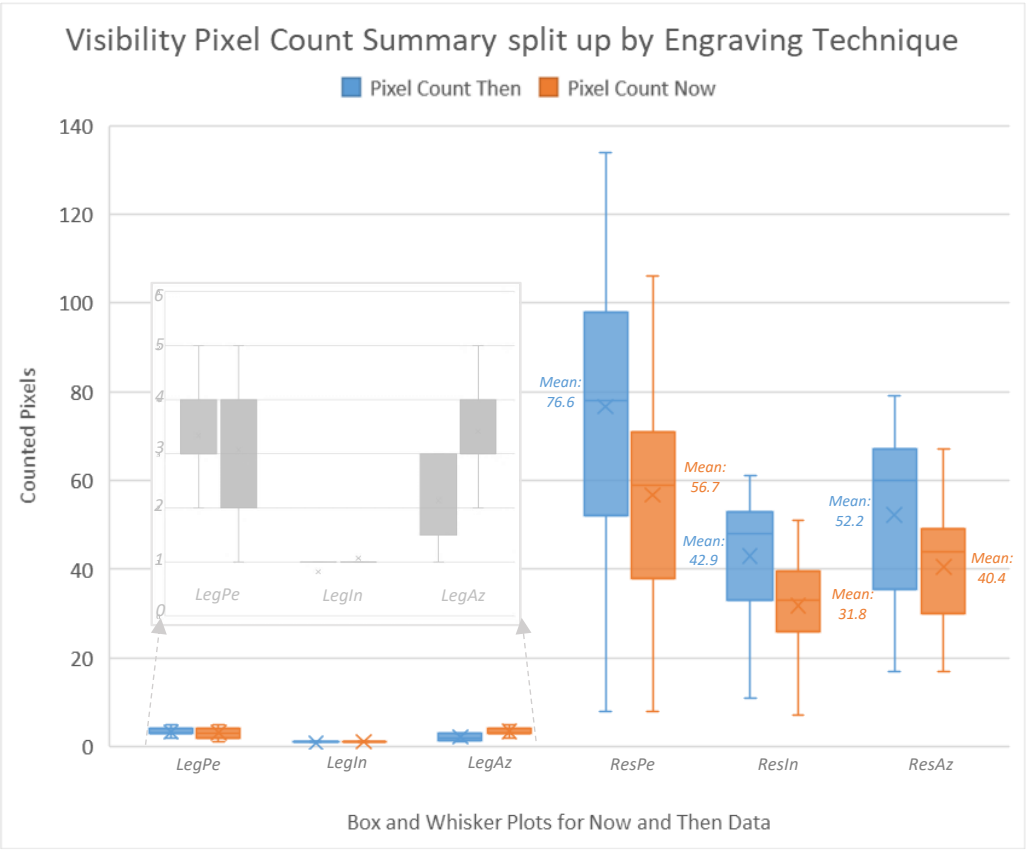


Figure 7.4.54.: Box and whisker plots (legibility data on the left, resolution data on the right) summarising the range of pixel calculations based on engraving techniques now and in the Upper Palaeolithic.

The mean value, highlighted in each of the two preceding graphs, are worthy of comparison. These values, on a general scale, are the average amounts of pixels visible at the sites under study. When all data is combined (Fig. 7.4.53), a decrease in pixel count by approximately 7 pixels is recorded between the Upper Palaeolithic bedrock colouration and the colourations that the schist slabs bear nowadays. Whilst this does not seem very much, one only needs to look at figures for the legibility means (Fig. 7.4.54) to realise that their average values lie at 3.5, meaning that a decrease of 7 pixels would, colloquially, 'make or break' the difference between resolution and legibility ranges. This means that **with continuous degradation of rock surfaces, rock art visibility decreases over time**, urging for the necessity of strict conservation measures going forward (cf. Batarda Fernandes, 2008).

A similar trend can be analysed when looking at the difference in pixel counts between the different engraving techniques applied throughout the Côa territory. Not only can a basic change (largely decrease) in time (i.e. discolouration and drop in visibility of now to then data) be observed, but also can individual difference be noticed when looking specifically at the engraving types themselves. In a more specific consideration of these differences, Figure 7.4.54. regards the differences in pixel count by engraving techniques. It quickly becomes apparent that the ResPe group is most visible, which naturally matches up with the data collected in the previous experiment on visibility of engraving techniques. It also shows that for the Res group, the *Then* and *Now* trends follow a similar pattern, namely a common decrease in ~10 pixels counted for these instances. When inspecting the Leg group, the difference is not so uniform (cf. the zoomed-in box of Fig. 7.4.54). So, for instance, whilst there is a slight decrease in the mean for LegPe results and an even slighter decrease for the LegIn results, there appears to be an increase of mean data (as all other box and whisker data plotted) for the LegAz pixels. It has to be mentioned here, however, that the data for legibility pixels frequently circulates around the 0-1 pixel mark with a box plot maximum of only 5 pixels, which of course strongly deviates from the range of data displayed for the Res group.

Nevertheless, the positive uptake in pixel counts for Azilian engravings is intriguing. This difference in mean values between the different engraving techniques being impacted by the colouration of the schist, is further illustrated in the next graph (Fig. 7.4.55). It compares the mean differences based on the raw pixel counts and their averages, which reveals how much of an influence the rock colour actually has.

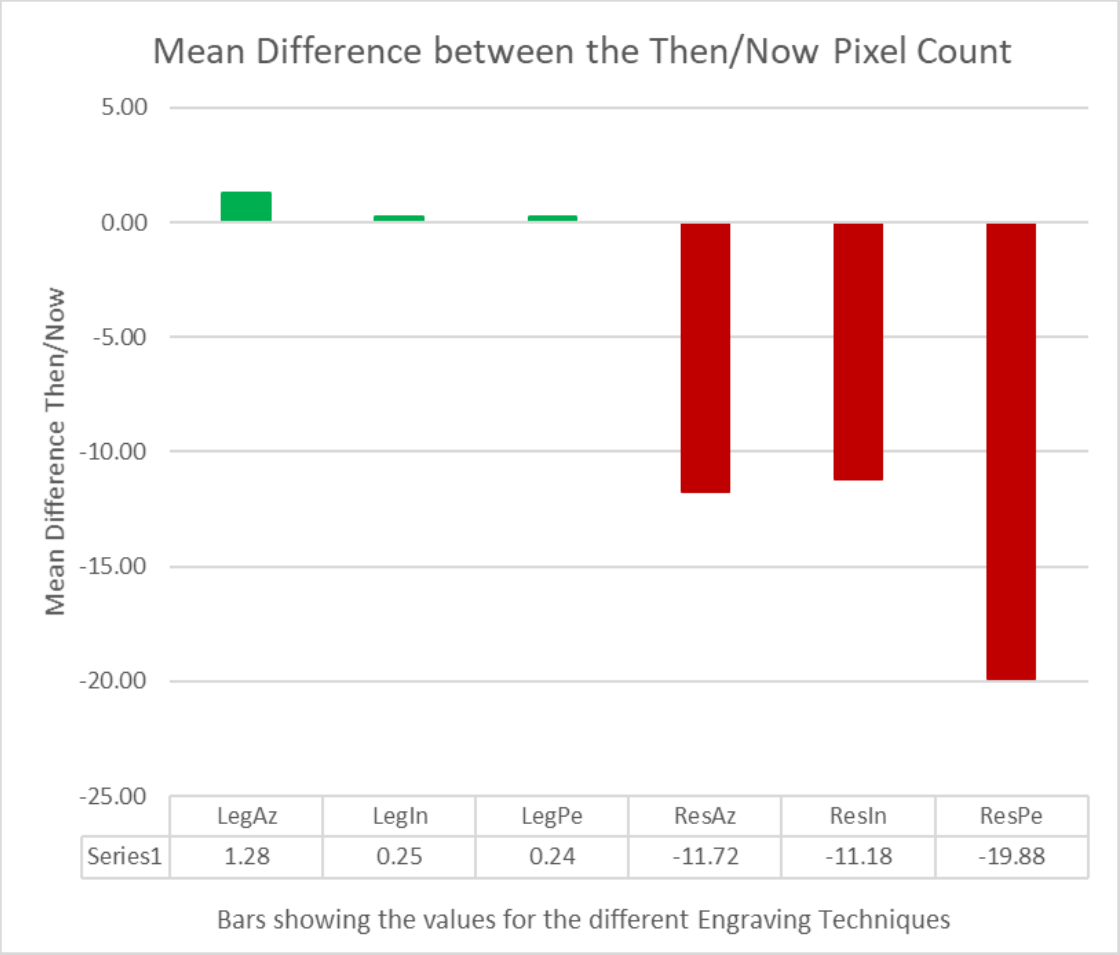


Figure 7.4.55.: Bar graphs showing the mean difference of pixel count change between now and then based on the different engraving techniques. A positive (green) pixel count is noted in the legibility group and a large negative (red) pixel count is noted for the resolution group.

The bar graph above (Fig. 7.4.55) shows the mean difference between the then and now pixel count, with the legibility group values in green (meaning a positive pixel difference between then and now) and the resolution values in red (meaning a negative pixel difference between then and now). The graph nicely illustrates the effect colour or rather discolouration has on both legibility and resolution visibility ranges in the study area. Whilst the ability to resolve rock art seems to decrease significantly over time, legibility levels (ones one is closer at the rock art to actually identify the species on display) increase with the discolouration of the schist. Whilst this has detrimental effects on our modern ability to detect (resolve) rock art in the first place, the closer (legible) readings of rock art once one knows where the rock art is, is positively affected, albeit by a very small margin. Yet, why the Azilian grouping stands out as being particularly visible with a change in rock colour, still remains an open debate. Potentially, its detailed, striated nature makes legibility in close quarters increase rather than decrease in time.

Additionally, the same set of data can also be presented using the values for their percentage change, which is useful as it shows the real difference, independent of the total pixel variable (Fig. 7.4.56). This calculation will reveal, in return, which specific resolution type is affected most by a change in bedrock colour.

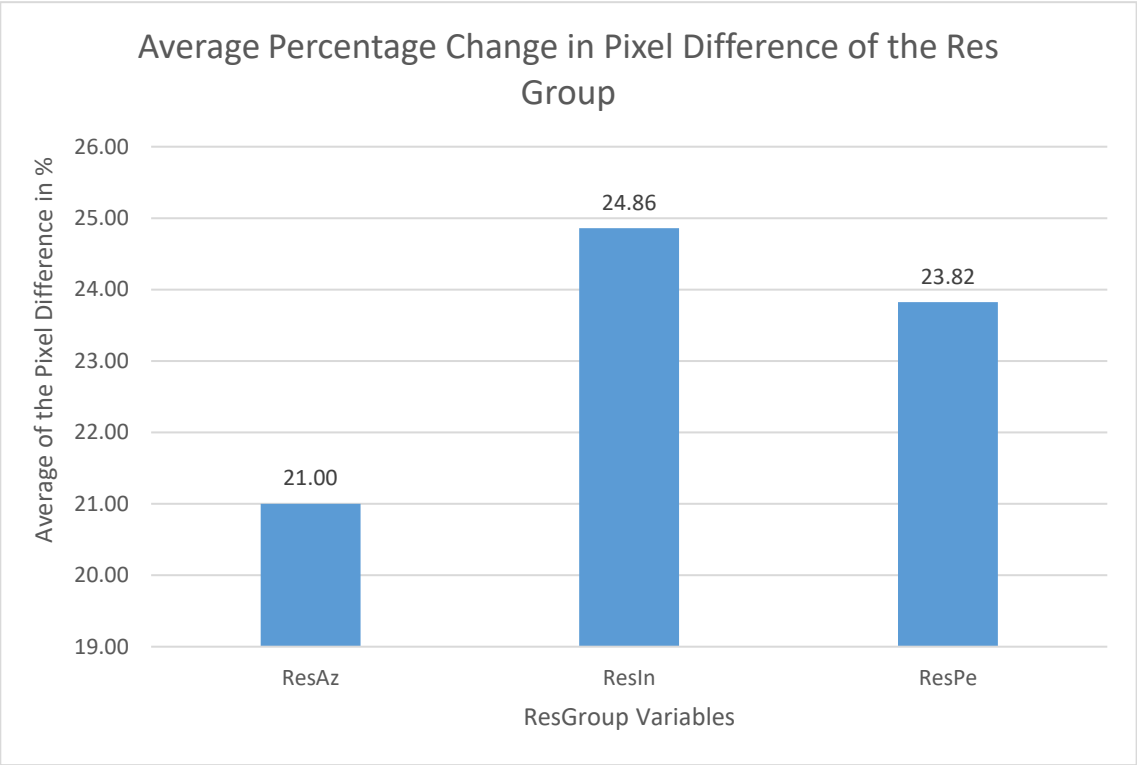


Figure 7.4.56.: Bar graphs illustrating the percentage difference in average pixel counts between the Upper Palaeolithic and now.

The data above demonstrates that, in fact, **the ResIn group is most affected by and most susceptible to colour change**, even though the total number of pixels changed is highest in the ResPe group (cf. Fig. 7.4.55). This is because the ResPe group is generally most visible, so, largely, has more pixels to change, which is different for the ResIn group, which is least visible amongst the Res group variables (cf. ibid). The ResAz type seems least affected by colour changes.

There are a couple of groupings that can be undertaken to test the validity of the methodological technique employed in this section. Whilst this does not produce any valuable result in terms of the influences of colours on the number of pixels, it is nevertheless an important tool to verify the workings behind this approach. For instance, can the OFFSETA range (that is the value that corresponds to the location (height) of rock art on a specific panel), be set against the Pixel Count for both time periods (aka bedrock colourations). This should, if the data was collated correctly, reveal a positive trendline, since an increase in the panels median height of the engravings should also increase the pixel count and thus its wider visibility in the region. The graphs below corroborate this trend, both for the PC Then (Fig. 7.4.57) and the PC Now (Fig. 7.4.58). The trendline is relatively weak in both cases, which is very likely due to the fact that the values of the OFFSET range are quite small in comparison to the overall resolution of the DEM and its associated changes in the landscape characteristics.

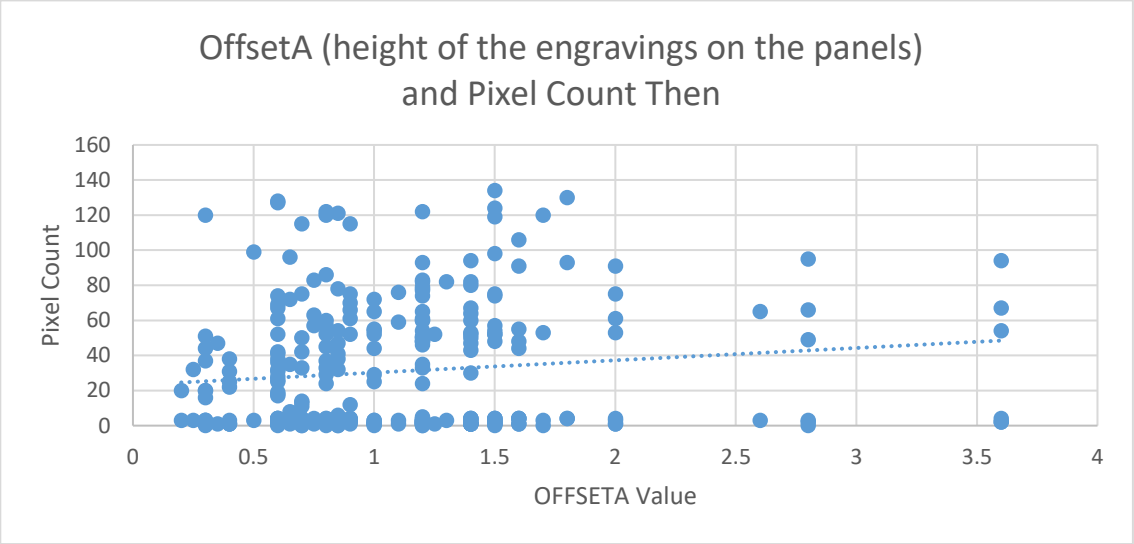


Figure 7.4.57.: Scatter graph relating OffsetA with pixel counts then.

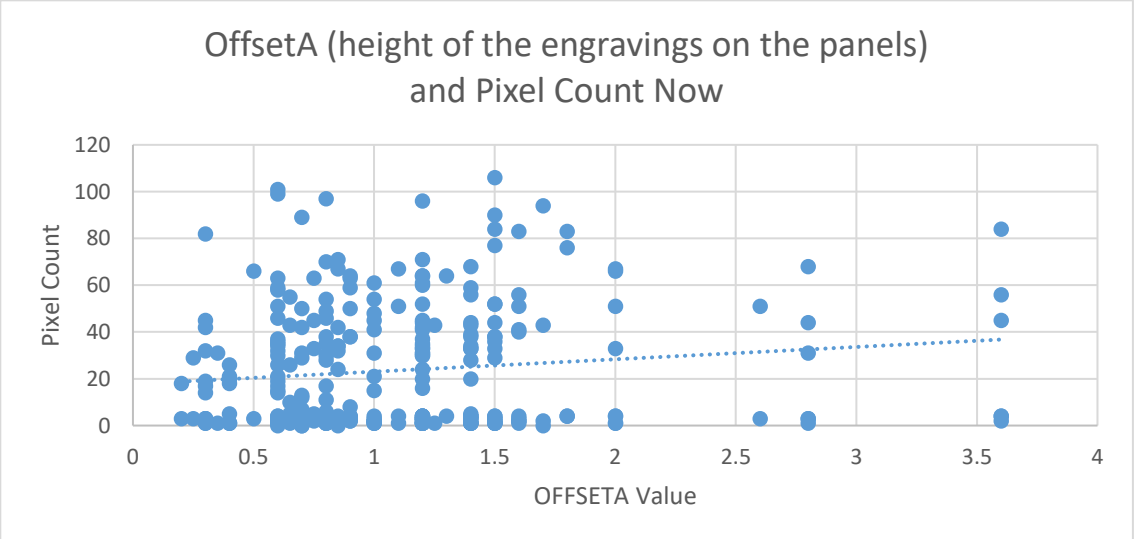


Figure 7.4.58.: Scatter graph relating OffsetA with pixel counts now.

Another set of groupings compares the calculated visibility radius versus the pixel counts. This tests whether there is actually a positive trend, which should be the case, between an increase in radius count correlating to an increase in pixel count. The graphs below (Fig. 7.4.59-7.4.60) illustrate an increase in the range of pixel values with increasing radius size. Again, this scatter is not surprising since the viewsheds that are created with larger radii naturally exhibit more available pixels, which are likely or not likely to be seen. Furthermore, the large spread of pixel counts that the 90m resolution radii offer, shows that the Côa Valley is comprised of a large range of landscape compositions and that all sites, uniquely situated in their own geographies, generate a multitude of visibility ranges. These individual pixel variations are able to foreshadow the tendencies in the forthcoming private-public audience debate.

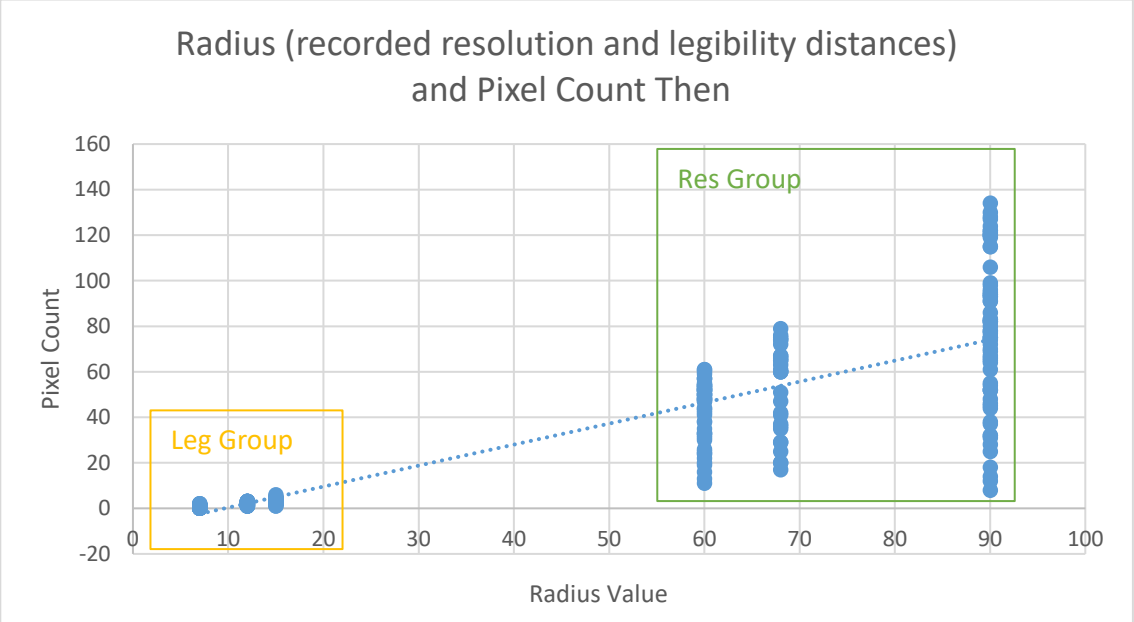


Figure 7.4.59.: Scatter graph relating radius values with pixel counts then.

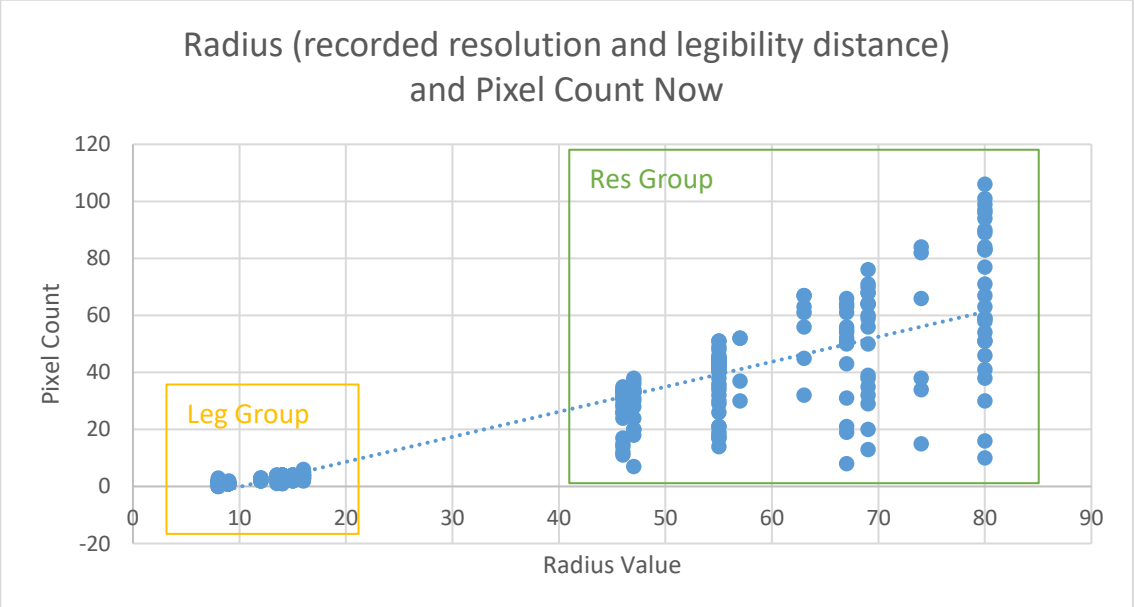


Figure 7.4.60.: Scatter graph relating radius values with pixel counts now.

Individual site visibility

While quite a few more groupings could be made and its connections be used to infer the validity of this approach, the following last set of analyses will likely be of most interest to the reader at this point – which is the distribution of the visibility pixels across the Côa region as a whole. The initial intention was to create pie charts on a GIS map showing the differences in site visibilities across the region, both representing the visible pixels at each site and the non-visible pixels. However, due to the fact that the maximum pixel count for the entire DEM is extremely high (n=19464865 pixels) in comparison to the often times high conglomeration of pixels in the box plots' lower quartiles (i.e. many low pixel counts such as N=0 or N=1; cf. Fig. 7.4.53 and 7.4.54), a percentage plotting of these numbers seems entirely counterproductive, as this would result in miniscule percentages of visible pixels and their display not worthwhile.

Instead of using the absolute pixel count available and relating the visible pixels at each site, the pie charts in the following maps will use the highest number of visible pixels recorded (n=134 for ResPe; n=61 for ResIn and n=79 for ResAz) as the common denominator in calculating individual site percentages. Therefore, there will be one site, which bears a full pie chart as it will have 134/134 (or 61/61; 79/79) pixels visible, to which the rest of the charts will then be compared to. Furthermore, instead of having one graph with crowded 304 pie charts, the following figures (Fig. 7.4.61-7.4.68) are split up by region and Res groups to make comparison easier. Hence for easy understanding of these graphs, a whole green pie chart indicates the maximum that any site within that Res group is able to see (one could think of these 100% green charts as *visibility type sites* for the area). When red slices appear in the charts, the sites' visible area is then comparatively lower than at the type site and one can sense how far any of the non-type sites are approaching the maximum value. Type sites are marked with a blue box in the following figures and its features can be assessed in Appendix F. Legibility charts were not constructed due to their low type site denominator values, making comparisons largely redundant.

Individual site visibility - resolution of pecked engravings (then)

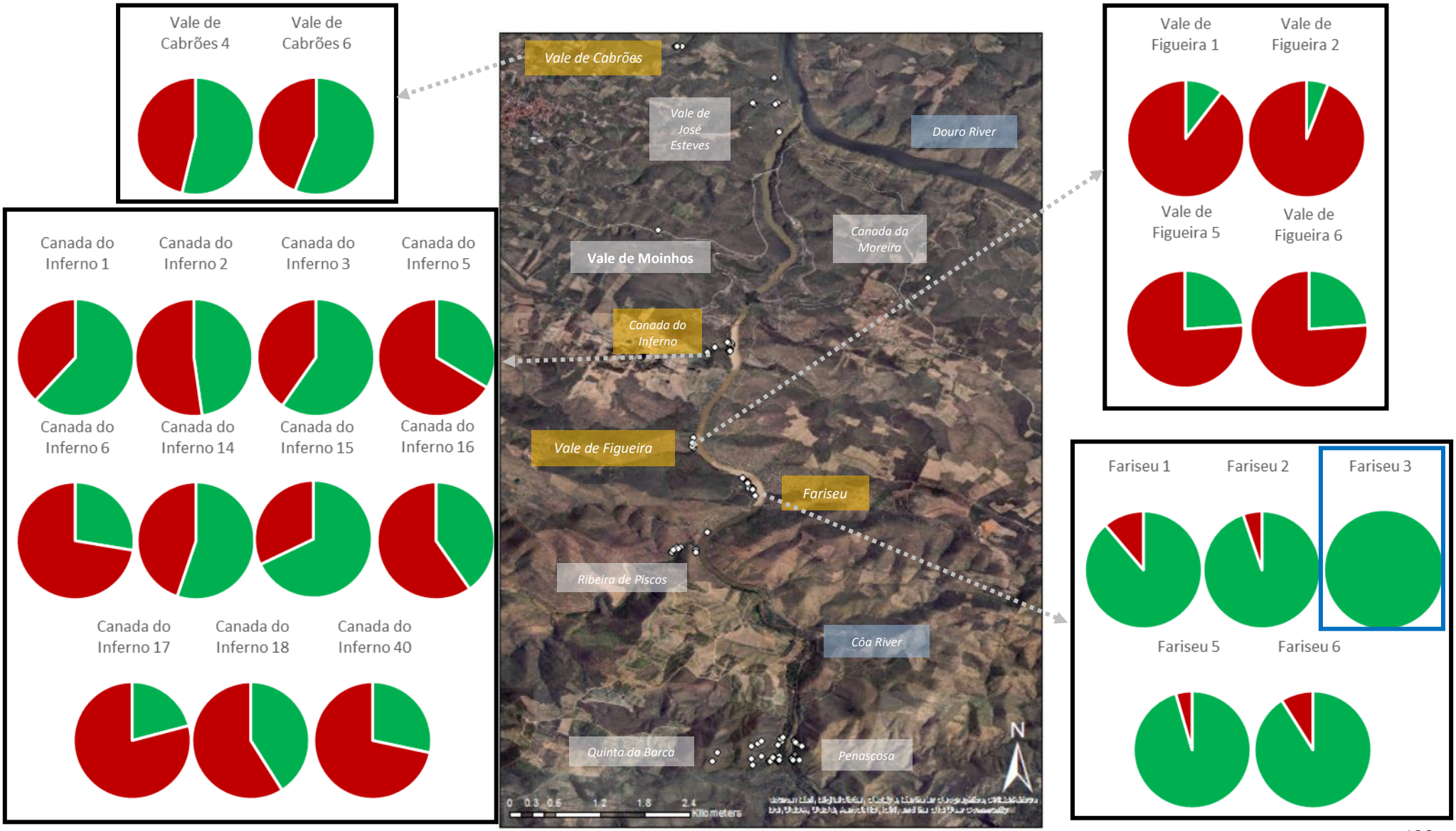


Figure 7.4.61.: Map showing Visible/Non-Visible Pixel Pie Charts for ResPe at Vale de Cabrões, Canada do Inferno and Vale de Figueira.

Individual site visibility - resolution of pecked engravings (then)

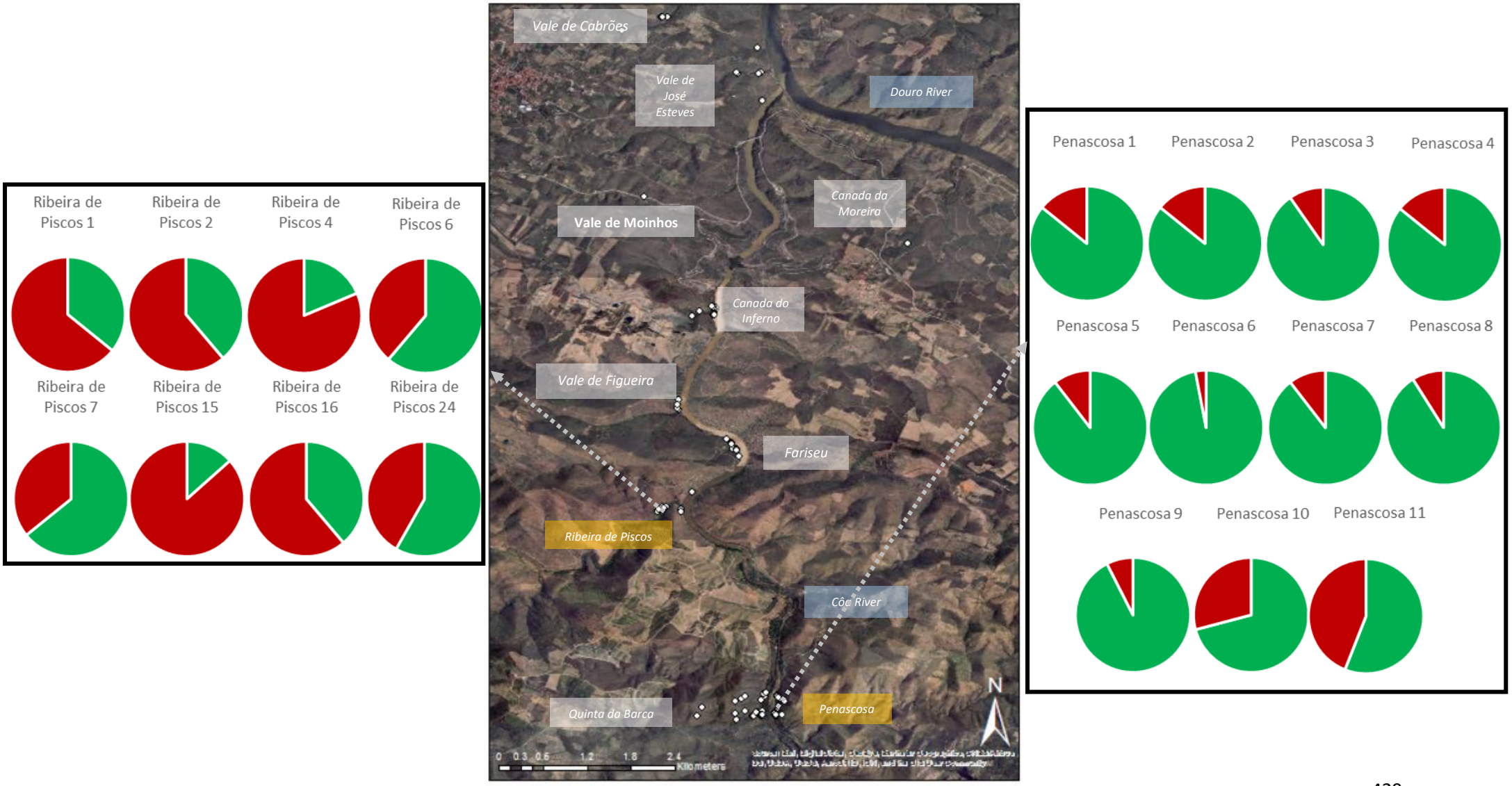


Figure 7.4.62.: Map showing Visible/Non-Visible Pixel Pie Charts for ResPe at Ribeira de Piscos and Penascosa.

Individual site visibility - resolution of pecked engravings (then)

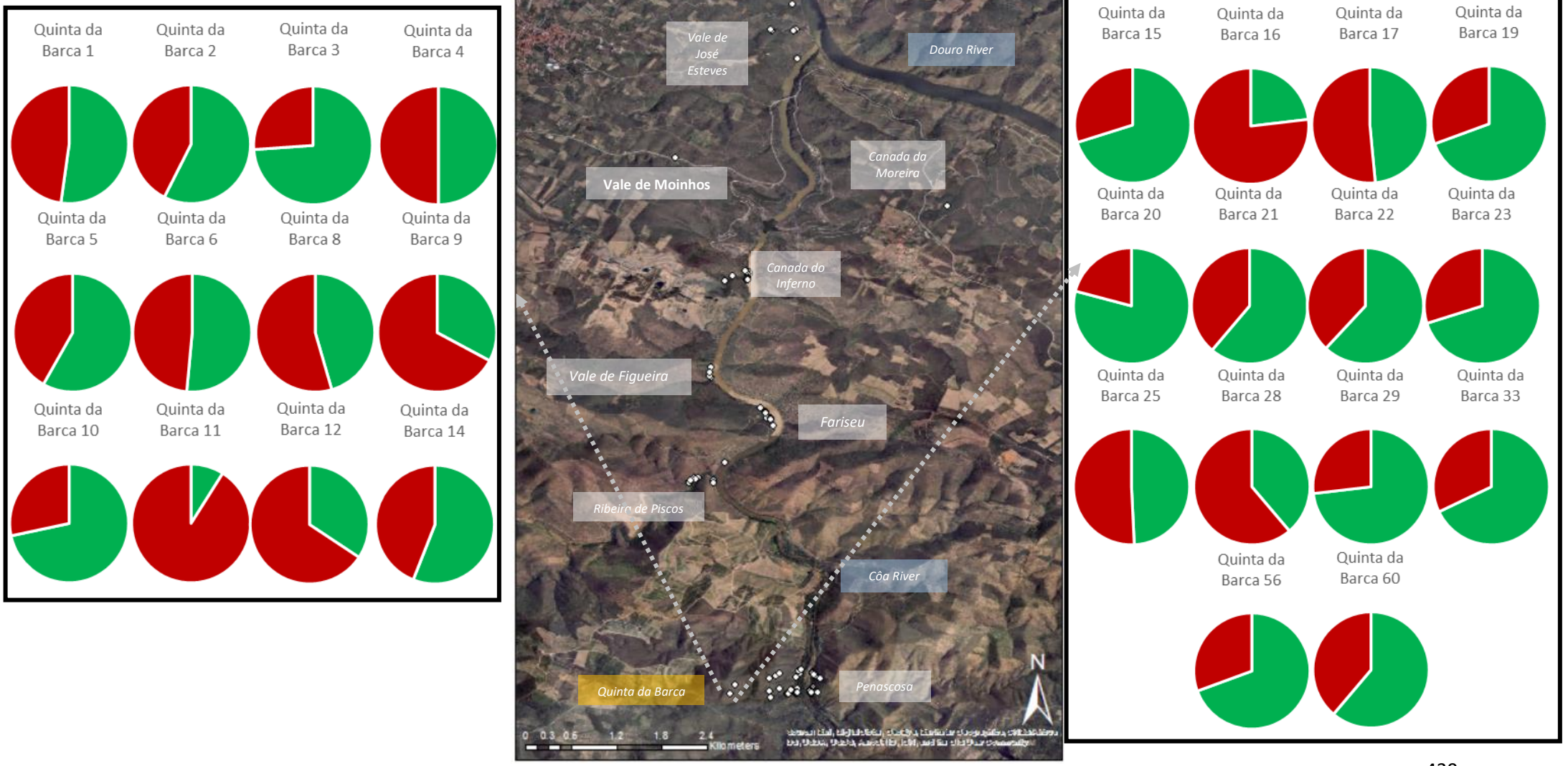


Figure 7.4.63.: Map showing Visible/Non-Visible Pixel Pie Charts for ResPe at Quinta da Barca.

Individual site visibility - resolution of incised engravings (then)

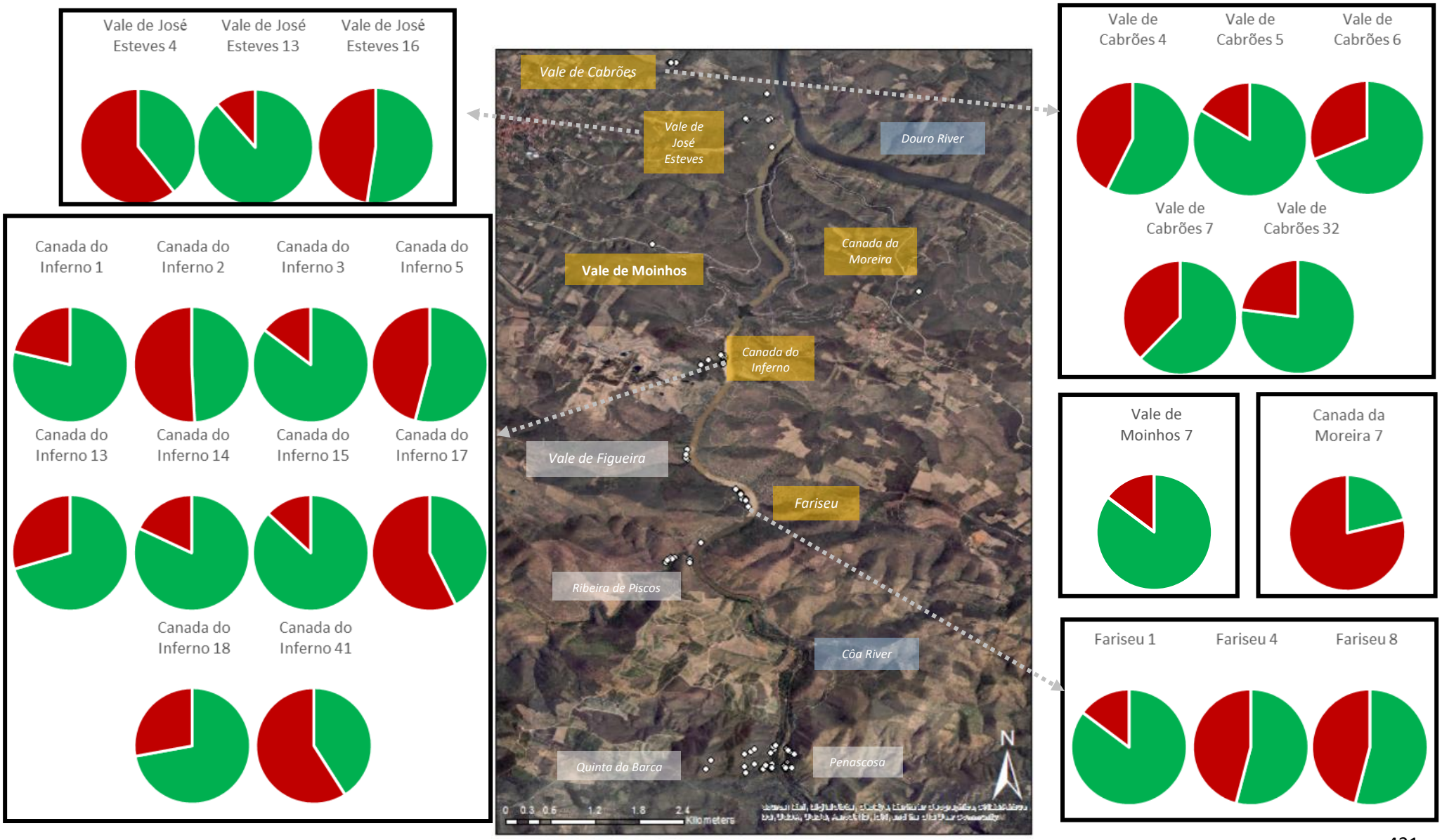


Figure 7.4.64.: Map showing Visible/Non-Visible Pixel Pie Charts for ResIn at Vale de José Esteves, Vale de Cabrões, Canada do Inferno, Vale de Moinhos, Canada da Moreira and Fariseu.

Individual site visibility - resolution of incised engravings (then)

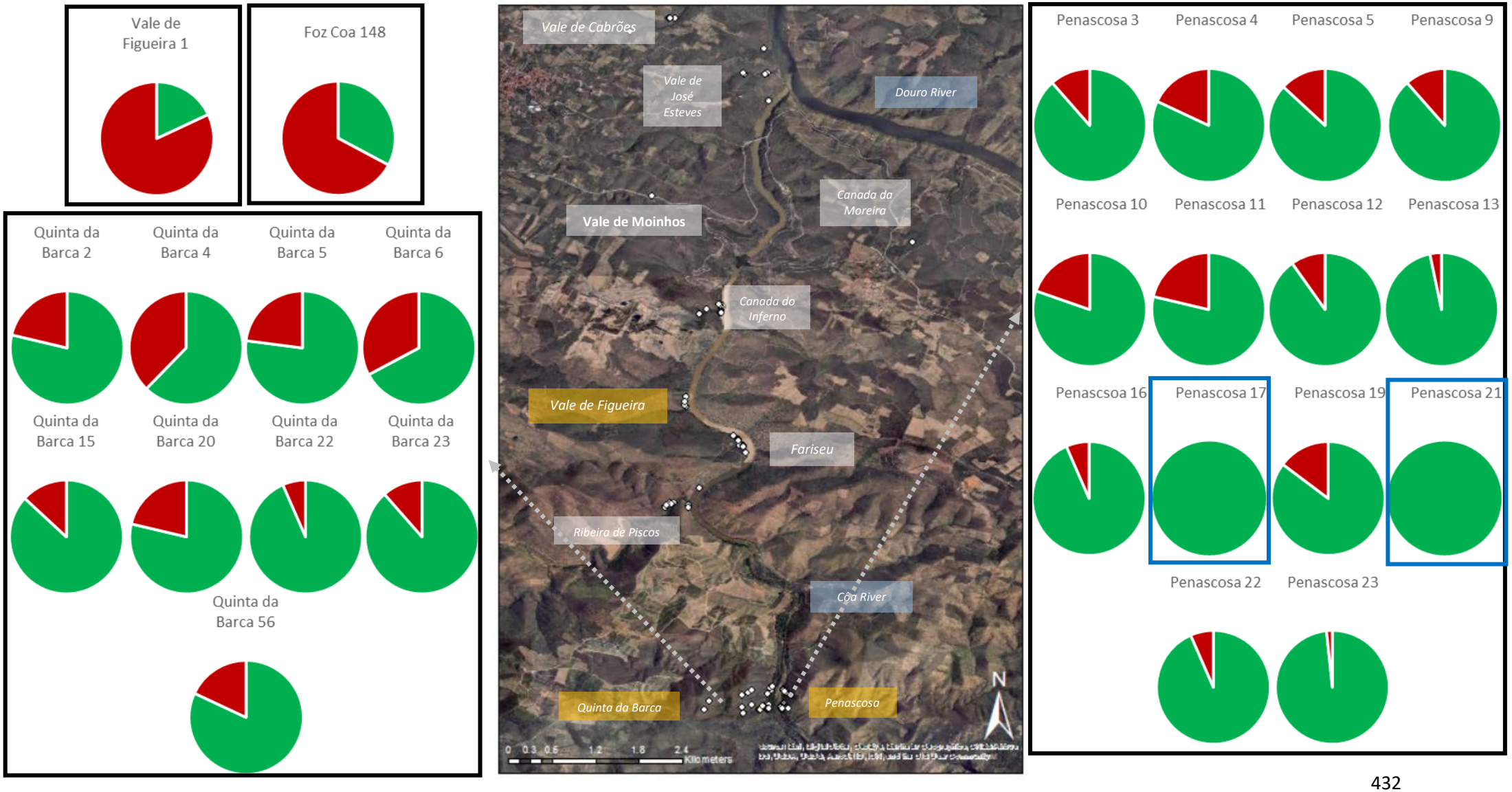


Figure 7.4.65.: Map showing Visible/Non-Visible Pixel Pie Charts for ResIn at Vale de Figueira, Quinta da Barca and Penascosa.

Individual site visibility - resolution of incised engravings (then)

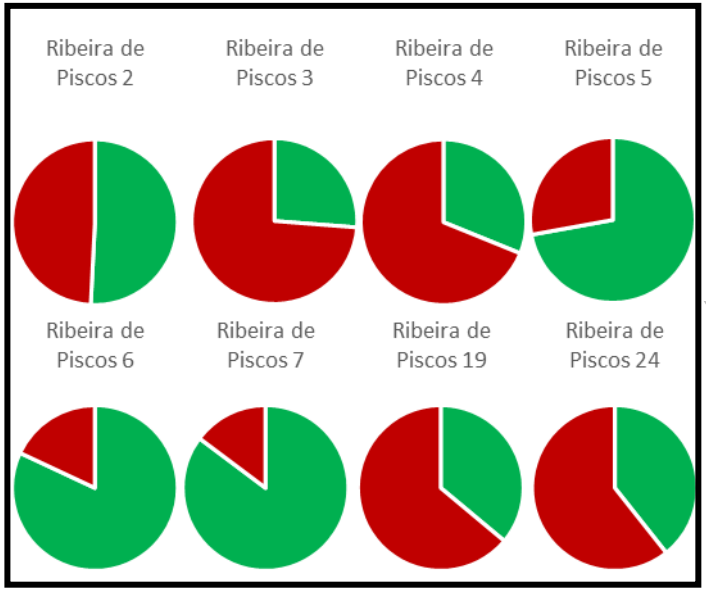




Figure 7.4.66.: Map showing Visible/Non-Visible Pixel Pie Charts for ResIn at Ribeira de Piscos.

Individual site visibility - resolution of Azilian-style engravings (then)

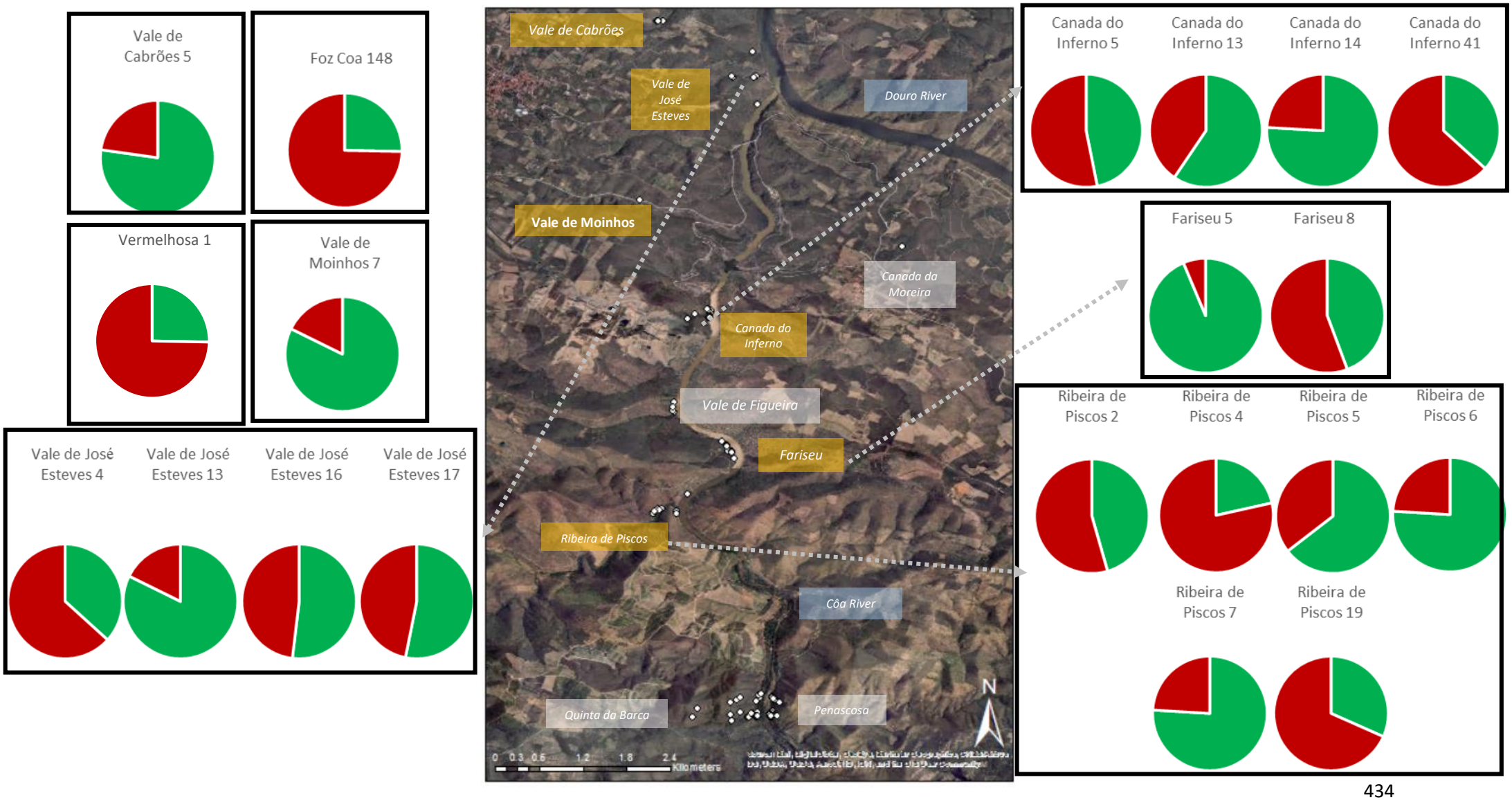


Figure 7.4.67.: Map showing Visible/Non-Visible Pixel Pie Charts for ResAz at Vale de Cabrões, Vermelhosa, Vale de José Esteves, Canada do Inferno, Fariseu and Ribeira de Piscos.

Individual site visibility - resolution of Azilian-style engravings (then)

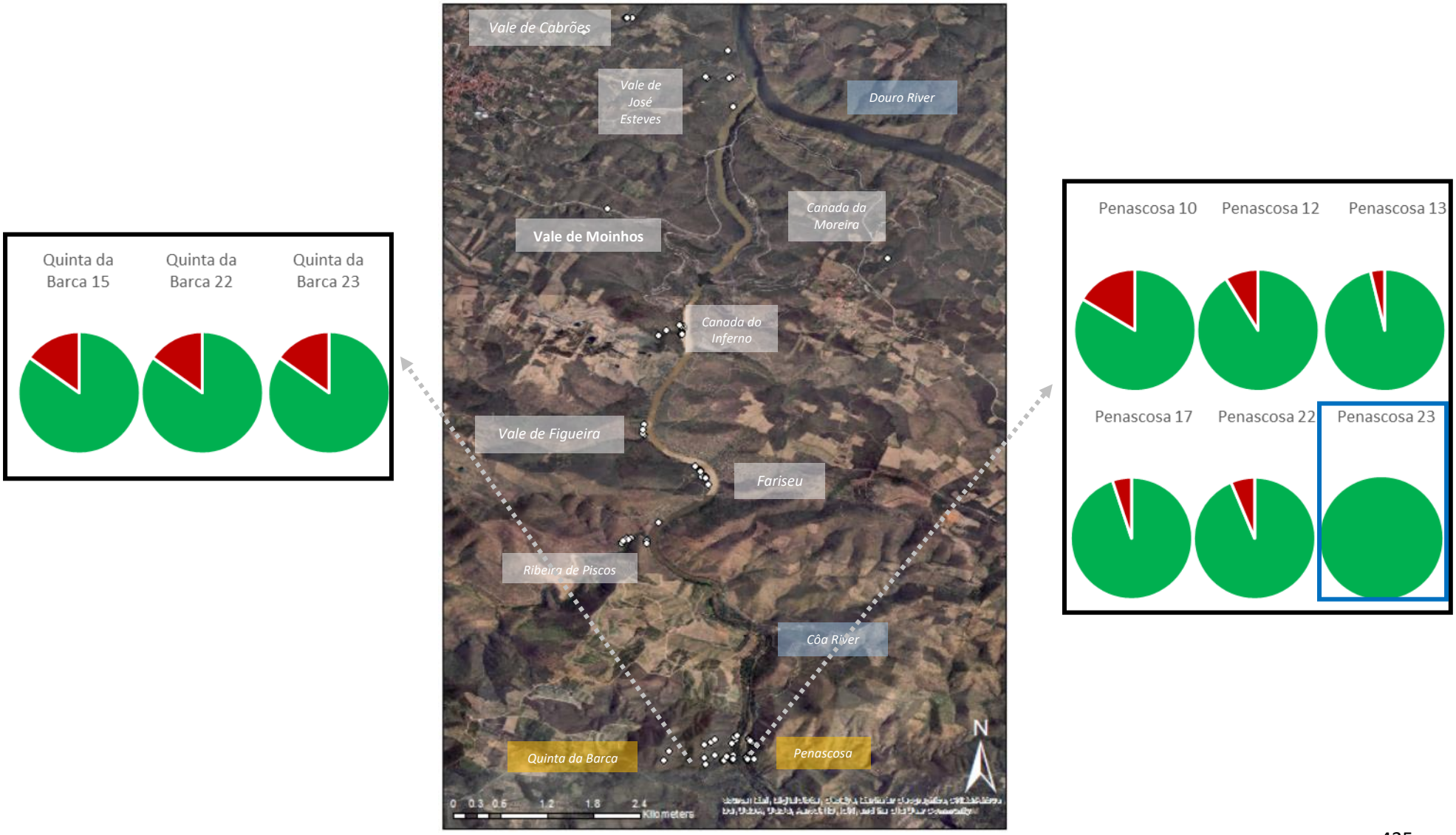


Figure 7.4.68.: Map showing Visible/Non-Visible Pixel Pie Charts for ResAz at Quinta da Barca and Penascosa.

Whilst the multitude of pie charts is likely overwhelming, the general idea of this display strategy is to show the differences in green and red at particular sites, thus assessing how close individual sites approach the maximum calculated visibility. Consequently, sites at, for instance, Penascosa seem to come particularly close to the maximum visibility of any site, whilst sites at Vale de Figueira deviate significantly. Largely, the following table allows for comparison between these pixel and Res Group differences:

Res Group/ Pixel Majority	Mixture of Green and Red	Green	Red
ResPe	Vale de Cabrões Canada do Inferno Ribeira de Piscos Quinta da Barca	Fariseu Penascosa **(Type Site: Fariseu 3)**	Vale de Figueira
ResIn	Vale de José Esteves Vale de Cabrões Canada do Inferno Fariseu Ribeira de Piscos	Penascosa Quinta da Barca Vale de Moinhos **(Type Site: Penascosa 17, 21)**	Vale de Figueira Foz Côa Canada da Moreira
ResAz	Vale de José Esteves Canada do Inferno Fariseu Ribeira de Piscos	Vale de Cabrões Penascosa Quinta da Barca Vale de Moinhos **(Type Site: Penascosa 23)**	Foz Côa Vermelhosa

Table 7.19.: Pixel majorities at sites across the Côa Valley. This is based on averaged pixels when divided by majority pixels (i.e. 134/61/79) available.

When inspecting the commonalities in this table (Table 7.19), sites in each colour category reoccur in individual Res groups, too. This means that the engraving technique exerts similar pixel majorities/minorities (as also found out in Fig. 7.4.54), which even holds true when individual sites are compared against each other. Moreover, the sites' similar behaviours in these pie chart calculations, between the different Res groups, is unsurprising since the individually calculated viewsheds dictate the pixel count, onto which the different visibility distances are attached. Pixel counts change with viewsheds, which change with resolution values. The next page shows the visibility majorities, according to technique, across the region:

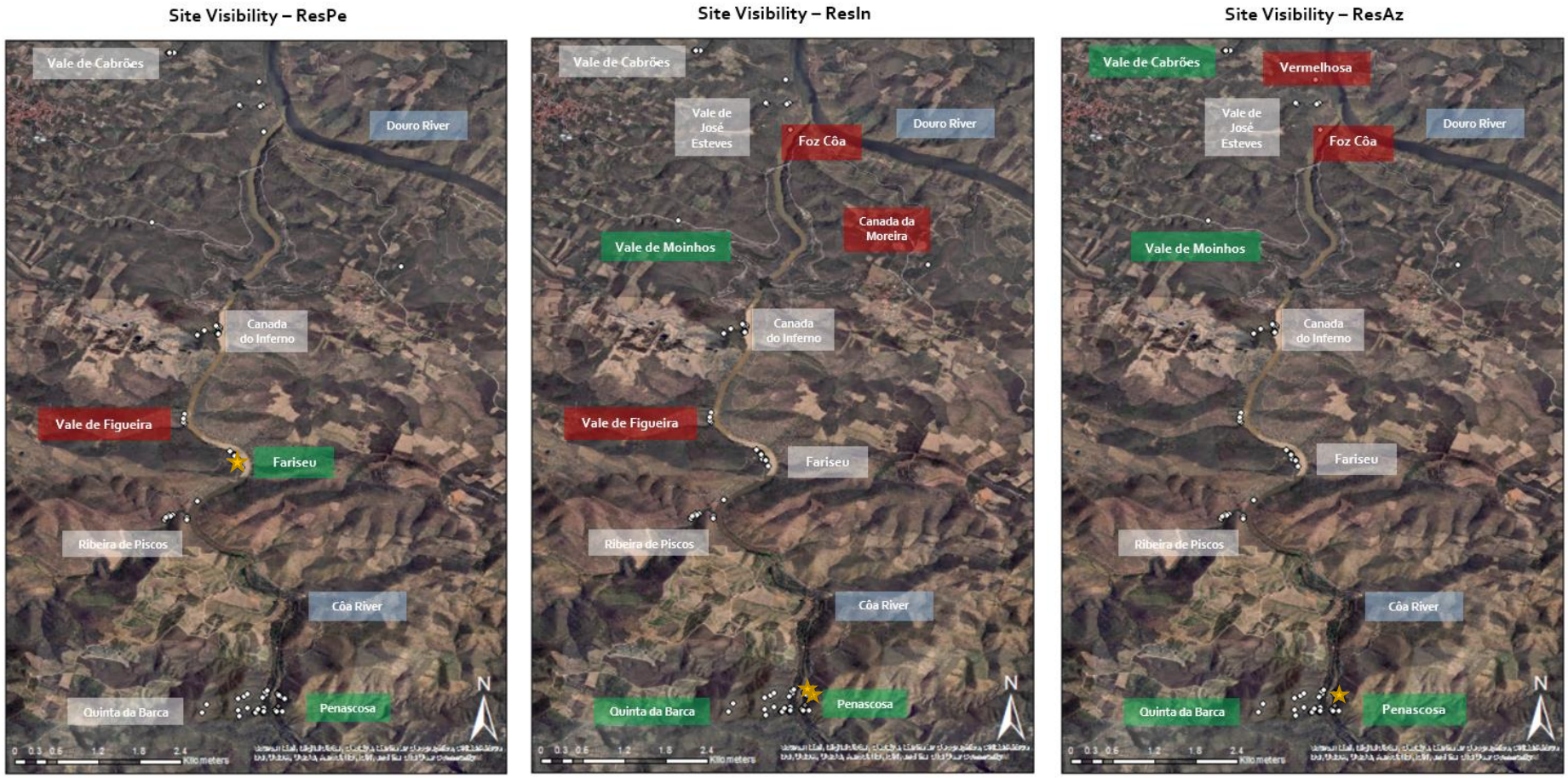


Figure 7.4.69.: Collage of maps showing the extend of how individual site pixels compare to the noted type sites (yellow star).The green sites come close to the maximal available pixel count, the red sites are at the opposite pixel count spectrum and the grey sites average between green/red.

As can be noticed when comparing these three maps against one another, the red sites (those with a particularly large slice of red compared to the type site) conglomerate in the northern parts of the Côa Valley, with the panels at the two southern sites of Penascosa and Quinta da Barca particularly visible, according to the model. Only sites that are actually exhibiting the analysed techniques are mapped. This is why some parts display sites which are lacking in other maps. The grey-tinted sites, which display a roughly even split of green and red slices in their pie charts, hence exert approximately half the visibility than the respective type site. These sites appear scattered throughout the valley. Whilst the half-split is largely maintained at these sites, there are three panels amongst the ResPe grey/mixture sites, at Ribeira de Pisco 15 and Quinta da Barca 11 and 16, which are particularly low in green pixels, revealing a particularly poor visibility. This shows that sites with a multitude of panels can also bear outliers. The panel of Fariseu 5 in the ResAz group falls into the opposite extreme, whose green pixel value is extremely close to the denominating value in this group and displays itself as being more visible than the rest of the panels at this location.

How visible are panels with different degrees of overlap?

Whilst it would be possible to ascertain whether panels that possess many visibility pixels also have similar depictions, again, it has to be questioned whether that information would advance our understanding of rock art motif and location choices in ways that would make such analyses worthwhile. What is worthy of consideration, however, is how the pixel counts are spread across panels that possess varying degrees of superimpositioning. For, a panel that possesses only basic overlap is physically less visible than a panel that possesses heavy overlap of motifs since its mass of engravings sparks greater visibility anyways. Hypothetically, if the artists' intention behind superimposing motifs is for greater visibility in the valley as one approaches a rock art rich area, than this might be reflected in how many pixel counts these sites hold. By this logic, a heavily superimposed panel, attracting greater visibility than panels with fewer overlaps, would also possess more visibility pixels than a panel with no overlap. However, a reverse logic might also apply. It could be argued that panels that already possess major features aiding in its visibility at the outset (such as heavy overlap masses or pecked marks as opposed to the lesser visible incisions), do not also need to have the largest pixel counts possible. Accordingly, larger superimposed areas and deeper hewn features would compensate for a lack of a high visibility pixel count. Consequently, artists might have selected the size, overlap and engraving technique to suit the demands of the landscape setting, rather than the other way around. The following box and whisker plots will test this relationship (Fig. 7.4.70).

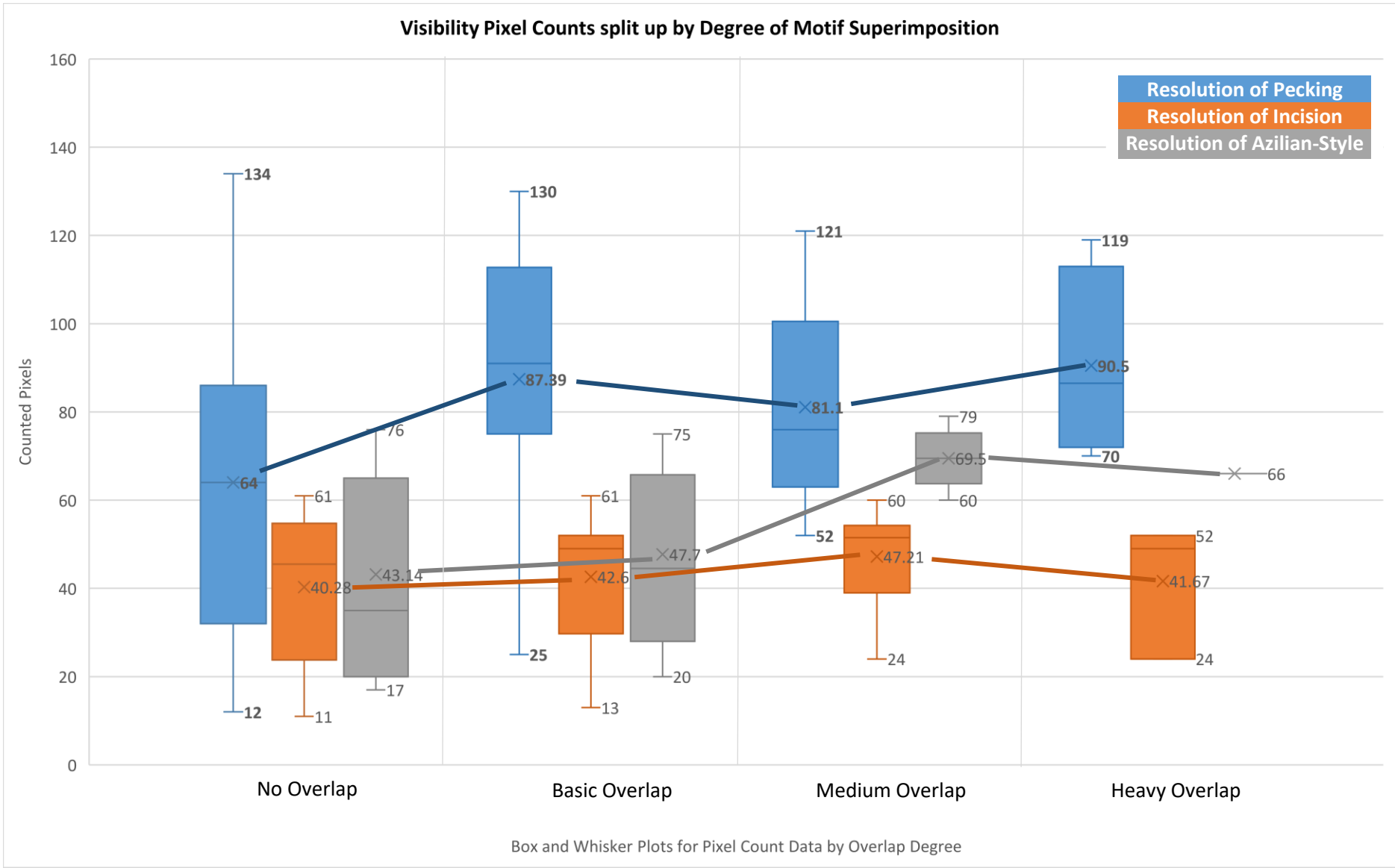


Figure 7.4.70.: Box and whisker plots showing the amounts of pixel counts (then) for varying engraving techniques and overlap degrees.

The graph overleaf illustrates how many pixels are exerted by panels with increasingly complex degrees of motif overlap. This analysis tests whether an increase in overlap also correlates with an increase in pixel count. The blue plots indicate the pixel counts when pecked marks are subjected to resolution distances. Whilst there is a general positive trend of increased overlap complexity that matches an increased pixel count, it appears striking that the mean value of pixels for basic and heavy overlap panels assimilates. This highlights that, based on initial resolution of motifs, it does **not seem to matter whether panels, already in locations featuring large viewsheds, are also given compositions bearing heavy or little overlap.** This is also confirmed by the slight dip in mean pixel values for medium overlapped panels. Interestingly, the pixel counts for pecked panels is lowest for those bearing no overlaps. It is at locations at which artists already sparingly depict, that the mean pixel count is lowest amongst the data collected. Hence, **panel locations that intrinsically bear relatively low visibility, also attract marks created with low visibility characteristics.** This goes against the initial hypothesis that geographical areas low in physical visibility (viewsheds) would attract heavy peck marks and overlaps, as offsetting measures for greater visibility. Furthermore, mean pixel counts for incised marks remain consistent across overlap types (cf. orange trend in Fig. 7.4.70). This underscores that the **visibility of panels seems irrelevant to artists creating incised marks**, producing the lowest recorded resolution and legibility values.

Overall, these results signal that artists have a particular set of strategies that relate to features being seen or not, and it would seem that a delicate relationship between artists, landscapes and their art was upheld. Furthermore, the geological formations and surroundings of the panels play a large role in creating small or large viewsheds, yet it is the active choice of the artists to choose these particular locations and their particular carving techniques and degrees of overlap. The large abundance of rocks which bear no rock art will have meant that artists would have been able to freely select their rocks and their 'visualities'. Choosing a rock which has a particularly poor visibility, therefore, will have been done on purpose, since other rocks would have been available that would 'analytically' bear better outgoing features. This means that there will have been factors beyond those discussed here that attracted artists to these rocks. Gell (1998 :24) argues that "artists do not (usually) make art objects for no reason, they make them in order that they should be seen by a public, and/or acquired by a patron". To relate this thought to the rock art under study, this last theoretical consideration might help pave a new path towards understanding rock and rock art selection. After all, an important question, which plays on the mind of many rock art researchers, is who would have encountered and engaged with the carved rocks.

7.4.5. Theoretical considerations - private versus public dimensions of rock art

What does visibility and locality tell us about the artists' intentions?

Even though it is impossible to understand the functions and meanings of *uninformed* corpora of rock art, it is nevertheless paramount to understand its original intended audiences. In fact, it is easily conceivable that within a single composition or even from a separate motif, an array of meanings, rather than just one universal meaning, might unfold. This multitude of meanings can, therefore, attract a multitude of audiences, who might all be seeking very different things from the art in the first place.

Questioning the characteristics of the rock art's audience within the area of this study seems as unattainable as the quest for its meaning itself. Yet, if one starts to think about ways to interrogate intended 'viewership', a look at the sheer practicalities of viewing art suffices to rule out certain audiences. In other words, figuring out the arts' wider context in terms of its accessibility and visibility constraints can indicate the size of the groups that will have been able to see the art as a collective. This can be tested against the many practical rock art features such as pigmentation, size and engraving techniques. Both Zilhão (1997) and Baptista and Diez (2002) have so far devoted parts of their studies to this dimensional aspect of the rock art. However, a systematic study that includes a number of possible influencing factors on visibility and attached audiences has not been conducted as of yet.

Debating private versus public spaces in relation to rock art is no new endeavour. Whilst not much in the way of private versus public audiences has been written with regard to Upper Palaeolithic open-air rock environments, several such mentions can be found in relation to how cave art might have been used. There exists a certain scholarship, which approaches rock art filled landscapes with a phenomenological mind-set. Phenomenological interpretations include, for instance, that femaleness is revealed at vulva-shaped sites and that elevated places in the landscape have religious connotations. Similarly, according to this school of thought, easily visible sites are meant for public consumption and by default, hidden art is, therefore, meant for a private, specialist audience (Hyder, 2004). The danger with these interpretative lines is that they are too often assumed true without proper investigation or data that back up these claims.

A more substantial investigation, similar to the approach that Schaafsma took in 1985, is presented by Ochoa and García-Diez (2018), who investigate the interior of caves for their art

accessibility and its audience channelling. Largely, they asses the spacious characteristics that would fit certain amounts of people performing certain types of physical acts/movement modes (such as kneeling, standing, crawling etc.). Based on their analysis, it becomes clear whether specific art panels will have been able to be viewed by many people in one go or not. Prior to this, Cabré (1915: 285) talked about "socially exposed" spaces in relation to "exterior graphic ensembles" (like the site of Chufín in Spain) that will have been seen by all members of a group, thus becoming *public.* This spurred on debates on the functions of interior versus exterior spaces, commonly associating exterior places with daily activities and bestowing interior localities with religious and divine meanings (Laming-Emperaire, 1962 and Leroi-Gourhan, 1992).

However, in relation to what can be found in the open-air rock art of the Côa Valley, it seems highly unlikely that all of the art resembles daily, in other words laic, activities. The art mainly consists of animal depictions which likely resembles aspects of hunter-gatherers' daily tasks and it is the location of outdoor rock art sites, which Weaver and Rosenberg (1978: 34) would take as an "interpretation of seasonal activities related to hunting and gathering". Nevertheless, the sheer amount of art, as well as its highly individualised and detailed characters in various locations spaced across the riverbanks, does not leant itself to merely this explanation.

Henceforth, this theoretical approach encompasses the results from the typographical application onto rock art and the results from the GIS analyses of the different sites. Therefore, this serves as a brief preliminary 'overview' of this research and prepares readers for the conclusion of results which follow next. It brings together intentional and dimensional issues within rock art practices to culminate in a debate on the public or private function of Upper Palaeolithic engravings and their audiences. To achieve this, the following chart (Table 7.20) lists several factors based on the results of the previous sections and hypothesises various links. Moreover, where possible, an audience side was chosen indicating which direction the Côa rock art leans towards (this was done based on the majority of these features).

Influencing Factor	Public Audience	Private Audience
Engraving Specific		
Size of the Engraving	Large (metres)	Small (centimetres)
Colour of the Engraving	Bright	Dark
Part of the Depicted Animal	Maximal (full-bodied)	Minimal (e.g. head only)
Engraving Technique	Pecked (or multitude of techniques in one motif)	Fine line incision
Overlap of Engravings (Superimpositioning)	Initially heavy overlap to attract attention, then basic overlap to make identification simple	Initially basic overlap enough, then heavy overlap for personal tracing of lines and disentanglement
Gestaltian Compositions	Easily perceptible laws	More intricate laws
Rock Specific		
Colour of the Schist Used	Contrasting to colour of engraving	Blending in with the colour of engraving
Panel Type /Rock Composition	Large rock face	Small, hidden
Location Specific		
Accessibility of the Panel Location	Easily accessible	Inaccessible; Hidden/Out of sight and walking paths
Area in Front of Panel	Accommodating to large crowds	Accommodating to single viewers
Visibility of Engravings (Distance Study)	Resolution ranges	Legibility ranges
Extend of Viewshed	Fan-Like	More Localised
Number of Pixels in Viewshed	Close to the ResPe Maximum of 134 Pixels i.e. majority of green pie charts	Deviating from the maximum pixel values (or legibility data) i.e. majority of red pie charts
Knowledge of Intra-Site Visibility Locations	Likely	Highly likely
Landscape Specific		
Overall Location of the Site	At tactical points/waymarks	Secret location
Total Count	**5**	**4 (+5)**

Table 7.20.: Table setting out the hypothetical assumptions that apply to public as well as private spaces and audiences in relation to factors tested and hinted at within this thesis. Green boxes show definite majority of art sites with these characteristics, yellow boxes propose a tentative link.

Was every panel containing rock art to be seen by everyone in the community?

As already hinted upon earlier, each site offers its own unique visibility characteristics and should hence be judged on their own merits for their audience suitability. However, when evaluating the green fields in both columns (Table 7.20), **the public dimension outweighs the private dimension for rock art sites around the valley**. Where the two options seem far too subjective to judge their respective weighting, the rows have been taken out of the equation. This was for example the case for the identification of Gestaltian components and knowledge of intra-site visibility. The same goes for rows for which not enough research has been conducted, such as the area in front of the panels or the situatedness of the sites. Only where it was possible to compare sufficient amounts of the gathered data for this thesis between the two columns, such as assessing the majority of animal parts, engraving techniques or the extend of the viewsheds, a definite answer was provided, swaying to a particular side.

Having said this, once the more **tentative yellow options are included, the private component overshadows public sites by far**. From (subjective) experiences during fieldwork, in cases where locations are easily navigable and accessible, a sense of public intentionality can clearly be identified. In these places, large audiences would have been able to be accommodated, which in itself bears meaning as to why rock art was depicted in certain places. By contrast, in the more difficult to access and less spacious areas, a rather personal atmosphere was noted. To this end, Aubry and Luís (2012: 528) have observed that "late-glacial art is much more private and discrete than the pre-Magdalenian phase, in terms of size, techniques, placement and overall visibility – [changes which are concurrent with the changes identified in the lithic raw material]". This would mean that the table above can also be read and altered in accordance with changes in rock art phases. Yet, this thesis's objectives do not place a great emphasis on technical changes of art over time, as this would have required a closer 'physical' reading of panel environments and engraving strokes in the rock art settings themselves.

7.4.6. Conclusions: Integrated Rock Art Visibility

The questions that were asked at the start of this sections are now concluded:

1) **How are (a) individual motifs; (b) incomplete motifs; (c) different techniques and (d) superimposed imagery distributed across the Côa Valley?**

Whilst initially there appears to be a random scatter of individual motifs across the valley, certain types tend to conglomerate in specific areas, such as horses and anthropomorphs appearing towards the middle of the valley, with fish appearing both near the Côa and the Douro rivers. Motifs tend to fill out the further north one travels in the region which can likely be correlated to changes in engraving techniques, across the spread of the valley and across time (cf. Luís *et al.* 2015). Broadly speaking, artists did not deliberately situate varying degrees of superimposed imagery, yet a trend in the locations of heavy overlapping motif panels points to possible waypoints and should be investigated further in the future.

2) **How visible are different rock art panels?**

Several virtual 'buffered-observers' have been placed in the rock art landscapes of the Côa in search of (inter-) visibility of specific rock features, such as colouration and typography ranges. This approach uncovered several active steps, which would and will prove useful in rock art viewing expeditions. The further generation of 608 viewsheds widened out this visibility study and revealed a spread from miniscule to far-reaching visible areas exerted by Côa rock art panels (assessed through viewshed pixels). Changes in bedrock colourations between the UP and nowadays show a general decrease in rock art visibility, which identifies the need for continuous conservation. A statistical analysis, based on visible and not visible pie charts of these pixels, revealed areas that are particularly conducive (green) to rock art visibility, mostly towards the south of the study area.

3) **What does visibility and locality tell us about the artists' intentions?**

In combining all study aspects that have come out of all 'experiments' thus far, a final table contrasts elements of rock art particularly targeting public or private audiences. This assesses whether all panels containing rock art are to be seen by everyone in the community, or whether certain areas are reserved for a more intimate viewing, for audiences with knowledge of where rock art is located. Whilst areas with particularly bad visibility (red pie charts), will necessitate viewers to naturally come in closer to inspect the art (more private), there are other aspects of rock art, which are targeted towards more public crowds. These audiences likely tend to be drawn into the arts' fresh white pigmentation, their positioning on larger surfaces and their often heavily impacted pecked nature, even at large resolution distances. Hence, it is possible to understand motivations of artists based on the way they choose their location including viewsheds, choose their rocks and chose their display methodologies.

8. Conclusions – Upper Palaeolithic Visuality

8.1. Upper Palaeolithic Visuality

In line with the notion that rock engravings are *visual additions to the landscape*, all engravings inherently bear reference to their surrounding visual worlds as seen through the human artists' and observers' eyes. These visual realisations by past inhabitants of the Côa Valley are able to, non-verbally, hold witness to the perceptions of prey animals within the artists' societies and their understandings thereof. Nevertheless, the study of the making and use of rock art, especially without emic insights, is often deemed to be a highly subjective and thus fruitless endeavour within archaeological academic circles. Yet, what the newly formed field of *Visual Palaeopsychology* is able to bring to the table, is empirical data generation based on testable and reproducible responses to visual perception tasks. In fact, these experimental tasks, specifically set up for this thesis to investigate visual Upper Palaeolithic phenomena of the Côa Valley, are able to offer major methodological and theoretical contributions to the fields of psychology and archaeology alike.

8.2. Key Findings

This thesis set out to investigate how Upper Palaeolithic artists and rock art consumers used their visuality and that of their surrounding landscapes to their advantage. This was addressed through three main objectives:

Objective 1 - Motif Level: Why are the engravings depicted in the way they are?

Objective 2 - Panel Level: Why are specific panels and panel compositions chosen?

Objective 3 - Landscape Level: Why are the engravings placed in specific locations?

A set of research questions were composed to fall under each of the main objectives, which were subsequently addressed with the help of experimental procedures. Each main objective was dedicated its own main chapter, i.e. Objective 1 – chapter 5 (Prey), Objective 2 – chapter 6 (Perception) and Objective 3 – chapter 7 (Landscapes). In order to prevent an overly repetitive account by recalling all of the generated results, this section seeks to synthesise the overall findings in view of the overarching aim of this research.[47] For this to be done most effectively, the "hypothetical" thought experiment from the first chapter is now recreated, this time through moving from hypotheses to results, with more definite answers as to how artists and audiences go about creating and consuming rock art.[48]

[47] For more details, each main chapter contains a one-page results summary and should be consulted separately.
[48] Readers are reminded that results are based on the panels and motif drawings available to the author at the time of research and that, of course, some rock art will have been destroyed in the past (particularly due to the building of the hydroelectric dams) and that more rock art features are likely to be found in future.

The Motif Level – Prey

Prompt 1: Start off by thinking about your desired motifs.

The first prompt inspired readers to think about the specificities of the to-be-depicted motif, such as choice of depiction, its size and alignments on a given surface. So as to investigate these specificities, the archaeological groundwork section for the *Prey Level* was filled with graphs denoting quantities of motifs and bodily details detected in the Côa, as well as graphs specifying the level of completeness that depictions come in and their facing or "walking" directions. Major findings here include a clear dominance of aurochs, horse, ibex and deer on the panels, with anthropomorph, fish and bird depictions being more sparingly depicted in the region. 58% of all motifs were depicted facing towards the right, which might be due to the manner in which engravings were created and obscured throughout the indirect hammering technique. Many depictions comprise a complete outline, yet the majority (62%) are left incomplete pointing to the fact that the artists' focus did not lie on carefully crafted full-bodied motifs, but often on a more minimal version of these. This sparks interest into exactly which features are being focussed on and why, with notions such as *artistic minimalism* at the forefront of this discussion.

It is for these reasons that the two experiments that followed in chapter 5 (***Drawing Animals*** and ***Bubbles***) were set up. The element of how people draw/engrave selected motifs was explored through the means of a drawing experiment, conducted by participants with varying levels of familiarity with Upper Palaeolithic art and the subject species. A clear trend towards better drawing ability for familiar subjects was noted, as was the trend that participants tended to align their drawings closely with priming images (change in direction and more detail) upon presentation of such material. A differential drawing order became apparent between the two target species, yet a major focus was placed on the start and finish of lines on salient features such as the head. The concept of *mediated* versus *unmediated* imagination was introduced to readers, providing useful insights into how thinking about something versus thinking about something *in context*, can yield very different mental imagery. The drawing order as well as the imagination tasks provided opportunities for comparison to Upper Palaeolithic engraving habits, yet the methods of drawing/painting and engraving, of course, need distinguishing at all times.

The aspect of saliency (i.e. elements that are most prominent/diagnostic in any given stimuli) was further explored by the means of ***Bubbles***. Participants' task performance was dependant on stimulus duration, meaning that the longer a stimulus was presented to participants, the more successful their classifications became. In reminiscing about the way horse and bison were largely classified, by means of positive 'hit' (green) shading and negative 'miss' (red) shading on

the empty animal canvasses of Fig. 5.4.15 and 5.4.16, outlines of animals were heavily diagnostic, in particular were areas that would distinguish them, i.e. their species specific characteristics. These, for instance, are comprised of the horns and hump of the bison and the sinuous dorsal line, ears and elongated face of the horse. Areas within the stimuli that appeared uniform across both species, such as areas of the torso's fur pattern, hooves and largely the areas of legs and tails, were frequently misclassified. This indicates that these areas do not aid in species discrimination. The established areas of positive and negative classifications strikingly map onto the art patterns found in the Côa Valley. Rock art animals are found in outlined manners, with detailed areas of their torso and hooves missing from the artistic creations. Emphasis is placed on the animal's respective areas of high saliency, most often agglomerating in areas surrounding the protomos (comparable to the features of a bust).

Given the fact that successful hunting was the key to survival in the Upper Palaeolithic, the abundant number of depictions relating to the species' *discriminanda*, likely suggests that hunters are also involved in the art-manufacturing process. To put it simply, the majority of art represents only those aspects of animals that were necessary to distinguish them from each other. Incidentally, these aspects are also the ones that hunters would utilise in the aid for successful hunting missions. **If the art had been made "only" by artists, then it would likely look more intricate and elaborate**, yet it largely does not.

The Panel Level – Perception

Prompt 2: Now, think about the motif's embeddedness in its wider panel.

The next prompt encouraged readers to link their desired motif with their desired panel setting. Particular emphasis was placed on compositions and superimpositions of motifs. Thus, the archaeological groundwork section for the *Panel Level* focussed on engraving techniques since similar carving methods are important in creating cohesion in any compositional setting and on the panel characteristics of bedrock colouration and cardinal direction. Pecked marks are most common in the Côa rock art corpus (38%), yet it also boasts a high degree of engravings which are fashioned with a mixture of techniques, such as an initial incision followed up with deeper peckmarks. This again reveals how artists approach the creation process. Nowadays, the valley features a plethora of schist (dis-)colourations, yet it is assumed that in the past the dominating colour will have likely been dark grey. This information is particularly useful in understanding the visibility of engravings on schists and foreshadows active choices on the use of motif overlap as well as additional pigments.

The aspect of panel cohesion and compositioning was explored by the means of experiment 3, which ***put Upper Palaeolithic rock art to the Gestaltian test***. Despite its obvious anachronistic

use, many Gestaltian principles were able to be applied to Côa panels and their motif concentrations. Since viewers are always actively looking for the simplest path to form cohesion in stimuli, this experiment offered a way to create a Gestaltian design hierarchy of how Upper Palaeolithic engravings tend to work best together. It was established that viewers tend to comprehend a panel in a Gestaltian way first, by a dominance of motif technique (i.e. motifs that bear similar engraving techniques are recognised first); secondly, by motif similarity which is then followed by motif proximity, with their combination, of course, yielding a best possible Gestaltian design. Since many panels were identified as having a plethora of these principles working in unison, it can be assumed that artists spend considerable time creating their work to be as perceptible as possible. The adoption of these elements also provides insight into possible authorship(s) and enlarges our conceptions on how best a panel should be read (with underlying storylines) and used, particularly with Gestaltian design pathways in mind.

The effects on visibility of motif overlaps were investigated in experiment 4, termed ***Perceiving Superimpositions.*** A variety of reasons as to why one might superimpose were presented, with visibility purposes being at the forefront of these deliberations. In terms of overlap of specific species, Côa panels exhibit an agglomeration of multiple species in one spot with no apparent pattern that would dictate that individuals of a particular species should always be in close contact with each other. These findings point back to the reasons for superimpositions and can now be read accordingly. The overall number of panels that exhibit superimpositions lies at 59% (of which 13% are composed of medium to heavy overlaps), with the remainder of the investigated panels (n= 50/122) featuring no overlapping motifs. Hence, more than half of all panels investigated for this study show motifs that overlap each other.

Combining this observation with results from chapter 5, it can be questioned why most depictions are only partially finished, likely in line the saliency of diagnostic features, yet still overlap other motifs and create extra (counterintuitive) layers of visual complexity. It could be argued that a minimally engraved motif overlapped by other motifs counteracts a visually-salient and visually-appealing strategy. In fact, the next two sub-experiments set out to investigate exactly this conundrum. In one experiment participants were subjected to several overlapping panels, each with different degrees of overlaps and bedrock backgrounds. It appears that the more superimposed a panel becomes, the more imaginary the motif count gets. Moreover, the stronger the contrast between bedrock and motif colouration, the better the detection, with participants performing best (i.e. their perceived number of motifs comes

closest to the actual number of motifs) on the darkest panels shown to them. These results align with the previous suspicion that multiple overlaps counteract visual saliency.

To get a more nuanced understanding of why else one would superimpose, the last sub-experiment in this series set out to study the location at which these overlaps occur. A clear tendency for overlapping features within a panel setting presents itself more towards the upper-left corner, which is correlated to the naturally occurring human visual tendency towards a central and left hemifield viewing bias. The experiment concludes with the sentiment that Upper Palaeolithic artists intended to guide their audiences through their compositions in a perceptually accommodating fashion. When regarding its wider implications, information on the clear predisposition to overlap motifs in certain spots can be utilised when on the lookout for new rock art in the region. So, whilst rock art overlaps tend to obscure the intrinsic characteristics of each motif on display, the fact that overlaps are located in as visually prominent spots as possible, seems to indicate the priorities that rock art artists set themselves. Audiences get drawn in by the great visibility of overlaps and only upon closer inspection take into consideration the effects of artistic minimalism and those of Gestaltian significance. This points to a two-step intended viewing approach.

The Landscape Level - Landscapes

***Prompt 3: Lastly, think about its place*.**

This last prompt invited the reader to think about suitable locations for their envisaged art. Readers were also asked if they would consider colouring in their engravings, for artistic or visibility purposes alike. To test the feasibility of these responses, the final two experiments (***Rock Art Visibility*** and ***Integrated Rock Art Visibility***) set out to study the rock art's possible pigmentation in the past and its impact on visibility and the rock art's physical location in places of great or poor visibility.

Through rigorous testing (both in the form of a control study and *in-situ* study) of a variety of engraving colours, bedrock colours, animal types and engraving techniques, a clear winner when it comes to *optimal visibility* of rock art, was discerned. Namely, the naturally occurring white residue in the carvings on as dark a background as possible. It was found that additional pigmentations, such as red ochre or black charcoal, would have acted in a counter-perceptive way. Hence, the addition of colour reduces visibility over increasing distances and should merely be regarded as a stylistic choice, not a perceptual aid. Given the fact that the previous experiments show that artists were actively influenced by their underlying cognitive capabilities to create rock art motifs and compositions, it seems likely, that the overall rock art making

process was also influenced by similar underpinnings. As such, optimal visibility would have been key to creators of the art.

Rock art features were GPS-coded and mapped, and as such, the art's existence in a variety of locations across the Côa region testifies to the preferred terrains of both the hunter-gatherers/ artists and the prey animals alike. The findings from the visibility study were subsequently synthesised into GIS models, which computed the areas of visibility exerted from the rock art itself, but also the viewshed scopes that different landscapes possess in determining feasible rock art locations. Radii were drawn around observers that highlighted which features could be visible from particular spots in the landscape. This resulted in several locations which enforce inter-visibility of rock art sites, which, in turn, will have guided audiences on paths of rock art discovery in adjacent areas. It seems, as if artists created rock art panels with particularly striking features, interleaved with rock art panels bearing less visible features, intentionally, to channel their audiences. To award spectators (equipped with different intent for viewing) with different sets of carving features, and hence, to distinguish between more private and more public spots of viewing. Overall, this entirely novel method of integrating the established visibility parameters into analyses of viewshed buffering proves useful in signalling why rock art was created in specific areas.

8.3. Concluding all Rock Art Levels

To summarise, the experiments, coupled with their foregoing archaeological groundwork sections, are able to demonstrate that **rock art artists intended to guide their audiences through their work in an as perceptually accommodating fashion as possible**. This insight can therefore be applied onto answering the three main objectives:

(1) Motif Level: Why are the engravings depicted in the way they are?

The majority of engravings are depicted in the way they are because rock art creation is cognitively driven, mimicking the minimal information necessary for hunters to distinguish different prey species. The more elaborate creations are likely attributable to a more artistic or didactic function.

(2) Panel Level: Why are specific panels and panel compositions chosen?

Artists helped themselves to a plethora of perceptually easy-to-process tools to guide audiences through their creations. As such, many principles of *Gestalt* were already utilised by artists of the past, even if this notion, of course, only gets termed as such nowadays. It is exactly this fact, that artists utilised these principles, despite being ignorant about their formal definitions that make the labelling of rock art creations as 'cognitively driven', even more convincing. This is also perceptible in the way artists used the natural human tendency of a left-to-centre visual attention bias within many of their superimposed artworks. Artists maintain a clear visual strategy throughout the Côa Valley and have clearly understood their audiences' viewing preferences, let alone their own.

(3) Landscape Level: Why are the engravings placed in specific locations?

When it comes to the selection of where and with what rock art is to be produced, again, rock art artists use their intrinsic perceptual abilities to great advantage. The lack of pigments found in the Côa region, is probably not due to often-assumed weathering processes, but may be due to the fact that colouring rock art would not have provided the visuality that rock artists/audiences desired. Artists played around with resolution and legibility levels of their audiences, to actively guide spectators through rock art rich/poor areas, and as such, can distinguish/create private and public acts of viewing.

The following graphic summarises these major findings at each scalar level (Fig. 8.1):

Key findings (preferences of the artist) at each scalar level:

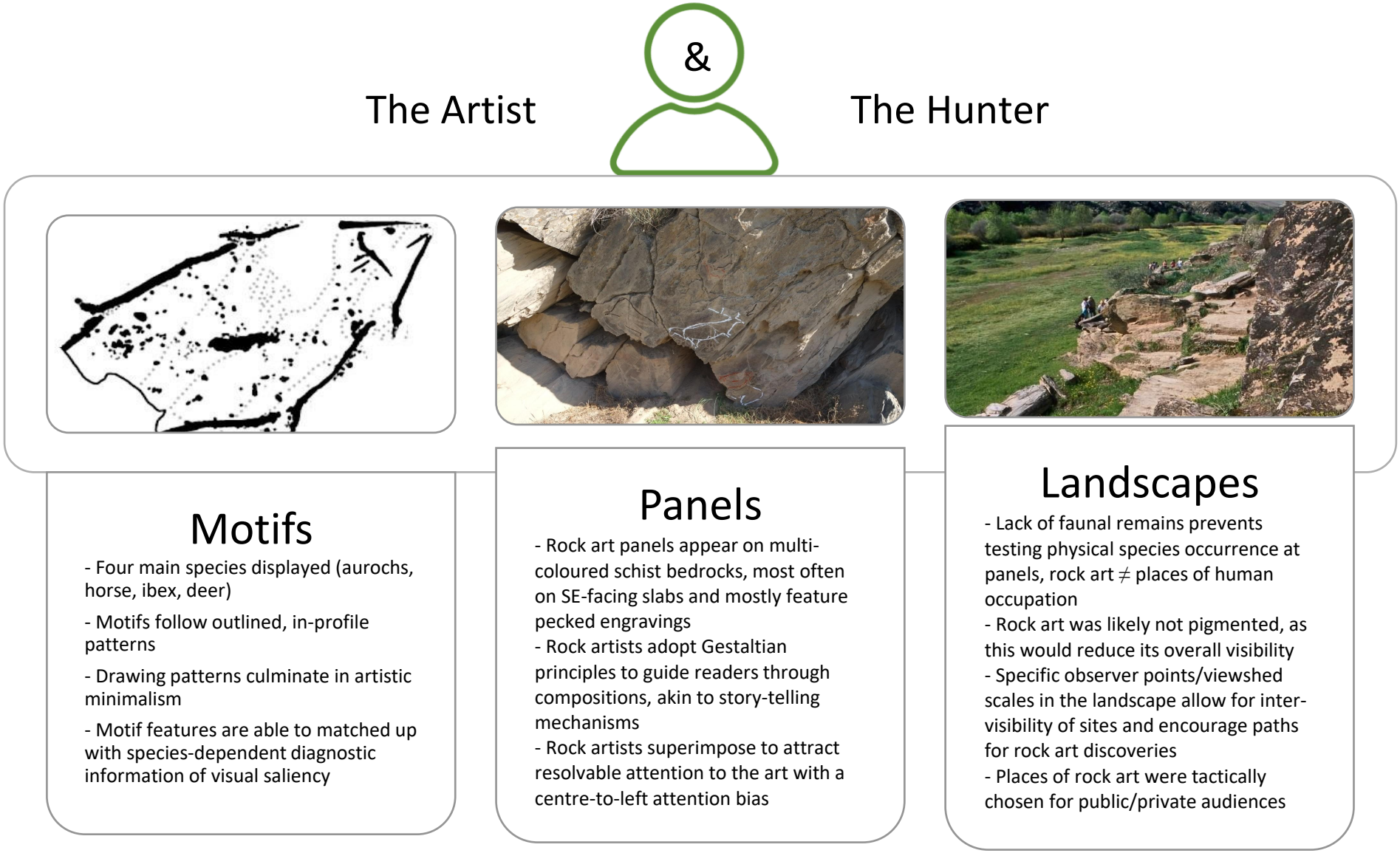


Figure 8.1.: Graphic concluding major findings at each scalar level. Left fish depiction (drawing courtesy of Fundação Côa Parque), photographs of panel and landscape by author, 2018.

8.4. Evaluation: Prey – Perception – Landscapes: A fitting trio?

In addition to the commonly cited limitations that studies with regulated time spans often encounter, many of the research methodologies and the generated results can always be expanded upon with further testing and improvements. This next evaluative section is deliberately kept brief, since many of the foregoing chapters already feature lengthy limitation sections. Much of the evaluative reflection on how this thesis has progressed can be attributed to limitation of time to conduct experiments and constraints in access to specific fieldwork sites. Nevertheless, the following thoughts on procedural shortcomings and success are shared for each of the experiments within the main chapters (Chapters 5, 6 and 7), all aspects which beg for a closer evaluative consideration.

Experiment 1: Drawing Animals

Whilst this experiment is but a small-scale report of observation on drawing practices, the results form an interesting base for understanding why animals are drawn the way they are, influenced by familiarity with the motifs and drawing, by drawing techniques and potentially by handedness. Since the practice of drawing is arguably detached from the practice of engraving, this experiment needs to be extended into a large-scale engraving trial, for which participants utilise stone tools and schist surfaces to physically engrave motifs, covering all its constraints and likely necessity for minimalism over detail.

Experiment 2: Bubbles

Due to the fact that animals do not solely present themselves to hunters in profile view, more angle positions and more motif subjects, as well as test subjects need to be integrated into future iterations of the software. Eye-tracking integrations would offer more nuanced insights, as would aspects on how participants perceive moving, as opposed to stationary, animals.

Experiment 3: Gestaltian Art

The fact that not all drawings from the Côa corpus were accessible at the point of research, made a more rigorous set of analysis on how many panels display how many Gestaltian principles impossible. As such, in future, a quantification of Gestaltian aspects used by the artists would give even more credence onto how aspects of human visual perception guide art making and composition processes. Furthermore, the adoption of these principles makes a visual story-telling process conceivable. In conjunction with the established Gestaltian hierarchy in mind, future studies could elaborate whether storylines can be recreated through looking at motif techniques first, followed by motif similarity, then motif proximity. This, in turn, might then illuminate new facets on whether rock art was created in one sitting (or even by just one or multiple authors) or with potential stops and starts over time.

Experiment 4: Perceiving Superimpositions

Archaeologists in the Côa region continue to discover new rock art panels. The established centre-to-top-left viewing bias matches up with many of the superimposition occurrences on rocks. This will aid in future rock art discoveries, with excavators focussing on these. In future, whenever new finds are made, the "superimposing superimpositions" methodology should be applied to add to the overall graphic ensemble of rock art viewing practices, deeming this experiment perpetually unfinished.

Experiment 5: Rock Art Visibility

To test its wider applicability, the results of the rock art visibility study, in particular its distance observations, ought to be applied in more *in-situ* locations around the valley. This study could further be complemented by the introduction of portable eye-tracking devices to understand which features of the rock are sequentially observed. On an even larger scale, the author deems the methodology of taking plastic film motifs with different engraving techniques and colourations, to have broad applicability to other rock art clusters on other continents and even onto other materials.

Experiment 6: Integrated Rock Art Visibility

One major contribution that would add weight to the findings of this section, would be applying the legibility data onto landscape GIS mapping. Most of the results in this experiment had to use the generated resolution data, because the digital elevation models were not fine enough (i.e. <10m resolution) to allow for the more intricate viewing distances, such as one or two meter legible distances, to be included. This investigation would nicely complement the resolution approach, which had to be taken here due to the unavailability of such DEMs. A resolution/legibility experiment of non-engraved rocks would further test how deliberate the locations of engravings were.

To summarise, it must be mentioned that the results are of course not directly translatable into a universal understanding of how and why all rock art motifs were shaped the way they were, how and why rock art panels were selected and how and why these two components then merged to integrate into a landscape setting. What can be said, however, is that the experiments reveal certain logical aspects of rock art compositions that were rigorously tested and analysed based on visual behaviour of ancient artists and responses to visual phenomena by modern participants. These aspects elucidate that the art was created with a clear visual adeptness and concern for visually appealing as well as cohesive material for its viewers.

8.5. Future Directions: The Wider Implications of this Study

Wider outcomes contributing to thematic advances in the field…

The results of this thesis have far-ranging implications for a number of different thematic strains which repeatedly occur throughout rock art research, Palaeolithic research and archaeological, psychological and anthropological research more generally. As such, below is a selection of topics to which this thesis contributes. Reminiscing about every result from this thesis (e.g. how many hooves are represented when depicting horses etc.) would unnecessarily overshadow a more big-picture thinking approach, which is why sub-topics and selected major findings are concluded here.

The Artist and the Audience – One aspect that rock art researchers constantly strive to decipher, arguably the one that ties all this research together, is that of the originator and the interpreter, the creators and the receivers, the makers and users. For, understanding who has made the art and for whom it was made, simultaneously deals with a lot of questions such as art's purpose and function along the way. The *Bubbles* experiment illuminates a likely identity of the artist, namely the hunters themselves, who were so attuned to salient aspects of their anatomy which equalled those necessary for cognitive discrimination between species. The audience, in return, is argued to have been heavily visually targeted by the artists, making the depictions visually easy to take-in and arranging motifs and scenes in a visually accommodating manner. Such targeted help indicates that the artists were closely working towards satisfying the needs of their audiences. This then, in the broadest sense, has implications for the art's essence of easy recognition and readability for a quick data transfer. At the same time, it appears that honouring the detailed nature of animal gestures functioned to didactically train audiences onto paths of rock art and landscape discoveries (such as the teaching of 30-meter effective close quarter hunting on the art itself). This further implicates that rock artists saw multifaceted functions for their art and their target audiences, far removed from those theoretical papers that simply regard shamanism or art for art's sake to be the only way forward.

Public versus Private Art – The latter parts of this thesis have delved further into the more nuanced 'functions' of the art, although as stated along the way, trying to establish a single function for rock art is overly ambitious without having access to emic insights into the contextual nature of the art. Perhaps what would fit more suitably into this discussion is the idea of trying to find a target setting for the art, in other words, whether the art was meant for public or more private use, which nicely ties in with the establishment of audience identity too. In fact, the GIS radius studies that involved the rock art's visibility ranges in conjunction with the art on display indicates several areas within the Côa region that are meant for more private or

conversely more public contemplations, with size of the rock, size of the depiction and overall visibility ranges playing their part in far-range accessibility and visibility. Several areas of the Côa Valley have been characterised as being easily visible, sometimes even resolvable from across riverbeds. A case study at the sites of Quinta da Barca and Penascosa even indicates, in a truly public fashion, how rock art is being made visible from one site to the next, almost as if the artists wanted to send their audiences on paths (even public pilgrimages) of rock art discovery throughout the region. In many other areas however, artists tended to utilise aspects of the landscapes that made the art naturally closed off through river meanderings or placing markings in difficult-to-access areas. Artists drew the audiences in by deliberately creating small-scale detailed depictions to create these private moments of discovery and rediscovery. The smaller the rock art depictions, the closer one has to come towards it to understand its nature, whereas the larger the depictions, the further away one has to stand to take in its entire essence. Both variants are weighed-up against the collected data, with more sites eventually being assigned to the more private domains, indicating the grounds surrounding the Côa river as more geared towards private individuals rather than the masses (yet specific spots alongside the river's edge, those naturally open sites such as Penascosa, make a wider community purpose highly conceivable too).

The Reuse of Art – A repeated topic that resurges throughout this thesis is the reuse or recycling of art. Sometimes art gets reprocessed when aspects of an animal are integrated into a new form of engraving by the artists themselves (for example in cases where rock art animals have eight legs or three heads to show movement; although current data cannot disprove that this could have been done by same artist at the same time). In fact, insights into story-telling have been revealed through the subconscious (and anachronistic) use of Gestaltian principles in the creation of visually appealing scenes. From another perspective and the vast amounts of superimpositions present in the study area, the location of art is often-times testament to the repurposing of the art for remembrance purposes, perhaps not for the sake of the art-making itself but for the sake of place-making and the creation of embodied memory. Whilst the art lying further in the panel's background of these superimpositions are not erased in any form, the fact that there is repetitive action ascribed to these localities fills these places with an aura of importance, perhaps even indicating more elaborate aggregation events at such public sites with high repetitive footfall (those with open radiused visibility and those with varied styles mixed up in superimposed panel compositions). The aspect of aggregation in this instance can both be linked to an aggregation of humans in one place, yet also of animals in one place, which nicely leads to the last area of thematic importance, namely that of territoriality and movement.

The Art and Movement/Territoriality – Routes throughout the Côa Valley have not only been mapped through the new-found understanding of visibility connections at sites such as Penascosa and Canada do Inferno, also links to more distant areas such as Siega Verde have been established, sharing many similarities of depiction preferences and likely contributing to an artistic whole in the past. This expression of the *artistic whole* serves as a reminder that territories that we know of today, such as the Côa Valley in Portugal and the Siega Verde Valley in Spain, did not exist as such in the past. Imposing certain euro-centric views onto the past through the baggage that 'territoriality' more broadly brings with it, often-times leads to unnecessary speculation. Overall, however, in light of all these findings within this thesis (artists/ audiences; public/private functions; the repurposing of art and the clear strategic movements of hunter gatherers naturally attuned to their environments), the idea by Aubry *et al.* (2010: 503) of the Côa being an aggregational area "where dispersed bands would seasonally come together to fulfil their economic, social and culture needs" looks more and more realistic.

Future uses of the symbiosis between archaeology and psychology

The research conducted serves as an essential step in the initial bridge-building process to combine archaeological with psychological research. Both disciplines can benefit from each other's insights into aspects of human artistic creations. Archaeology offers the material evidence and methodologies to date and categorise *art*, whilst psychology explains the cognitive processes behind such creations. The conclusions above bring us closer to an understanding of the involvement of the visual system within rock art making (i.e. motif type selection and motif shape creation) and rock art viewing processes (i.e. locations of motifs on panels and (inter)-visibility between rock, motif and landscape). Largely, the thesis' interdisciplinarity ought to become a more common practise within archaeological rock art studies and beyond.

Future uses of the methodological approaches

Arguably, the thesis's biggest contribution lies within its methodological scope, offering readers insights and first pilots into a unique way of investigating rock art. All of the research methodologies presented here are entirely novel and implemented for the very first time. Whilst all experiments follow a scalar approach building up on each other, each experiment can also be regarded as a stand-alone piece of research generating fruitful insights into rock art making and consumption. The novel approaches should be seen as paving the way for development in wider academic communities. Moreover, the integration of the theoretical aspects (e.g. typography and audience channelling) with the methodological aspects (e.g. physical and virtual distance studies), sets the agenda for future studies of rock art, applicable to other regions and periods, illustrating the significant insights to be gained from such a holistic approach.

Wider impact on how to situate open-air rock art…

Having established a multitude of aspects regarding the underlying reasons for art productions and consumption, it is now possible to apply these onto wider realms of hunter-gatherer lifeways. In particular, the applicability of these findings onto cave art production and consumption ought to be comparatively investigated in the future. Does the model of the hunter as the artist still hold true for cave environments, or would the often detailed and pigmented nature of cave art on walls testify to other artistic purposes? Overall, this research brings new insights into the long-term debate on whether deciphering the purpose behind rock art is possible. This thesis' findings, that **rock art motif creation, rock art compositioning and rock art location choices are cognitively motivated**, undeniably give this debate previously unheard-of matters for future discussions.

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APPENDIX

This appendix contains a selection of data outputs and images used and generated during the course of this research. Throughout this appendices collection, it will occur that only a sample of the entire dataset is presented. If this is the case, it will be clearly stated in the headings/captions of the figures in question.

Content

Appendix A – The Engraves Species Database

Appendix B – Drawing Animals

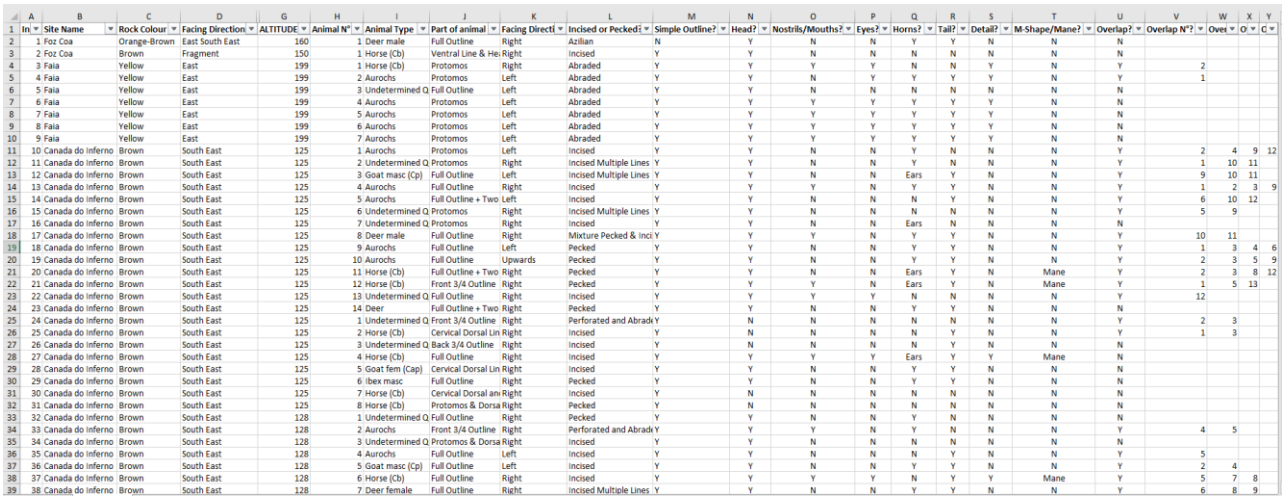
Appendix C – Bubbles

Appendix D – Perceiving Superimpositions

Appendix E – Visibility Study

Appendix F – Integrated Visibility Study

Appendix A – The Engraved Species Database (example screenshots from data capture)



In	Site Name	Rock Colour	Facing Direction	ALTITUDE	Animal N°	Animal Type	Part of animal	Facing Direct	Incised or Pecked	Simple Outline?	Head?	Nostrils/Mouths?	Eyes?	Horns?	Tail?	Detail?	M-Shape/Mane?	Overlap?	Overlap N°?				
1	Foz Coa	Orange-Brown	East South East	160	1	Deer male	Full Outline	Right	Azilian	N	Y	N	N	Y	Y	N	N	N					
2	Foz Coa	Brown	Fragment	150	1	Horse (Cb)	Ventral Line & He	Right	Incised	Y	Y	N	N	N	N	N	N	N					
3	Faia	Yellow	East	199	1	Horse (Cb)	Protomos	Right	Abraded	Y	Y	Y	N	N	N	Y	N	Y	2				
4	Faia	Yellow	East	199	2	Aurochs	Protomos	Left	Abraded	Y	Y	N	Y	Y	Y	Y	N	Y	1				
5	Faia	Yellow	East	199	3	Undetermined Q	Full Outline	Left	Abraded	Y	Y	N	N	N	N	N	N	N					
6	Faia	Yellow	East	199	4	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N					
7	Faia	Yellow	East	199	5	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N					
8	Faia	Yellow	East	199	6	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N					
9	Faia	Yellow	East	199	7	Aurochs	Protomos	Left	Abraded	Y	Y	Y	Y	Y	Y	Y	N	N					
10	Canada do Inferno	Brown	South East	125	1	Aurochs	Protomos	Left	Incised	Y	Y	N	N	Y	N	N	N	Y	2	4	9	12	
11	Canada do Inferno	Brown	South East	125	2	Undetermined Q	Protomos	Right	Incised Multiple Lines	Y	Y	N	N	Y	N	N	N	Y	1	10	11		
12	Canada do Inferno	Brown	South East	125	3	Goat masc (Cp)	Full Outline	Left	Incised Multiple Lines	Y	Y	N	N	Ears	Y	N	N	Y	9	10	11		
13	Canada do Inferno	Brown	South East	125	4	Aurochs	Full Outline	Right	Incised	Y	Y	Y	N	Y	Y	N	N	Y	1	2	3	9	
14	Canada do Inferno	Brown	South East	125	5	Aurochs	Full Outline + Two	Left	Incised	Y	Y	N	N	N	Y	N	N	Y	6	10	12		
15	Canada do Inferno	Brown	South East	125	6	Undetermined Q	Protomos	Right	Incised Multiple Lines	Y	Y	N	N	N	N	N	N	Y	5	9			
16	Canada do Inferno	Brown	South East	125	7	Undetermined Q	Protomos	Right	Incised	Y	Y	N	N	Ears	N	N	N	N					
17	Canada do Inferno	Brown	South East	125	8	Deer male	Full Outline	Right	Mixture Pecked & Inci	Y	Y	Y	N	Y	Y	N	N	Y	10	11			
18	Canada do Inferno	Brown	South East	125	9	Aurochs	Full Outline	Left	Pecked	Y	Y	N	N	Y	Y	N	N	Y	1	3	4	6	
19	Canada do Inferno	Brown	South East	125	10	Aurochs	Full Outline	Upwards	Pecked	Y	Y	N	N	Y	Y	N	N	Y	2	3	5	9	
20	Canada do Inferno	Brown	South East	125	11	Horse (Cb)	Full Outline + Two	Right	Pecked	Y	Y	Y	N	Ears	Y	N	Mane	Y	2	3	8	12	
21	Canada do Inferno	Brown	South East	125	12	Horse (Cb)	Front 3/4 Outline	Right	Pecked	Y	Y	Y	N	Ears	Y	N	Mane	Y	1	5	13		
22	Canada do Inferno	Brown	South East	125	13	Undetermined Q	Full Outline	Right	Incised	Y	Y	Y	Y	N	N	N	N	Y	12				
23	Canada do Inferno	Brown	South East	125	14	Deer	Full Outline + Two	Right	Pecked	Y	Y	N	N	Y	Y	N	N	N					
24	Canada do Inferno	Brown	South East	125	1	Undetermined Q	Front 3/4 Outline	Right	Perforated and Abrad	Y	N	N	N	N	N	N	N	Y	2	3			
25	Canada do Inferno	Brown	South East	125	2	Horse (Cb)	Cervical Dorsal Lin	Right	Incised	Y	N	N	N	N	Y	N	N	Y	1	3			
26	Canada do Inferno	Brown	South East	125	3	Undetermined Q	Back 3/4 Outline	Right	Incised	Y	N	N	N	N	Y	N	N	N					
27	Canada do Inferno	Brown	South East	125	4	Horse (Cb)	Full Outline	Right	Incised	Y	Y	Y	Y	Ears	Y	Y	Mane	N					
28	Canada do Inferno	Brown	South East	125	5	Goat fem (Cap)	Cervical Dorsal Lin	Right	Incised	Y	Y	Y	N	Y	Y	N	N	N					
29	Canada do Inferno	Brown	South East	125	6	Ibex masc	Full Outline	Right	Pecked	Y	Y	N	N	Y	Y	N	N	N					
30	Canada do Inferno	Brown	South East	125	7	Horse (Cb)	Cervical Dorsal an	Right	Incised	Y	N	N	N	N	N	N	N	N					
31	Canada do Inferno	Brown	South East	125	8	Horse (Cb)	Protomos & Dorsa	Right	Pecked	Y	N	N	N	N	N	N	N	N					
32	Canada do Inferno	Brown	South East	128	1	Undetermined Q	Full Outline	Right	Pecked	Y	Y	N	N	Y	N	N	N	N					
33	Canada do Inferno	Brown	South East	128	2	Aurochs	Front 3/4 Outline	Right	Perforated and Abrad	Y	Y	Y	N	Y	N	N	N	N	4	5			
34	Canada do Inferno	Brown	South East	128	3	Undetermined Q	Protomos & Dorsa	Right	Incised	Y	Y	N	N	N	N	N	N	N					
35	Canada do Inferno	Brown	South East	128	4	Aurochs	Full Outline	Left	Incised	Y	Y	N	N	Y	N	N	N	Y	5				
36	Canada do Inferno	Brown	South East	128	5	Goat masc (Cp)	Full Outline	Left	Incised	Y	Y	N	N	Y	Y	N	N	Y	2	4			
37	Canada do Inferno	Brown	South East	128	6	Horse (Cb)	Full Outline	Right	Incised	Y	Y	Y	Y	N	Y	Y	Mane	Y	5	7	8		
38	Canada do Inferno	Brown	South East	128	7	Deer female	Full Outline	Right	Incised Multiple Lines	Y	Y	N	N	Y	Y	N	N	Y	6	8	9		

Figure A.A.1: Details of the Database View (showing 38/1117 engraving catalogues).

	A	B	C	D	G	H	I	J	K	L
1	In	Site Name	Rock Colour	Facing Direction	ALTITUDE	Animal N°	Animal Type	Part of animal	Facing Directi	Incised or Pecked
2	1	Foz Coa	Orange-Brown	East South East	160	1	Deer male	Full Outline	Right	Azilian
3	2	Foz Coa	Brown	Fragment	150	1	Horse (Cb)	Ventral Line & He	Right	Incised
4	3	Faia	Yellow	East	199	1	Horse (Cb)	Protomos	Right	Abraded
5	4	Faia	Yellow	East	199	2	Aurochs	Protomos	Left	Abraded
6	5	Faia	Yellow	East	199	3	Undetermined Q	Full Outline	Left	Abraded
7	6	Faia	Yellow	East	199	4	Aurochs	Protomos	Left	Abraded
8	7	Faia	Yellow	East	199	5	Aurochs	Protomos	Left	Abraded
9	8	Faia	Yellow	East	199	6	Aurochs	Protomos	Left	Abraded
10	9	Faia	Yellow	East	199	7	Aurochs	Protomos	Left	Abraded
11	10	Canada do Inferno	Brown	South East	125	1	Aurochs	Protomos	Left	Incised
12	11	Canada do Inferno	Brown	South East	125	2	Undetermined Q	Protomos	Right	Incised Multiple Lines
13	12	Canada do Inferno	Brown	South East	125	3	Goa	Ibex Outline	Left	Incised Multiple Lines
14	13	Canada do Inferno	Brown	South East	125	4	Aurochs	Full Outline	Right	Incised
15	14	Canada do Inferno	Brown	South East	125	5	Aurochs	Full Outline + Two	Left	Incised
16	15	Canada do Inferno	Brown	South East	125	6	Undetermined Q	Protomos	Right	Incised Multiple Lines
17	16	Canada do Inferno	Brown	South East	125	7	Undetermined Q	Protomos	Right	Incised
18	17	Canada do Inferno	Brown	South East	125	8	Deer male	Full Outline	Right	Mixture Pecked & Inci
19	18	Canada do Inferno	Brown	South East	125	9	Aurochs	Full Outline	Left	Pecked
20	19	Canada do Inferno	Brown	South East	125	10	Aurochs	Full Outline	Upwards	Pecked
21	20	Canada do Inferno	Brown	South East	125	11	Horse (Cb)	Full Outline + Two	Right	Pecked
22	21	Canada do Inferno	Brown	South East	125	12	Horse (Cb)	Front 3/4 Outline	Right	Pecked
23	22	Canada do Inferno	Brown	South East	125	13	Undetermined Q	Full Outline	Right	Incised
24	23	Canada do Inferno	Brown	South East	125	14	Deer	Full Outline + Two	Right	Pecked
25	24	Canada do Inferno	Brown	South East	125	1	Undetermined Q	Front 3/4 Outline	Right	Perforated and Abrade
26	25	Canada do Inferno	Brown	South East	125	2	Horse (Cb)	Cervical Dorsal Lin	Right	Incised
27	26	Canada do Inferno	Brown	South East	125	3	Undetermined Q	Back 3/4 Outline	Right	Incised
28	27	Canada do Inferno	Brown	South East	125	4	Horse (Cb)	Full Outline	Right	Incised
29	28	Canada do Inferno	Brown	South East	125	5	Goa	Ibex vical Dorsal Lin	Right	Incised
30	29	Canada do Inferno	Brown	South East	125	6	Ibex masc	Full Outline	Right	Pecked
31	30	Canada do Inferno	Brown	South East	125	7	Horse (Cb)	Cervical Dorsal an	Right	Incised
32	31	Canada do Inferno	Brown	South East	125	8	Horse (Cb)	Protomos & Dorsa	Right	Pecked
33	32	Canada do Inferno	Brown	South East	128	1	Undetermined Q	Full Outline	Right	Pecked
34	33	Canada do Inferno	Brown	South East	128	2	Aurochs	Front 3/4 Outline	Right	Perforated and Abrade
35	34	Canada do Inferno	Brown	South East	128	3	Undetermined Q	Protomos & Dorsa	Right	Incised
36	35	Canada do Inferno	Brown	South East	128	4	Aurochs	Full Outline	Left	Incised
37	36	Canada do Inferno	Brown	South East	128	5	Goa	Ibex Outline	Left	Incised
38	37	Canada do Inferno	Brown	South East	128	6	Horse (Cb)	Full Outline	Right	Incised
39	38	Canada do Inferno	Brown	South East	128	7	Deer female	Full Outline	Right	Incised Multiple Lines

Figure A.A.2: Zoomed-in view of database features (Part 1).

M	N	O	P	Q	R	S	T	U	V	W	X	Y
Simple Outline?	Head?	Nostrils/Mouths?	Eyes?	Horns?	Tail?	Detail?	M-Shape/Mane?	Overlap?	Overlap N°?	Over	O	C
N	Y	N	N	Y	Y	N	N	N				
Y	Y	N	N	N	N	N	N	N				
Y	Y	Y	Y	N	N	Y	N	Y	2			
Y	Y	N	Y	Y	Y	Y	N	Y	1			
Y	Y	N	N	N	N	N	N	N				
Y	Y	Y	Y	Y	Y	Y	N	N				
Y	Y	Y	Y	Y	Y	Y	N	N				
Y	Y	Y	Y	Y	Y	Y	N	N				
Y	Y	Y	Y	Y	Y	Y	N	N				
Y	Y	N	N	Y	N	N	N	Y	2	4	9	12
Y	Y	N	N	Y	N	N	N	Y	1	10	11	
Y	Y	N	N	Ears	Y	N	N	Y	9	10	11	
Y	Y	Y	N	Y	Y	N	N	Y	1	2	3	9
Y	Y	N	N	N	Y	N	N	Y	6	10	12	
Y	Y	N	N	N	N	N	N	Y	5	9		
Y	Y	N	N	Ears	N	N	N	N				
Y	Y	Y	N	Y	Y	N	N	Y	10	11		
Y	Y	N	N	Y	Y	N	N	Y	1	3	4	6
Y	Y	N	N	Y	Y	N	N	Y	2	3	5	9
Y	Y	N	N	Ears	Y	N	Mane	Y	2	3	8	12
Y	Y	Y	N	Ears	Y	N	Mane	Y	1	5	13	
Y	Y	Y	Y	N	N	N	N	Y	12			
Y	Y	N	N	Y	Y	N	N	N				
Y	N	N	N	N	N	N	N	Y	2	3		
Y	N	N	N	N	Y	N	N	Y	1	3		
Y	N	N	N	N	Y	N	N	N				
Y	Y	Y	Y	Ears	Y	Y	Mane	N				
Y	Y	N	N	Y	Y	N	N	N				
Y	Y	N	N	Y	Y	N	N	N				
Y	N	N	N	N	N	N	N	N				
Y	N	N	N	N	N	N	N	N				
Y	Y	N	N	Y	N	N	N	N				
Y	Y	Y	N	Y	N	N	N	Y	4	5		
Y	Y	N	N	N	N	N	N	N				
Y	Y	N	N	N	Y	N	N	Y	5			
Y	Y	N	N	Y	Y	N	N	Y	2	4		
Y	Y	Y	Y	N	Y	Y	Mane	Y	5	7	8	
Y	Y	N	N	Y	Y	N	N	Y	6	8	9	

Figure A.A.3: Zoomed-in view of database features to be read as an extend to the right of Figure A.A.2 (Part 2).

Appendix B – Drawing Animals – Sample Questionnaire

Experimental approaches to understanding Prehistoric art. **Questionnaire 1**

Epiphany Term 2017.

Name.

Drawing 1 (horse)

I chose the view/profile I drew because:

I began the drawing (at what part of the horse s body?)...

... and then drew the following in this order...

...finishing the drawing with...

Drawing 2 (bison)

I chose the view/profile I drew because:

I began the drawing (at what part of the horse's body?)...

... and then drew the following in this order...

...finishing the drawing with...

Figure A.B.1.: Questionnaire(Part 1) used during the drawing experiment to gain additional insights into the drawing process.

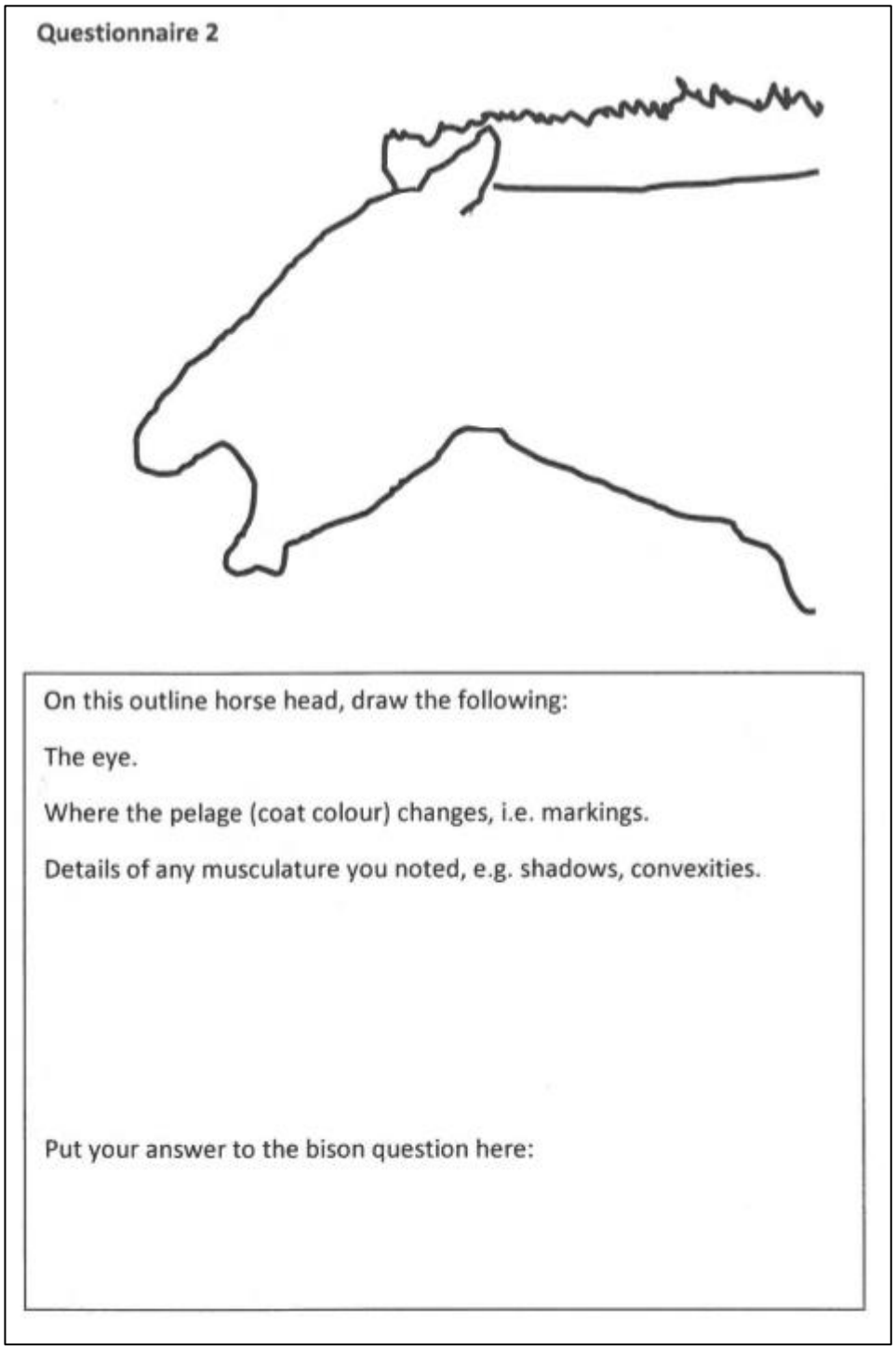


Figure A.B.2.: Questionnaire(Part 2) used during the drawing experiment to gain additional insights into the drawing process and the effect of priming.

Appendix B – Drawing Animals – Sample Drawings

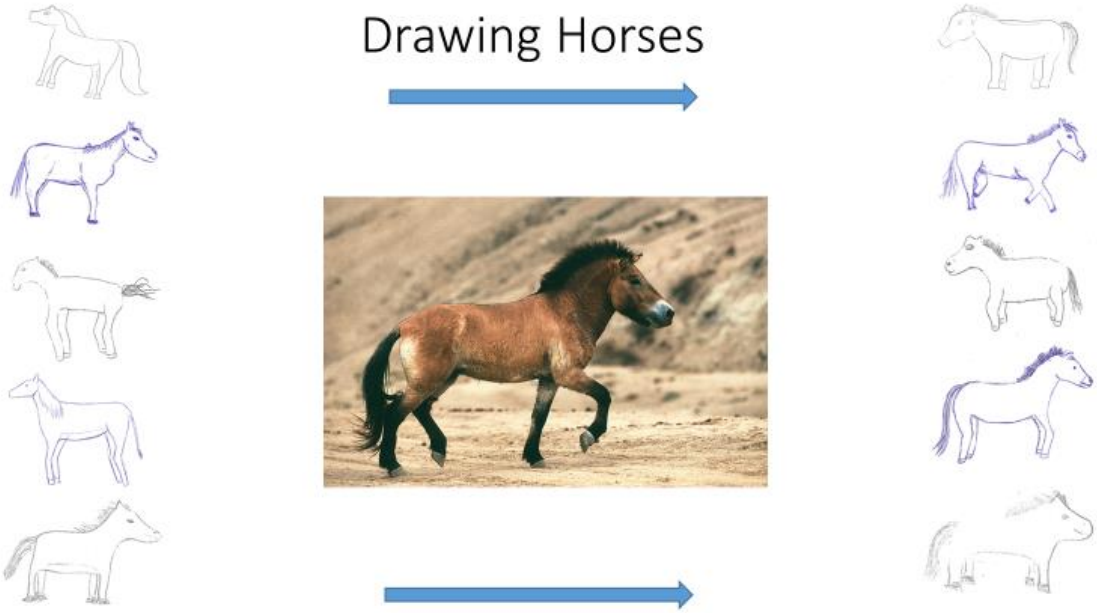


Figure A.B.3.: Year 1 examples from the horse drawing trial before (left) and after (right) priming (middle).

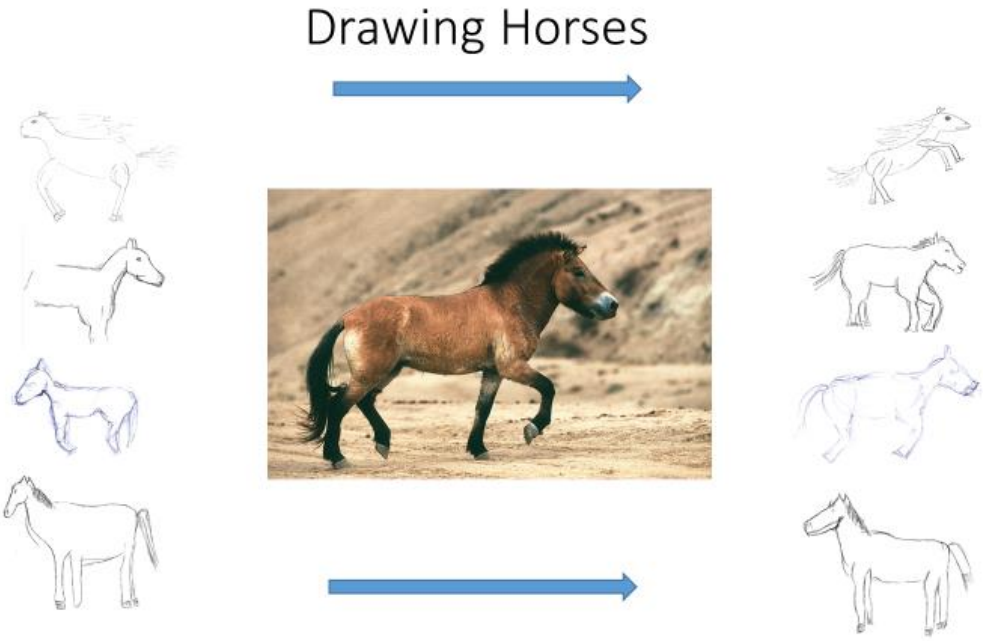


Figure A.B.4.: Year 2 examples from the horse drawing trial before (left) and after (right) priming (middle).

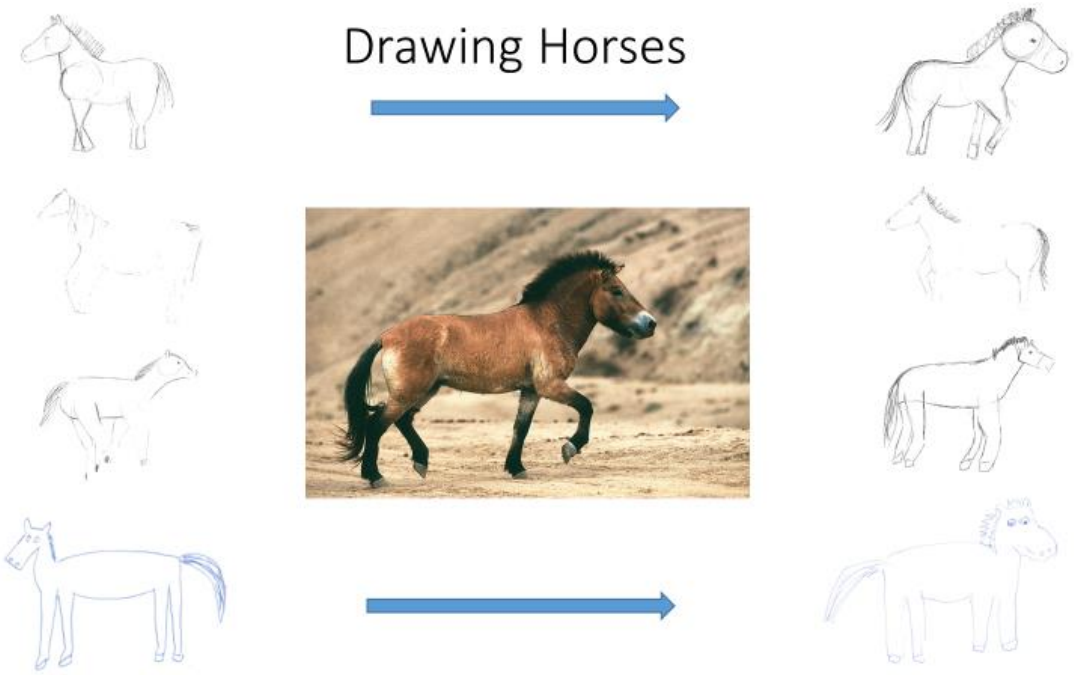


Figure A.B.5.: More Year 2 examples from the horse drawing trial before (left) and after (right) priming (middle).

Figure A.B.6.: Year 3 examples from the horse drawing trial before (left) and after (right) priming (middle).

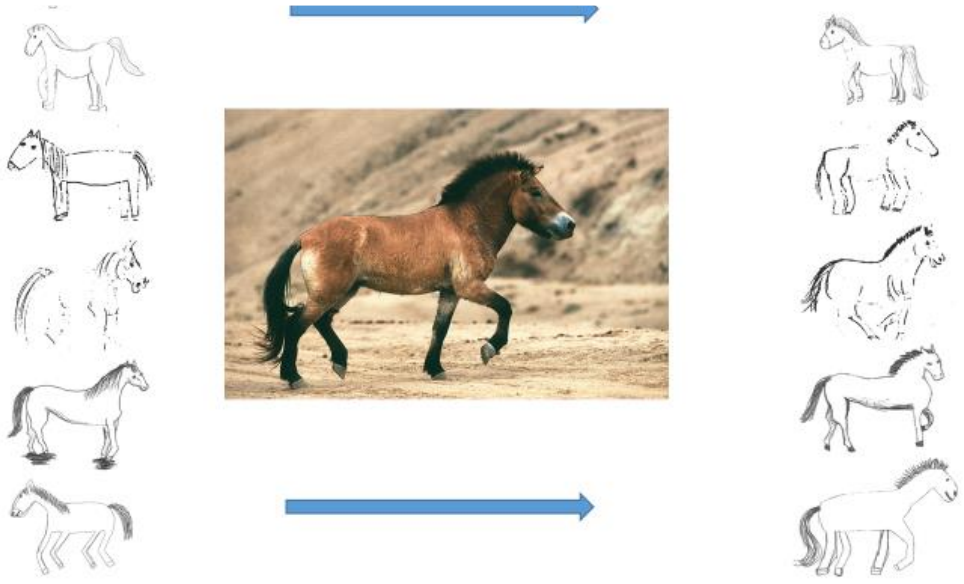




Figure A.B.7.: Year 1 examples from the horse herd drawing trial.



Figure A.B.8.: Year 2 examples from the horse herd drawing trial.

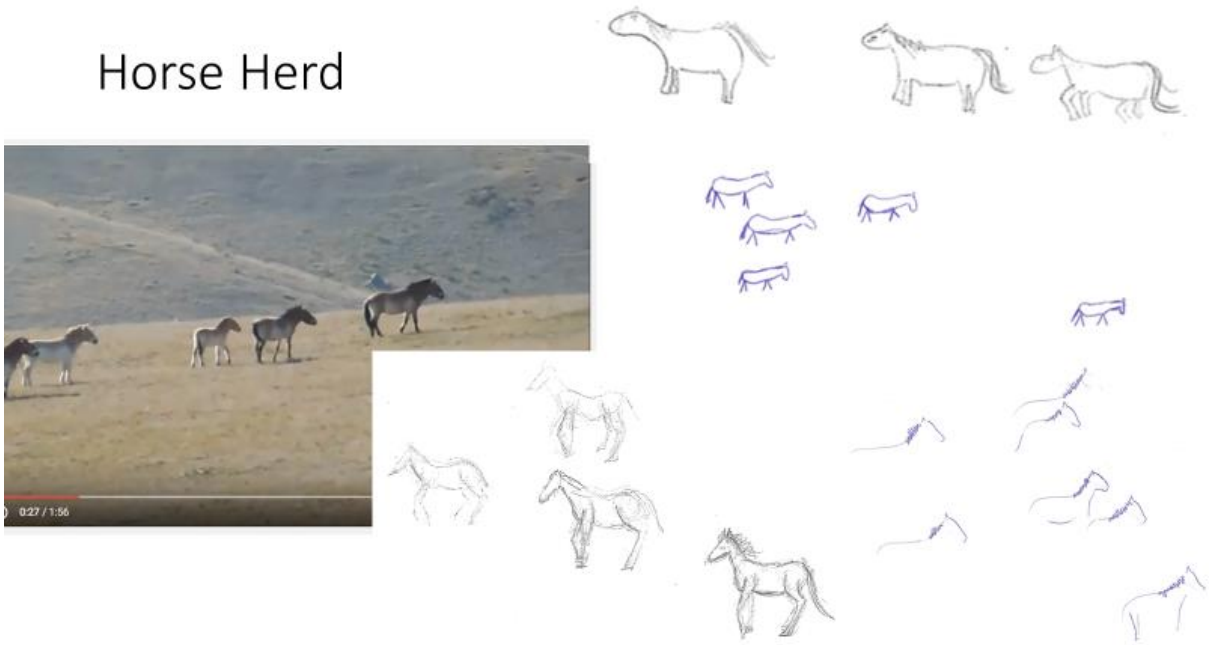


Figure A.B.9.: More year 2 examples from the horse herd drawing trial.



Figure A.B.10.: Year 3 examples from the horse herd drawing trial.

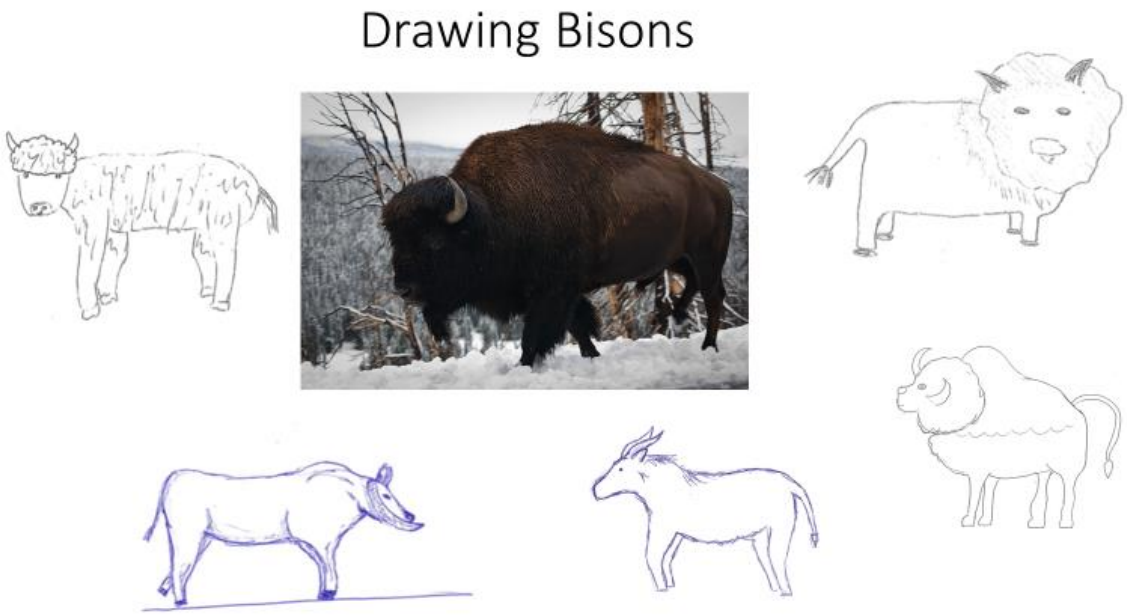


Figure A.B.11.: General examples from the bison drawing trial after priming.

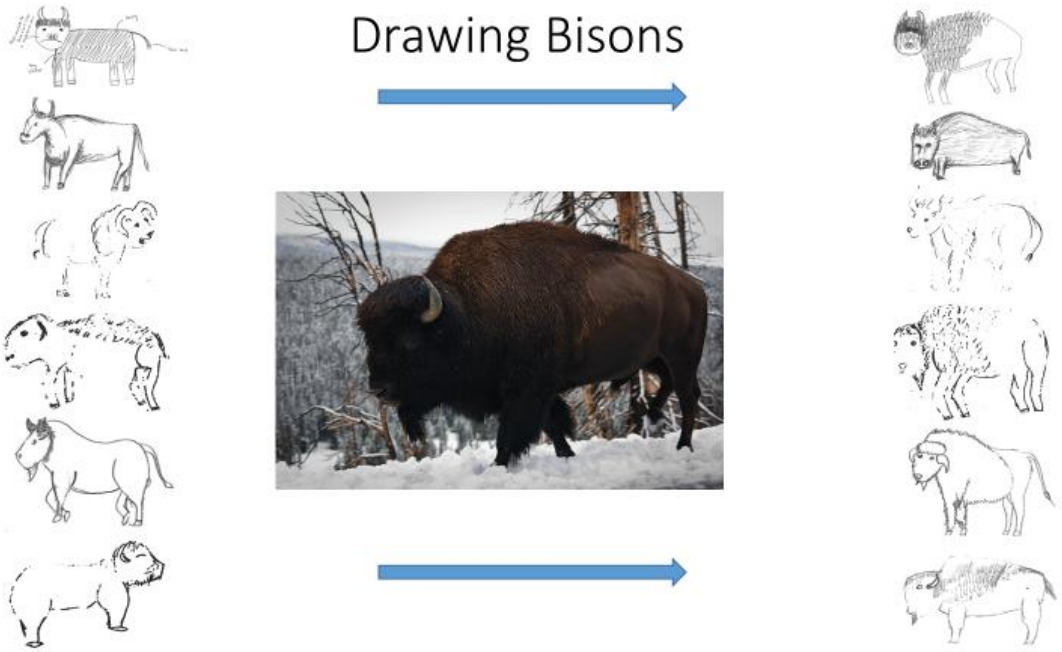


Figure A.B.12.: Year 1 examples from the bison drawing trial before (left) and after (right) priming (middle).

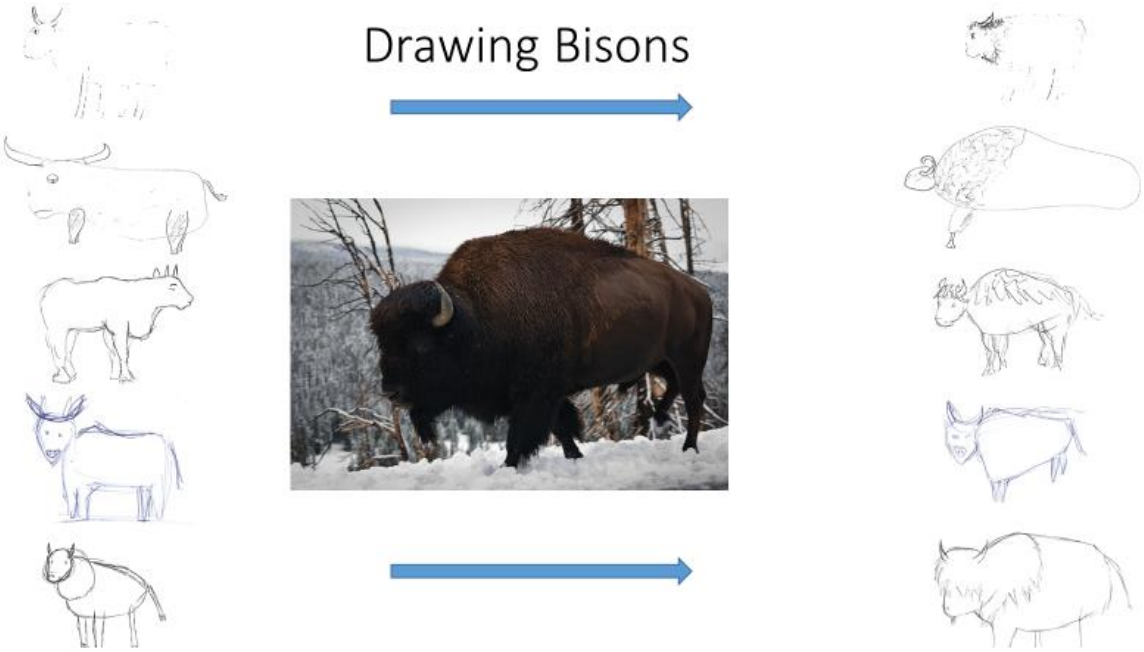


Figure A.B.13.: Year 2 examples from the bison drawing trial before (left) and after (right) priming (middle).

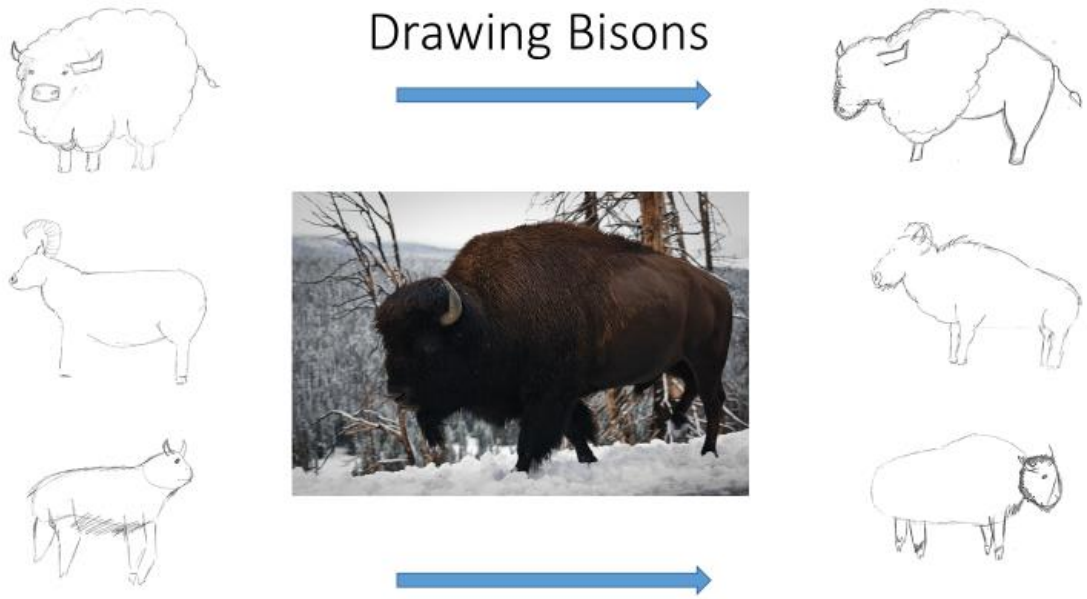


Figure A.B.14.: Year 2 examples from the bison drawing trial before (left) and after (right) priming (middle).



Figure A.B.15.: Examples from the bison herd drawing trial after priming.



Figure A.B.16.: Examples from the bison herd drawing trial after priming.



Figure A.B.17.: Year 1 examples from the bison fight drawing trial after priming.



Figure A.B.18.: Year 2 examples from the bison fight drawing trial after priming.



Figure A.B.19.: Year 3 examples from the bison fight drawing trial after priming.



Figure A.B.20.: Examples from “Artistic Minimalism” trial.

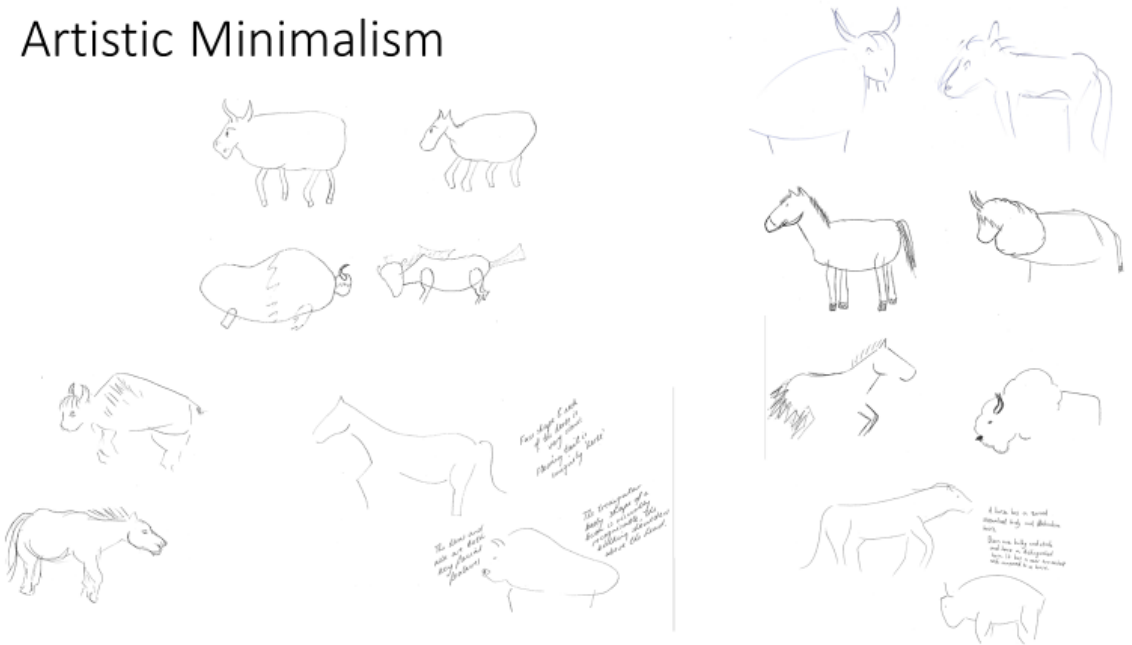


Figure A.B.21.: Examples from “Artistic Minimalism” trial.

Appendix C – Bubbles – Participant Information Sheet (interchangeable for all experiments in this thesis)

Participant Information Sheet

Project title: Prey, Perception, and the Visual Psychology of Early Figurative Art
Researcher: Lisa-Elen Meyering
Department: Archaeology and Psychology
Contact details: lisa-elen.meyering@durham.ac.uk
Supervisor names: Prof. Paul Pettitt and Prof. Robert Kentridge

You are invited to take part in a study that I am conducting as part of my PhD at Durham University. This study has received ethical approval from my *departmental ethics committee*. Before you decide whether to agree to take part it is important for you to understand the purpose of the research and what is involved as a participant. Please read the following information carefully. Please get in contact if there is anything that is not clear or if you would like more information. The rights and responsibilities of anyone taking part in Durham University research are set out in our 'Participants Charter': https://www.dur.ac.uk/research.innovation/governance/ethics/considerations/people/charter/

What is the purpose of the study?

- The aim of this study is to (a) understand visual procedures and decision making related to the making of open air rock art; (b) gain information on how participants respond to specified stimuli and prior priming processes; (c) identify which features of shown stimuli (in this case of prey animals) yield in direct, successful identification.
- The funder of this project is The Leverhulme Trust in association with The Centre for Visual Arts and Cultures at Durham University.
- The study will be completed in early 2020.

Do I have to take part?

Your participation is voluntary and you do not have to agree to take part. If you do agree to take part, you can withdraw at any time, without giving a reason.

Will my data be kept confidential?

All information obtained during the study will be kept confidential. If the data is published it will be entirely anonymous and will not be identifiable as yours. If direct quotes from questionnaires are used, permission will be obtained and answers will be anonymised.

What will happen to the results of the project?

- Results will be presented in the PhD thesis and in other project outputs, such as academic conferences and in future academic publications.
- No personal data will be shared, however anonymised data may be used in publications, reports, presentations, web pages and other research outputs. At the end of the project, anonymised data may be archived and shared with others for legitimate research purposes.

Durham University is committed to sharing the results of its world-class research for public benefit. As part of this commitment the University has established an online repository for all Durham University Higher Degree theses which provides access to the full text of freely available theses. The study in which you are invited to participate will be written up as a thesis. On successful submission of the thesis, it will be deposited both in print and online in the University archives, to facilitate its use in future research. The thesis will be embargoed before it will be published in an open access format.

Who do I contact if I have any questions or concerns about this study?

If you have any further questions about this study, please speak to the researcher or their supervisor.

Thank you for reading this information and considering taking part in this study.

Version 1 October 2016

Figure A.C.1.: Example participant information sheet used for all experiments (with altered purpose) during this research.

Appendix C – Bubbles – Consent Form

Consent Form

Project title: Prey, Perception, and the Visual Psychology of Early Figurative Art
Researcher: Lisa-Elen Meyering
Department: Archaeology and Psychology
Contact details: lisa-elen.meyering@durham.ac.uk
Supervisor names: Prof. Paul Pettitt and Prof. Robert Kentridge
This form is to confirm that you understand what the purposes of the project, what is involved and that you are happy to take part. Please initial each box to indicate your agreement:

I confirm that I have read and understand the information sheet for the above project.	
I have had sufficient time to consider the information and ask any questions I might have, and I am satisfied with the answers I have been given.	
I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	
I agree to take part in the above project.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason.	

Participant's Signature_____ Date_____

(NAME IN BLOCK LETTERS)_____

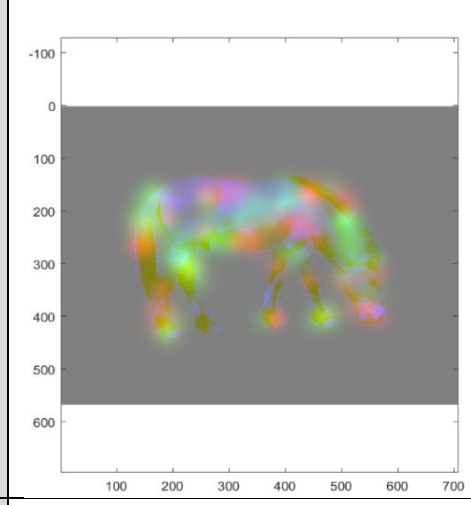
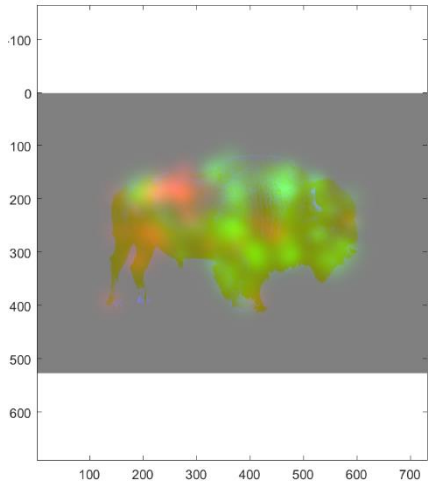
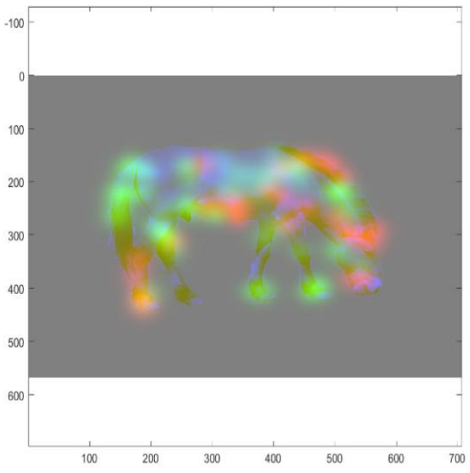
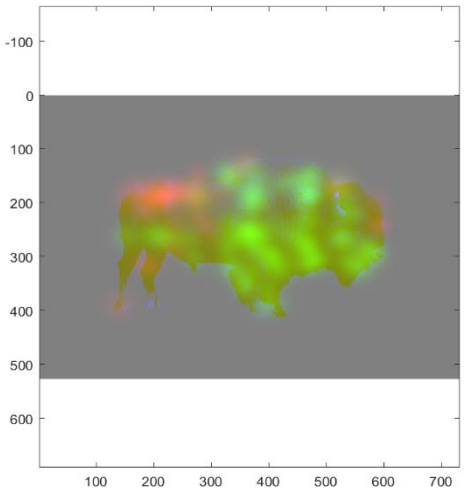
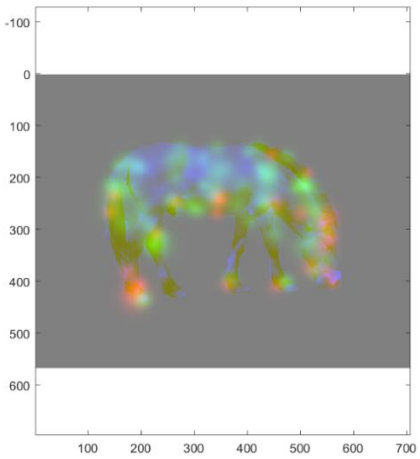
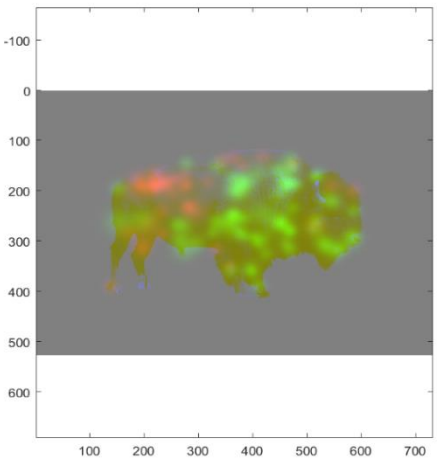
Researcher's Signature_____ Date_____

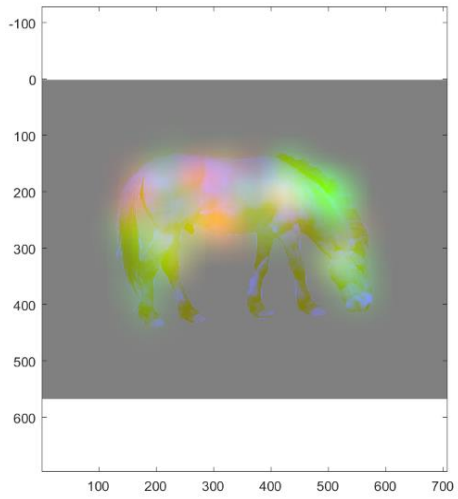
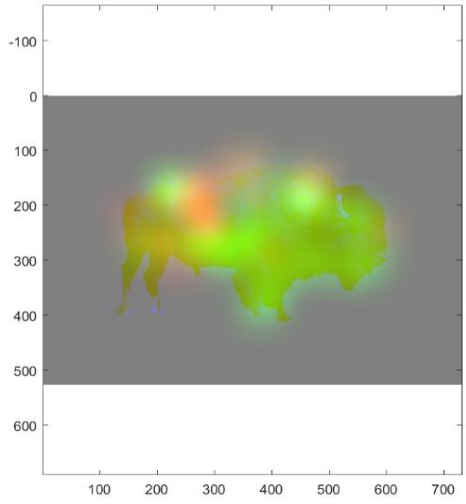
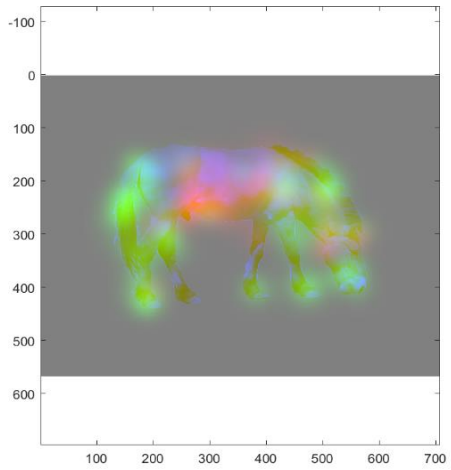
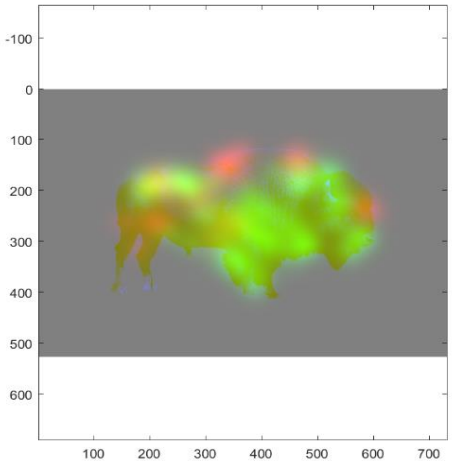
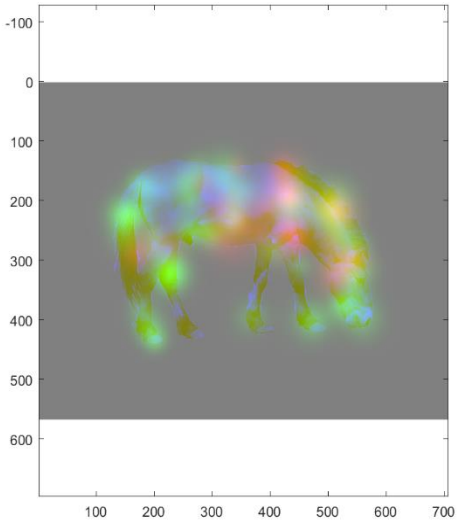
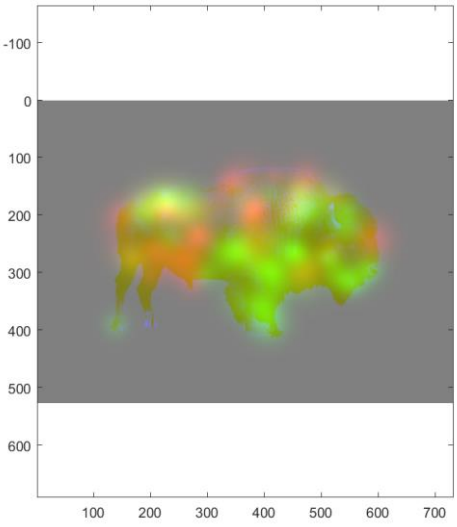
(NAME IN BLOCK LETTERS)_____

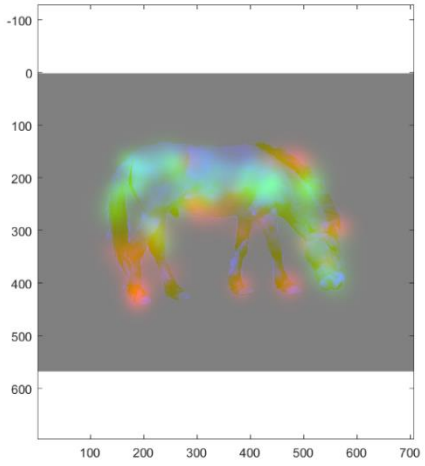
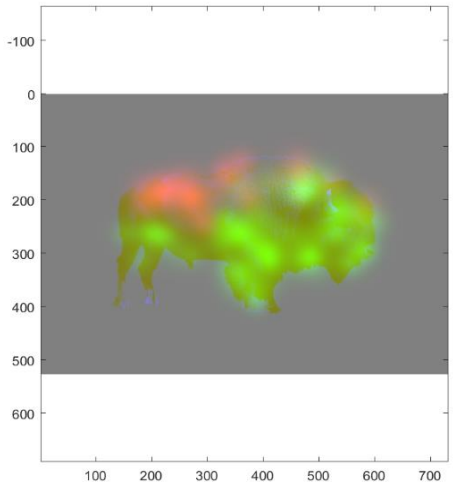
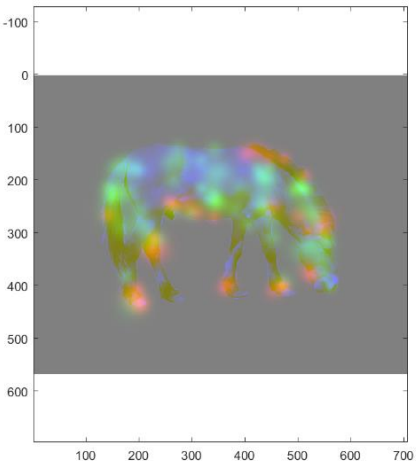
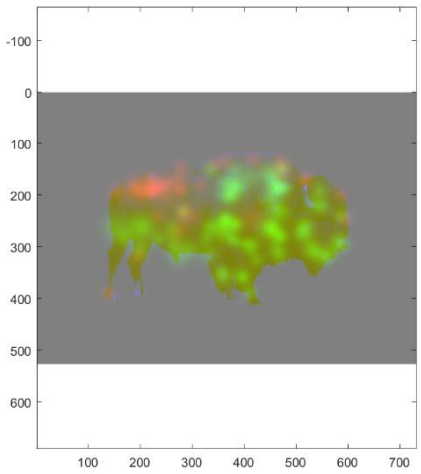
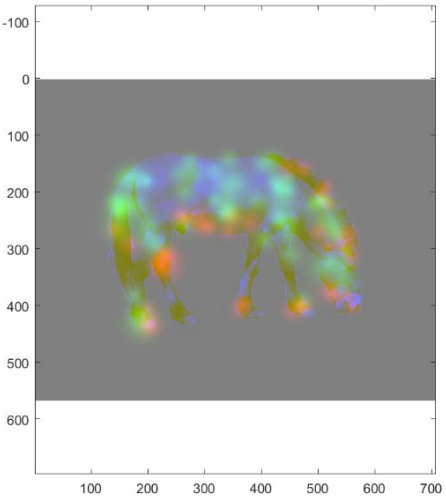
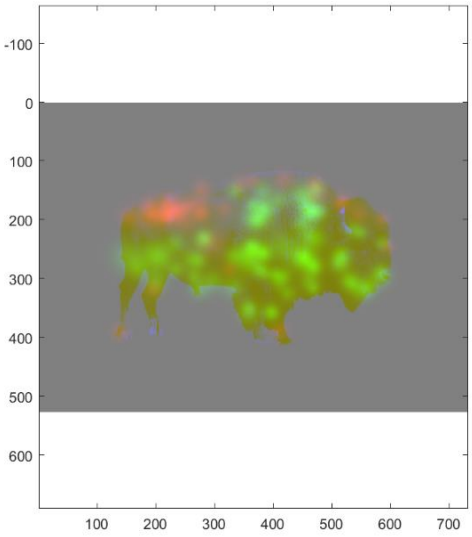
Version 1 October 2016

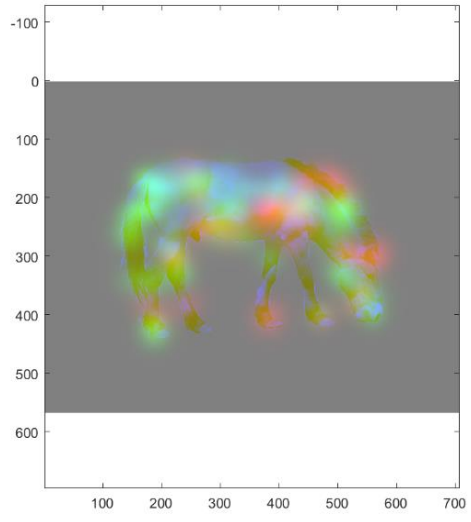
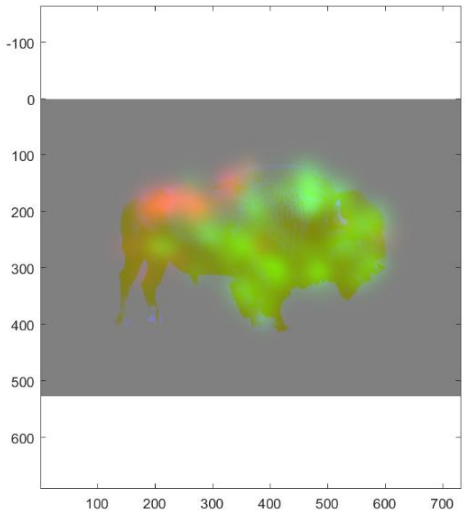
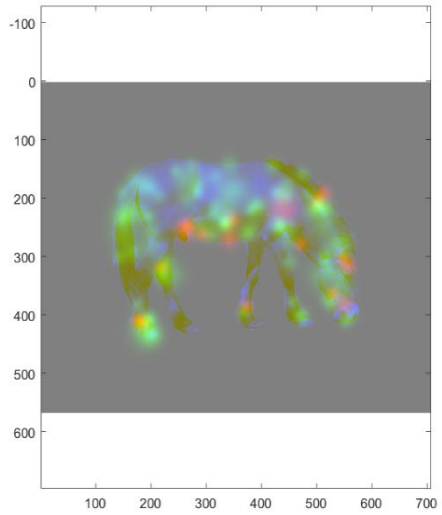
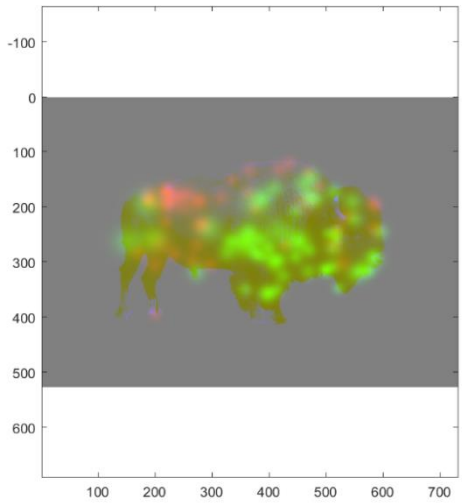
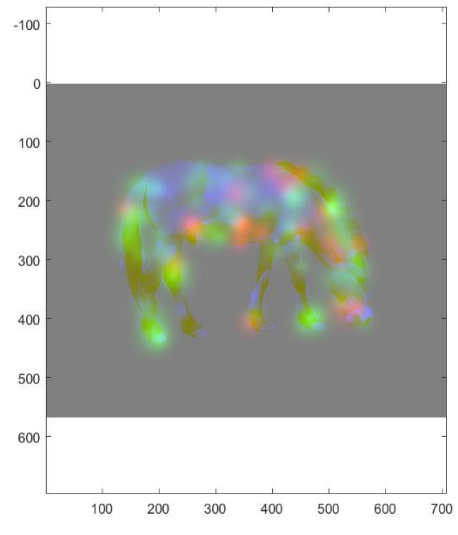
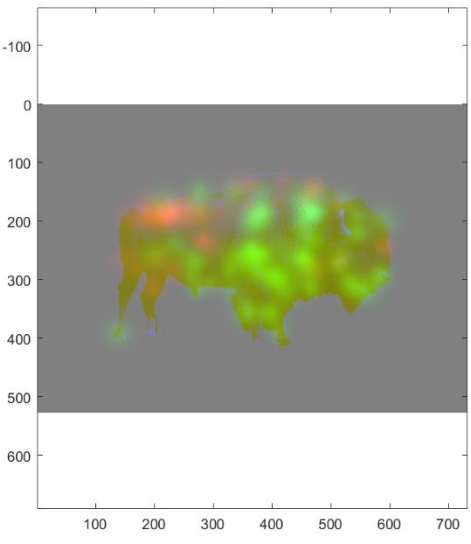
Figure A.C.2.: Example consent form used for all experiments during this research.

Appendix C – Bubbles – Sample Output - Year 1

Observer Nr.	Combined Classification Image Horse	Combined Classification Image Bison
Year 1 P. 1 Trial 1		
Year 1 P. 1 Trial 2		
Year 1 P. 1 Trial 3		

Year 1 P. 2 Trial 1		
Year 1 P. 2 Trial 2		
Year 1 P. 2 Trial 3		

Year 1 **P. 3** **Trial 1**		
Year 1 **P. 3** **Trial 2**		
Year 1 **P. 3** **Trial 3**		

Year 1 **P. 4** **Trial 1**		
Year 1 **P. 4** **Trial 2**		
Year 1 **P. 4** **Trial 3**		

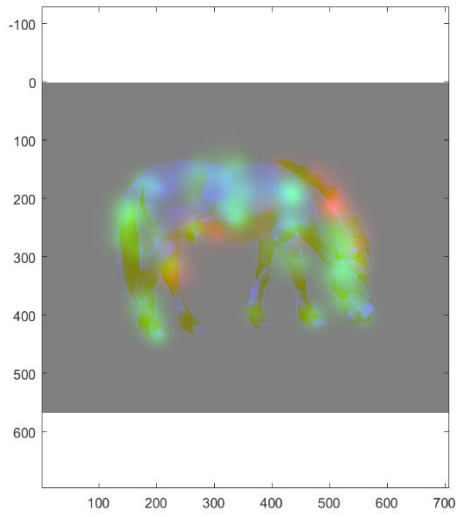
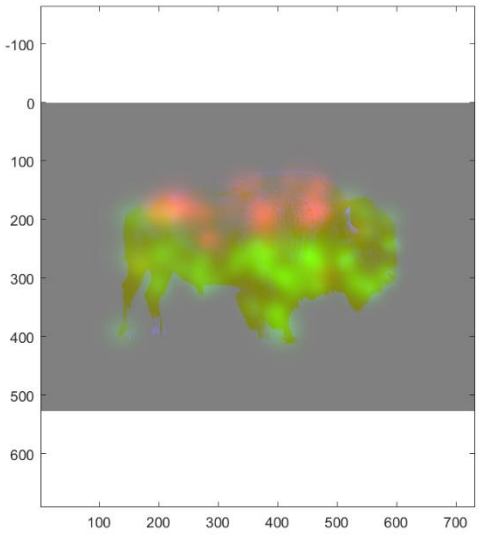
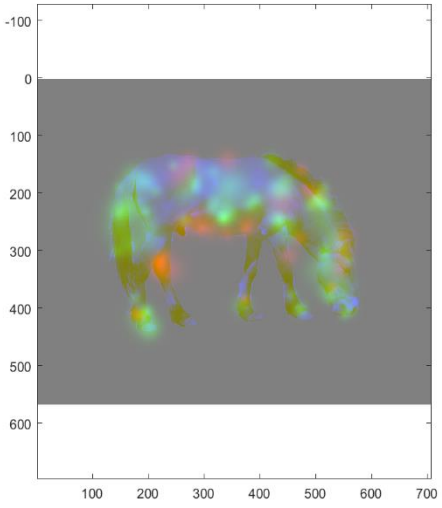
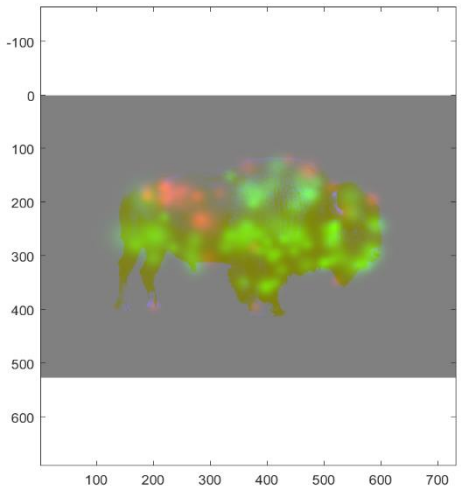
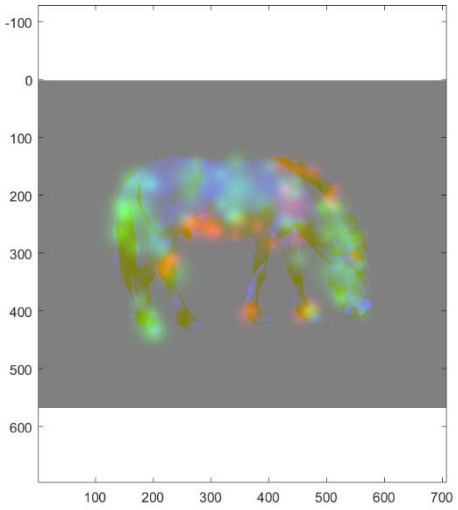
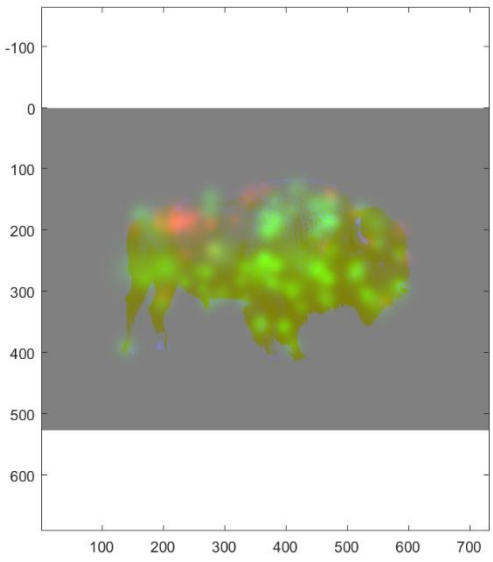
Year 1 **P. 5** **Trial 1**		
Year 1 **P. 5** **Trial 2**		
Year 1 **P. 5** **Trial 3**		

Table A.C.: Collation of combined *classification images* for Year 1 trials.

Appendix D – Perceiving Superimpositions – Image Bank of Overlap Types

All drawings are extracted from Santos's thesis (2017) and are courtesy of Fundação Côa Parque. All panels with heavy overlaps are displayed within chapter 6 of the thesis.

No Overlap (10 randomly selected examples):

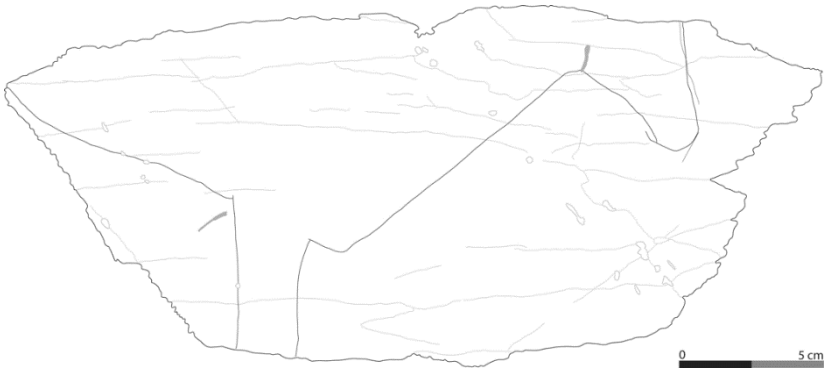


Figure A.D.1.: Fragment 1 of Foz do Côa

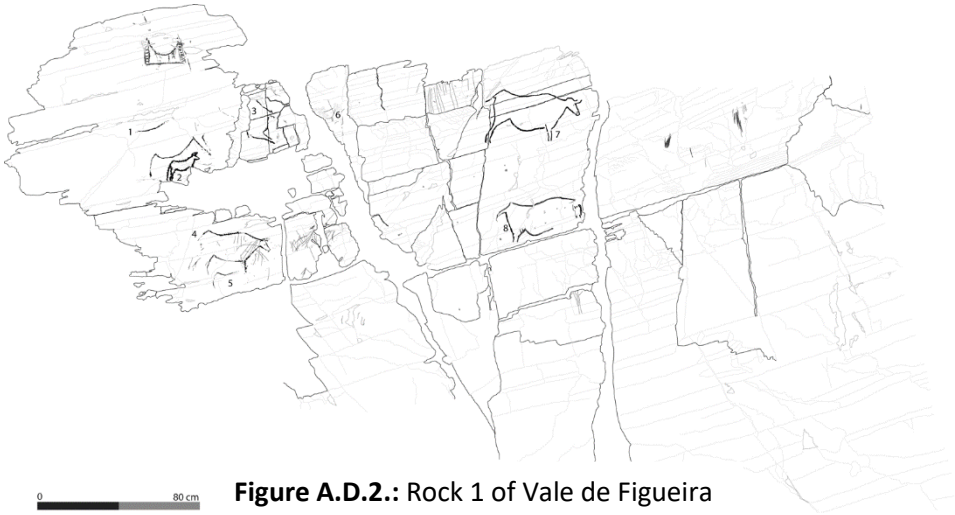


Figure A.D.2.: Rock 1 of Vale de Figueira



Figure A.D.3.: Rock 2 of Canada do Inferno

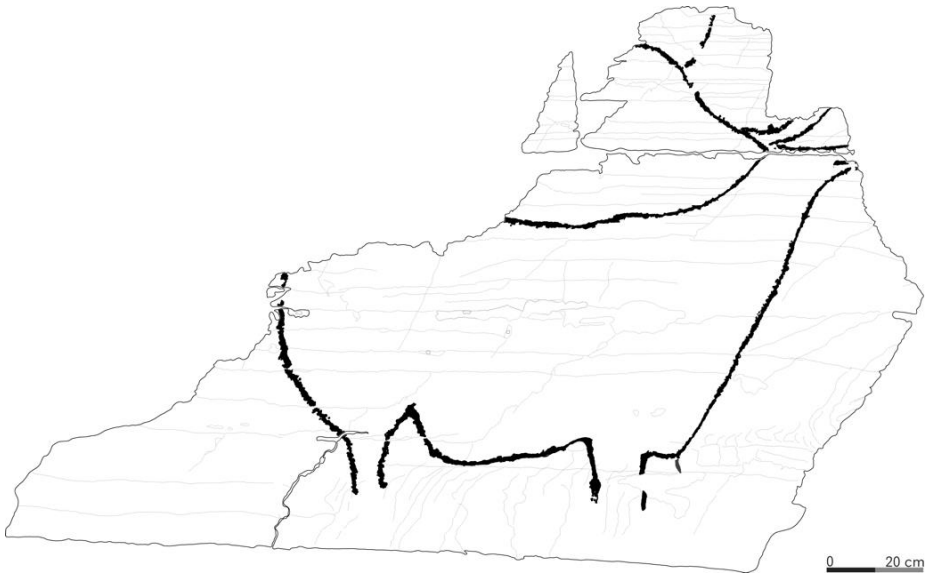


Figure A.D.4.: Rock 2 of Fariseu

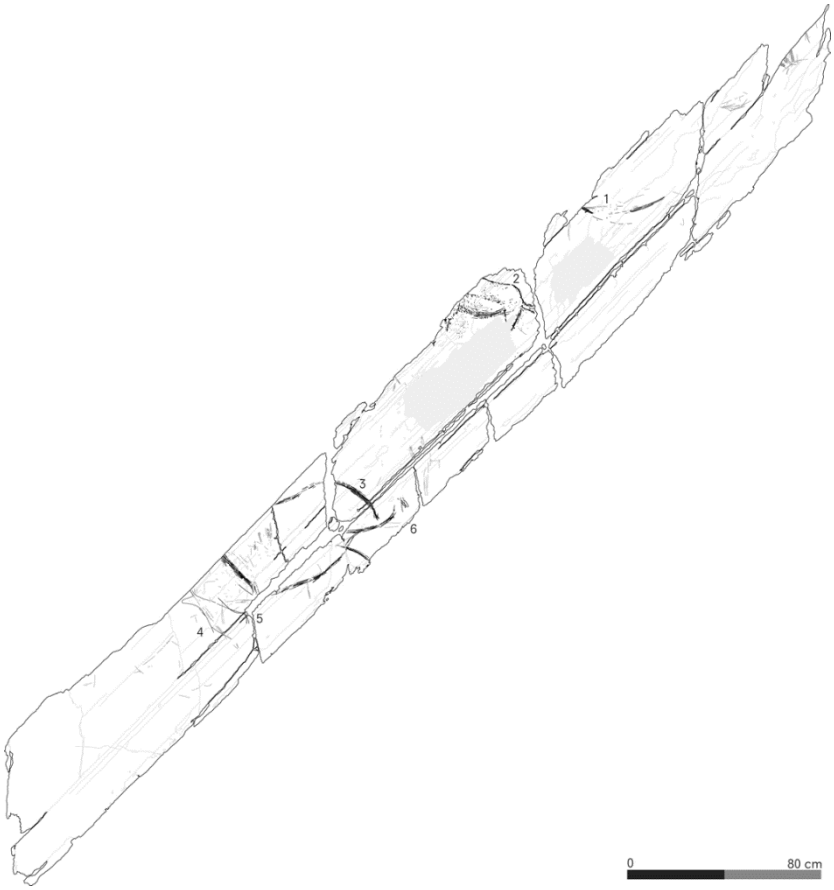


Figure A.D.5.: Rock 10 of Canada do Inferno



Figure A.D.6.: Rock 13 of Penascosa

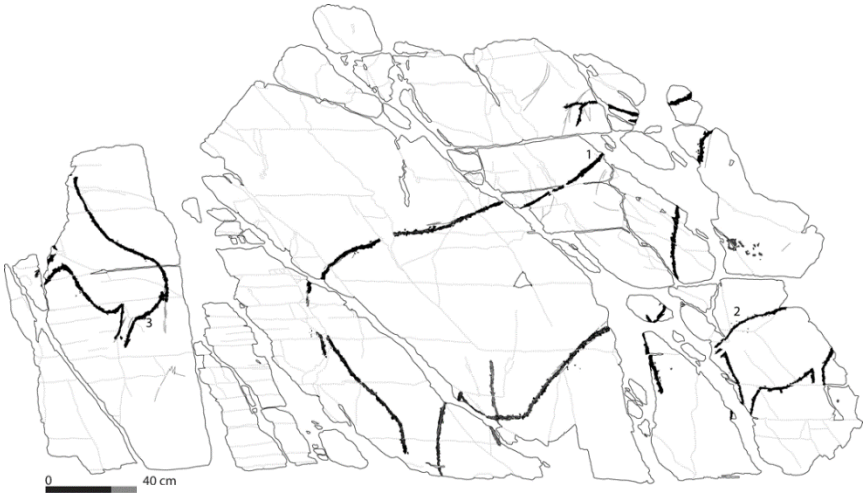


Figure A.D.7.: Rock 15 of Ribeira de Piscos

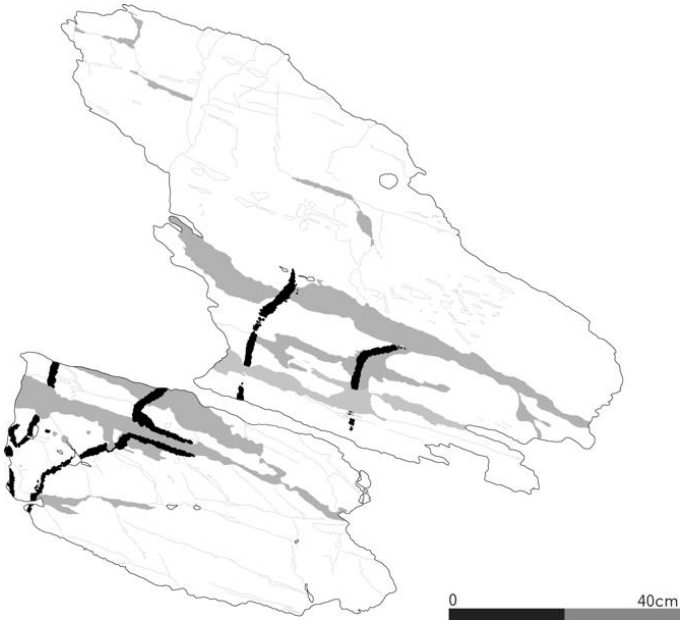


Figure A.D.8.: Rock 16 of Quinta da Barca



Figure A.D.9.: Rock 17 of Quinta da Barca



Figure A.D.10.: Rock 21 of Quinta da Barca

Basic Overlap (10 randomly selected examples):

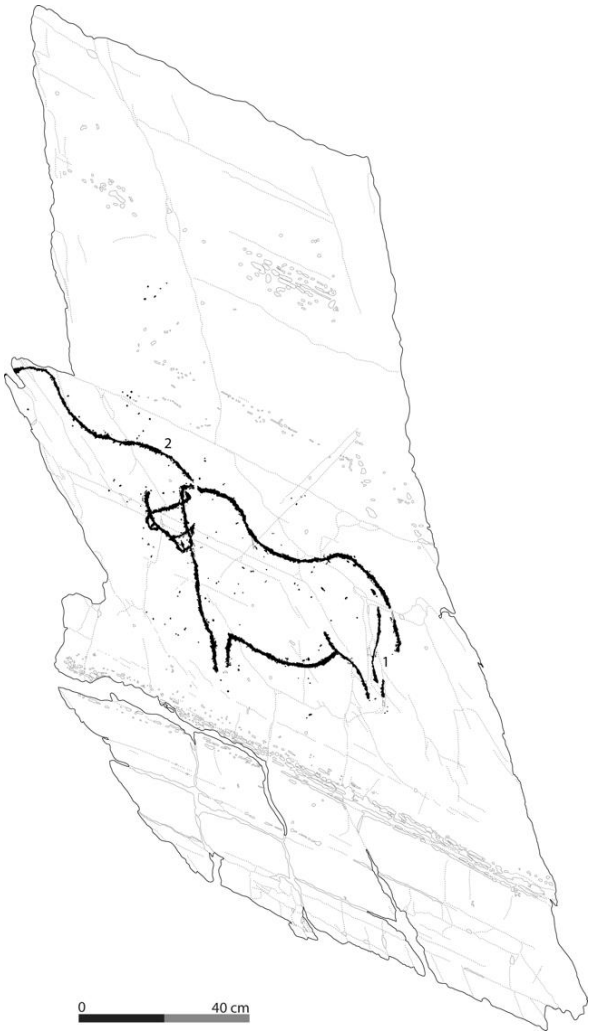


Figure A.D.11.: Rock 1 of Ribeira de Piscos

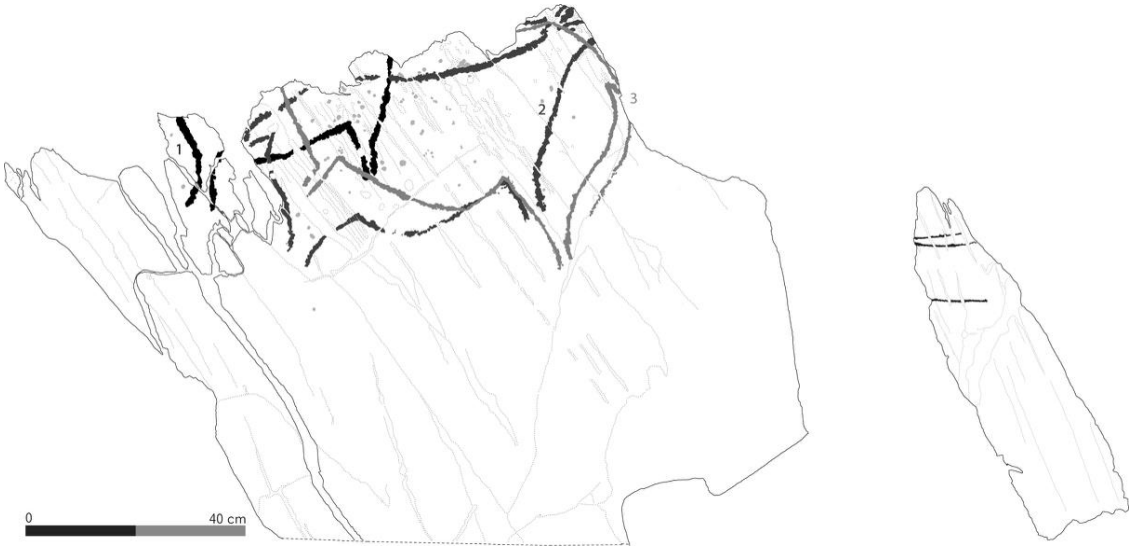


Figure A.D.12.: Rock 10 of Quinta da Barca

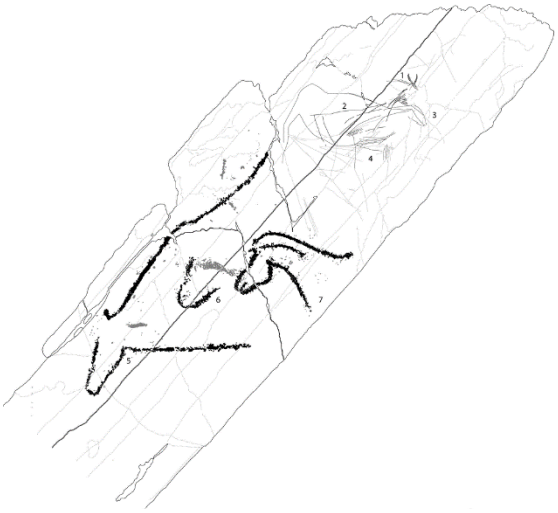


Figure A.D.13.: Rock 12 of Canada do Inferno



Figure A.D.14.: Rock 13 of Quinta da Barca



Figure A.D.15.: Rock 17 of Canada do Inferno

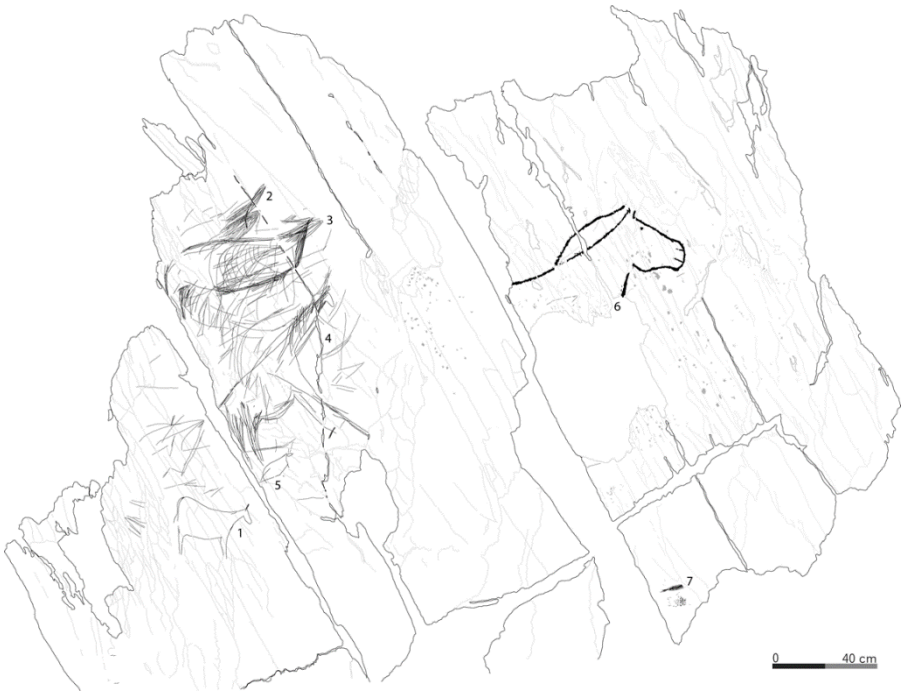


Figure A.D.16.: Rock 15 of Quinta da Barca

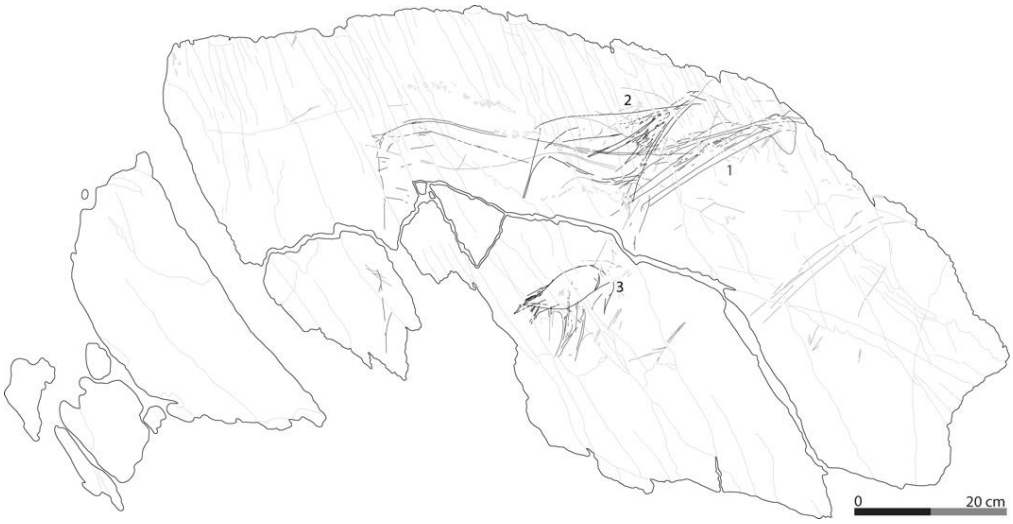


Figure A.D.17.: Rock 19 of Ribeira de Piscos



Figure A.D.18.: Rock 6 of Faia



Figure A.D.19.: Rock 19 of Canada do Inferno



Figure A.D.20.: Rock 14 of Quinta da Barca

Medium Overlap: (10 randomly selected examples)



Figure A.D.21.: Rock 1 of Canada do Inferno

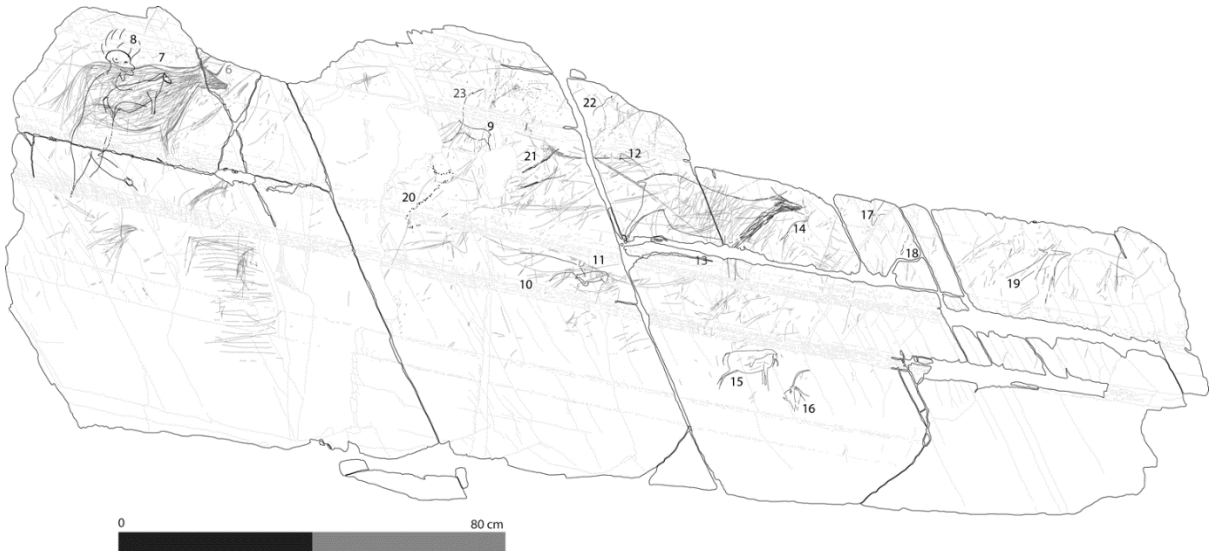


Figure A.D.22.: Rock 2 of Ribeira de Piscos



Figure A.D.23.: Rock 22 of Penascosa

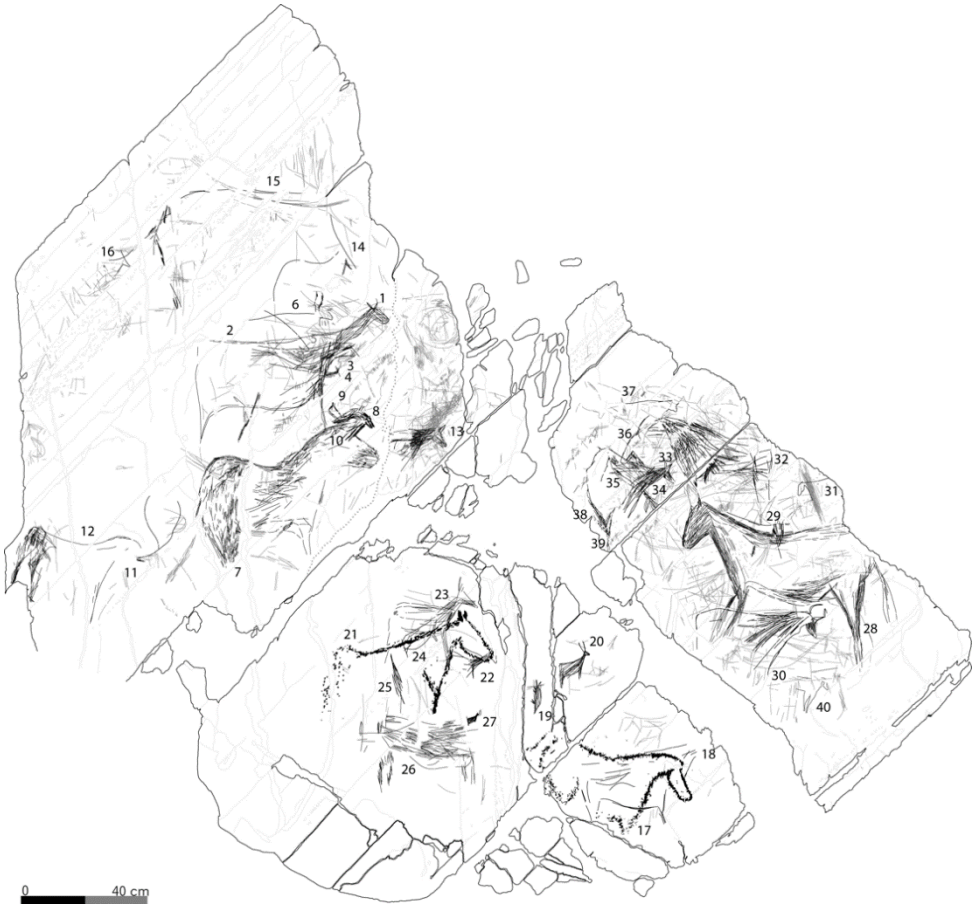


Figure A.D.24.: Rock 14 of Canada do Inferno

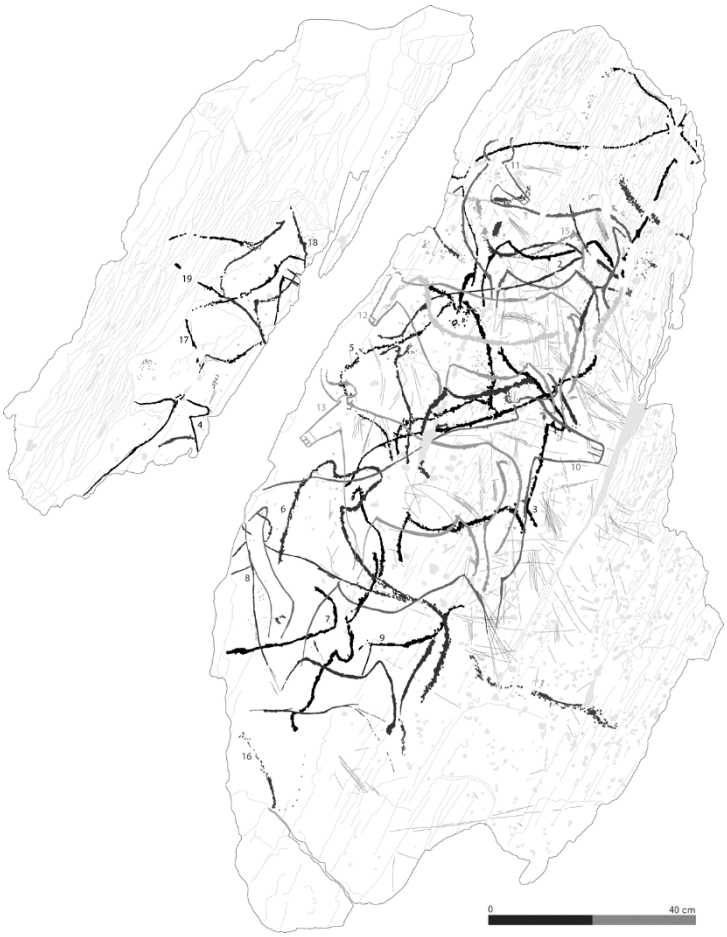


Figure A.D.25.: Rock 3 of Penascosa

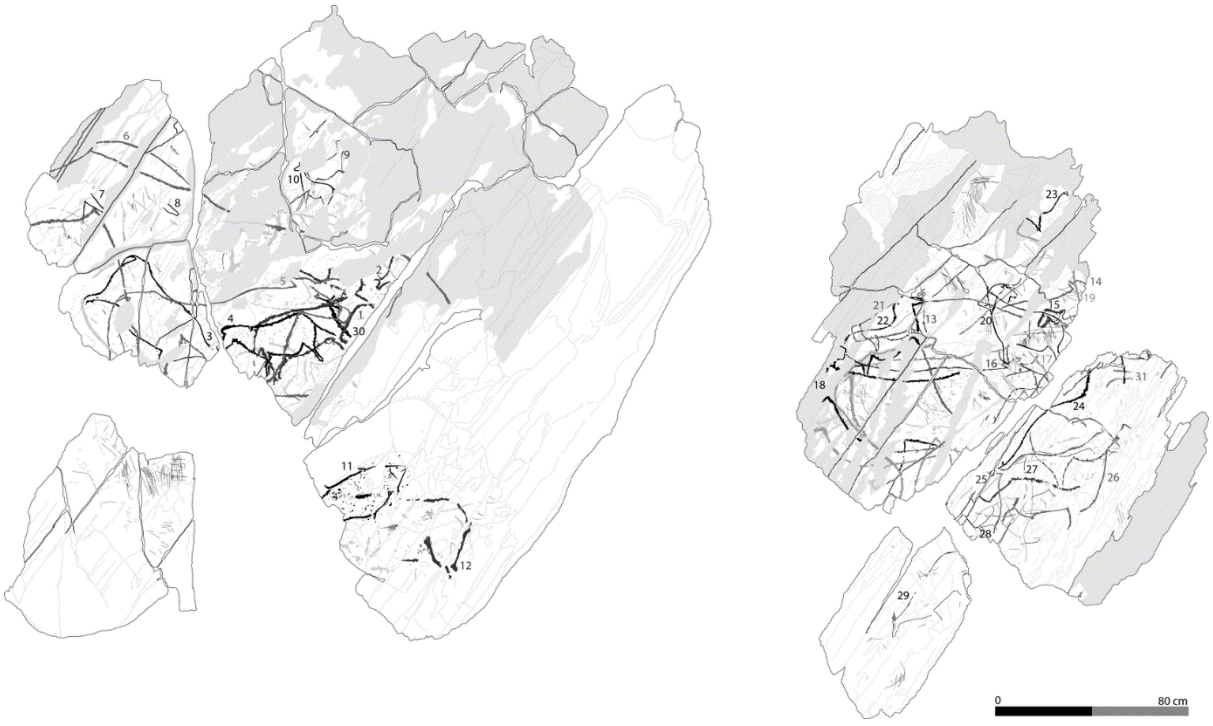


Figure A.D.26.: Rock 5 of Penascosa

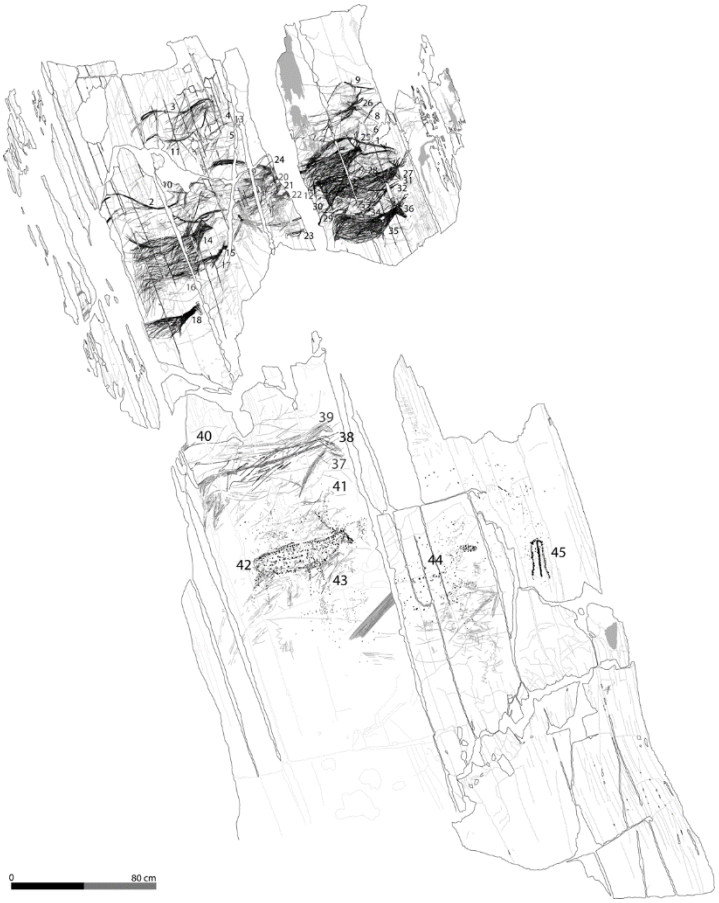


Figure A.D.27.: Rock 14 of Quinta da Barca



Figure A.D.28.: Rock 16 of Canada do Inferno



Figure A.D.29.: Rock 13 of Vale de José Esteves

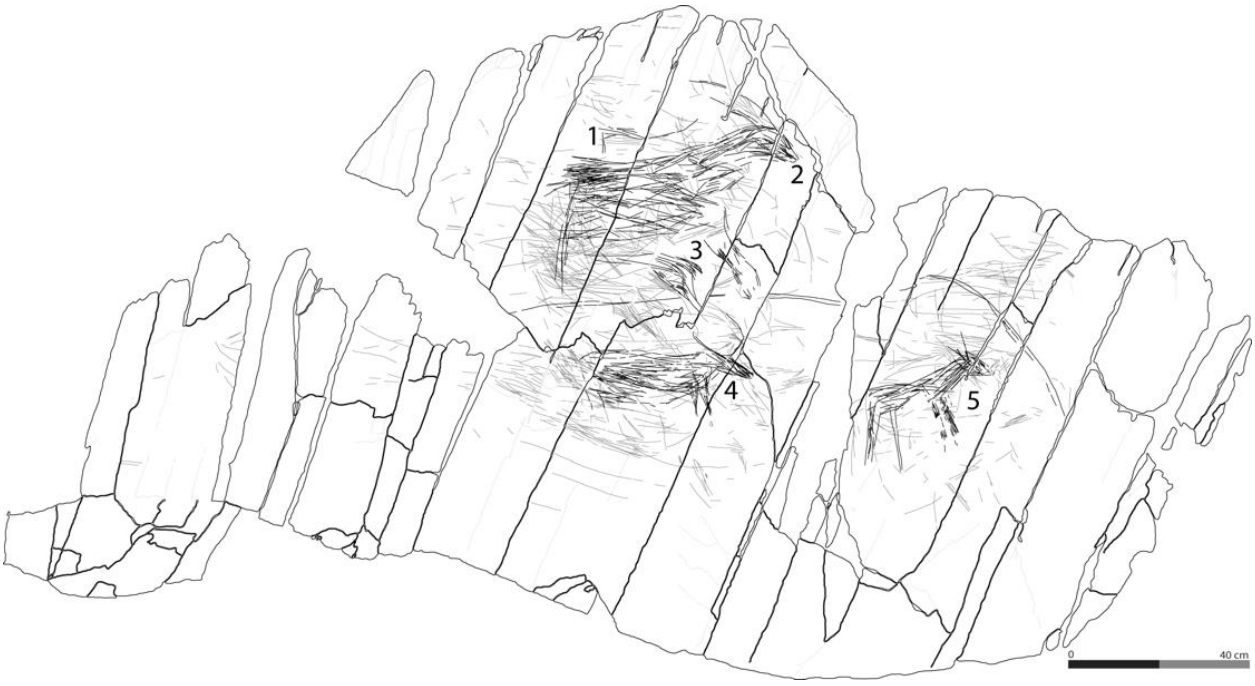


Figure A.D.30.: Rock 12 of Penascosa

Appendix D – Sample Images of Panels with Marked-Up Overlap Regions

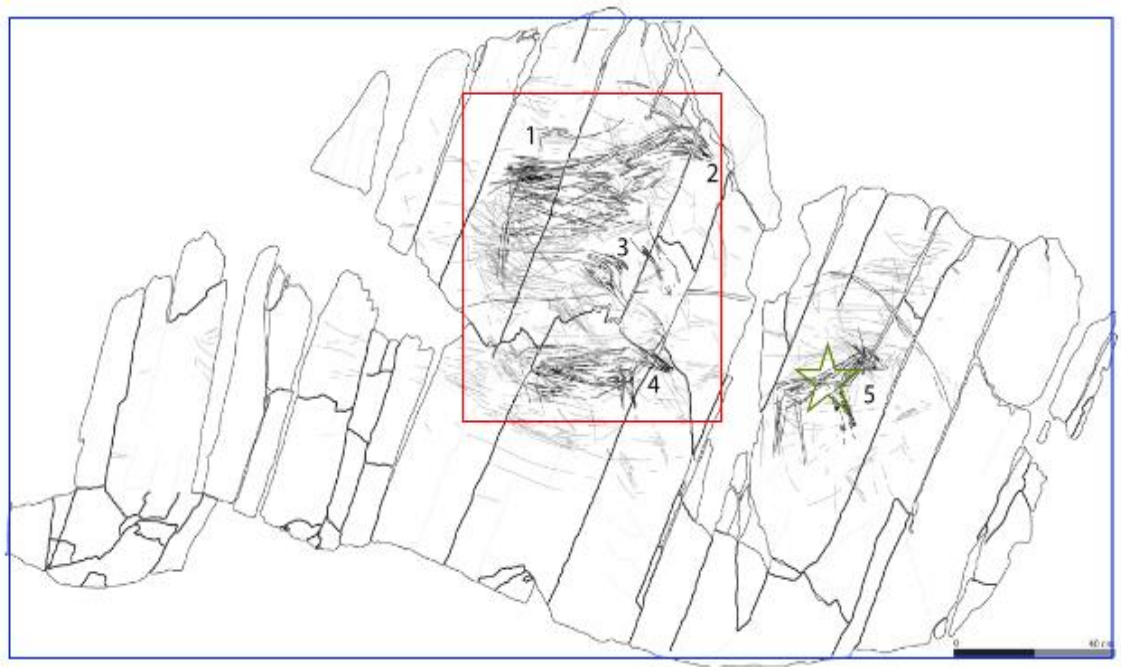


Figure A.D.31.: Rock 12 of Penascosa with marked overlap regions.

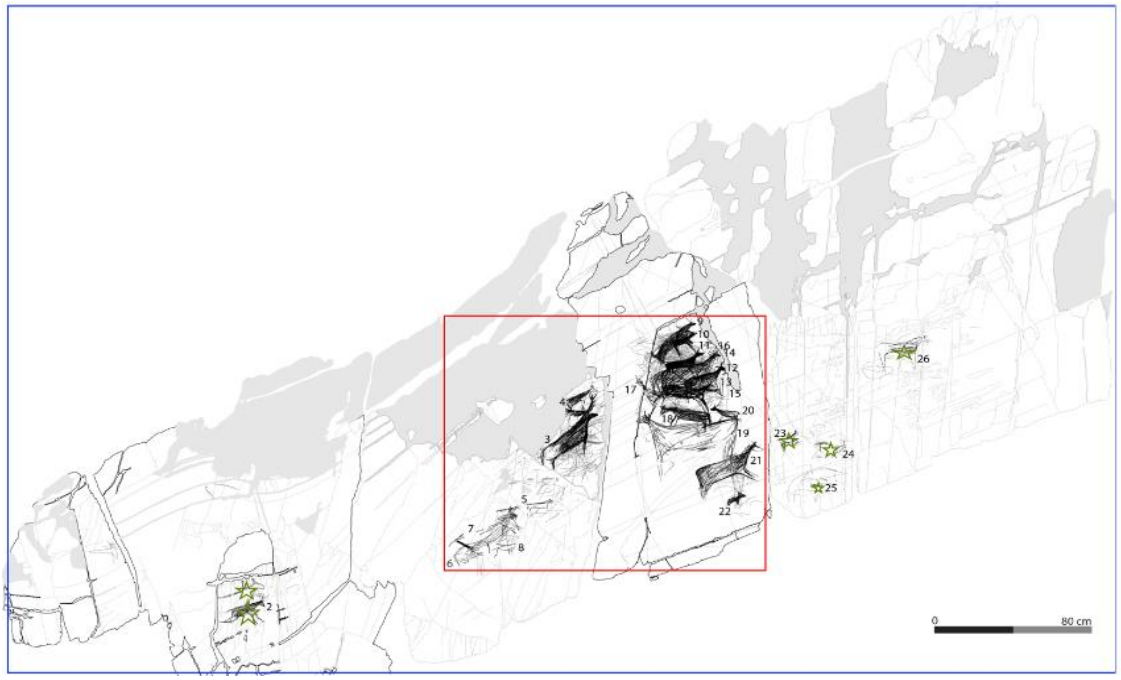


Figure A.D.32.: Rock 13 of Vale de José Esteves with marked overlap regions.

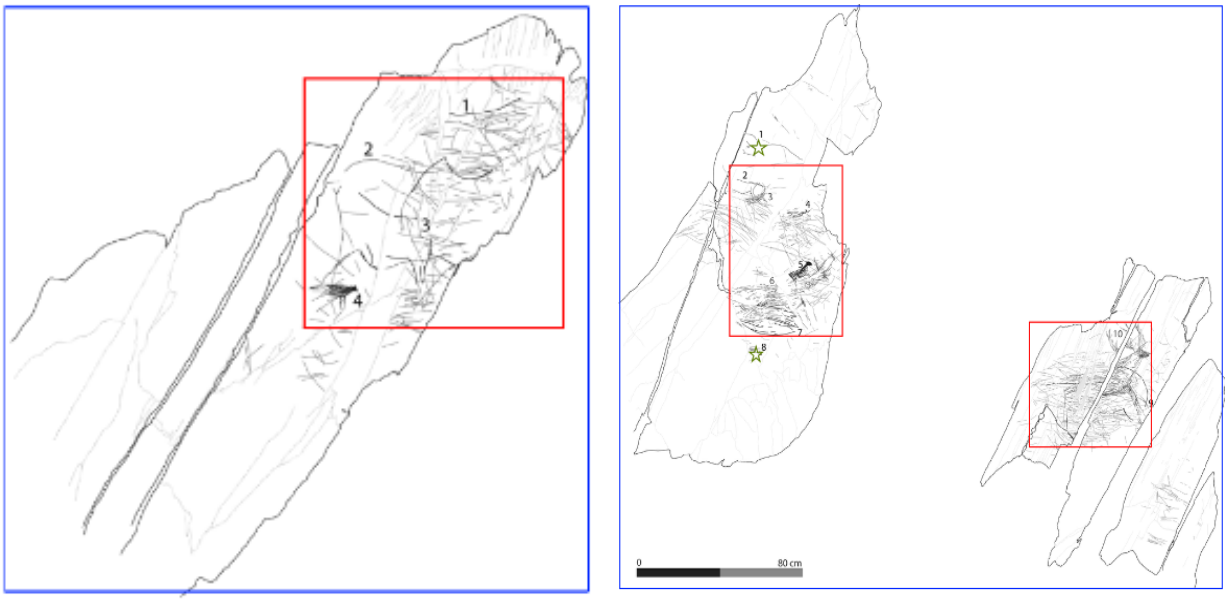


Figure A.D.33 and A.D.34.: Rock 22 of Penascosa (left) and Rock 23 of Penascosa (right) with marked overlap regions.

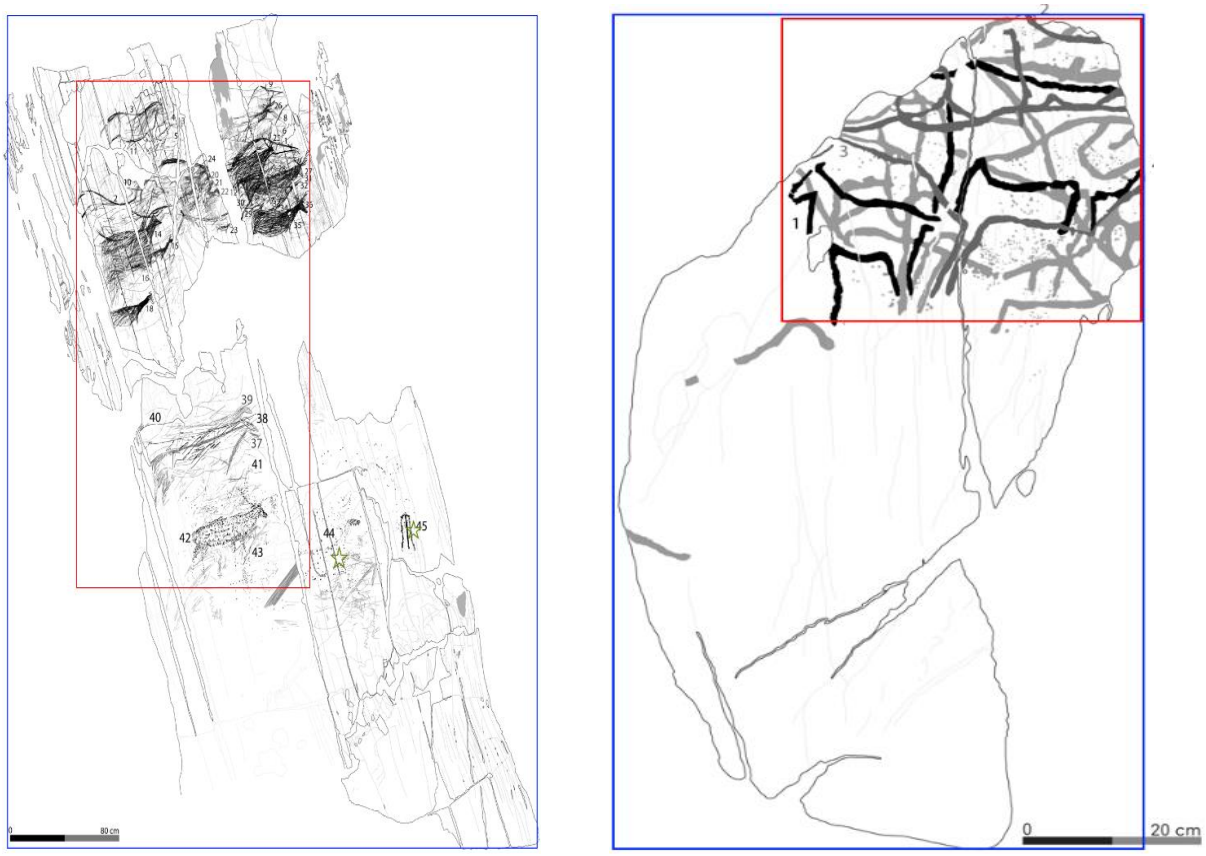


Figure A.D.35 and A.D.36.: Rock 23 of Quinta da Barca (left) and Rock 25 of Quinta da Barca (right) with marked overlap regions.

Appendix E – Visibility Study – Parameters

Example experimentation chart (dark schist)

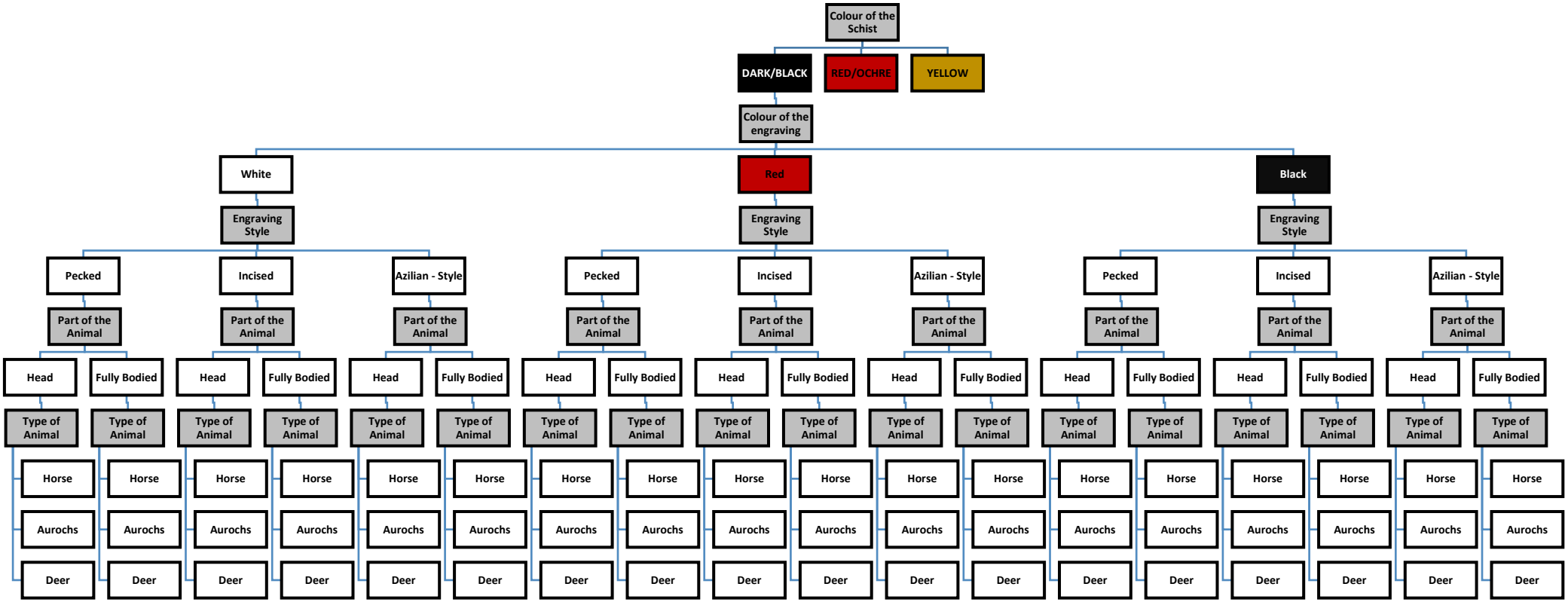


Figure A.E.1.: Experimentation chart explaining what types of images are re-produced for testing within the specified control-study environment.

Example experimentation chart (red schist)

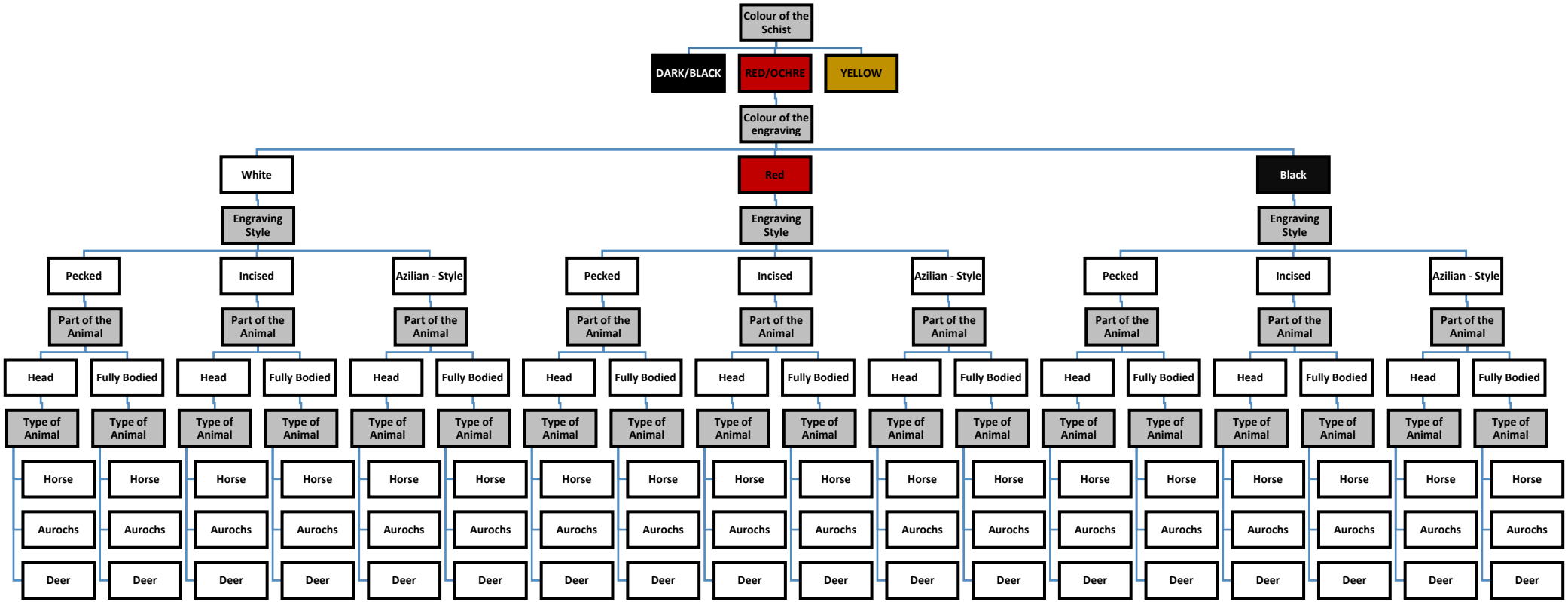


Figure A.E.2.: Experimentation chart explaining what types of images are re-produced for testing within the specified control-study environment.

Appendix E – Visibility Study – Images from Fieldwork - Control Study



Figure A.E.3.: Selection of photographs from the control study for visibility distances.



Figure A.E.4.: Selection of photographs from the control study for visibility distances.



Figure A.E.5.: Selection of photographs from the control study for visibility distances.





Figure A.E.6.: Selection of photographs from the control study for visibility distances.

Images from Fieldwork – In-Situ Study



Figure A.E.7.: Selection of photographs from the in-situ study for visibility distances (here displaying red engraving films).



Figure A.E.8.: Selection of photographs from the in-situ study for visibility distances (here displaying black engraving films).



Figure A.E.9.: Selection of photographs from the in-situ study for visibility distances (here displaying white engraving films).

Appendix F – Integrated Visibility Study

ArcGIS created Maps contextualising the Côa Region and its Rock Art

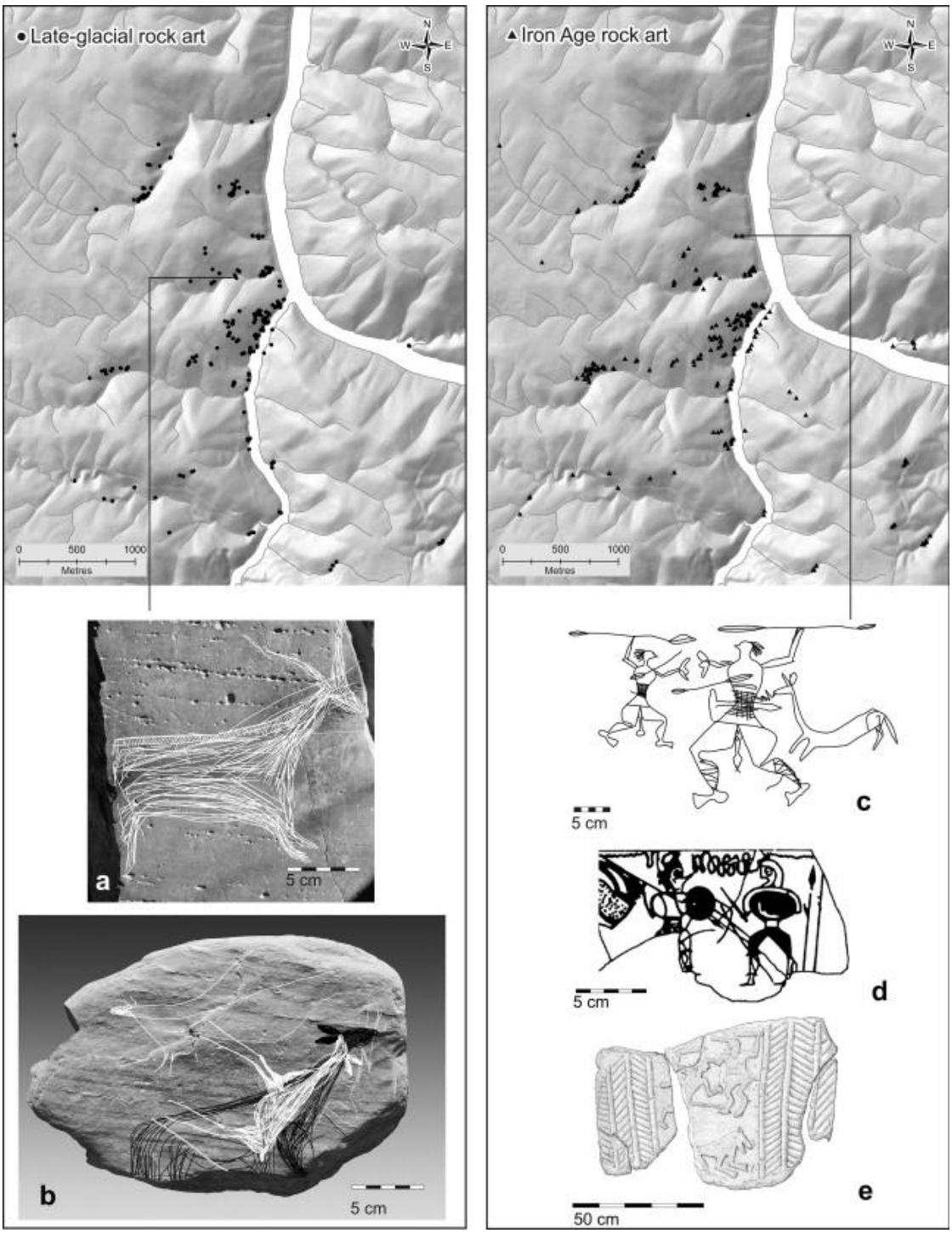


Figure A.F.1.: Late-glacial and Iron Age rock art spatial distribution in the study region established by stylistic comparison: Vale de José Esteves' Panel 16 (inventory number of the rock art panels of the Côa Valley Archaeological Park) (a); portable art on schist slab from the stratigraphic unit 4 of the Fariseu site (dated by luminescence to between 11,000 yr and 12,000 yr and by ^{14}C to 10,000–12,000 cal yr BP) (Aubry et al., 2010) (b); Vermelhosa's Panel 3 (Baptista, 1999) (c); Vase painting from Numancia, Soria, Spain (Sopeña, 1995) (d); stele from Tona, Barcelona, Spain (Sanmartí and Grego, 2007) (e).

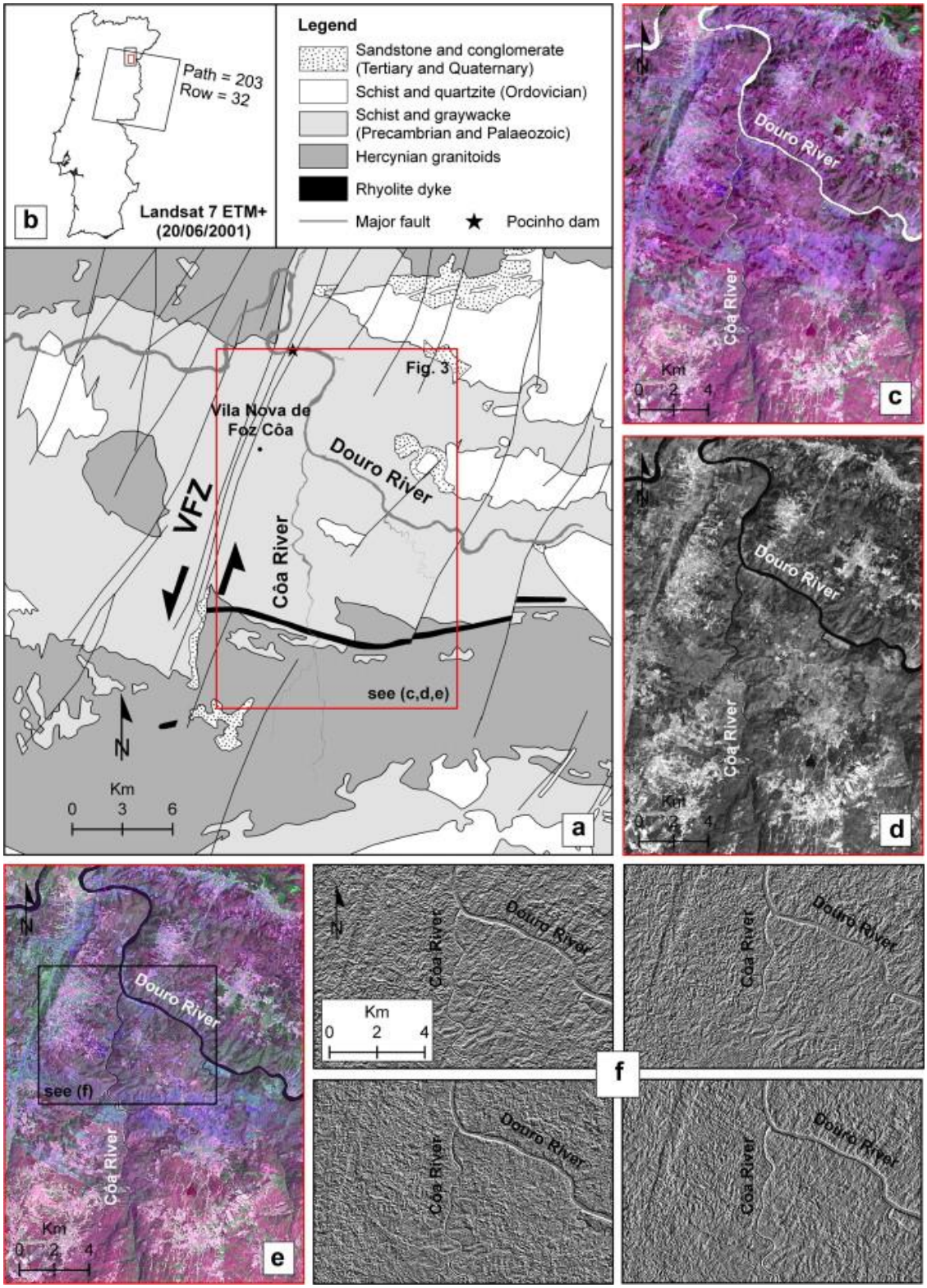


Figure A.F.2.: Geological setting of the study region in northeastern Portugal from Carta Geológica de Portugal 1:500,000 scale (Carvalho, 1992). VFZ = Vilariça Fault Zone. The arrows indicate: the sense of slip (a); coverage area and parameters of Landsat scenes used in this study (b); colour composite of multispectral Landsat 7 ETMplus (Enhanced Thematic Mapper Plus) bands 7,4,2 (c); panchromatic Landsat 7 ETMplus band 8 (d); pan-sharpened colour composite image using resolution merging process with (c) and (d) images (e); applying directional filters (i.e., N-S, E-W, N-E and N-W), with 3 × 3 in pixel size, on the pan-sharpened colour composite image (f). (Image and caption text from Aubry *et al.* 2012a).



Figure A.F.3.: Lineation map of the study area. The lineations detected by visual interpretation of all the processed Landsat images were reported. Thick lines represent the major faults where the arrows indicate sense of slip and detected from the literature, supplemented by field surveys. The thin lines are fractures and joints detected by satellite images and, in some cases, are supplemented by field surveys. VFZ = Vilariça Fault Zone (a); rose diagrams with class interval of 10° and population of 705 showing the statistical distribution based on lineament length and frequency detected by the satellite images analysis (b); arrangement of structures associated with a NNE-SSW sinistral shear zone (the VFZ) for the study region. R = synthetic riedel shears; R1 = antithetic riedel shears; N = normal faults; F = fold axis; RF = reverse faults; P = secondary synthetic shears; T = tensional fractures; short black arrows = sigma 1 (maximum compressive stress); short grey arrows = sigma 3 (maximum tensile stress) (c). (Image and caption text from Aubry *et al.* 2012a).

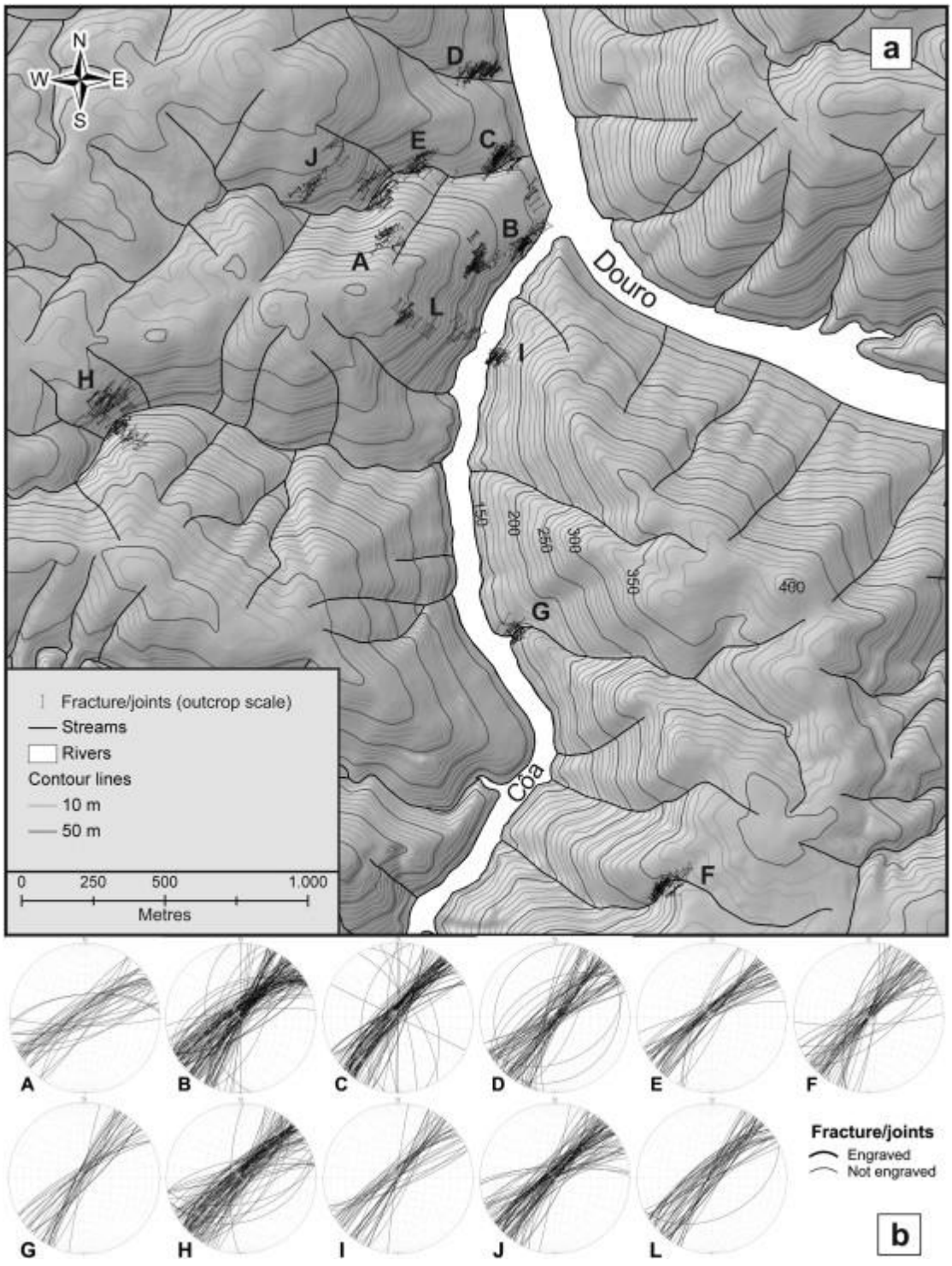


Figure A.F.4.: Fracture/joints strike related to slope topography in the Douro/Côa confluence area (a); orientation in equal-area stereoplot of poles to fracture/joints (engraved and un-engraved) measured in outcrops of the study area (local scale - no map view) (lower hemisphere projection was used) (b). (Image and caption text from Aubry *et al.* 2012a).

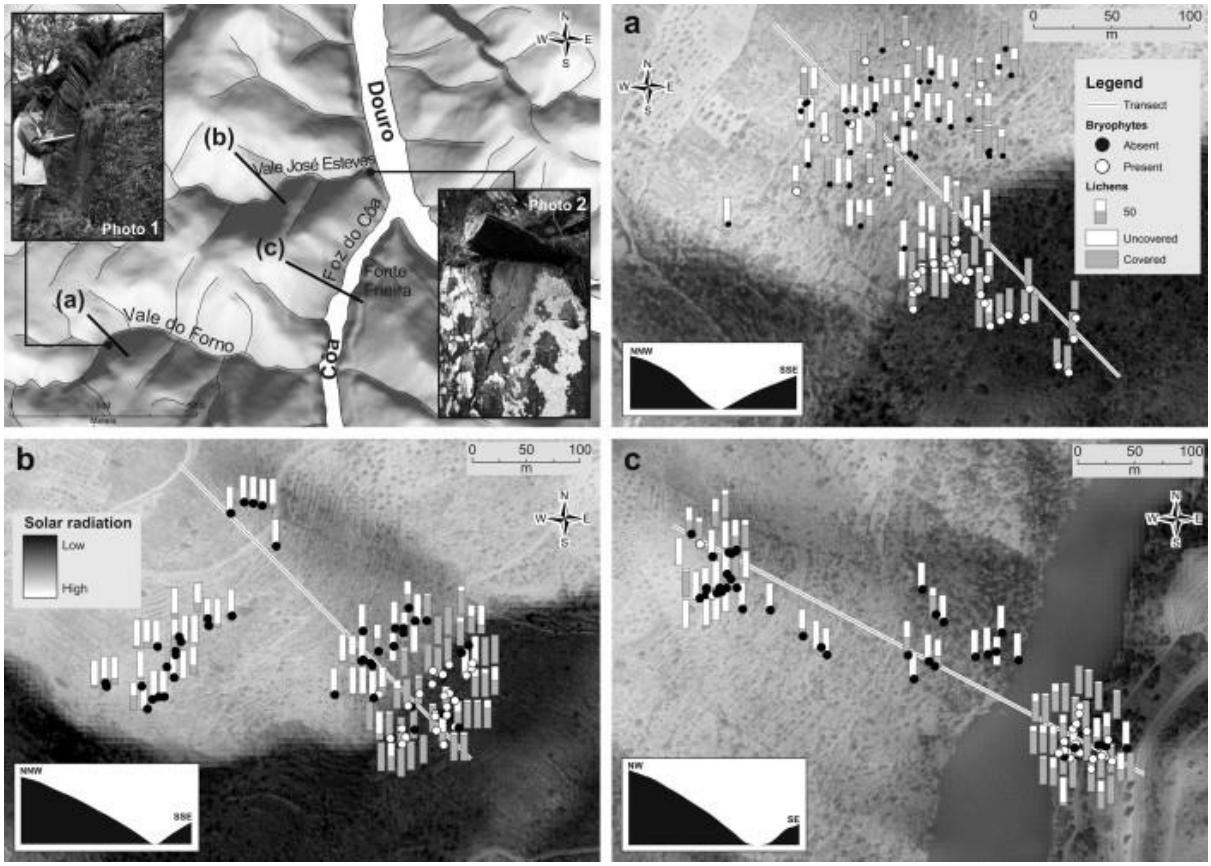


Figure A.F.5.: Rock art panel surface conservation in relation to natural solar radiation, lichen and bryophyte colonisation along three transects: Vale de Forno (a); Vale de José Esteves (b); Fonte Frieira (c); Examples of substantial bryophyte colonisation in a non-sheltered surface of the panel (photo 1) and absence of lichen colonisation in a shaded area (photo 2). (Image and caption text from Aubry *et al.* 2012a).

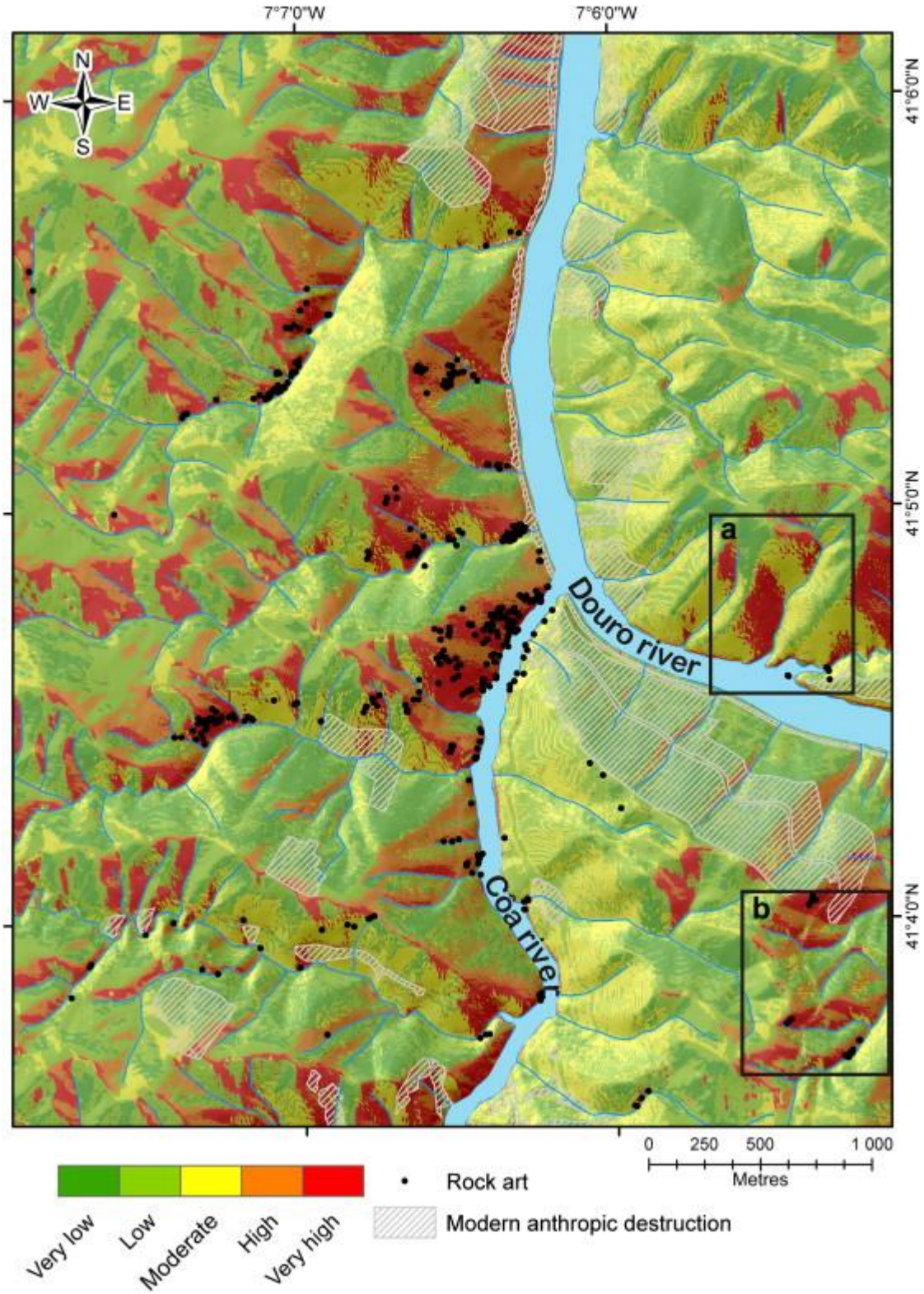


Figure A.F.6.: Côa panel formation and preservation model map. Location of the areas surveyed during field verification. (Image and caption text from Aubry *et al.* 2012a).

Appendix F – Integrated Visibility Study – Preliminary Steps for GIS Procedures

A **series of preliminary steps** are undertaken to prepare and conduct the mapping of viewsheds within the Côa region (conducted in ArcGIS version 10.5) and a separate series of methodological steps for each "inwards" and "outwards" strategies are employed:

1. Importing of 30m DEMs from USGS covering a large area surrounding the Côa Valley and a more specific 10m CôaDEM from Fundação Côa Parque.
2. Using the Mosaic Command to "stitch" together 4 separate DEMs from USGS (Arc Toolbox → Data Management Tools → Raster → Raster Dataset → Mosaic to New Raster).

Inwards Observer Feature Points:

1. Determining Rock Art locations with suitable parameters for visibility visualisation.
    - A total of 6 sites have been selected for which viewsheds will be created.
2. Adding XY Data (GPS coordinates) for all panels at these 5 sites.
3. Determining suitable Observer Feature Points.
4. Adding OFFSETA (Eye-height of observer) as new field to the attribute table for each XY datapoint.
5. Creating Viewsheds for each of the desired observation feature points (Arc Toolbox → Spatial Analyst → Visibility → Viewsheds).
    - INPUT RASTER: 10m CôaDEM.
    - INPUT POINT RASTER: The XY Data with OFFSETA value in attribute table.
    - OUTPUT RASTER: The Viewshed corresponding to the observer in question.
    - Z Factor: 1.
    - Set the Earth Curvature Correction to be enabled.
3. Creating "Buffer Zones" – range distances according to the results from the r0ck art visibility study (Experiment 5). (Geoprocessing → Buffers → Input Features (Observer Point) → Output (as required) → Distance (Visibility Results) → Create Buffer).
6. Modifying the different visibility buffer zones → symbology tab in line with visibility colourations, differentiating between resolution and legibility levels.

Outwards Panel Feature Points:

1. Determining Rock Art locations with suitable parameters for visibility visualisation.
    a. A total of 5 sites have been selected for which viewsheds will be created.
2. Adding XY Data (GPS coordinates) for these 5 sites on for each of which viewsheds will be generated.
3. Adding the following new fields to the attribute table for each XY datapoint (data varies per panel attribution):
    - OFFSET A – Average height of rock art depiction on panel.
    - OFFSETB – Eye-height of observer.
    - AZIMUTH1 & AZIMUTH2 – depending on the cardinal alignment of the panel, a horizontal angle span will be determined out of which panels will be visible.
    - RADIUS2 – range distances according to the results from the r0ck art visibility study (Experiment 5).
4. Creating Viewsheds for each of the desired panels (Arc Toolbox → Spatial Analyst → Visibility → Viewsheds).
    a. INPUT RASTER: 10m CôaDEM.
    b. INPUT POINT RASTER: The XY Data with added data in attribute table.
    c. OUTPUT RASTER: The Viewshed corresponding to the Panel in question.
    d. Z Factor: 1.
    e. Set the Earth Curvature Correction to be enabled.
5. Modifying the Viewsheds symbology in line with visibility colourations, differentiating between resolution and legibility levels (cf. Table 7.14).

Appendix F – Integrated Visibility Study – Features of Visibility Types Sites

Visibility Type Sites

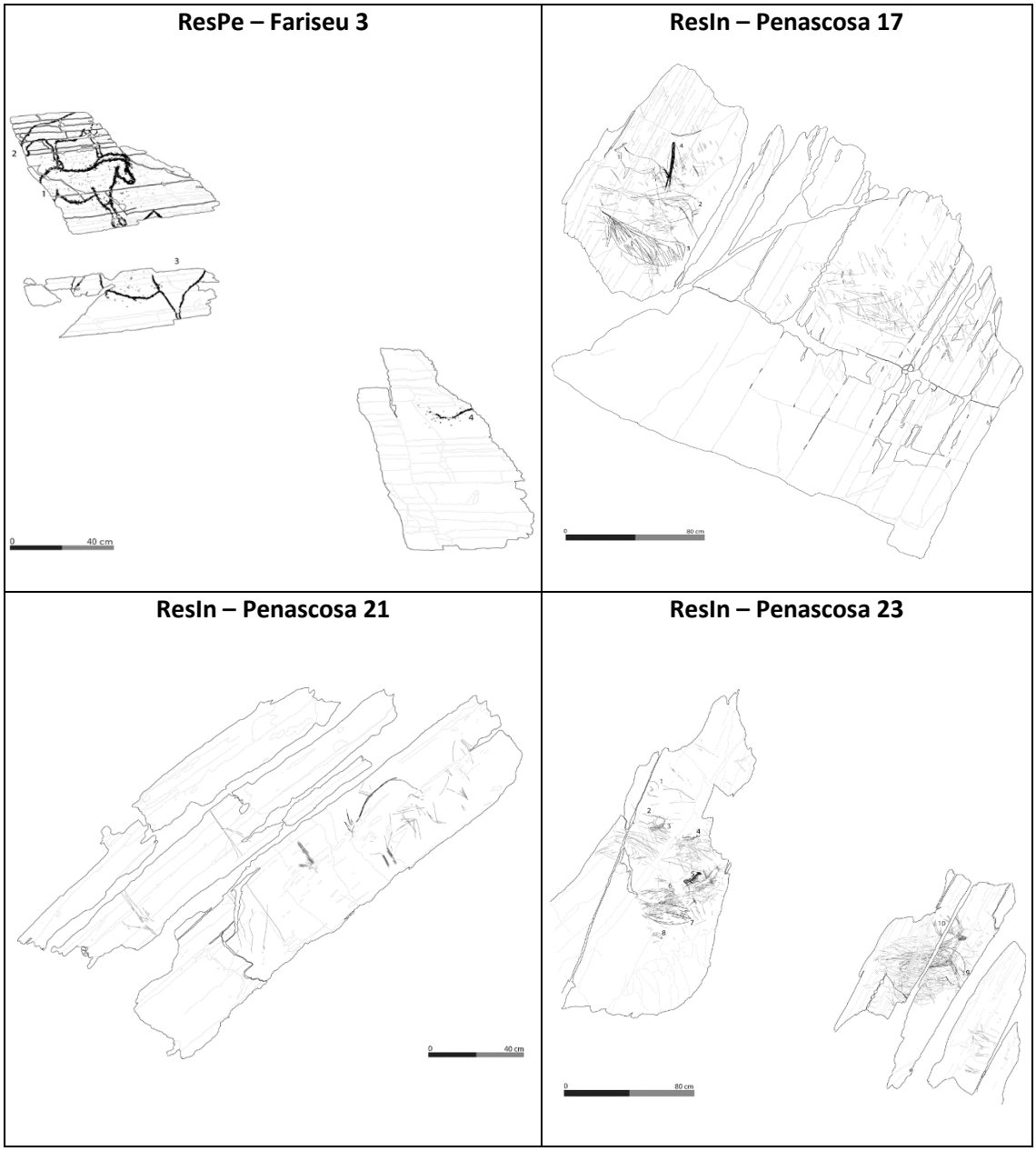


Figure A.F.7.: Panel extents of the visibility *type sites* identified in chapter 7.4.
(Drawings courtesy of Fundação Côa Parque)

Appendix F – Integrated Visibility Study – Motif/Engraving Style Distribution Maps

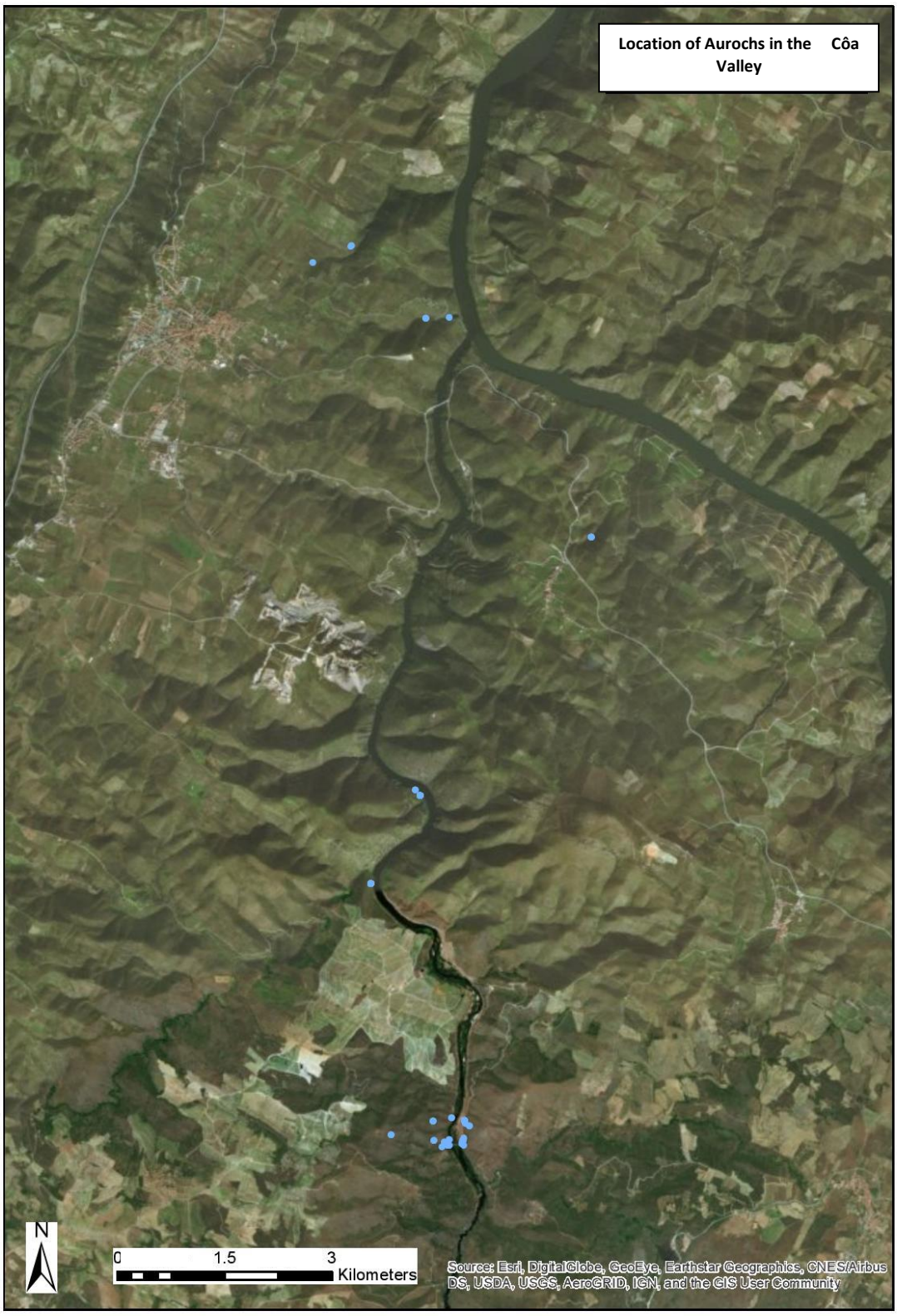


Figure A.F.8.: Distribution pattern of aurochs depictions in the Côa Valley.

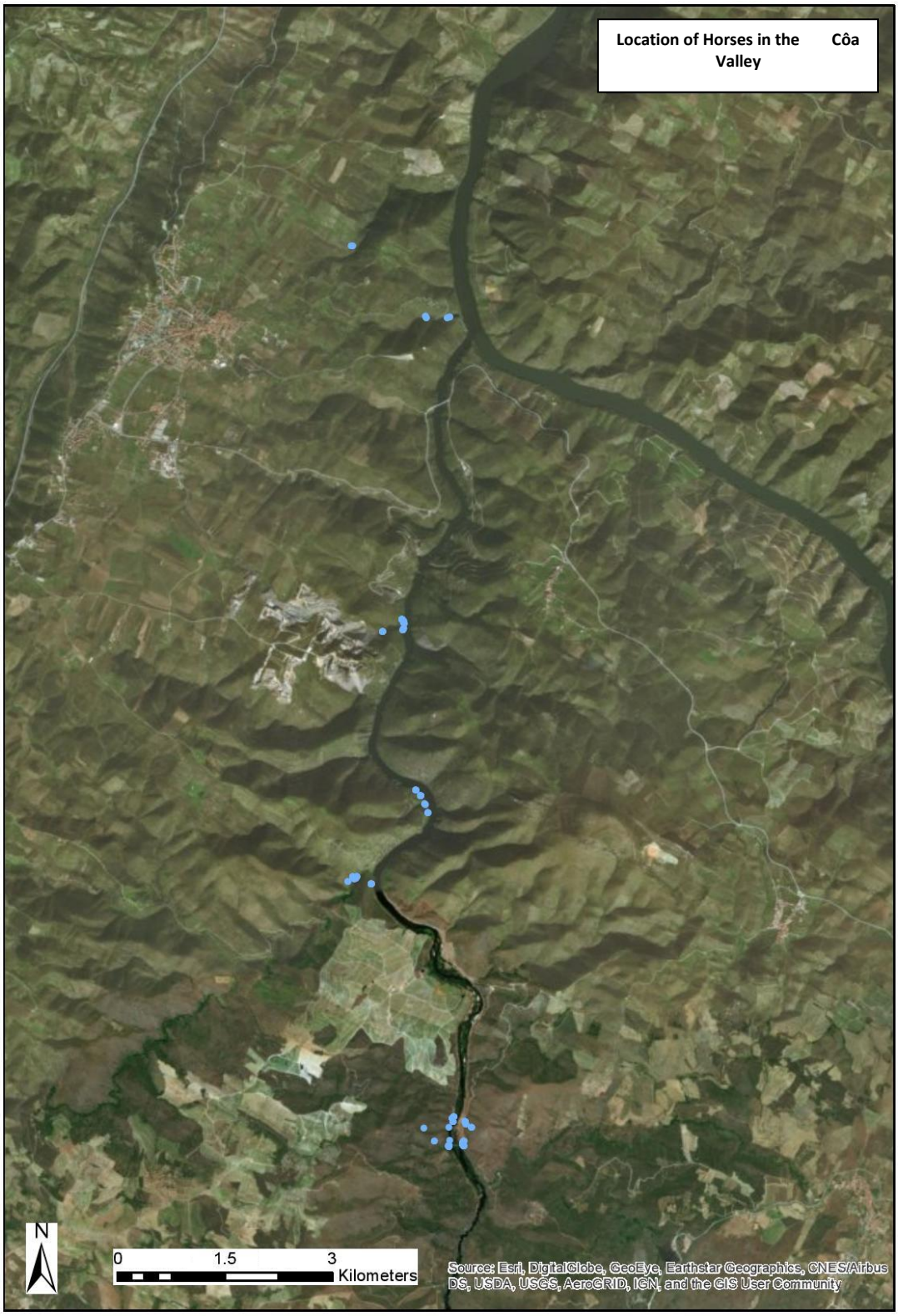


Figure A.F.9.: Distribution pattern of horse depictions in the Côa Valley.

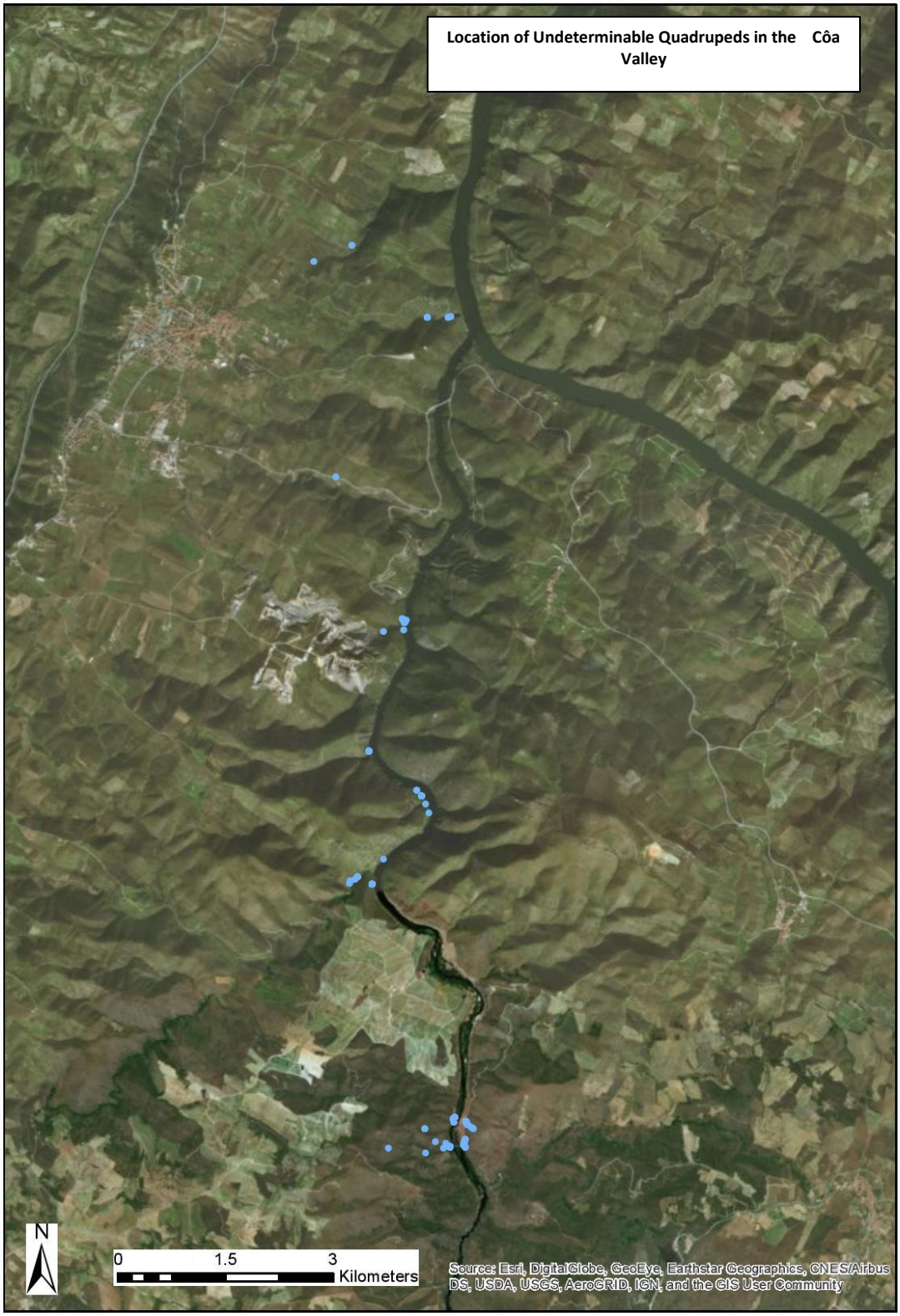


Figure A.F.10.: Distribution pattern of undeterminable quadruped depictions in the Côa Valley.

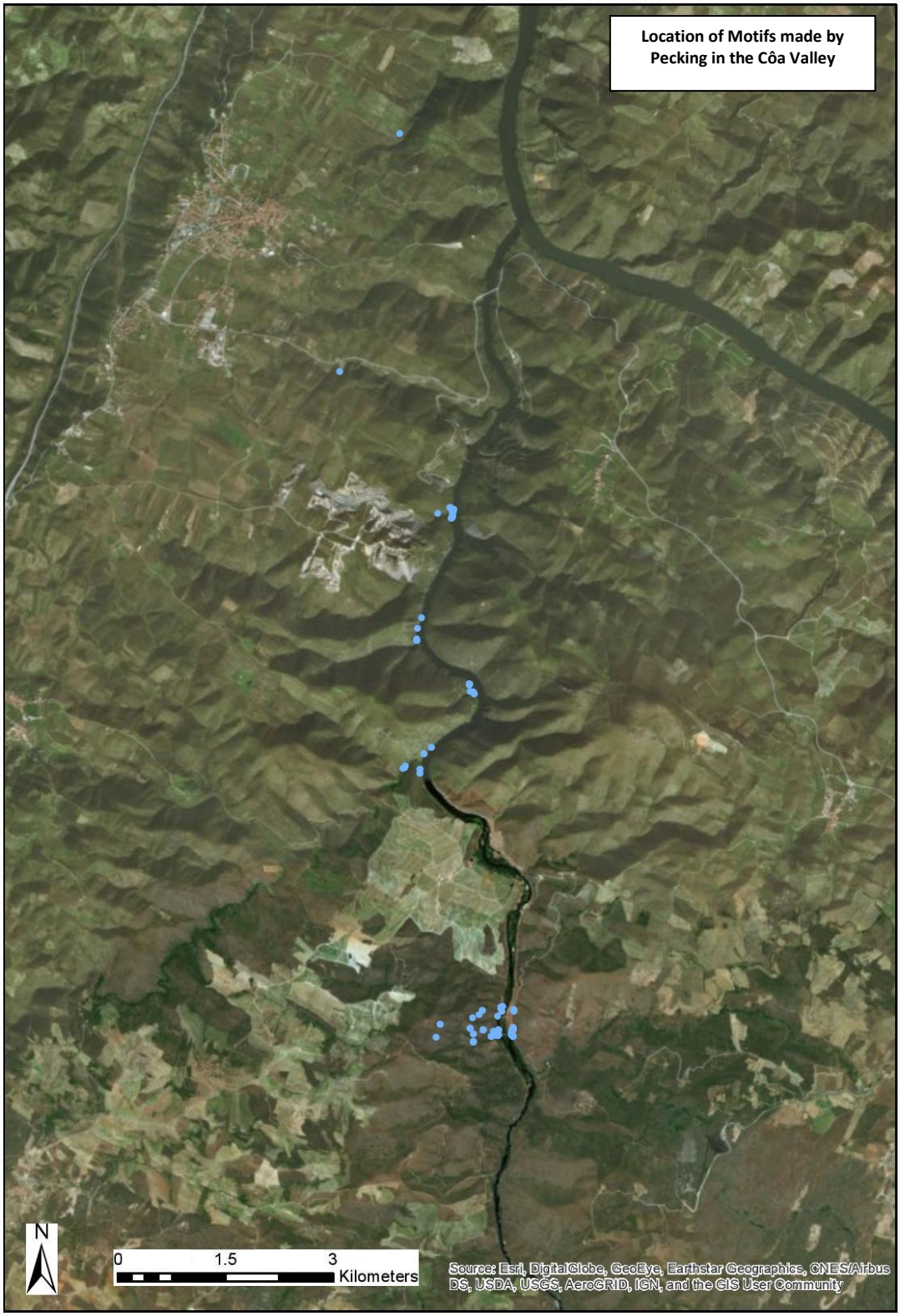


Figure A.F.11.: Distribution pattern of pecked depictions in the Côa Valley.

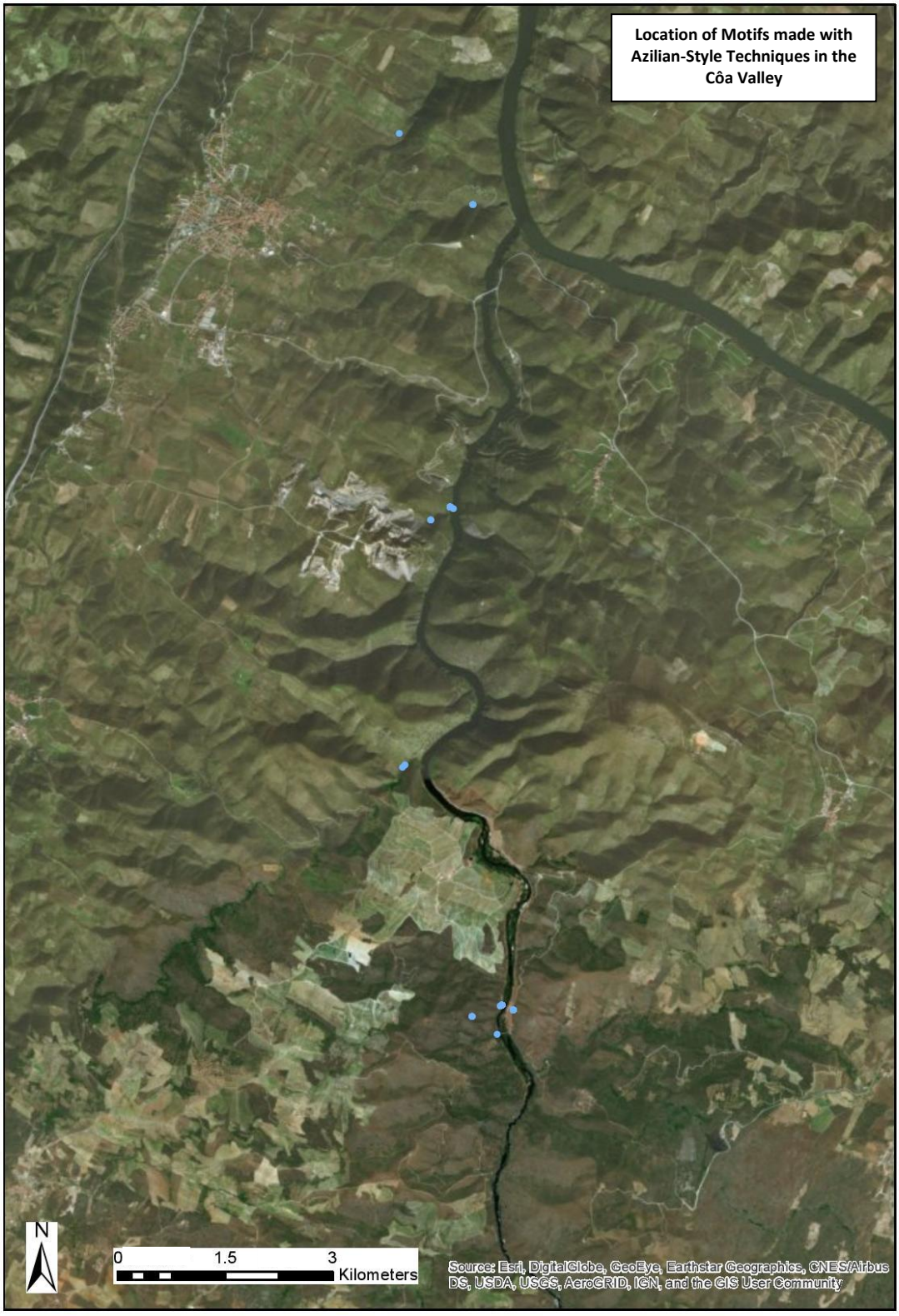


Figure A.F.12.: Distribution pattern of Azilian-Style depictions in the Côa Valley.