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*The Human-Animal Boundary: Adding a New
Perspective to the Pre-Modern History of the Nervous
System*

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Introduction

This thesis takes a new perspective on the history of neuroscience by focussing on an issue that has been a neglected but integral part of the life sciences since Antiquity: the negotiation of the human-animal boundary in anatomical and experimental practices and their underlying philosophical debates about the status of humans. While the subject of human-animal relations has produced an abundant and still growing amount of literature in the humanities, the systematic reliance on animal models for the formation of knowledge about the human body has scarcely been a subject of serious discussion in the history of science and medicine.¹ William F. Bynum, one of the few medical historians who devoted an article to the subject in 1990, concluded that "[g]iven the importance of animal disease models in the past century or so, it is surprising that there appears to be so little historical literature on the subject."² Since then, an interest in the subject has been on the increase, but the issue of how the human-animal boundary has been negotiated in actual scientific practices has still not been historically investigated in depth. This is particularly true for those branches of the life sciences that are now classed as neuroscience, which not only includes the anatomy and physiology of the brain and nerves, but also the philosophical systems that influenced the conception of human and animal nervous systems. Bynum's article is in this context revealing, for the epigraph he chose to introduce the subject is in fact situated within the realm of neuroscience. Bynum describes here an event taking place at the London Medical Congress in 1881 at which the physician and neurosurgeon David Ferrier (1843-1928) demonstrated a monkey with symptoms of paralysis induced by an experimental ablation of the motor area of the brain's left hemisphere. The limping animal led one member of the congregation, the French neurologist Jean-Martin Charcot (1825 – 1893), exclaim "C'est un

¹ I will discuss the existing literature in the field in my literature review further below.

² William F. Bynum, "'C'est un Malade': Animal Models and Concepts of Human Diseases" (*Journal of the History of Medicine and Allied Sciences* 45 (1990), pp. 397- 413), p. 399.

malade!’”, thus alluding to a recognition of behaviour in similarly afflicted patients in hospitals.

It is probably no coincidence that Bynum picked the showcase of an experimental neurologist to introduce the subject. As I hope to show in my thesis, the history of neuroscience³ is a particularly rich field for investigating the important but also ambivalent role that animal models have played in the life sciences. By way of example, we could, for instance, shift the perspective in Bynum’s epigraph by arguing that the symptoms displayed by the monkey—motor dysfunctions—were comparatively easy to spot, hence the quick identification by Charcot and other members of the conference. A disorder of sensory functions, on the other hand, would have required further explanations since the outward signs of sensation in health and disease are much more subject to interpretation than a reduction or absence of motion in limbs. In a clinical context, it normally requires a thorough interrogation of the patient to determine neurological conditions such as anesthesia (absence of sensation) or hyperesthesia (increase in sensitivity). In an experimental context, where the underlying causes of such conditions are mostly studied, the situation is somewhat different. Apart from the problem of sensitivity as subjective experience, the main question here is whether an analogy of human and animal sensual experience can and could be upheld at all times during the experimental process.

Bynum’s paper focuses mainly on the rise of experimental medicine and pathology in the nineteenth century, but the questions he raises about animal models in medical research can also be applied to other historical and disciplinary contexts in which animals featured as substitutes for the human body. As my own project focuses on the early days of neuroanatomy and physiology, I seek to establish what Bynum termed “the intellectual

³ Being aware that the term ‘neuroscience’ proper only came into being in the nineteenth century, I will nonetheless use the term to refer to those historical theoretical frameworks and research activities that dealt with the material embodiments of cognition and sensation, as these eventually led to the now established association of these faculties with the nervous system.

framework that justified the extrapolation of information obtained in animals to human beings.”⁴ I have chosen this particular branch of the life sciences because its implicit conceptions and negotiations regarding the corporeal and non-corporeal sources of (human) bodily and mental perception reveal most poignantly the extent to which such enquiries circled around the issue of the human-animal boundary. Almost all knowledge gained from animal investigations of the nervous system, be it based on anatomical observations or on functional experiments, remained (and often still remains) ambiguous because the non-physical aspects of nervous functions, in particular their cognitive dimension, had little possibility of rigorous verification in an animal. This is one reason why related research activities and philosophical disputes about the human body and mind have since Antiquity been specifically linked to a negotiation of what it is that causes us to differ from a non-human animal. But the unresolved question of whether animals experience nervous faculties in the same way that humans do also had an influence on actual ideas about the structure-function correlation of the brain and nerves with the non-physical aspects of the mind and the senses. The link between sense perception, cognition, and the nervous system is thereby just one among several embodiment theories that had been available to pre-modern anatomists. Over time it prevailed, for instance against the heart-centred view of the body, but regardless of the particular source organ under investigation, the negotiation of the human-animal boundary runs deep in these fields of enquiry. Another reason for the continuous negotiation of potential analogies between the species is that, despite a lasting notion of a fundamental difference between humans and animals, the animal had been a long established anatomical and experimental representative for human bodily faculties of all kinds. This was not only fostered by methodological necessity, i.e. the prohibition of vivisection, at times also dissecting, humans. The understanding that human bodies function according to the same, or

⁴ Bynum, ‘C’est un Malade’, p. 401.

similar, working principles as animal bodies, a notion that was backed up by visible anatomical analogies, provided an ongoing rationale for the use of animals as substitutes for the human body. Yet, it has hardly ever been investigated what impact this constant animal-to-human transfer of observations, descriptions of structure, and experimental results had on the way that pre-modern researchers conceived of faculties associated with the nervous system as the true constituents of human nature. I argue that, despite the ongoing belief that humans stood at the apex of creation, the use of animals as models for the human body steadily rubbed against the metaphysical conviction that humans had something superadded to their corporeal materiality. As this latter aspect often prompted an investigation of the body in the first place – exemplified by the search for the seat of the soul – the human body and mind also retained a model function in which preconceived notions about the superior faculties of human bodies determined the way that animal investigations were conducted. Needless to say, the varied conceptualisations of the soul—as corporeal or incorporeal, unified, two or threefold—also had an impact on how the division of human and animal nature was conceived not only in terms of bodily, but also of mental faculties. The search for the corporeal aspects of sense perception and cognition, or ‘mind’, being the umbrella term for those functions that used to be ascribed to the soul, is in fact an ongoing project in the life sciences.⁵ Lester S. King once noted in his book *The Philosophy of Medicine* (1978) that “[t]he soul has no part in modern medicine but its close relative, the mind, enjoys an honored status.”⁶ He maintained that the term ‘soul’ is now rejected in science because of its religious overtones, whereas ‘mind’ has become an established part of it. However, since ancient times, in anatomical as well as philosophical discourses on the human versus the animal body, the term soul has been a carrier of various meanings, only a few of which were

⁵ See, for instance, the extensive collection of interdisciplinary articles on all aspects of the mind, including the problem of assessing states of consciousness in animals by Brie Gertler and Lawrence Shapiro (eds.), *Arguing About the Mind* (Routledge: New York and London, 2007).

⁶ Lester S. King, *The Philosophy of Medicine* (London et al: Harvard University Press, 1978), p. 125.

specifically linked to the context of divine intervention and immortality. In fact, nearly all aspects of mental activity and sense perception, both of which are increasingly grounded in the brain due to the advancement of neuroscience and medical technology, have been mentioned as functional aspects of the soul in the past.⁷ Then and now, as King further noted, “mind and matter, soul and body were distinct, yet somehow interconnected.”⁸ As this thesis aims to show, the same can be said about the nature of humans versus animals whose perceived dichotomy became enmeshed in the emerging discipline of neuroscience. It comes as no surprise, then, that ongoing discourses related to the soul further upheld the anatomical and philosophical negotiation of the human-animal boundary.

Thus, despite a focus on those bodily faculties that are now associated with the nervous system, my thesis situates itself within a variety of historical enquiries: next to investigating the growing importance of the nervous system, it touches on the related history of anatomy and physiology and considers changing philosophical notions of the soul and the mind, but mostly, it aims to link these investigations to an overall historical debate on what constitutes humanity as opposed to its counterpart, the animal. I am aware that with such a multi-layered perspective comes an inherent danger of not giving enough credit to each of these fields of enquiry. But, although my thesis could be described as attempting a historical synthesis of these aspects, it does not aspire to be a comprehensive unification of what are now historical disciplines in their own right. Rather, I am investigating the role that animals played in the emerging discipline of neuroscience, including the metaphysical discourse on the status of humans, as a pointed example of the ambivalence that has accompanied the use of animal models in the life sciences. I have come to believe that a continuous (re)assessment of the human-animal boundary is the one thread that connects ancient philosophies and anatomical

⁷ As it is, metaphysical reflections about the transcendent concepts of soul, mind and consciousness are still happening in modern neuroscience; see, for instance, a recent article on the subject that was published in a Journal on neurosurgery: Brian Dolan, ‘Soul Searching: a Brief History of the Mind/Body Debate in the Neurosciences’ (*Neurosurgical Focus* 23 (1): E2 (2007), pp. 1-7).

⁸ King, *Philosophy of Medicine*, p. 125.

practices with those of the early modern (and modern) period. Thus, my project is not so much a rewriting of the history of (neuro)science, but a shifting of perspective within it. By singling out specific historical moments and historical actors in this particular branch of the life sciences, I want to draw attention to what has often been acknowledged in passing, but has so far not been studied in depth: the fact that human uniqueness—more and more equated with mental faculties—has been constituted metaphysically in opposition to the nature of animals, while the boundary between them became increasingly blurred in hands-on anatomical and experimental investigations of the brain and nerves.

The following literature review will help to situate my project further within the aforementioned fields of enquiry by identifying not only the current focal points and relevant gaps, but the specific contribution that my thesis offers at the interface of the history of the life sciences and the field of human-animal studies.⁹ I will first focus on those works that are situated in the history of the neurosciences, anatomy and experimentation, and then broaden the perspective by discussing works that specifically deal with the subject of human-animal relations and the boundary between the species. The literature review will be followed by an outline of my thesis chapters at the end of the introduction.

⁹ As with nearly all of the works discussed in the literature review, my thesis does not simply provide a (hi)story of animals. I agree with Erica Fudge who pointed out that due to the lack of documents and inarticulateness of animals such a thing is in any case impossible; see her chapter ‘A Left-Handed Blow: Writing the History of Animals’, in Nigel Rothfels (ed.), *Representing Animals* (Bloomington & Indianapolis: Indiana University Press, 2002, pp. 3-18), p. 6. Rather, what the various approaches in the broad field of human-animal studies reveal is, as Fudge further argues, that all accounts and interpretations of animal life come to us in the form of texts written in the past and present by humans. Thus, due to my focus on the human-animal *boundary*, I have likewise considered it more fruitful to concentrate on human agents in my research and to look at the way that ideas about human-ness and animal nature have been constantly modified and reflected upon in the context of the emerging discipline of neuroscience. Furthermore, as my project traces the manifold and continuously changing conceptions of the physical and mental mechanisms of nervous faculties in humans versus animals, my research draws mostly on primary sources that highlight the philosophical, anatomical, and experimental discourses circling around these issues.

Literature Review

Nearly all books, chapters or articles on the history of the nervous system mention animals in one way or another, which is not surprising considering that animal bodies have been the main sources of knowledge in the life sciences throughout history. Yet, a thorough discussion of the substitute function they fulfilled in specific research projects, functions that often exceeded the anatomical or experimental task at hand, is oddly absent. It is probably fair to say that the early use of the microscope has generated more excitement and insightful accounts about the possibility of progress related to this specific instrument, than an anatomical reliance on animal species that have not even been considered the closest to humans at the time. However, a very recent – and to my knowledge the only – work has appeared which discusses the use of animals in the field of neuroscience as a subject in its own right, namely a chapter in the Handbook of Clinical Neurology series (Vol. 95: *History of Neurology*) by Frank W. Stahnisch: ‘On the Use of Animal Experimentation in the History of Neurology’. As the title conveys, it is more of an overview of animal experimentation since Antiquity, and Stahnisch himself acknowledges that “it is far from conclusive and can only cover some landmark experiments.”¹⁰ Yet, despite its teleological account via discoverers and discoveries, some interesting remarks convey that the subject of animal experimentation in the history of (neuro)science can be approached from other angles than either the sole focus on discoveries or the ethics of animal experimentation. That there even exists now a historical chapter focusing exclusively on the use of animals in research in an influential and widely-read Clinical Handbook series suggests to me that, after all, the subject *has* gained some interest among historians of neuroscience.

¹⁰ Frank W. Stahnisch, ‘On the Use of Animal Experimentation in the History of Neurology’, in *History of Neurology*, ed. by Stanley Finger, François Boller and Kenneth L. Tyler. Handbook of Clinical Neurology series, Vol. 95, 3rd series (Edinburgh and Amsterdam: Elsevier B.V., 2009, pp. 129-148), p. 129. I thank Frank Stahnisch for sending me a draft of this chapter prior to its publication.

A similar development can be detected in the history of anatomy, with which my thesis also connects. Again, traditional but still influential accounts of anatomical discoveries do not dwell on the fact that those discoveries had been made with animal bodies. Quite often, by way of enhancing the relevance of progress made in anatomy in particular time periods, an overall reliance on animal investigations is even criticized. I will discuss the implications of this, together with the respective literature, in more detail in Chapter 1. However, by the end of the 1990s, various historians, also referred to in more detail in Chapter 1, had begun to rewrite the history of anatomy. The novelty of their approaches consisted in shifts of perspectives away from discoveries and discoverers onto more general subjects, such as anatomical illustrations and disseminations of knowledge,¹¹ religious influences,¹² and the cultural and social contexts of the rising interest in anatomy and the body as such.¹³

Interestingly, these historians had also begun to acknowledge more strongly the issue of the animal-to-human transference of observations in anatomy; more often than not, they even devoted a small subchapter to the subject. Yet, due to their different agendas, none of them suggested that this aspect might have had an equally large impact on the field of anatomy as the afore-mentioned sources of influence. To assess and evaluate the use of animals and its impact on how anatomists and philosophers since ancient times thought about humans, brains and souls, is the main drive of this study.

Within the history of science and medicine, the so-called ‘practical turn’ led to an increasing focus on the historical contexts of experimentation,¹⁴ but, as indicated above, the amount of

¹¹ See here especially Andrea Carlino, *Books of the Body: Anatomical Ritual and Renaissance Learning* (Chicago and London: The University of Chicago Press, 1999; first 1994).

¹² See Andrew Cunningham, *The Anatomical Renaissance. The Resurrection of the Anatomical Projects of the Ancients* (Aldershot: Ashgate, 1997); and his more recent book *The Anatomist Anatomis'd: An Experimental Discipline in Enlightenment Europe. History of Medicine in Context* (Farnham, UK: Ashgate, 2010).

¹³ French, Roger K., *Dissection and Vivisection in the European Renaissance* (Aldershot and Brookfield, VT: Ashgate, 1999).

¹⁴ The best-known study that focussed on a large variety of questions regarding the history of experimentation is probably still the one by Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump. Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985). For an overview of more recent perspectives, see Frank W. Stahnisch, ‘Historical and Philosophical Perspectives on Experimental Practice in

literature that followed in its wake falls oddly short of discussing the method of using animals as tools and ‘projection screens’ of human traits, as it were, in enquiries about the human body and mind in the life sciences.¹⁵ However, as early as the 1970s, scholars from a sociological-anthropological background had begun to investigate scientist-animal interactions and the transformations that living organisms undergo in the modern laboratory. Despite an overall focus on modern human-animal interactions, some of these studies provide interesting analytical categories that can in fact be utilised as tools to conceptualise the binary thinking pertaining to debates about human-animal nature within different historical contexts. Of these, the discourse on the ‘natural’ versus the ‘analytical’ animal in Michael Lynch’s ‘ethnography of the neurosciences’, for instance, captures the active ingredient of *transforming* the animal according to the needs of the researcher. As we will see, this act of transformation also happened in early modern investigative practices of the nervous system.¹⁶

Medicine and the Life Sciences’ (*Theoretical Medicine and Bioethics* 26 (2005), pp. 397-425); and Hans-Joerg Rheinberger, ‘History of Science and the Practices of Experiment’ (*History and Philosophy of the Life Sciences* 23 (2001), pp. 51-63). See also the focus issue on ‘Laboratory History’ in *Isis* Vol. 99 (2008), which tackles the issues of institution, space, and experimentation as work practice, but, like all the above-mentioned, does not address the subject of animals as a vital part of experimental practices.

¹⁵ Notable exceptions (apart from Anita Guerrini and Holger Maehle, whose works I will discuss in more detail below) are George Canguilhem who, as early as 1965, wrote an essay on ‘L’Expérimentation en Biologie Animale’, printed in his *La Connaissance de la Vie. Deuxieme edition revue et augmentee, Neuvieme triage* (Paris: Librairie philosophique, 1992), pp. 17-39; Frederic L. Holmes, ‘The Old Martyr of Science: The Frog in Experimental Physiology’ (*Journal of the History of Biology* 26:2 (1993), pp. 311-328); and Peter Harrison, ‘Reading Vital Signs: Animals and the Experimental Philosophy’, in Erica Fudge (ed.), *Renaissance Beasts. Of Animals, Humans, and Other Wonderful Creatures* (Urbana and Chicago: University of Illinois Press, 2004), pp. 186-207. A recent popular book related to this is by the philosopher Rom Harré, *Pavlov’s Dogs and Schrödinger’s Cat: Scenes From the Living Laboratory* (New York: Oxford University Press, 2009). It addresses the way that living beings, including plants and bacteria, are used as instruments in a wide range of scientific practices. The journal *Annals of Science* has most recently devoted an interesting special issue to the representation of animals in the early modern period, though its focus is largely on the illustrations, etchings, engravings and colour plates as found in anatomical and natural history books; see Domenico Bertoloni and Anita Guerrini, ‘The Representation of Animals in the Early Modern Period’ (*Annals of Science* 67:3 (2010)).

¹⁶ See Michael Lynch, ‘Sacrifice and the Transformation of the Animal Body into a Scientific Object: Laboratory Culture and Ritual Practice in the Neurosciences’ (*Social Studies of Science* 18:2 (1988), pp. 265-289), which is based on a study conducted in 1975-1977. The particular relationship between scientists and experimental animals is discussed by various contributors in *The Inevitable Bond: Scientist-Animal Interactions*, ed. by Hand Davis and A. Dianne Balfour (Cambridge: Cambridge University Press, 1992). The effect this ‘bond’ has on experimental results is the focus of Otniel Dror’s article ‘The Affect of Experiment: The Turn to Emotions in Anglo-American Physiology, 1900-1940’ (*Isis* 90 (1999), pp. 205-237). The practice of trans-species transplantation has also fostered interesting studies on the crossing of species boundaries in science; see for instance Nik Brown and Mike Michael, ‘Switching between Science and Culture in Transpecies Translation’ (*Science, Technology, & Human Values* 26:1 (2001), pp. 3-22).

A closer connection to the subject of the human-animal boundary in the history of science is presented by a variety of studies on animal experimentation and the controversies surrounding it. These also constitute the source of my interest in the current project as the history of (anti-)vivisection first made me aware of the attitudes of science and society towards the human-animal difference. Richard D. French's *Antivivisection and Medical Science in Victorian Society* (1975)¹⁷ is a pioneering example of such literature on the subject that was published in the wake of the Cruelty to Animals Act's centennial anniversary in Britain. James Turner's *Reckoning with the Beast* (1980)¹⁸ extended the focus from the laboratory to the treatment of animals in other realms of society (e.g. the slaughterhouse and animal blood sports), but also caught my interest because of its emphasis on the Victorian obsession with animal pain as the leading cause for animal welfare movements in Britain and the US. The majority of such studies focus on the nineteenth century, as did my own M.A. dissertation on the subject,¹⁹ simply because the issue of using animals in scientific research had then entered the public domain. Different aspects related to the history of animal experimentation are brought together in Nicolaas Rupke's edited volume *Vivisection in Historical Perspective* (1990).²⁰ Yet, apart from the introductory chapter, which provides an overview of attitudes towards animal experimentation from Antiquity to the end of the eighteenth century, the focus is again mostly on the nineteenth century. By contrast, Holger Maehle also investigated the discourses on animal experimentation within early modern science and society.²¹ Next to the beginnings of ethical debates among scientists and learned members of society, his work also mentions the crucial issue of the animal-to-human

¹⁷ Richard D. French, *Antivivisection and Medical Science in Victorian Society* (Princeton: Princeton University Press, 1975).

¹⁸ James Turner, *Reckoning with the Beast: Animals, Pain, and Humanity in the Victorian Mind* (Baltimore and London: The Johns Hopkins University Press, 1980).

¹⁹ Stephanie Eichberg, 'Vivisection Investigated and Vindicated' (1842): A Scientific Assessment of the Vivisection Debate in Early Victorian Britain (Unpublished M.A. Dissertation, Freie Universität Berlin, 2005).

²⁰ Nicolaas Rupke (ed.), *Vivisection in Historical Perspective* (London and New York: Routledge, 1990; first 1987).

²¹ Andreas-Holger Maehle, *Kritik und Verteidigung des Tierversuchs. Die Anfänge der Diskussion im 17. und 18. Jahrhundert* (Stuttgart: Franz Steiner Verlag, 1992).

transferability of experimental results, an issue that is also discussed throughout my thesis in relation to the allegedly different sense experiences of humans and animals. Next to Maehle, Anita Guerrini is also one of the few historians who have investigated the issue of animal experimentation prior to the nineteenth century. Though her first article on the subject, ‘The Ethics of Animal Experimentation in Seventeenth-Century England’,²² focuses mostly on the ethical debates, her more recent book *Experimenting with Humans and Animals*²³ also discusses the underlying rationale for using animals in experimental research throughout history.

Apart from the subject of anatomy and experimentation, the phenomenon of pain is another important issue that informs my subject, most notably because as a sensation it is classed as a nervous faculty, but also because pain has always been a test case for discussing the mind-body dualism as well as the human-animal boundary (as discussed in Chapter 2.1.2. and 4.). The most comprehensive account, to which I mainly refer in my thesis, is still Roselyne Rey’s *The History of Pain* (1993). Despite her claim that her book is “dedicated to discovering the ways in which physicians, physiologists, and neurologists have throughout the ages attempted to understand the practical mechanisms of pain and to find appropriate remedies for it,”²⁴ thus locating it firmly within the history of medicine, Rey has been very apt in considering not only the medical contexts, but also their philosophical and cultural backgrounds. Because her framework is so vast, Rey’s book has the additional advantage of pointing out some obvious but often dismissed observations, for instance that pain is a functional sign, rather than an observable entity that could be given an exact location in the tissues or organs. Significantly, she also discusses pain in the context of vivisection, in which an analogy of bodily feeling and mental awareness in humans and animals had to be drawn in

²² Anita Guerrini, ‘The Ethics of Animal Experimentation in Seventeenth-Century England’ (*Journal of the History of Ideas* 50: 3 (1989), pp. 391-408).

²³ Guerrini, *Experimenting with Humans and Animals: From Galen to Animal Rights* (Baltimore and London: Johns Hopkins University Press, 2003).

²⁴ Roselyne Rey, *The History of Pain* (Paris: Editions la Decouverte, 1993), p. 3.

order to make sense of experimental observations. Rey's historical overview of the changing conceptions of pain already captures the fact that we have come a long way towards believing that "[p]ain is based on an anatomical and physiological foundation, and if there is one experience where the human condition's universality and the species' biological unity is manifest, pain is certainly it."²⁵ Although large parts of my research project could also be defined as a historical study of the degree to which the phenomenon of sensation (via the example of pain) was or was not conceived in terms of a human-animal continuity, I want to highlight that the very focus on sense experience was at all times inextricably linked with the question of the human-animal difference versus similitude. My underlying hypothesis is therefore that nearly all the problems inherent in neuroscientific debates on the issue of bodily-cum-mental sense experience have also been central to the issue of the human-animal boundary. This is almost, but not quite, touched upon in the most recent attempt to tackle the problem of pain and its link to the human-animal boundary. Thorsten Galert's thesis on animal pain and animal cognition applies concepts from the discipline of philosophical anthropology, but it does so at the borders of psychology, medicine, neuroscience and behaviourism.²⁶ The book does not exactly propose a new approach or working definitions; rather, it evaluates critically and puts to the test modern theories about consciousness, about

²⁵ Rey, *History of Pain*, p. 5. Apart from Rey, however, the general consent among authors writing about modern concepts of pain seems to be that, whereas the behaviour of people in pain signals their mental anguish, the pain behaviour of animals was and is more readily explained in terms of an inbuilt automatic response to a painful stimulus. Like many other influential books on pain, David B. Morris' *The Culture of Pain* (London: University of California Press, 1991), is a modern day account with a strong emphasis on the cultural and social influence of feeling and expressing of pain, which rather seems to prove the point that the experience of pain is uniquely human. So does Elaine Scarry's, *The Body in Pain. The Making and Unmaking of the World* (Oxford et al.: Oxford University Press, 1985); though her claim that pain expressions are independent of language could be used as an argument that the phenomenon of pain also exceeds species boundaries. Patrick Wall, one of the founders of the McGill Pain Questionnaire (1971), contemplates in his book *Pain: The Science of Suffering* (London: Weidenfeld & Nicolson, 1999) the difficulty of defining the exact point at which the mind becomes aware of pain which shows the long-lasting inability to deal with the mind-body dualism. Valerie Gray Hardcastle's *The Myth of Pain* (London et al.: MIT Press, 1999), on the other hand, does not dwell on the difference between human and animal pain, but provides interesting criticism on the obsession with mental aspects of pain in the research literature. Her statement "in all likelihood, all pains are physical in origin," (ibid., p. 31.) betrays her materialist position with regard to pain, but she also covers philosophical and psychiatric views.

²⁶ Thorsten Galert, *Vom Schmerz der Tiere. Grundlagenprobleme der Erforschung tierischen Bewußtseins* (Paderborn: mentis, 2005 [Marburg Univ. Diss. 2004]).

the animal as a projection field for unresolved concepts, and the way that the issue of pain features as a prime example for ongoing debates. In the book's conclusion we find the author's claim that he wants to provide a 'methodical basis for cognitive ethology', thus situating his book among other works that have tried to work out a theory of animal consciousness and cognition since the 1970s. The overall impression from modern studies such as Galert's is that the reason for the ongoing disagreement as to whether animals have any cognitive abilities, and what these might be in particular, is a more basic disagreement about the exact definition of mind in humans. As I will show, this has long been reflected in past and present debates about the human-animal boundary, which are in fact a one-sided quest for knowledge about human nature. As Galert suitably says, the question whether animals feel pain, for instance, is really about establishing whether animals feel pain in the same way as we do.²⁷

The fickle concept of mind is also enmeshed in historical controversies over the (animal) soul, which has been investigated by Leonora Cohen Rosenfield in her well-known book *From Beast-Machine to Man-Machine*.²⁸ Though her context is resolutely French, and her main focus is mechanical philosophy (via the concept of animal automatism), she also shows that the notion of the mechanical body is inextricably linked with debates on the human-animal difference. More recent works on the subject of the human and animal soul have been published by Hans Werner Ingensiep.²⁹ Ingensiep looks mainly at German debates and

²⁷ Galert, *Vom Schmerz der Tiere*, p. 15.

²⁸ Leonora Cohen Rosenfield, *From Beast-Machine to Man-Machine: Animal Soul in French Letters from Descartes to La Mettrie*. New and enlarged edition. (New York: Octagon Books, Inc., 1968; first 1940).

²⁹ See, for instance, Hans Werner Ingensiep, 'Seelenordnungen und Neurozentrik: Auf den Spuren der Seelenlehren in der Antike, der frühen Neuzeit und der Gegenwart', in Ute Kindermann and Almuth Hattenbach, *Die Sonderstellung des Gehirns - eine biologische Tatsache?* (Gießen : Focus, 1997), pp. 11-31; and idem: 'Tierseele und tierethische Argumentationen in der deutschen philosophischen Literatur des 18. Jahrhunderts' *NTM N.S.* 4: 2 (1996), pp. 103-118. Regarding the specific subject of animal souls, animal intelligence, and the concept of instinct, a remarkable compilation of historical treatises on the subject can be found in William Rounseville Alger, *A Critical History of the Doctrine of a Future Life. With a Complete Bibliography of the Subject* (Philadelphia : George W. Childs, 1864), pp. 868-873. It mentions nearly 200 works, ranging from the sixteenth-century Spanish physician Gómez Pereira's *Antoniana Margarita* (1564), (discussed in my Chapter 1.3.) to the most recent works at the time of his writing.

focuses largely on the eighteenth and nineteenth centuries, but he argues convincingly that within a European context, the roots of these debates as well as the lines of thought were remarkably similar.

As indicated above, a more direct contemplation of the issue of the human-animal boundary itself is mostly found in human-animal studies. Even though I feel that my approach is more firmly located in the history of the life sciences, I have also drawn a lot of inspiration from a variety of works on human-animal relations.³⁰ I feel that a variety of interesting concepts and approaches from this field could and should be made available to those that are interested in the history of the human mind and body with its intrinsic perception of the human-animal boundary. Due to a necessary limitation of scope, I will focus mostly on those works in whose wake I have followed, or else discuss evident gaps in the relevant literature that my project hopes to fill.

The fact that the magnitude of human-animal studies represents a way of thinking about *human* attitudes towards animals in different historical contexts has been exemplified by those books that carved the way for the current lively interest in human-animal relations. The epic study by Keith Thomas, *Man and the Natural World* (1983)³¹ is still among the best-known. Its subtitle – *Changing Attitudes in England, 1500-1800* – also indicates its occupation with human attitudes rather than animals per se. The different historical frameworks of other influential books, such as Harriet Ritvo's *The Animal Estate* (1987) and

³⁰ In recent times, the field of human-animal studies is often referred to as *anthrozoology*, though the latter more narrowly defines itself as research into human-animal interactions and/or human-animal relationships. Like *Animal Studies* or *Human-Animal Studies*, it transgresses disciplinary boundaries. A decent overview of this emerging field in historical studies can be found in Harriet Ritvo, 'History and Animal Studies' (*Society & Animals* 10:4 (2002), pp. 403-406); and the above-mentioned work by Erica Fudge, 'A Left-Handed Blow: Writing the History of Animals'. As of today, the broad and interdisciplinary field of human-animal studies is still producing a vast array of literature. Not only has the field split into many subspecialties, from dealing with only one animal species at a time to animals in specific contexts (i.e. as pets, laboratory animals, farm animals, wild animals, etc.) – all of them have different agendas covering historical, cultural, sociological, scientific and of course ethical issues. Bits and pieces of nearly all of them have inspired my project, but in the following discussion, I will only mention the most relevant.

³¹ Keith Thomas. *Man and the Natural World. Changing Attitudes in England, 1500-1800* (London: Allen Lane, 1983).

The Platypus and the Mermaid (1997);³² Aubrey Manning and James Serpell (eds.), *Animals and Human Society* (1994);³³ as well as Angela N.H. Creager and William Ch. Jordan (eds.), *The Animal/Human Boundary: Historical Perspectives* (2002),³⁴ imply further that it is in fact the changing conceptualisation of what constitutes the human (a vital aspect of my own investigations) that determines the specific view, status and treatment of animals in any given society and time period. Regarding the specific content and context of my thesis, two types of cultural discourses about animals, the “*Demand for Difference*” and the “*Demand for Similitude*”, as identified by Keith Tester, fit exceptionally well with the dual nature of scientific investigations of the body that, for instance, assign the bodily mechanisms but not the cognitive experience of sensation to animals.³⁵ Throughout my thesis, I will often refer to these types of discourses to specifically designate the two-fold use of animals in anatomical and physiological investigations: the need for the model function of animals as substitutes for the human body versus the need to establish a fixed *differentia specifica* of humans.³⁶

Other studies have tackled the issue of the human-animal boundary via investigations of existing concepts and definitions. Tim Ingold’s *What is an Animal?* (1994)³⁷ addressed the problem by providing different perspectives, definitions and meanings of the term ‘animal’ as

³² Harriet Ritvo, *The Animal Estate: The English and Other Creatures in the Victorian Age* (Cambridge, Mass.: Harvard University Press, 1987); idem, *The Platypus and the Mermaid and Other Figments of the Classifying Imagination* (Cambridge, Mass. and London: Harvard University Press, 1997).

³³ Aubrey Manning and James Serpell (eds.), *Animals and Human Society: Changing Perspectives* (London and New York: Routledge, 1994).

³⁴ Angela N. H. Creager and William Ch. Jordan (eds.), *The Animal/Human Boundary: Historical Perspectives. Studies in Comparative History 2* (Woodbridge: University of Rochester Press, 2002).

³⁵ Keith Tester, *Animals and Society. The Humanity of Animal Rights* (London and New York: Routledge, 1991), p. 88. Tester originally ascribes these discourses to the different demands of morality for the treatment of animals within society which stand for the need to create orderly and regulated social relationships through enhancing the ‘privilege of being human’ and extirpating ‘animality’. In his study, he links the beginning of these discourses to the Romantic movement; but, for the above-stated reason, I will borrow and utilise this dual discourse for my own purpose.

³⁶ The phrase *differentia specifica* originates in the Aristotelian rule of definition which found its entry into biology and other disciplines, such as logic and linguistics. See Bernd Buldt, ‘Genus Proximum’, in Jürgen Mittelstraß (ed.), *Enzyklopädie Philosophie und Wissenschaftstheorie. Second Edition, Vol. 3* (Stuttgart and Weimar: Metzler, 2008, pp. 85-86), p. 85. Throughout my thesis, I will use this phrase to denote the search of a specific property that distinguishes humans from animals. We will see that this property is not necessarily a biological one.

³⁷ Tim Ingold (ed.), *What is an Animal?* (London and New York: Routledge, 1994; first 1988).

opposed to ‘human’. Adrian Franklin’s *Animals and Modern Cultures* (1999)³⁸ gives a good overview of modern and postmodern concepts and theories that have been used to explain the changes in attitudes towards and treatments of animals. Franklin’s incentive to publish his book was precisely that the heightened number of studies on animals and the human-animal boundary in various disciplines have “few common points of departure or common objectives;”³⁹ the multifaceted assumptions on the subject requiring “explication and explanation.”⁴⁰ One aim of my thesis is to show that a deeper understanding of this ‘modern’ diversity of assumptions about the human-animal boundary can be gained by illuminating their historical development in which the life sciences played a large part.

Another issue related to the human-animal boundary is that of anthropomorphism, which has been an underlying bone of contention within the behavioural sciences and (human) animal studies ever since research on human-animal relations found its way into many disciplines within the humanities and sciences alike. The term still conveys a fair amount of criticism against scholars who attempt to give animals ‘a voice’ within human narratives but are accused of furnishing animals with attributes that are in essence ‘too’ human.⁴¹ The negative connotations of the term are traced back to the works of nineteenth-century evolutionary writers, most notably to Charles Darwin and Georges Romanes, whose language is believed to convey an unchecked version of anthropomorphism.⁴² In recent years a considerable

³⁸ Adrian Franklin, *Animals and Modern Cultures: A Sociology of Human-Animal Relations in Modernity* (London: Sage Publications, 1999).

³⁹ *Ibid.*, p. 1. For an overview of current interests in animals in science and sociology, see Pru Hobson-West, ‘Beasts and Boundaries: An introduction to animals in sociology, science and society’ (*Qualitative Sociology Review* III:1 (2007), pp. 23-41); and Melanie Rock, Eric Mykhalovskiy and Thomas Schlich, ‘People, Other Animals and Health Knowledges: Towards a Research Agenda’ (*Social Science & Medicine* 64 (2007)), pp. 1970-1976.

⁴⁰ Franklin, *Animals and Modern Cultures*, p. 1.

⁴¹ See here especially John S. Kennedy’s *The New Anthropomorphism* (Cambridge: Cambridge University Press, 1992), which constitutes the most prominent example of this criticism. Himself a behavioural scientist, Kennedy issued his book as a warning against what he felt to be a new wave of anthropomorphism coming in the wake of cognitive ethology.

⁴² See here especially Eileen Crist’s chapters on Darwin and the naturalists in her book *Images of Animals: Anthropomorphism and Animal Mind* (Philadelphia: Temple University Press, 1999); and Elizabeth Knoll, ‘Dogs, Darwinism and English Sensibilities’, in Robert W. Mitchell, Nicholas S. Thompson and H. Lyn Miles

number of books on anthropomorphism have been published in which the concept itself and its use in science and society is scrutinised by various scholars.⁴³ Of these, Eileen Crist's *Images of Animals* (1999) unravels yet another aspect of the dichotomy between humans and animals. By way of focusing on everyday versus scientific notions of animals via the medium of language, Crist's book provides important groundwork for explaining the different conceptualisations of animal life. According to Crist, animal behaviour can be explained either within the framework of human action (thus coded in the language of subjective experience) or it is classed as natural (thus intrinsically meaningless) phenomena as reflected in technical, scientific terminology.⁴⁴ The consequences of this division of frameworks within which to place animal behaviour do not only determine the view, status and treatment of animals, but have implications for the way that humans – traditionally projecting their own traits onto non-human animals – have gained knowledge about their own nature. As Crist argues, the diffuse meaning of subjectivity in the 'anthropomorphic' way of writing about animals "allows for the implicit or explicit emergence of animal mind."⁴⁵ However, in the specific case of anthropomorphism in anatomical and physiological research on animals, I would argue that the matter is more complex. Here, the use of animals as substitutes for the human body leaves no alternative but to apply a certain kind of anthropomorphisation of the animal's body and behaviour in order to retain the animal's model function. Thus, in neuroscience, despite the deliberate attempt to reflect the 'non-subjective stance of natural phenomena' to use Crist's terms, 'external representation' becomes meaningless since no framework of understanding can be applied to liken animal sensation to human sense

(eds.), *Anthropomorphism, Anecdotes, and Animals* (Albany: State University of New York Press, 1997), pp. 12-21.

⁴³ The most important ones reflecting the diversity of opinions and backgrounds in the field are the above-mentioned books by Kennedy, *The New Anthropomorphism*; Crist, *Images of Animals*; Mitchell et al. (eds.), *Anthropomorphism, Anecdotes, and Animals*; and, more recently, Lorraine Daston and Gregg Minton (eds.), *Thinking with Animals: New Perspectives on Anthropomorphism* (New York: Columbia University Press, 2005).

⁴⁴ Crist, *Images of Animals*, p. 4.

⁴⁵ *Ibid.*, p. 5.

experience *without* ascribing a subjective (that is the mental) experience of sensations, such as pain, to the animal. Overall, one of the shortcomings of this emerging new field is that the issue of anthropomorphism is not placed within a wider historical context, that is, its beginnings are only linked to the emergence of Darwinism and evolutionary theory, and the focus is mostly on modern behavioural research. One exception is the work of Erica Fudge that, by identifying anthropocentrism and anthropomorphism as defining features of early modern discourses in which humans contemplated themselves and animals, provides a link between historical studies on human-animal relations and specific debates on the issue of anthropomorphisation.⁴⁶ Within the context of my thesis, my explicit focus on faculties associated with the nervous system aims to show that early modern anatomical and experimental investigators used anthropomorphism as a “tool to generate hypotheses”⁴⁷ about the human body, while anthropocentrism provided the basis for the (mostly non-corporeal) concepts of human-ness itself.

What is altogether striking are not only the various ways in which the dichotomy of animal and human nature is discussed in the afore-mentioned studies, but the similarity of the dual discourses identified by most of the scholars. Crist’s two types of description of animals (*internal versus external*), for instance, match with Lynch’s two types of conceptualisation of animals in the laboratory (*natural versus analytical*) and with Keith Tester’s two types of discourse (*Demand for Difference* and *Demand for Similitude*). Speaking about the human-animal boundary is, apparently, to identify either side of a discourse, just as speaking about sensation is to establish first whether one talks of physical sensation or the mental experience of it. Comparing the various discourses on the human brain and nerve faculties with those of

⁴⁶ See here especially Fudge, *Perceiving Animals: Humans and Beasts in Early Modern English Culture* (Basingstoke: MacMillan Press LTD, 2000), introduction, pp. 1-10.

⁴⁷ Frans B.M. de Waal in his foreword to Mitchell et al. (eds.), *Anthropomorphism, Anecdotes, and Animals*, pp. xiii-xvii: xvi.

animals might thus also highlight the roots and particular problems associated with these types of binary thinking in the life sciences.

Chapter Outline

Chapter 1 of my thesis serves two purposes: it is, first, intended as an historical overview and introduction to the history of the nervous system and associated theories of cognition and sensation. Secondly, it will point out the shortcomings of traditional accounts on the subject by emphasising the importance of animal models for anatomical as well as philosophical enquiries into the human mind/soul and body from Antiquity until the Renaissance. My second chapter sets the scene for a more thorough analysis of anatomical and experimental practices, as done in Chapter 3 and 4, by discussing the influence of mechanical philosophy on the conception of corporeal versus incorporeal faculties in animals and humans. I will concentrate here predominantly on the Cartesian beast and body machine, due to the controversies it sparked in the following decades, but will also engage with Gassendian philosophy which also had an influence on neuroanatomical investigations as discussed in the following chapter. Chapter 3 narrows the focus by using Thomas Willis' (1621-1675) neuroanatomy as an example of the way that the human-animal boundary was negotiated in hands-on anatomical practices. Willis was the most influential seventeenth-century representative of neuroanatomy who, at the same time, created novel ways of understanding and investigating the nervous system. A brief section (3.2) further discusses how the overall heightened anatomical focus on the nervous system in the seventeenth century led to new philosophical notions of the mind and sensory faculties. Here, I will focus here especially on Lockean sensationalism but will also mention the Cartesian advocate Antoine Le Grand who continued to promote a strict mechanical view of animal and human bodies, for both were the

main theoretical strands available in the eighteenth-century for a conception of the nervous body as well as the human-animal boundary. Chapter 4 moves on to the eighteenth century, where experimental investigations of nerve functions took centre stage. I will here mainly focus on Albrecht von Haller's sensibility trials, for these not only sparked a European controversy, but in a way encapsulate all the dilemmas associated with the use of animals in research on such unresolved issues as sensation and the question of the soul. Similar to Aristotle two thousand years before and Lynch's modern-day neuroscientists two hundred years later, Haller tried to operate with a universal body in his experiments, viewing the particular animal under investigation as a representative of all living beings that possessed a nervous system. His experimental approach conveys the *Demand for Similarity* regarding human and animal sense experience, as exemplified by an anthropomorphisation of the animals' pain manifestations. But it also battled with the continuous *Demand for Difference* between humans and animals, as his description of human pain still invoked the rational soul.

There are admittedly countless pathways for exploring the human-animal boundary within the history of neuroscience, with an equally large supply of textual sources and/or individuals to be investigated. Needless to say, a limitation in focus is inevitable in a project like this. My focus on particular individuals over others who might equally be claimed to have shaped the scientific and intellectual climate of the periods I am investigating, is not so much due to their path-breaking discoveries, but rather to the extent to which their investigations were debated, contested, restaged and revived over time. In this they serve as exemplary showcases of how a history of neuroscience might look like that puts the issue of the human-animal boundary centre stage.

1. Ambiguous Analogies: Human Faculties and Animal Bodies in the History of Neuroscience

For in the first place, as we shall see, not everyone was studying the human body [...] ⁴⁸

This chapter aims to show that philosophical debates and anatomical investigations of the human body have since ancient times been closely linked to a continuous negotiation of the human-animal boundary. The nervous system was thereby just one among other organ systems that provided a platform for testing hypotheses about human-animal analogies and disparities. But, next to the soul, the brain and nerves came to be associated most strongly with those faculties that are believed to constitute the human, such as cognition, and sense experience. I will focus accordingly on those philosophers and anatomists that helped tie the link between the body/brain and the soul/mind. Apart from the search for potential source organs of these faculties that were at the same time thought to constitute the human, it was the overall attempt to locate those faculties in the *animal* body that is of special interest here. Gaining knowledge about the human body was the primary quest but, due to varying prohibitions on dissecting humans, it were mostly animal structures that were studied to shed light on these faculties. ⁴⁹ However, alongside the earliest anatomical speculations and investigations of animal bodies, there was little or no doubt that humans stood apart from other living beings by having something superadded to the materiality of their body. *Anima* – the ‘breath of life’ – described at first as a living principle that could be found in everything that visibly breathed, moved about or, as in the case of plants, changed its size and height by

⁴⁸ Cunningham, *The Anatomical Renaissance*, p. 7.

⁴⁹ I use the term ‘animal’ here to denote all non-human animals that have been used for anatomical and experimental investigations, irrespective of species. The pre-modern anatomists’ choice of particular animals for specific investigations did not seem to have been informed by any prevalent system of animal classification. Rather, the choice of particular animals was directed by either practical reasons (a more steady supply of common species, such as cats and dogs) or by the particular organs under investigation whose anatomical visibility was often greater in some animal species than in others. In any case, a multitude of different animal species fulfilled not only the function of anatomical representatives of the human body; they were at the same time used to pinpoint the differences between humans and animals.

growing. But in humans, *anima* fulfilled yet another role that set them apart from the rest of creation – that of cognitive and intellectual functions. Exactly where this half-material thing, which came to be known as the soul, was to be found or what it consisted of, were questions that continued to be asked and re-asked for well over two thousand years. Its existence was rarely disputed, though controversies regularly erupted over the exact nature of the soul, its seat, and its relationship with the body. As an intermediary between the soul and the body, the faculty of sense perception, which connected the body's interior with the outside world, kept refocusing the attention of philosophers and anatomists onto the body as the soul's material vehicle that could be subjected to observation. These anatomical searches for the central organ where all sense impressions originate initiated the specific embodiment theory that later became known as neuroscience. Thus, though it might seem rather far-fetched to go back as far as Antiquity, the ongoing use of animals as anatomical representatives of the human body since ancient times, as well as ancient theories and philosophies of the nervous body, eventually formed the multi-faceted framework of thought available to the seventeenth- and eighteenth-century protagonists of my thesis. In fact, the Renaissance revival of ancient anatomical practices and ancient notions of corporeal and immaterial souls set the scene for those specific investigations of the brain and nerves that early modern anatomists conducted. The historical overview of anatomical investigations and philosophical notions prior to the seventeenth century in my first chapter will therefore begin with Antiquity. As indicated in my chapter outline, I will also evaluate the way that modern historiography has reflected on past investigations of human and animal bodies. We will see that the standard historical literature shows a surprising and somewhat ahistorical bias towards anatomists and philosophers who claimed to have investigated human rather than animal bodies in their research.

It is well known that historians evaluate the success or lack of success of ancient and early modern anatomists on the basis of “what we now take that human body to be truly like,”⁵⁰ as Cunningham has put it, “[i]ndeed it is on this basic criterion that historians have customarily made their judgements about which past anatomists deserve credit for their work, and which deserve blame for not seeing what was in front of their noses.”⁵¹ Yet, it might not be coincidental that such modern-day historical judgements of past anatomists reflect the stance of Renaissance anatomists, such as Vesalius (see Chapter 1.2.1), whose new anatomical agendas were aimed at asserting their own authority in the field, rather than dismissing the ancient anatomical method of dissecting animals as such. Due to Vesalius’ avowed focus on the human body, however, his anatomical work is still believed to be the ultimate source of our modern anatomical conceptions of the (human) body. This conception tends to forget that Vesalius himself drew extensively on ancient anatomical projects, and thus indirectly reconnected with an age-old approach to the problem of the human-animal boundary.

1.1. Antiquity

Though the earliest medical records from ancient Egypt that have been found suggest that injuries to the brain had long been associated with loss or impairment of sensation, movement, memory, and speech—long before a concept of the nervous system as such existed—the idea that the brain was the specific source of cognition and sensation originates in ancient Greece.⁵² The theory of the brain as the corporeal source of these faculties

⁵⁰ Andrew Cunningham, *The Anatomical Renaissance*, p. 7.

⁵¹ *Ibid.*

⁵² See Stanley Finger, *Minds Behind the Brain. A History of the Pioneers and Their Discoveries* (Oxford et al.: University Press, 2000), pp. 13-19; and *idem*, *Origins of Neuroscience. A History of Explorations into Brain Function* (Oxford et al.: Oxford University Press, 1994), pp. 6-7; see also Sidney Ochs, *A History of Nerve*

competed for a long time with a heart-centred philosophy of the body; however, Michael Frampton's recent study of ancient theories of animal motion suggests that much of the overall theoretical framework for modern debates on the material embodiments of cognition, sensation, and voluntary motion was "reasonably well articulated by the late fifth century B.C."⁵³ In the early fifth century BCE, the Greek physician Alcmaeon of Croton⁵⁴ declared that all the senses were connected in some way with the brain and that the brain was consequently responsible for all sense perception.⁵⁵ Alcmaeon also asserted that anatomical dissections were needed to study and fully understand this phenomenon and, as he obtained his knowledge mainly from animal dissections, his research could be described as an early case of comparative anatomy in the sense that animals were dissected to shed light on the workings of the human body, involving a comparison of both.⁵⁶ Implicit in the use of animals as substitutes for the human body was the assumption that animals and humans shared at least the corporeal mechanisms of sensual processing. The fundamental difference between them, which at the same time constituted the superior nature of human beings, was crucially shifted to a level that could not as easily be grounded in bodily matter. Alcmaeon pinpointed this when he asserted that the human-animal difference was best defined as distinguishing between sense perception, which all living beings experienced, and understanding or thought, which was unique to humans.⁵⁷ Cognitive faculties, in particular the more abstract ones of

Functions: From Animal Spirits to Molecular Mechanisms (Cambridge: Cambridge University Press, 2004), pp. 1-24.

⁵³ Michael Frampton, *Embodiments of Will: Anatomical and Physiological Theories of Voluntary Animal Motion from Greek Antiquity to the Latin Middle Ages, 400 B.C.-A.D. 1300* (Saarbrücken: VDM Verlag Dr. Müller Aktiengesellschaft & Co. KG, 2008), p. 33.

⁵⁴ The exact dates of Alcmaeon's life and work are unknown; it is still disputed among historians whether he should be placed in the late sixth, rather than the fifth century B.C. See Vivian Nutton. *Ancient Medicine* (London and New York: Routledge, 2004), p. 47.

⁵⁵ See Frampton, *Embodiments of Will*, p. 22; and Heinrich von Staden, *Herophilus: The Art of Medicine in Early Alexandria*. Edition, translation and essays (Cambridge: Cambridge University Press, 1989), p. 248.

⁵⁶ See Clifford Rose, 'European Neurology from its Beginnings until the 15th Century: An Overview' (*Journal of the History of the Neurosciences* 2:1 (1993), pp. 21-44), p. 23.

⁵⁷ See Edwin Clarke and C.D. O'Malley, *The Human Brain and Spinal Cord: A Historical Study Illustrated by Writings From Antiquity to the Twentieth Century* (San Francisco: Norman Publishing, 1996; revised and enlarged second edition; first 1968); John I. Beare, *Greek Theories of Elementary Cognition. From Alcmaeon to*

will and reason, remained the most essential markers of difference between humans and animals. Yet, philosophers and anatomists alike continued to link these faculties to a bodily source organ—an organ that was generally found in humans *and* animals, hence the use of animals to study it—seemingly without questioning the methodological flaw of investigating in animals what they deemed only existent in humans. As a consequence, as we will see in later chapters, the heightened emphasis on anatomical investigations led to an ever increasing search for structural evidence that might anatomically represent the superiority of cognitive and sensual faculties in humans. Thus, throughout history, animal bodies remained the most important platform on which to project and then investigate those properties that were thought to constitute the human.

The Hippocratic Corpus, a collection of medical manuscripts dating from around 450-350 BCE, is another ancient source that contains passages in which the brain is described as exerting “the greatest power in man,”⁵⁸ listing emotions as well as intellectual functions. The unnamed author of the late fifth-century treatise *On the Sacred Disease* (*De Morbo Sacro*, c. 410 BCE), for instance, viewed the brain as “the interpreter of consciousness”⁵⁹ and laid out the core concepts that shaped subsequent debates on the corporeal sources of cognition and sensation. Among these were the above-mentioned conception of a source organ (the brain, the heart, or the diaphragm) embodying and controlling higher psychological faculties, and that an invisible but material substrate (*pneuma* or Lat. *spiritus*) served as a transmitting vehicle from the source organ to respective parts of the body.⁶⁰ The intimate connection between nerves

Aristotle (Oxford : Clarendon Press, 1906), p. 251; Frampton, *Embodiments of Will*, p. 22; and Rose, *European Neurology*, p. 24.

⁵⁸ See ‘On the Sacred Disease’, in *Hippocrates*. With an English translation by W.H.S. Jones. Vol.II, Loeb edition (London: William Heinemann, 1923), pp. 138-183: 179. See also Finger, *Minds Behind the Brain*, p. 29. On the importance of the Hippocratic Corpus, see also Nutton, *Ancient Medicine*, pp. 60-62.

⁵⁹ [Hippocrates], *On the Sacred Disease*, p. 179.

⁶⁰ See von Staden, *Herophilus*, pp. 248-249, and [Hippocrates], *On the Sacred Disease*, p 169. This Hippocratic author interestingly mentions goats as “the most common victims” of epilepsy. It was not unusual in Antiquity to think of diseases as transgressing the boundary between animals and humans. See, for instance, Nutton who mentions other Hippocratic writers who extrapolated from a diseased animal to elucidate similar human conditions, see *Ancient Medicine*, p. 77.

and the brain had not yet been made, that is, the idea of the nerves as distribution channels for the *pneuma* or *spirits* became prominent only in later writings.⁶¹ Regarding the nature of *pneuma*, later evolving under the concept of (animal) spirits, the atomistic theory flourishing in ancient Greece is also worth mentioning as it subsequently formed a part in the multiple frameworks of thought available to seventeenth-century philosophers and anatomists, such as Pierre Gassendi, and through him, Thomas Willis (see Chapters 2.2. and 3. respectively). For the ancient atomists, such as Democritus of Abdera (c. 460-370 BCE) who was one of its earliest advocates, everything was made up of atoms or composites.⁶² This was further promoted by Epicurus (341-270 BCE), the leading atomist philosopher of Hellenistic Greece, whose followers concluded that the soul (*psyche*) was part of the material body, i.e. made of atoms concentrated in the chest. In conjunction with the body, it produced sensation and psychological functions, such as emotions and intelligence, all of which were solely the result of the mechanical interactions of atoms.⁶³ This notion had some interesting implications for the conception of bodies and souls as well as the boundary between humans and animals, as the dominance of certain types of atoms in the body determined the character traits of individual humans, but also of different animal species.⁶⁴ The difference between humans and animals thus depended on the physical make-up of the body whose individual composition was not likely to shed light on more generalised notions of difference between larger groups of species.⁶⁵ Unsurprisingly, due to the Epicurean notion that the soul was material and perished with the body, the atomist theory later clashed with Christian natural philosophy,

⁶¹ Frampton, *Embodiments of Will*, p. 33.

⁶² See Pierre-Marie Morel, 'Epicurean Atomism', in James Warren (ed.), *The Cambridge Companion to Epicureanism* (Cambridge et al.: University Press, 2009), pp. 65-83.

⁶³ See also Beare, *Greek Theories of Elementary Cognition*, pp. 254-255.

⁶⁴ See Christopher Gill, 'Psychology', in *The Cambridge Companion to Epicureanism* (Cambridge et al.: Cambridge University Press, 2009), pp.125-141), p. 129.

⁶⁵ *Ibid.*, p. 130. On the human-animal contrast in Epicureanism see also Julia E. Annas, 'Epicurus on Agency', in Jacques Brunschwig and Martha C. Nussbaum (eds.), *Passions and Perceptions: Studies in Hellenistic Philosophy of Mind* (Cambridge: Cambridge University Press, 1993), pp. 53-71.

and was therefore condemned for much of the Middle Ages.⁶⁶ In any case, neither the travelling spirits or atoms, nor the psychical faculties themselves could be made visible; yet, the attempt to locate these in the body determined the agenda for future anatomical research. Neither did the fact that the conjecture of *pneuma* or *spirits* remained unsupported by anatomical facts deter early modern anatomists from utilising the ancient notion of atoms in their investigations.

At about the same time that Hippocratic authors and other Greek anatomists reflected on potential source organs and related substances of sensorimotor and psychical faculties, the philosopher Plato (428-348/7 BCE) advocated the concept of the tripartite soul. Plato's overall philosophical project was in fact devoted to the soul as the defining trait of humans, and he was interested in the body only as a deliberately designed vehicle for the more important immortal soul. His conception of the body was most likely informed by common anatomical knowledge, but, as the body was mostly "an account of soul,"⁶⁷ as Cunningham puts it, anatomical dissections were not a necessary part in Plato's overall philosophical scheme. He conceived of the brain as the centre of the human body that housed the higher psychical faculties as well as the body's lower souls, but believed that faculties such as sensation and sense perception were first and foremost a faculty of the soul, with the body/brain only acting as its instrument.⁶⁸ In Plato's model of the tripartite soul, the human body was infused with the vegetative part of the soul responsible for the body's growth and nutrition and for the lower passions such as appetite and desire; the vital part of the soul was endowed with energy or spirit; and, finally, in humans, the most important part of the soul, the rational and immortal one, was set apart in the head, thus protected "from the deleterious

⁶⁶ Due to the Epicurean material view of the soul that died with the body, the Renaissance poet Dante Alighieri consigned Epicurus to the sixth circle of hell in his *Divine Comedy* (1314) (*Inferno*, Book X, line 14).

⁶⁷ Cunningham, *The Anatomical Renaissance*, p. 13.

⁶⁸ See Plato, *Timaeus*, translated with an introduction by Donald J. Zeyl (Cambridge et al.: Hackett Publishing Company, 2000), pp. 54-63 [61c3-68d7]; see also Beare, *Greek Theories of Elementary Cognition*, pp. 210-215; and Clarke and O'Malley, *The Human Brain and Spinal Cord*, pp. 5-6.

polluting effects of the mortal elements of the soul which are located further down in the body.”⁶⁹ Plato’s conception of the rational and immortal part of the soul as constituting ‘the true man’, could, similar to Alcmaeon’s proposition, not be investigated anatomically, and thus remained detached from discourses about potential differences between human and animal bodily configurations.⁷⁰ Plato’s tripartite soul also conveys that neither the choice of a source organ as the seat of the soul nor the configuration of bodily organs as such, made much difference to the overall conception of the human-animal boundary.

Plato’s human and soul-centred philosophy remained influential throughout the Middle Ages and beyond; yet, his equally influential student Aristotle (384-322 BCE) chose a radically different way of philosophising about bodies, souls, and universal principles of living beings. Animal anatomy took centre stage in Aristotle’s ongoing project because, in order to understand the operations of the soul, Aristotle viewed a thorough knowledge of the bodies of different animal species as indispensable. Cunningham describes Aristotle’s project as a search for knowledge about ‘The Animal’ as an epitome for all living beings – including humans, whose soul just happened to possess more faculties than those of any other creature.⁷¹ Yet, precisely because human beings were considered supreme animals in Aristotle’s scheme, his perspective remained anthropocentric to some extent. As G.E.R. Lloyd remarked, “since this feature corresponds to certain deep-seated assumptions widely shared today, it may occasion little surprise.”⁷² Aristotle’s writings are thus especially valuable as they reveal the coming into being of assumptions and thought processes that constitute our anthropocentric world view. Aristotle’s basic starting point was a simple one,

⁶⁹ Nutton, *Ancient Medicine*, p. 117.

⁷⁰ Yet, Plato’s well-known emphasis on the diaphragm as the corporeal boundary between the lower and higher mortal soul betrayed his human-centred view of the body. His student Aristotle, who focussed on bodily structures that could be found in most animals, placed no importance on the diaphragm as it was not a universal part shared by all living beings; see Cunningham, *The Anatomical Renaissance*, p. 21.

⁷¹ See Cunningham, *The Anatomical Renaissance*, pp. 13-22.

⁷² G.E.R. Lloyd, *Science, Folklore and Ideology. Studies in the Life Sciences in Ancient Greece* (Cambridge: Cambridge University Press, 1983), p. 26.

namely that in any investigations of living beings, one must begin with humans because they are the type of animals most familiar to us. But this also implied that humans provided the standard and purpose of comparison for all other animals. Thus, before the animal could acquire its model function in the life sciences, it had to be modelled against the human first. Accordingly, as Lloyd pinpoints in Aristotle's method, "characteristic human differentiae [...] are being used to map differences between animals – the exact converse of using animal types to map the differences between human natures [...]"⁷³ The boundaries between animals and humans were thereby not rigid ones, as the main feature that all living beings shared was in Aristotle's view the soul. Crucially, the question whether animals have souls became subject to heated debates throughout the early modern period. For Aristotle, however, the soul was something close to the original sense of *anima*, a living principle that encompassed every aspect of the working body.⁷⁴ Since different organisms have different ways of life, he concluded that there must be different souls, each with its own set of faculties or powers. Depending on their varying powers or properties, souls were also grounded to a varying degree in the body. Significantly, the rational soul—the *differentia specifica* of humans—was the least dependent on the body, since its operating principle remained unchanged even when a weakened or less complex bodily configuration may prevent a full exertion of its powers.⁷⁵ In order to classify the distinct nature of existing souls, Aristotle went about dissecting a large variety of animals (though not humans). The fact that he projected animal anatomy and its functions onto human bodies, i.e. using the animal as a universal model for the soul's corporeal functions, suggests that, in his view, 'ensouled' bodily mechanisms transgressed the human-animal boundary. Any functional differences did therefore not depend on the

⁷³ Lloyd, *Science, Folklore and Ideology*, p. 25.

⁷⁴ See Aristotle, 'On the Soul', in *On the Soul and Other Treatises of Aristotle*. Vol. 6 of *The Works of Aristotle*, edited and translated from the Greek by Thomas Taylor. Vol. XXIV of The Thomas Taylor Series (Wiltshire, England: The Prometheus Trust, 2003; first 1808), p. 51 [Book II, 412a] and p. 58 [Book II, 415a].

⁷⁵ Aristotle cites the example of old age in which sense perception and mental capacities diminish because of the body wasting away, while the power of the rational soul remains just as it used to be at a younger age; see Aristotle, *On the Soul*, p. 44 [Book I, 408a].

presence or absence of a divine and immortal soul. Yet, though the operating principles of corporeal functions were not fundamentally different amongst living beings, Aristotle envisaged a scale of complexity, a certain hierarchy of ensouled faculties that placed humans at the top, and animals between plants and humans. In his *scala naturae*, plants were at the bottom for they needed only vegetative souls for their growth. Animals were placed higher, because of their sensitive faculties, which were linked to imagination but excluded will and understanding. And humans stood at the apex of the natural world, due to their possession of a rational soul that was equipped with the faculty of reason and will.⁷⁶

Interestingly, Aristotle seems to have had some difficulties dividing the sensitive soul, “which cannot easily be admitted either as irrational, or as possessing reason,”⁷⁷ from the rational part of the soul, thus keeping the borderline between animals and humans equally flexible. Plants proved to him that an organism could thrive with the most basic of souls, i.e. the vegetative. For animals he claimed, however, that their sensitive soul could not function on its own but required the life-supporting vegetative soul as well. In a similar vein, the rational soul relied on the sensitive soul and its faculties, though sentient faculties as such did not require the intellect.⁷⁸ Yet, somewhat contradictorily, Aristotle argued elsewhere that the rational soul was the only one that could exist independently from the body – a notion that was taken up and emphasised by subsequent philosophers.⁷⁹ Aristotle’s inability to trace the borderline between the sensitive soul and the rational soul reflects an ongoing problem in modern neuroscience where it has so far not been possible “to answer satisfactorily the question where sense-perception ends and thinking commences.”⁸⁰

⁷⁶ See Aristotle, *On the Soul*, pp. 53-57 [Book II, 412b-414a]. See also Lloyd, *Science, Folklore and Ideology*.

⁷⁷ Aristotle, *On the Soul*, p. 91 [Book III, 432a]. For the development of the concept of *scala naturae* or the *chain of being*, see also Arthur O. Lovejoy, *The Great Chain of Being: A Study of the History of an Idea* (Cambridge, Massachusetts: Harvard University Press, 1936).

⁷⁸ See Beare, *Greek Theories of Elementary Cognition*, p. 203.

⁷⁹ See Aristotle, *On the Soul*, pp. 54-57 [Book III, 413b-414].

⁸⁰ Beare, *Greek Theories of Elementary Cognition*, p. 260.

Because his dissections had revealed to him that animals that had no brain at all could nonetheless perceive and act, Aristotle, being also unaware of the importance of nerves, dismissed the brain as the seat of the soul.⁸¹ To him, the heart seemed a more logical place for all ensouled functions, such as generation, nutrition, sensation, (voluntary) motion, and cognitive powers,⁸² due to its central position in the body and its alleged responsibility to induce heat. The amount of heat generated by the heart bore a direct relation to the mind's intelligence, with humans being the warmest of all.⁸³ This fit well with his conception of the brain's purpose as a mere regulator of the body's temperature, but also implies that Aristotle's theory regarding heat-induced intelligence indicated a difference in degree, rather than in kind, between human and animal intelligence. Following on from that he concluded that humans had larger brains simply because these were needed to cool down the larger amount of heat produced by the heart.⁸⁴ Aristotle's cardiocentric view was soon replaced by a renewed emphasis on the brain and nervous system, but his work altogether laid the foundation for future investigations by forming the basis from which to rework and re-imagine the most fundamental properties of the human versus the animal body anatomically and philosophically.⁸⁵ As Carlino puts it, Aristotle's zoological works "provided a theoretical

⁸¹ Aristotle further refuted the theory of the brain as the seat of sensation on three grounds: first, that the brain itself was devoid of sensation, so could not be the command centre of sensory faculties of the body; secondly his (mistaken) anatomical observation that the brain has no continuity with the sense organs themselves; and, thirdly, his equally false observation that the brain is void of blood vessels, which ruled out the brain completely as in his view only body parts nourished with blood were capable of sensation. Frampton, who re-enacted the anatomical dissections of Aristotle and Galen in his study, argues that this last observational mistake of Aristotle is probably due to his accidentally pulling away the superficial layer of cerebral veins and arteries together with the closely attached meninges, in order to lay bare the brain. See Frampton, *Embodiments of Will*, p. 41. On a theoretical level, Aristotle had worked out a consistent theory, which implies that his anatomical gaze had been directed only towards bodily configurations that he expected to see, as was the case with most anatomists in the time to come.

⁸² See Aristotle, *Parts of Animals*. With an English translation by A.L. Peck. Reprinted Loeb edition: Aristotle XII (Cambridge et al.: Harvard University Press, 2006; first 1937, revised and reprinted 1961), p. 115 [Book II, 647a]; see also Frampton, *Embodiments of Will*, pp. 31ff.

⁸³ The conception of heat as the most important element in the body stems from the works of Hippocrates and was later advocated by Galen; see Margaret Tallmadge May (ed.), *Galen on the Usefulness of the Parts of the Body*. Translated with an introduction and commentary (Ithaca, New York: Cornell University Press, 1968), p. 50.

⁸⁴ See Aristotle, *Parts of Animals*, pp. 151-155 [Book II: 652b-653b]. See also Nutton, *Ancient Medicine*, p. 118.

⁸⁵ Aristotle's heart-centred natural philosophy had a last major comeback in the Middle Ages, especially through the writings of the Persian physician and philosopher Avicenna (c.980-1037), the bishop and theologian

legitimation of a research paradigm that was based on the analogy between animal and human physiology.”⁸⁶ Furthermore, the correlation between ‘psychic’ or ensouled functions and bodily characteristics was the essential conceptual device that enabled Aristotle and all subsequent anatomists to gather data on all parts of the body.

After Aristotle’s death, in 322 BEC, Greek anatomists emerged who overcame the ancient taboos and dissected human corpses. The physicians Herophilus of Chalcedon (cf. 330-250 BEC) and Erasistratus of Ceos (c. 330-255 BEC), based in Ptolemaic Alexandria in the early Hellenistic period, revived an interest in the nervous system by discovering nerves and their connection to the brain as part of an extensive anatomical study of the body that possibly included the vivisection of humans.⁸⁷ They occupy an important place in the ancestry of neuroscience, not only for anatomically distinguishing between the brain’s ventricles which were conceived as the seat of the intellect, for describing various cranial nerves, and for locating the origins of motor nerves in the spinal cord and the brain.⁸⁸ Within historiography, Herophilus’ and Erasistratus’ anatomical accomplishments are also explained by their unrestrained and extensive dissections of human corpses, as opposed to the seemingly less valid animal dissections of their forerunners (and successors).⁸⁹ Clarke and O’Malley illustrate this perspective by stating that, “[...] there appears to be no doubt, that both Herophilus and Erasistratus possessed an extensive understanding of the anatomy of the nervous system; this resulted from the fact that in Alexandria, for the first and only time in

Albertus Magnus (1193/1206 –1280), and in modified form by Thomas Aquinas and other medieval scholastics until human dissection became once again available as a means of research in universities. However, traces of it continued to reappear in the seventeenth century, most notably in William Harvey’s (1578-1657) path-breaking discovery of the blood circulation system. See Nutton, *Ancient Medicine*, pp. 119-120.

⁸⁶ Carlino, *Books of the Body*, p. 133.

⁸⁷ There is a passage in the introduction to *De Medicina*, written by the Roman encyclopedist Aulus Cornelius Celsus (c. 25 B.C. -50 CE), where he reports that some physicians, including Herophilus and Erasistratus, used to vivisection condemned criminals with permission from the Egyptian kings; see Nutton, *Ancient Medicine*, pp. 166-167.

⁸⁸ See von Staden, *Herophilus*, pp. 247ff.

⁸⁹ See, for instance, Nutton, *Ancient Medicine*, p. 128; C.D. O’Malley, *Andreas Vesalius of Brussels, 1514-1564* (Berkeley: University of California Press, 1964), p. 5; and Clarke and O’Malley, *The Human Brain and Spinal Cord*, p. 11. Nearly all historians that mention Herophilus emphasise this aspect.

antiquity, data on the structure of the human body could be derived directly from dissection of the body rather than indirectly from analogy based upon animal dissection.”⁹⁰ It is certainly true that Herophilus and Erasistratus, for medical reasons, aimed at a more detailed understanding of the exact configuration of the human body, which is admittedly much aided by a dissection of human corpses. Yet, the statement above does not only imply that true knowledge of “the body” could and can only be derived from human bodies; it also negates the fact that animal dissections were not abolished simply because human corpses had become available for dissection. Herophilus’ description of the *rete mirabile*, for instance, shows that he continued to dissect animals, since this network of vessels at the base of the brain is generally not found in humans. Julius Rocca suggests the obvious by stating that since “[i]t is highly likely that Herophilus had only a limited number of human subjects available for brain dissections, and relied upon animal subjects to correlate and augment his human finds [...] Herophilus probably extrapolated this structure to the human brain.”⁹¹ It is even more likely that the use of animals remained as common as ever in anatomical investigations, especially since the opportunity for a direct comparison of human and animal bodies provided a more thorough basis for establishing analogies as well as differences of their structures. In Galen’s *On Anatomical Procedures*, for instance, we find a passage quoted from Herophilus’ *De Dissectionibus* in which the latter had reflected on the differences in size, shape, weight etc. of the liver in various animals and humans, which in turn served Galen as a guide for choosing the right animal species to investigate this organ.⁹²

⁹⁰ Clarke and O’Malley, *The Human Brain and Spinal Cord*, p. 11.

⁹¹ See Julius Rocca, *Galen on the Brain: Anatomical Knowledge and Physiological Speculation in the Second Century AD*. *Studies in Ancient Medicine* 26 (Leiden and Boston: Brill, 2003), p. 204. See also Roy Porter, *The Greatest Benefit to Mankind. A Medical History of Humanity from Antiquity to the Present* (London: Fontana Press, 1999; first 1997), p. 67. Recently, however, the concept of the *rete mirabile* in humans has re-entered neuroscientific debates since two Japanese neurosurgeons found a similar structure in a patient in 2005; see Sebastian Pranghofer, “‘It could be Seen more Clearly in Unreasonable Animals than in Humans’: The Representation of the *Rete Mirabile* in Early Modern Anatomy” (*Medical History* 53 (2009), pp. 561-586).

⁹² See Galen, *De Anatomicis Administrationibus (On Anatomical Procedures)*. Translation of the surviving books with an introduction and notes by Charles Singer (London: Oxford University Press, 1956), p. 163 [(Book

Ancient (and succeeding) anatomists had in fact more reasons to study animal anatomy than a mere prohibition of human dissection. On a practical level, there was at all times a more reliable and steady supply of animals. Quite often, anatomical structures were easier to observe in some animal species due to larger or a less complex, though still analogous, configuration of nerves, vessels, or organs such as the brain or heart (see, for instance, Chapter 3 on Thomas Willis who for these reasons advocated the use of animal brains for study).⁹³ Last but not least, the dissection of live animals remained a vital part of anatomical research, since an observation of internal organs in action was held to be indispensable for acquiring knowledge about their nature and function. All this, along with an often-mentioned choice of animals whose internal structure more closely resembled those of humans, indicates that anatomists have long been aware of the existing human-animal continuity on the level of anatomical structures. Thus, the preference for dissecting humans does not necessarily imply that animals ceased to function as substitutes for the human body.

Yet, in historiography, sufficient progress in the study of the nervous system, or any organ system for that matter, is almost always linked to the possibility of studying human anatomy. Clarke and O'Malley's verdict reflects the ongoing premise that the human body has always been the first choice in anatomical investigations, a premise that is echoed in or might even stem from historical sources such as Vesalius' *De Corporis Humani Fabrica* (1543), as well as nineteenth-century historical overviews of anatomical and medical achievements.⁹⁴ Yet again, I would argue that this premise, implying that animal bodies have always been and are still viewed as too fundamentally different from human beings, is a false one that stands in

VI, Ch. 8, 570-571]. Singer adds in a footnote that this passage quoted in Galen is in fact one of the longest surviving fragments of Herophilus' writings; see idem, p. 249 n 133.

⁹³ See also Cunningham, whose chapter on the meaning of comparative anatomy in the long eighteenth century identified this aspect as one of the core traditional uses of this anatomical sub-discipline; idem, *The Anatomist Anatomis'd*, p. 314

⁹⁴ The classic reference for this is Max Neuburger, *The Historical Development of Experimental Brain and Spinal Cord Physiology Before Flourens (1897)*. Translated and edited, with additional material, by Edwin Clarke (Baltimore and London: Johns Hopkins University Press, 1981).

opposition to the long tradition of comparative anatomy and the use of animal models as substitutes for the human body. Apart from the issue of complexity, there was no reason for not studying the configurations and workings of organs or organ systems in living beings whose bodies were believed to operate according to the same or similar working principles. On the level of functional investigations, anatomists in fact needed the animal to assert potential differences to humans in the first place. Only a comparative study of the brain enabled anatomists to hypothesise on the superior intelligence of humans in terms of a more complex structure, for instance via the higher number of convolutions in the brain—a structure-function correlation that was made as early as the time of Erasistratus and would recur in many subsequent anatomical writings on the nervous system.⁹⁵ As such, it is probably safe to assume that all anatomical investigations were based on the dissection of animals, in one way or another.

After Herophilus and Erasistratus, no major anatomical research seems to have been conducted, or else subsequent works are lost to us, and it would altogether take another 400 years before ancient theories of embodied faculties of human and animal bodies were anatomically revisited by the physician Galen of Pergamum (129-c. 200/216 CE).⁹⁶ Apart from the fact that his prolific writings are also the source of much of what we know about the anatomical research of his predecessors, Galen is the last main protagonist to be discussed in the context of ancient notions about the use of animals for enhancing knowledge of the human body. Instead of reiterating his anatomical and philosophical views and writings of the body, I want to highlight Galen's various reflections on the use of animals for dissection, because these make his anatomical writings an important source for the ancient,

⁹⁵ See Clarke and O'Malley, *The Human Brain and Spinal Cord*, pp. 11-12; and Rose, 'European Neurology', p. 29.

⁹⁶ For an overview of Galen's life and career see especially Nutton's *Ancient Medicine*, p. 216ff; regarding his anatomical investigations in particular, see Frampton's *Embodiments of Will*.

medieval, and early modern rationale for using animals as anatomical representatives of the human body.

Despite a strong tendency to criticise all anatomical enterprises that went on before him, Galen was a zealous advocate of the Hellenistic brain-centred anatomy and followed closely their anatomical procedures.⁹⁷ He also drew on Aristotle's philosophy of nature, being guided specifically by Aristotle's writings on the continuity of external and internal structures among humans and animals.⁹⁸ Philosophically, Galen upheld and elaborated Plato's tripartite notion of the soul, grounding it more firmly in the physical body by assigning the vegetative soul to the liver and veins (producing the natural spirits or *pneuma*), the vital soul to the heart and arteries (producing the vital spirits), and the rational soul to the brain which housed the animal spirits and was responsible for their flow to respective organs in the body.⁹⁹ Galen altogether synthesised the theories of Aristotle, Plato, the Alexandrian anatomist-physicians, and Hippocratic medicine, thus creating an anatomical and medical vision of the body that remained standard throughout the medieval period and beyond. Next to several treatises on particular organs that were intended as manuals for dissection, his main anatomical writings, where he reflected on the use of animals for dissection, include *De Usu Partium* (On the Use of Parts)¹⁰⁰ and *De Anatomicis Administrationibus* (On Anatomical Procedures).¹⁰¹ *De*

⁹⁷ See Nutton, 'Roman Medicine, 250 BC to AD 200', in Lawrence I. Conrad et al (eds.), *The Western Medical Tradition 800 BC to AD 1800* (Cambridge et al.: Cambridge University Press, 1995, pp. 39-70), p. 66.

⁹⁸ Even though many of Galen's own extensive investigations were aimed at disproving Aristotle's heart-centred view of the body.

⁹⁹ See Nutton, *Ancient Medicine*, p. 117.

¹⁰⁰ For the following discussion I will use the translation by May, *Galen on the Usefulness of the Parts of the Body* (see note 83). *De Usu Partium* consisted of 17 books, written between 165 and 175 A.D. in Rome; for more information on the history of the text, its translations and editions, see also May, *ibid*, pp. 3-12.

¹⁰¹ Originally, this work consisted of altogether 15 books, only nine of which (including the part on the brain), were known to succeeding anatomists. These nine books have been translated by Charles Singer, *Galen on Anatomical Procedure* (see note 92), which I use in the following discussion. Although the remaining books have now also been translated (from the Arabic by W.L.H. Duckworth in 1962), I will not refer to them as they had remained unknown in the West until the twentieth-century, thus having no impact on the early modern anatomists I discuss in my later chapters. See also Cunningham, *The Anatomical Renaissance*, p. 27 and 35 n 30.

Placitis Hippocratis et Platonis (On the Doctrines/Teachings of Hippocrates and Plato)¹⁰² is also of interest, for here he deconstructs many of his predecessors' and opponents' views of the workings of the body's structures, and uses his anatomical and physiological

investigations to prove his own (or rather Hippocrates' and Plato's) theories.

Due to the bulk of his writings and his status of authority for later generations of anatomists, historians often emphasise that he conducted anatomical dissections on a scale that remained unrivalled until the publication of Vesalius' *De Humani Corporis Fabrica* (1543). Yet, as his anatomical investigations were based on animal, mostly simian, dissections and

vivisections,¹⁰³ there is an overall consensus that his anatomical descriptions are for the most part invalid due his excessive extrapolation from animals to humans. Even recent works that provide an otherwise more balanced account of Galen's achievements by placing his

anatomical errors in the context of his time conclude that Galen had, as Roy Porter suggests, simply been "[f]orced to apply animal findings to humans."¹⁰⁴ In a sense, Porter's statement

rings true in that Galen, like any other anatomist, would certainly have preferred to have equal access to human corpses and had himself warned of the dangers of transferring all

observations from animals to humans.¹⁰⁵ But it is often not mentioned that Galen also

believed that knowledge about the corporeal structures, for instance regarding muscles and

the skeleton, "is to be thoroughly learnt either from man, or from the body of the ape, or

¹⁰² Galen completed the first six books of this work during his first stay in Rome (162-166 A.D.) and finished the last three books in 169 A.D. He intended to show that Hippocrates and Plato not only shared the same view of the powers of the soul that control the activities of humans and animals, but that he agreed with them; for subsequent quotes, I use the following edition: [Galen], *On the Doctrines of Hippocrates and Plato*. Edition, Translation and Commentary by Phillip de Lacy. 2 volumes (Berlin: Akademie - Verlag, 1978).

¹⁰³ Galen dissected a large variety of animals, but his favourite one seems to have been the monkey, in particular the Barbary ape, because he viewed their structure as closest to humans; see O'Malley, *Vesalius*, p. 7 and Nutton, *Ancient Medicine*, p. 231f. Charles Singer, though, believes that he mainly used the Rhesus monkey; see Singer, *Galen on Anatomical Procedures*, introduction, p. xxi. See also Frampton, *Embodiments of Will*, p. 57.

¹⁰⁴ Porter, *The Greatest Benefit to Mankind*, p. 75.

¹⁰⁵ Galen himself actually criticised his predecessors and fellow anatomists for false extrapolations, e.g. for dissecting "the heart or tongue of an ox without realizing that these are utterly unlike those of a human being;" Galen, *On Anatomical Procedures*, p. 136 [Book II, Ch. IV, 291]. Galen also indirectly emphasised the need to study human anatomy in his treatise on the skeleton; *ibid.*, p. 3 [Book I, Ch. II, 220-227]. See also Nutton, *Ancient Medicine*, p. 231. Nutton is one of the few who does not actually condemn Galen for studying animal anatomy, but acknowledges that the use of animals also had its advantages for the anatomist; *ibid.*

better from both,¹⁰⁶ implying that a comparative study was in any event more fruitful than the knowledge solely gained from either human or animal dissections. Nonetheless, because of Galen's favourite choice of animal, his anatomical writings have been viewed merely as "a description of the soft parts of the ape imposed on the skeleton of man."¹⁰⁷ To quote another example of conventional historiography, O'Malley pinpoints the common criticism by stating that, "it is certainly true that he [Galen] made many elaborate dissections [...], which he described in detail, and if his descriptions are sometimes difficult to criticize from the point of view of human anatomy, this is the result of fortuitously close resemblance between the particular human and animal structure."¹⁰⁸ However, to describe Galen's impetus to study the interior of the body via dissections on animals, as well as his particular choice of animal species, as 'forced' or coincidentally right (as the term 'fortuitously' seems to indicate), is, I would argue, beside the point of Galen's whole anatomical enterprise. This is not to say that his anatomical descriptions were at all times correct. In fact, like all of the anatomists that feature in this thesis, Galen often "saw what he needed to see in order to support his theory"¹⁰⁹—an error that is down to interpretation rather than a confusion of animal and human structures. It altogether appears somewhat ahistorical to assume that Galen did not know what he was doing when he chose to dissect particular animals to explain specific human structures, or that he only occasionally got it right from a modern point of view. In fact, Galen constantly reflected on his animal dissections, and often justified his particular choice of animal by naming the structural analogies as he saw them. His was not a random or even

¹⁰⁶ Galen, *On Anatomical Procedures*, p. 5 [Book I, Ch. II, 226]; my italics.

¹⁰⁷ Singer, *Galen on Anatomical Procedures*, p.xix. This is not quite true, for in the same text, Galen points out the differences between human and ape anatomy, for instance regarding the anatomy of the feet; see *ibid.*, p. 51 [Book II, CH. VIII, 322-324].

¹⁰⁸ O'Malley, *Vesalius*, p. 8.

¹⁰⁹ May, *Galen on the Usefulness of the Parts of the Body*, p. 12. The best-known example refers to Galen's 'discovery' of a bone in the heart of an Elephant; see Galen, *On the Usefulness of the Parts*, pp. 326-327 [Book VI, Ch. 18 and 19, I, 365-366].

desperate choice of using animals instead of human corpses—there was a fundamental conviction underlying his anatomical practice:

In a word, the activities and appearances of the parts which each of these creatures outwardly displays will give you a hint of its internal structure. For parts that perform the same function and have the same outward appearance necessarily have the same inner structure [...]

Whoso then is trained to use his reason and uses his natural ability, easily finds the elements that are identical and those that are different [in each creature]; whereas it is by certain accidents that the element of difference is produced in the various particulars in what we call ‘individuals’ [of the same species] [...]

Even one with neither natural gifts nor training may, by dissecting many animals, come dimly to conceive that it is neither by accident nor by chance that the identical element is present in each species [...]¹¹⁰

Similar to Aristotle, Galen assumed a continuity, if not to say universality, of basic corporeal structures in living beings that were shaped by Nature from design, and consequently ended up describing and dissecting animals whose structures were in his view either externally or internally as close to humans as possible.¹¹¹ From a modern point of view, one could even argue that, by choosing apes and monkeys in the majority of his anatomical dissections, he displayed a greater anatomical rationality than his early modern successors. Thomas Willis, by contrast, who is otherwise conceived as a founder and representative of modern neuroanatomy, relied mainly on dogs and sheep for his dissections. He dissected a monkey only once and was astonished to see how similar the complexity of human and monkey brains were (see Chapter 3). inhere

¹¹⁰ Galen, *On Anatomical Procedures*, p. 148 [Book VI, Ch. I, 537]; pp. 149-150 [Book VI, Ch. I, 539]. Singer has pointed out that this is a compression from Aristotle’s *Historia Animalium* [Book III, Ch. 7]; and p. 150 [Book VI, Ch. I, 539]; for further examples, see *ibid.*, p. 91 [Book IV, Ch. I, 415-416] and pp. 97-98 [Book IV, Ch. III, 430-431]. In nearly every chapter, Galen advises on which animals to study best for the particular structure under investigation; examples are in fact too numerous to list all of them here. However, in Book IV on the muscles and Book VI on digestion and alimentary organs, he accumulated his reflections on the principles of comparative anatomy, including the six classes of quadrupeds that he deemed valuable for dissections due to their structural resemblance to humans; see *ibid.* [Book IV, Ch. III and Book VI, Ch. I and III in particular].

¹¹¹ Regarding Aristotle’s influence on Galen’s argument from design see May’s introduction to *Galen on the Usefulness of the Parts*, pp. 10-12. However, as Cunningham rightly points out, Galen as an anatomist was also a Platonic in the sense that he was first and foremost concerned with anatomizing those features that occurred in the human body; see *The Anatomical Renaissance*, p. 29; and Galen, *On Anatomical Procedures*, p. 91 [Book IV, Ch.I, 415-416], where he measures the features of animals against the perfection of the human body.

Though Galen's theoretical framework certainly differs from modern biomedical research practices in which, incidentally, apes and monkeys play once more a major role, the underlying rationale, that is, the belief in a human-animal continuity and analogy of bodily configurations, is the same. What Roger French ascertained for the later Renaissance anatomists—"it was plain to everybody that man shared animal characteristics with beasts"¹¹²—is in fact the one thread that connects ancient anatomy with all subsequent investigations of the human body. That the practice of animal dissections continued even when human corpses became available suggests once more that the use of animals for dissection had never been only due to necessity or even ignorance. The majority of pre-modern anatomists being a case in point, there is even reason to doubt that Galen would have focussed exclusively on human bodies had he been able to do so. This is also underlined by some speculations that Galen might have had more knowledge of human anatomy than his writings—and subsequent historiographies—convey, which would render the reasoning that Galen's mistakes were due to an insufficient knowledge of human corpses equally false.¹¹³ Even if we do not go as far as to assume that Galen had actually dissected human corpses, his rationality for using monkeys and other animals for dissections is grounded in an actual comparison of human and animal structures. Next to the description of human and animal bodies in writings known to him, such as Aristotelian and Alexandrian anatomical works, his work as a physician provided him with surgical and anatomical experience to a degree that he could confidently claim to have seen many resemblances in structure between humans and animals:

¹¹² French, *Dissection and Vivisection*, p. 122.

¹¹³ See Singer, *Galen on Anatomical Procedures*, p. xxii f.; and Carlino, who provides further examples of Galen's reasoning, stating that "[c]ontrary to what has been maintained, at least from Vesalius to very recent writers, it appears from these episodes related by Galen that he might have had the opportunity of practicing [human] dissection even after his time in Alexandria," see idem, *Books of the Body*, pp. 148-149.

Again, extensive wounds and ulcers, reaching deep down, have exposed many parts which were recognized by the experienced as having the same structure as in the bodies of apes [...] In the course of various surgical operations that we perform, sometimes removing mortified flesh, sometimes cutting out bones, the likeness becomes apparent to the practised eye.¹¹⁴

For Galen and other anatomists, animals were therefore a valid choice for studying structures and phenomena related to the human body; regarding the study of ‘living anatomy’, they were, and are, in fact the only choice. It is revealing that those same historians that devalue Galen’s anatomical descriptions on the basis of extensive animal-to-human extrapolations applaud his experimental investigations. If the above-mentioned line of argument is followed through, though, the knowledge gained from animal vivisections yielded just as questionable – or valuable - results as the dissection of an animal’s structure. Overall, like succeeding anatomists, Galen was, as May puts it, “quite honestly convinced that when he applied to man his findings in “the animals most closely resembling man,” he was making a justifiable inference.”¹¹⁵

Regarding the nervous system, it is interesting to see what functions Galen ascribed to the brain in conjunction with the nerves and the transmitting substance *pneuma*. Galen’s view of the nervous system encompassed two main premises that guided his dissections and vivisections: “Where the beginning of the nerves is, there is also the governing part of the soul” and “The beginning of the nerves is in the brain.”¹¹⁶ Galen thus relied on the Alexandrian anatomist’s broad scheme of the brain, nerves and *pneuma* being conjointly

¹¹⁴ Galen, *On Anatomical Procedures*, p. 77 [Book III, Ch.V, 386].

¹¹⁵ May, *Galen On the Usefulness of Parts*, p. 40. In his anatomy of the digestive organs, Galen made very decisive statements that underline this contention: “On first hearing you may find unconvincing what I propose to say on the digestive organs [...]. Yet if you take pains to observe many animals, like and unlike in kind, it will no longer seem incredible, but marvellous, for they reveal one Art as the maker of all living things. In constructing the parts, He has ever before him their uses for His end [...] Omitting then, in the present account, any consideration of differences in the intestines and belly, you will find all the features I am going to mention in all the animals on which I advised you to gain anatomical experience;” *ibid.*, p. 153 [Book VI, Ch. 3, 547-549].

¹¹⁶ Galen, *On the Doctrines of Hippocrates and Plato*. p. 67 [Book I (“Testimonies and Fragments”), III, Vol.I]. Galen acknowledged that some nerves originated in the spinal cord, but viewed the spinal cord as an extended part of the brain; see *ibid.*, p. 69.

responsible for the faculties of sensation and motion. Erasistratus had first offered a consistent theory of the transmitting substrate, which he believed was drawn from the air through the lungs and turned into vital *pneuma* in the heart. By way of the carotid arteries, it travelled to the brain's ventricles where it was turned into the refined psychic *pneuma*, which in turn was then redistributed throughout the whole body via the nerves. Galen maintained this view of the brain's function, but he also had much to criticise about Erasistratus' anatomical theory, adding to and amending in particular the process of purification of the vital *pneuma* in the brain.¹¹⁷ He was a firm believer in the importance of the *rete mirabile* (or *retiform plexus*), a network of subdivided carotid artery vessels at the base of the brain that in his view comprised “the most wonderful of the bodies located in this region.”¹¹⁸ According to Galen, the *rete mirabile* was the place where the arterial blood, comprising the vital *pneuma*, was contained until the transformation into the psychic *pneuma* was completed.¹¹⁹ However, as indicated above, the case of the *rete mirabile* is commonly used as an example of the errors committed by Galen due to his animal-to-human transfer of anatomical observations. It is certainly the case that in his writings on this structure, he extrapolated extensively without acknowledging potential differences between animal and human brains.¹²⁰ Yet, considering this, the extrapolation of the *rete mirabile* to humans remained astonishingly persistent in anatomical writings—even Vesalius, who later voiced excessive doubts about its existence in

¹¹⁷ Through experimenting on living animals, Galen had also made the important observation that the arteries did not contain air as Erasistratus had maintained, but blood; see May, *On the Usefulness of the Parts*, p. 48; see also Rocca, *Galen on the Brain*, esp. Ch. 6 on ‘The Elaboration of Psychic Pneuma’ for a more detailed account of Galen’s theory of vital and psychic *pneuma*.

¹¹⁸ Galen, *On the Usefulness of the Parts*, p. 430 [Book IX, Ch. IV, II:10]. See also Finger, *Origins of Neuroscience*, p. 16; and Pranghofer, “It could be Seen more Clearly in Unreasonable Animals than in Humans”, p. 563f. Rocca mentions that this structure exists in the ox, goat, pig and sheep – the very animals that Galen used extensively for dissection, though it is absent in primates which raises the question why Galen did not comment on its absence in the monkeys he dissected; see Rocca, *Galen on the Brain*, p. 205.

¹¹⁹ See also Rocca, *Galen on the Brain*, pp. 201-219. It is interesting to note that since Thomas Willis’ *Anatomy of the Brain* (1664), this same region in humans is called the *Circle of Willis*.

¹²⁰ See Nutton, *Ancient Medicine*, p.231. Clifford Rose provides further examples of false extrapolations; see ‘European Neurology’, pp. 28-29.

humans did not feel confident enough to abolish it altogether.¹²¹ The function ascribed to this structure—the link between mental processes and muscular movement, between soul and body—was too important to ignore the *rete mirabile*. If animals were in possession of a structure that carried such important functions, then the assumption went that humans must have it too, which directed the anatomical gaze even in the face of its virtual absence in humans.

For dissections of the brain, Galen himself preferred the head of an ox, possibly because of its size.¹²² His description of the pineal gland as having the shape of a pine cone is another instance in which a false extrapolation seemingly occurs, for, as Rose pointed out, the pine cone shape is in fact singular only to beef cattle.¹²³ The pineal gland is worth mentioning as it took centre stage in the later Cartesian philosophy as the most important cerebral structure whose functions had formerly been ascribed to the *rete mirabile* – the seat or organ where the immaterial rational soul connected with the brain and body (see Chapter 2.1.1.). It is therefore interesting to see Galen anticipating much of the later arguments for and against the importance of this structure.¹²⁴

¹²¹See Pranghofer, “It could be Seen more Clearly in Unreasonable Animals than in Humans.” Even Herophilus, whose knowledge is thought to have been based mainly on human dissections (and vivisections) committed this error (see above); see also O’Malley, *Vesalius*, p. 9. Rocca speculates that Galen might have taken it for granted that humans were in possession of the *rete mirabile*, precisely because he trusted that Herophilus’ discovery of the structure had been based on human anatomy; see Rocca, *Galen on the Brain*, pp. 204-205.

¹²² It is again interesting to note that he did not use his otherwise favoured animal – the ape – for dissections on the brain. Galen himself mentioned that the sight of an ape’s facial distortions during vivisections disgusted him because it too much resembled those of humans in pain; see Galen, *On Anatomical Procedures: The Later Books*. Translated by W.L.H. Duckworth (London et al.: Cambridge University Press, 1962), p. 15 [Book IX, Ch. II]. On the other hand, using ungulates with a less complex brain structure possibly made it easier to determine the basic configuration of the brain.

¹²³ See Rose, ‘European Neurology’, p. 29. See also Galen, *On Anatomical Procedures*, p. 233 [Book IX, Ch. 3, 722]; and *On the Usefulness of the Parts*, p. 419 [Book VIII, Ch. XIV, I, 489].

¹²⁴ He criticised, for instance, the common (and recurring) notion of the pineal body acting as a “guardian and housekeeper, as it were, regulating the quantity [of *pneuma*] that is transmitted.” Instead, he assigned this task to the ‘epiphysis’ (today the vermis cerebelli), and rather believed that the pineal body acted as a support for the dividing veins before they entered into the cerebellum. He further argued that, since the pineal body was sitting outside the brain’s ventricle, it was technically not a part of the brain (the cerebellum in particular); and, as it did not seem to be moved by the brain, or else have motion itself, it could not possibly fulfil such an important function – an argument that early modern advocates and opponents of the Cartesian scheme repeated. See Galen, *On the Usefulness of the Parts*, pp. 419-420 [(Book VIII, Ch. XIV, I, 489-491)].

Through a series of public and private vivisections (CE 162-166 and 169-176 in Rome), backed up by observations on trepanned patients, Galen sought to prove empirically that the controlling part of the soul was located in the brain.¹²⁵ Among his vivisections, we also find experiments on the loss of sensation,¹²⁶ which, one could argue, is a rather subjective phenomenon with the added difficulty of using non-human subjects who could not have articulated verbally their state of sensual experience (see also Chapter 4 on this problem). Yet, Galen compared the loss of sensation to the loss of voice which he had investigated experimentally by cutting the laryngeal nerves, in which he claimed: “And if the animal so wounded should be a man, you will be in a position to ask him to say something. He will try, but you will hear nothing more than a whistling exhalation [...]”¹²⁷ Human injuries are here used as a backdrop to underline that experiments on animals yielded useful information about similar afflictions in humans. Interestingly, although he closely followed the procedures of the Alexandrian anatomists in his dissections of the brain and nerves, Galen did not associate a higher complexity of cerebral structure with higher mental faculties in humans. Regarding the amount of convolutions of the cerebral cortex, he explicitly rejected the connection Erasistratus had made between the complexity of the structure and the degree of intelligence,

for even donkeys have an exceedingly complex encephalon, whereas, judging by their stupidity it ought to be perfectly simple and uncomplicated. Hence it would be better to think that intelligence depends on the good temperament of the substance of the thinking body, whatever this body may be, and not an intricacy of structure.¹²⁸

It is revealing that Galen rejected a possible connection between human intelligence and the brain’s structure on the grounds that an animal – especially one which was otherwise

¹²⁵ See Galen, *On the Doctrines of Hippocrates and Plato*, pp. 79ff [Book I, 6.1.-12]. See also Frampton, *Embodiments of Will*, p. 152.

¹²⁶ See O’Malley, *Vesalius*, p. 8.

¹²⁷ Galen, *On the Doctrines of Hippocrates and Plato*, p. 121 [Book II, 4.19-24].

¹²⁸ Galen, *On the Usefulness of the Parts*, p. 418 [Book VIII, Ch. XXXIII, I, 488].

considered fairly ‘stupid’ – showed a complexity of structure similar to those of humans. In fact, later anatomists, such as Willis, still struggled to reconcile their observation of the structural similarity of human and animal brains with the fixed premise that a higher complexity of structure equalled higher mental faculties. Needless to say, such preconceptions were made without empirical evidence of the function that these structures actually fulfilled in the living organism. However, despite his awareness of the difficulties included in extrapolating from animals to humans, Galen saw their basic structural, as well as functional, analogies as a given.¹²⁹ And for those historians who have conducted a detailed study of his anatomical writings, it appears that “Galen’s anatomical epistemology is impressive. As a consistent account of the structure of the brain, it was not bettered until Thomas Willis.”¹³⁰

After the death of Galen, the practice of anatomical dissection once more ceased in the West, at least openly, until it was revived again about 1100 CE in Salerno, Italy.¹³¹ By this time, however, the church had lost touch with its Greek origins, and it was not until the twelfth century that European scholars rediscovered Greek philosophers through their contacts with Arabs. The medieval period is generally treated as an intermediate period which only contributed to later developments in anatomy and natural philosophy via the transmission of ancient knowledge. Though anatomical research lacked in originality compared to the early

¹²⁹ In his refutation of Stoic errors, Galen revealed in a by-sentence his belief that all conceptions of the soul and the body used the animal as a backdrop to promote their view of human faculties, but seems to exceed this common analogy to humans by going beyond mere anatomical structures: “But in the case of the irrational animals Chrysippus and the other Stoics boldly attack this view, claiming that the animals do not even experience desire: I mentioned earlier the shamelessness of this statement. He holds that none of the irrational animals has the spirited or desiderative or rational part: as I said also in the first book [of which only fragments survived], every Stoic, so far as I know, contrary to all clear evidence deprives them of all these (parts);” in Galen, *On the Doctrines of Hippocrates and Plato*, p. 71 [Book I, VI. (‘Refutation of Stoic errors’)].

¹³⁰ Rocca, *Galen on the Brain*, p. 240.

¹³¹ At least the Salernian anatomical writings that have survived date from around 1100: the medical teachings with which the practice of dissection was associated began in the late tenth century; see Cunningham, *The Anatomical Renaissance*, p. 37. See also Frampton, *Embodiments of Will*, p. 107. Contrary to the general assumption that dissection had not been practiced until the twelfth century, Lawrence Bliquez and Alexander Kazhdan have introduced some evidence of human dissection between the fourth and the twelfth century in Byzantium; see their article ‘Four Testimonia to Human Dissection in Byzantine Times’ (*Bulletin of the History of Medicine* 58 (1984)), pp. 554-557. See also Carlino, *Books of the Body*, pp. 151-152.

modern era, medieval natural philosophy put greater emphasis on the immortal (and immaterial) soul which marked human beings as the most important part of divine creation. Due to this, some aspects of the ancient theories of souls and bodies were now conceived as a challenge to the church's teachings on the soul. The notion of atoms, for instance, seemed irreconcilable with a God-centred philosophy, and did not sit comfortably with an emphasis on the soul as the prime mover of life.¹³² Aristotle, who had assigned a purpose to everything in the cosmos, was more acceptable to Christian cosmology; yet, some of Aristotle's ideas were also amended, for instance by the Italian medieval theologian Thomas Aquinas (1224/5 – 1274).¹³³ Aquinas placed the soul's faculties in the brain rather than the heart, but also made it clear that no physical organ could produce self-awareness or human thought. Plato's philosophy was also compatible with medieval cosmology insofar as, next to God, the human being stood at its centre, which is indicated by Aquinas' focus on human thought as the main faculty of the soul. Though it has been argued that Aquinas predates the Cartesian division of body and mind on theological grounds (he is also known to have used the clockwork simile to describe the workings of the material body), Norman Kretzmann maintains that his seemingly materialist notions should not be confused with the later mechanist understanding of the human body.¹³⁴ Rather, the human soul, which Aquinas equated with the Aristotelian rational soul, was seen as the true principle of life for humans. Needless to say that it also served as the true *differentia specifica* of humans when compared with other animals.

The use of reason to demonstrate the work of God forged a new intellectual tradition of natural philosophy, though, at first, natural philosophy did not aim to refute existing

¹³² See Carl Zimmer, *Soul Made Flesh: The Discovery of the Brain- and How it Changed the World* (London: William Heinemann, 2004), p. 17.

¹³³ See here especially Zdzisław Kuksewicz, 'Criticisms of Aristotelian psychology and the Augustinian-Aristotelian synthesis', in Norman Kretzmann et al (eds.) *The Cambridge History of Later Medieval Philosophy: From the Rediscovery of Aristotle to the Disintegration of Scholasticism 1100-1600* (Cambridge: Cambridge University Press, 2003; first 1982), pp. 623-628.

¹³⁴ Norman Kretzmann, 'Philosophy of Mind', in Norman Kretzmann and Eleonore Stump (eds.), *The Cambridge Companion to Aquinas* (Cambridge: Cambridge University Press, 1993, pp. 128-159), p. 130f.

anatomical conceptions of the body. Galenic and Aristotelian anatomy and philosophy sufficed to make visible God's creation, including the difference between humans and animals. Anatomical knowledge was accordingly still based largely on their writings. The animal continued to be used as a substitute for the human body in Salernian and subsequent medieval anatomical dissections, even when it had become possible to dissect human corpses once again.¹³⁵ But even the rare instances of human dissection were meant to illustrate what Galen had written, or else served to explain abnormalities of structure as part of medical or legal problems, rather than to illuminate the human body's structure or its functions in a new way.¹³⁶

The status of anatomy in the late medieval period is a case in point that it was not necessarily the prohibition of human dissections, be it based on religious or cultural grounds, which prevented an accumulation or enhancement of anatomical knowledge. Another flawed interpretation is the assumption that the leap forward in anatomical knowledge and practice, associated with the Renaissance anatomist Andreas Vesalius (see Ch. 1.2.1.), was not so much due to his renewed emphasis on anatomical research on human corpses, but on Vesalius's criticisms of Galen's *animal* dissections. Zimmer captures the somewhat false, though still prevalent, opinion on the history of human dissections in mediaeval times by stating that "[i]t would take centuries of these dissections before anyone realized that Galen's teaching had not been based on experience with human tissues and organs."¹³⁷ Medieval anatomists had been well aware that Galen had used animals for dissection, and it is no coincidence that Renaissance anatomists used ancient writings and practices as the starting

¹³⁵ Interestingly, the pig was then the favourite animal to be dissected because its viscera and internal structure were recognised as being even closer to the human configuration than those of the monkeys that Galen had used. See Cunningham, *The Anatomical Renaissance*, p. 37; French, *Dissection and Vivisection*, p. 15; and Francis Joseph Cole, *A History of Comparative Anatomy. From Aristotle to the Eighteenth Century* (London: MacMillan & Co. LTD, 1944), pp. 48-49.

¹³⁶ See O'Malley, *Vesalius*, pp. 12-13; French, *Dissection and Vivisection*, pp. 13-14; and Carlino, who also lists psychological and sociological reasons for the resistance to frequent human dissections that took centuries to overcome, see *Books of the Body*, pp. 2-3.

¹³⁷ Zimmer, *Soul Made Flesh*, p. 19.

point for their own investigations, including the use of animals as substitutes for the human body. The view that humans were the most complex of all animals remained a given since Antiquity, but so did the belief in a structural and functional continuity of humans and animals that could be utilised for anatomical investigations of the human body. Carlino elaborates on what I have identified as an ‘ahistorical’ view among historians who are seemingly not able to imagine that this human-centred view of the body is a very modern thing:

The opening up and observation of the inner human body seems to us the most obvious of available techniques for anatomy. But this was not the case for scientists until the time when the school of Alexandria was founded. [...] Texts never refer to the dissection of the human body, not even regretfully as to a desirable but forbidden procedure. Thus physicians and philosophers worked out other more indirect and (later anatomists would say) fallacious techniques through which to pursue their investigative purposes.¹³⁸

This unspoken methodological legitimation for using animals as substitutes for the human body persisted throughout the history of anatomy, despite the avowed criticisms of later Renaissance anatomists like Vesalius. As we will see in Chapter 3, in the specific context of seventeenth-century neuroanatomy, it became ever more difficult to reconcile this methodological reliance on the structural human-animal continuity with the growing belief that the faculties of the nervous system were the true constituents of humanity. The increased occupation with man’s place and status in nature from the sixteenth century onwards triggered not so much an exclusive study of the human body, but a more focussed comparison between humans and animals in order to assess the specialness of the human corporeal frame and soul. Chapter 1.2. provides an overview of these developments that are setting the scene for the investigation of the nervous system and the human-animal negotiation in seventeenth-century neuroanatomy.

¹³⁸ Carlino, *Books of the Body*, pp. 128-129.

1.2. The ‘New’ Renaissance Anatomy

The Renaissance anatomist was also deciding what ‘human’ meant.¹³⁹

An intensified discourse about the status of humans versus animals began with new translations of ancient works that led to a reappraisal of hitherto accepted philosophical as well as anatomical writings. The re-evaluation of broader ideas about life and the cosmos that happened in the Renaissance period also led to a reconsideration of the specific place that humans inhabited in the overall divine scheme.¹⁴⁰ The medieval legacy of a God- and human-centred outlook came to compete with the broad and diverse movement of a Renaissance naturalism that seized on certain core ideas of Platonism and Aristotelian philosophy invoking a continuity of life forms. Naturalism claimed that the supernatural need not be invoked to explain natural events and conceived of humans as related to other living beings, rather than inhabiting a place wholly different from the rest of creation. This fostered in turn the opposition of theologians who viewed the exclusion of the supernatural as a threat to established religion.¹⁴¹ The notion that matter was essentially active did not quite fit in with the larger emphasis on the immaterial God-given soul as prime mover of all live phenomena. As Gaukroger puts it, neo-Platonists and neo-Aristotelians

encouraged a picture of nature as an essentially active realm, containing many hidden or ‘occult’ powers which, while they were by definition not manifest, could nevertheless be

¹³⁹ French, *Dissection and Vivisection*, p. 126.

¹⁴⁰ In 1513, the Fifth Lateran Council had established the immortality of the human soul as official dogma, asking Christian philosophers to “‘use all their powers’ to demonstrate that the immortality of the soul can be known by natural reason, not by faith alone;” quoted in Margaret J. Osler, *Divine Will and the Mechanical Philosophy. Gassendi and Descartes on Contingency and Necessity in the Created World* (Cambridge and New York: Cambridge University Press, 1994), p. 62. The decision of the Lateran Council was triggered by the heretical claim of the Aristotelian naturalist Pietro Pompanazzi (1462-1525) that the human soul was material and perishable. Osler states that Pompanazzi’s controversial views constituted “the intellectual background from which many seventeenth-century discussions of the immortality of the soul developed,” *ibid.*

¹⁴¹ See Gaukroger, *Descartes: An Intellectual Biography* (Oxford: Clarendon Press, 1995), pp. 147-148.

tapped and exploited if only one could discover them[.] The problems were exacerbated by a correlative naturalistic thesis about the nature of human beings, which we can refer to as mortalism, whereby the soul is not a separate substance but simply the ‘organizing principle’ of the body.¹⁴²

The advent of mechanical philosophy, whose advocates wanted to remove the soul from all things material, can be understood as a reaction to this naturalist movement, though inadvertently the use of physics and mathematics to explain natural phenomena undermined the anthropocentric worldview even further. Nicolaus Copernicus (1473-1543) and Galileo Galilei (1564-1642) in particular had brought about a new ‘Anatomy of the World’, which pushed the earth, and with it humans, from the centre of the cosmos.¹⁴³ Theologians, who had initially embraced mechanical philosophy as a guard against Renaissance naturalism, now aimed to reconcile the new philosophy, that in essence also seemed to threaten the doctrines of the church, with the tenets of Christianity. All of this not only coincided with a heightened enquiry into the essence of human nature, the soul and the human body; inherent in these enquiries was also a philosophical and anatomical assessment of the human-animal difference. It is thus no coincidence that mechanical philosophers such as Pierre Gassendi (1592-1655) and René Descartes (1596-1650) emphasised a mechanical view of the body, while reinstating the rational soul as an immaterial God-given entity that, among all living beings, belonged to humans alone. But prior to the rise of mechanical philosophy in the Cartesian or Gassendian sense, whose influence on anatomy we will discuss later, was the advent of a ‘new’ anatomy that aimed at reassessing the human body anatomically. The emphasis on anatomy played a vital role in this overall search for what exactly constituted the

¹⁴² Ibid., p. 148f.

¹⁴³ This phrase is found in Francis Bacon’s (1561-1626) *Novum Organum* (1620) in which he outlined his new philosophy of science: “For I am building in the human understanding a true model of the world, such as it is in fact, not such as man’s own reason would have it to be; a thing which cannot be done without a very diligent dissection and anatomy of the world,” in *The Philosophical Works of Francis Bacon*. 3 vols. Edited by Robert Ellis, together with English translations of the principal Latin pieces (London: Longman, 1861), I: *Novum Organum*, p. 298. It is originally the title of a poem by John Donne (1572-1631); on the use of anatomizing as a mode of articulation in the sixteenth century see also Devon L. Hodges, *Renaissance Fictions of Anatomy* (Amherst: The University of Massachusetts Press, 1985).

human in opposition to other living beings, and it is also no coincidence that theories of animal automatism entered the stage at around the same time.

As indicated above, the heightened focus on the human body took its departure from passages in Aristotle and Galen who had praised it as the most complex and sophisticated creation in nature. Despite a sense of departure from old doctrines of the body that can be traced in the writings of most Renaissance anatomists, the advice and anatomical practices of the ancients were still followed.¹⁴⁴

Vesalius, of whom we will speak later, is the most prominent example of the ‘new’ Renaissance anatomy; yet, his overall project mostly aimed to revive and improve the anatomical project of Galen. His avowed focus on the human body also links him with Herophilus and Erasistratus (despite criticising the latter extensively), though, as we will see, like the Alexandrian anatomists, Vesalius did not actually break with the tradition of using animals for anatomical enquiries. Other anatomists of the period also focused on reviving the particular projects of ancient anatomists, each of whom highlighted specific practices and operating principles of the body. The Italian professor of anatomy at Padua, Realdus Columbus (c. 1515-1559), for instance, explicitly set out to revive the anatomical tradition of the Alexandrian anatomists with its emphasis on vivisection; needless to say that Columbus relied extensively on animal investigation.¹⁴⁵ Hieronymus Fabricius Aquapendente (c. 1537-1619), Paduan Professor of Anatomy and Surgery (from 1565-1613), revived Aristotelian anatomy in the sense that he studied the soul as an ‘act of the body’. Similar to Aristotle, he imagined that the soul could only be understood through its operations on the body, which required extensive dissections of all kinds of living beings. Thus, by investigating the body’s

¹⁴⁴ See Cunningham who locates the influence of Aristotle, Galen, and the Alexandrian anatomists in the anatomical writings of Gabriele de Zerbi (1445-1505), Alessandro Benedetti (c. 1450-1512), and Berengarius da Carpi (c. 1465-1530) – all of whom had either taught at Bologna or Padua, the latter of which was the university where Vesalius had taught and dissected; *The Anatomical Renaissance*, pp. 56-87.

¹⁴⁵ His work, *De Re Anatomica Libri XV*, was published posthumously in 1559; see Cunningham, *The Anatomical Renaissance*, pp. 143-166.

faculties (respiration, nutrition, sensation, etc.) as operations of the soul in as many animals as possible, he also upheld the specific anatomical tradition as instigated by Aristotle, a tradition that was continued by Fabricius' famous student William Harvey.¹⁴⁶

Among many others, all of these anatomists are worth investigating in more depth, as their specific conjectures about animals as models that were acted out in their anatomical work yield a fascinating insight into the early modern appraisal of the human-animal difference. Yet, this section on Renaissance anatomy is more about establishing the main strands of anatomical enquiry that gained momentum in this period: the quest for studying the human body in particular while the method of using animals as substitutes for that body continued to thrive. The difference between the ancient anatomists and those of the Renaissance is that the latter did no longer seem to use animals self-intuitively, that is as an obvious anatomical substitute for the human body, as had been the case in the classical period. Rather, in early-modern anatomical investigations, using the animal body as an object on which to project and then negotiate faculties that were thought to be explicitly human, gained new potency. As Erica Fudge describes the changes in the early modern period, "what remains in place in the early modern texts is the notion of the absolute centrality of humanity, what has changed are the means of enacting that centrality."¹⁴⁷

Overall, it seems that asserting a difference between humans and animals in anatomical (and philosophical) enquiries suddenly became of the ultimate importance. The promulgation of anatomical illustrations of the human body since the late Middle Ages that were partly based on ancient drawings and texts suggests an ongoing but also increasing interest in the human body's interior and its faculties. In the absence of useful applications for medicine, the accumulation of anatomical knowledge suggests a deeper commitment to know more about one's own body, a quest that Roger French identified as the injunction to 'Know thyself' in

¹⁴⁶ See Cunningham, *The Anatomical Renaissance*, pp. 167-187.

¹⁴⁷ Fudge, *Perceiving Animals*, p. 92.

the early seventeenth century.¹⁴⁸ French also notes that the motivation for studying the human body anatomically was also to *differentiate* between one's own and an animal's body that had formerly been the main resource of knowledge in anatomy.¹⁴⁹ As we have seen, it had long been obvious to anatomists that animals and humans belonged to the same group of living beings, i.e. that their morphology and bodily faculties were based on the same or similar working principles. But suddenly, as French puts it, "it was also plain that many animals differed a great deal from man, and [that] systematic studies of animals, like Aristotle's, could point to a range of increasing differences, and they included discussion about what 'animal' might mean [...]"¹⁵⁰ French thus indirectly acknowledges that a negotiation of the relationship between humans and animals was implicit in this move towards asserting human uniqueness. It would have been nice to see him dwelling a bit longer on the underlying reasons, as he might have resolved the paradox of anatomists utilising the human-animal analogy (which served as the essential backbone of anatomical and physiological investigations) versus their conviction that humans essentially differed from animals (due to their possession of a rational soul). Aristotle's division of the soul into the vital and the sensitive soul, responsible for the body's lower faculties, and the human rational soul, whose dependence on the senses was still an open question, enhanced the justification of using animals to investigate at least the lower and sense faculties of the human body. The presence of the vital/sensitive soul in both humans and animals implied that they also shared the operations and faculties of these souls. It is this analogy of human and animal bodily faculties that was the essential conceptual device that enabled anatomists since the time of Aristotle to gather large amounts of data about the working principles of the human body via animal

¹⁴⁸ See French, *Dissection and Vivisection*, p. 102. French traced the motto of 'know thyself' in the lecture notes of a student of anatomy in King's College, Aberdeen; apparently, it served to sum up the purpose of anatomy in early seventeenth-century anatomical lectures. The ideal of 'knowing oneself' is also ancient in origin as in the *gnothi seauton* of the Delphic oracle; see Roy Porter, *Flesh in the Age of Reason* (London et al.: Allen Lane, 2003), p. 3f.

¹⁴⁹ See French, *Dissection and Vivisection*, pp. 122-129.

¹⁵⁰ *Ibid.*, p. 122.

bodies.¹⁵¹ French goes even further, stating that “[a]t this level there would seem little philosophical or even medical purpose for dissecting human bodies at all, since the similarity with bodies of animals was so complete.”¹⁵² Yet, the degree to which the immaterial rational soul impacted on the body remained an unresolved question, which fostered the ongoing investigation of the corporeal aspects of this particular body-soul interaction in animals, while the search for human uniqueness in the bodily structure was upheld.

In her book *Brutal Reasoning*, Erica Fudge investigates the early modern discourse on the faculty of reason in humans, establishing that animals were a vital backdrop for cultural and philosophical enquiries on the subject. Acknowledging that this discourse had also found its way into anatomical practices, she asserts that the body as such “was not a central source of difference, and even when the human physique was invoked to reiterate distinction this physical difference was always merely a sign of the other, more significant, mental division.”¹⁵³ Yet, as the faculties of the rational soul were increasingly tied to the nervous system—an organ system that humans shared with animals—the question remains: if the rational soul, the most important human *differentia specifica*, was an invisible immaterial entity that by its very nature could not be made physically manifest, why would anatomists feel the need to focus on the physical differences in human bodies too? French, somewhat going round in circles, thinks that “[o]ne such reason for dissecting the human body was its special nature, even in a physical sense, notwithstanding its similarity to animal bodies.”¹⁵⁴ He cites the early examples of Gabriele de Zerbi (1445-1505) and Jacopo Berengario da Carpi (1460-1530), who had promoted human anatomy in Padua and Bologna not only because the human body was considered divine, but because man is intelligent, “and is the

¹⁵¹ See also Carlino, *Books of the Body*, p. 132, who maintains, however, that Aristotle’s empirical research with its principle of analogy lacked a theoretically coherent research question and did therefore not automatically result in a pressing need for human dissection.

¹⁵² French, *Dissection and Vivisection*, p. 125

¹⁵³ Erica Fudge, *Brutal Reasoning: Animals, Rationality, and Humanity in Early Modern England* (Ithaca, and London: Cornell University Press, 2006), p. 7.

¹⁵⁴ French, *Dissection and Vivisection*, p. 125.

measure of all animals,”¹⁵⁵ a doctrine that was taken over from Aristotle and Galen. French believes that both de Zerbi and da Carpi established the specialness of the human body, and with it a difference between the bodies of animals and humans, in order to appeal to Christian philosophers and to add to their authority as anatomists.¹⁵⁶ Eventually, theologians came to rely on medical and anatomical knowledge when discussing the body, whereas anatomists rarely consulted or cited the authority of the Scripture, due to the implementation of professional boundaries that enabled them to build up specialist knowledge.¹⁵⁷ As French interestingly notes, “[w]hat is surprising is not that the theologians should have agreed with the doctors what the body was like, but that such physical details should be necessary in a systematic theology dealing primarily with the nature of God and man’s relationship to Him.”¹⁵⁸ Thus, the human-animal difference established in anatomy also became an important device to carve out human uniqueness in the context of theology.

As Vesalius is generally cited as the most important and influential anatomist who encapsulated the changes in anatomical practice in the Renaissance period, the following discussion seeks to establish in what way the aspect of the human-animal difference was tackled in his anatomical project. The aim is to evaluate his alleged focus on human anatomy that has traditionally secured his place in the history of anatomy, and to take a closer look at his anatomy of the brain as a way of challenging this notion.

1.2.1. Vesalius’ *De Humani Corporis Fabrica* (1543)

Andreas Vesalius (1514-1564) was born in Brussels and studied Medicine in Paris, Louvain, and eventually Padua where he received his degree and was offered the chair of Surgery and

¹⁵⁵ Ibid.

¹⁵⁶ Ibid., pp. 128-129.

¹⁵⁷ Ibid., p. 129.

¹⁵⁸ Ibid., p. 131.

Anatomy in 1537.¹⁵⁹ Instead of reading classical texts, while an assistant did the manual task of cutting up the respective parts of the body, Vesalius performed his own dissections and used these as a primary teaching tool. It is a well-known and often-told story how Vesalius had grown increasingly dissatisfied by the discrepancy of his own observations and the descriptions of Galen, realising that, “Galen’s womb belonged to a dog, his kidneys to a pig, his brain to a cow or a goat. All told, Vesalius found two hundred pieces of animal anatomy in Galen’s human being.”¹⁶⁰ From this point of view, Vesalius’ impetus to redo Galen’s work was mainly based on Galen’s false extrapolations from animals to humans, a problem that Vesalius himself referred to in his preface to *De Fabrica*:

Nay more, deceived by his monkeys [...], he frequently wrongly controverts the ancient doctors who had trained themselves by dissecting human corpses. [...] I shall say nothing about the astonishing fact that in the manifold and infinite divergences of the organs of the human body from those of the monkey Galen hardly noticed anything except in the fingers and the bend of the knee – which he would certainly have passed over with the rest, if they had not been obvious to him without dissection.¹⁶¹

The monkey had been Galen’s favourite animal for dissection, hence Vesalius’ attack on this particular animal anatomy; yet, his criticism was also aimed at the overall and rather carefree extrapolations from animals to humans since the time of Galen. One could deduce from this that Vesalius was rather a strict opponent of using animal models in anatomical investigations of the human structure. However, his criticism of Galen did not lead Vesalius to concentrate exclusively on the human body. Apart from the fact that the lack of a sufficient number of human corpses still required the use of animals as substitutes, it would be mistaken to assume

¹⁵⁹ On the early life and career of Vesalius, see O’Malley, *Vesalius*; and Andrew Wear, ‘Medicine in Early Modern Europe, 1500-1700’, in Lawrence I. Conrad et al. (eds.) *The Western Medical Tradition 800 BC to AD 1800*, pp. 215-361: pp. 273-275.

¹⁶⁰ Zimmer, *Soul Made Flesh*, p. 20; see also Finger, *Minds Behind the Brain*, p. 62; Nutton, *Ancient Medicine*, p. 231; O’Malley, *Vesalius*, p.8; Wear, ‘Medicine in Early Modern Europe’, p. 275; and Cunningham, *The Anatomical Renaissance*, p. 117.

¹⁶¹ I have used here the translation by Benjamin Farrington, ‘The Preface of Andreas Vesalius to De Fabrica Corporis Humani 1543’ (*Proceedings of the Royal Society of Medicine* 25 (1932), pp. 39-48), p. 44.

that, epistemologically, Vesalius relied solely on the human body in his work.¹⁶² On the contrary, his new anatomy, which culminated in the publication of *De Humani Corporis Fabrica Libri Septem* (1543), had a major impact on future anatomists precisely because his work involved a thorough comparison of human and animal bodies. Whether his approach to prove Galen's extrapolations wrong made him a comparative anatomist is subject to debate, as his observations were not explicitly meant to illuminate animal anatomy in order to find a continuity of structure or functions.¹⁶³ But, as Dawne McCance convincingly asserts, "[i]n the Vesalian anatomy theatre, and paradoxically in the process by which the human body is being cut open and thus 'profaned', a distinctively modern and hierarchical human/animal difference is put in place."¹⁶⁴ We could also say that, by (re)discovering the human body and pointing out its differences to animal bodies, Vesalius introduced or even constituted the human as opposed to other living beings. The "discovery of the Vesalian body"¹⁶⁵ is thus not necessarily a discovery of the structural configuration of the body's interior as such, but rather a (re)discovery of the uniqueness of the human structure in comparison to animal bodies. It is in this context interesting that historians often emphasise Vesalius' correction of Galen's false animal to human extrapolations, but approvingly mention that he revived Galenic experimental physiology.¹⁶⁶ Yet, as I pointed out before, the results of function-related experiments were just as much extrapolated from animals to humans, and therefore

¹⁶² See also Guerrini, *Experimenting with Humans and Animals*, p. 28; and Stahnisch, 'On the Use of Animal Experimentation', p.132.

¹⁶³ See Cole, *History of Comparative Anatomy*, p. 56; and Wear, 'Medicine in Early Modern Europe', p. 275.

¹⁶⁴ Dawne McCance, 'Anatomy as Speech Act. Vesalius, Descartes, Rembrandt or: The Question of "the animal" in the Early Modern Anatomy Lesson', in Jodey Castricano (ed.) *Animal Subjects: An Ethical Reader in a Posthuman World* (Waterloo, Ontario, Canada: Wilfrid Laurier University Press, 2008, pp. 63-95) p. 65. See also Fudge who asserts a similar thing in the case of vivisection in the early modern period, namely that "the absolute animality of the human body is revealed even as humanness is expressed," idem, *Perceiving Animals*, p. 92.

¹⁶⁵ Jonathan Sawday, *The Body Emblazoned: Dissection and the Human Body in Renaissance Culture*, (London and New York: Routledge, 1995), p. 23.

¹⁶⁶ For instance Andrew Wear, who also explicitly adds that "[t]he essential point about the *Fabrica* is its emphasis that it is the first proper account of *human* anatomy," see Wear, 'Medicine in Early Modern Europe', p. 275; italics in the original. See also O'Malley, *Vesalius*, p. 8.

potentially just as erroneous, as the mere description of (equally extrapolated) anatomical structures.

The seven books of Vesalius' *De Fabrica* describe all parts of the human body in anatomical terms, with Book IV devoted to the nerves and Book VII to the brain. In some descriptions, such as in Book III on the blood-vessels, Vesalius reused all of Galen's (animal) anatomy. Singer notes that Vesalius might have found the dissection of vessels too challenging, and that Book III is for this reason "on a lower level" than the other parts, mainly because "the vascular system, as displayed by Vesalius, is basically not human [...] Roughly we may say that Vesalius, like Galen, describes the venous system of ungulates and the arterial system of monkeys."¹⁶⁷ One could reproach Vesalius for not having followed his own anatomical agenda consistently; yet, for me, this also raises the question whether Vesalius had actually meant to criticise Galen's use of animal anatomy per se, or if the whole debate does not just reflect the bias of modern interpretation. Cunningham, for instance, indicates that Vesalius' impetus for doing anatomy was to elaborate on Galen's project in the sense that a more thorough investigation of the human body was simply meant to provide the missing piece in Galen's anatomical puzzle. Then again, Cunningham also mentions that "anatomists had been dissecting human corpses for at least 200 years, since at least the time of Mundinus, and none of them had thought that the anatomy of Galen needed to be redone. *So there is something singular about Vesalius's attitude here.*"¹⁶⁸ Unfortunately, Cunningham does not offer any

¹⁶⁷ Charles Singer, *Vesalius on the Human Brain*. With an introduction and translation of the original text (London et al.: Oxford University Press [Published for the Wellcome Historical Medical Museum], 1952), introduction, p. xiii. The 'lower' level of Vesalius' anatomy of the blood vessels reflects another peculiarity: in nearly all historiographical accounts, Vesalius' anatomical project is said to have marked the beginning of modern anatomy in the sense that it was based on observation and experiment as the pillars of modern science, and for erasing the mistakes of the ancients. Yet, in terms of enhancing anatomical knowledge: what exactly was Vesalius' contribution to our modern understanding of the human body? As early as 1885, B.W. Richardson wondered in his chapter on 'Vesalius, and the Birth of Anatomy' how Vesalius "could have disclosed so much and not discovered more." Quoted in Cole, *History of Comparative Anatomy*, p. 56. Vesalius is associated with the discovery of only two structures, the *os vesalianum* (a rare accessory bone in the foot) and the *foramen vesalii* (a small opening in the wings of the sphenoid bone in the base of the skull, giving passage to a small vein). Cole interestingly adds that "neither of which is a normal constituent of the human body;" *ibid.*

¹⁶⁸ Cunningham, *The Anatomical Renaissance*, p. 118; my italics.

more thoughts on this other than that Vesalius himself believed the human body to be the “true book of the body.”¹⁶⁹ On the other hand, we can take Vesalius’ seemingly singular attitude as a reflection of the heightened awareness of the human body’s uniqueness in the Renaissance period, as well as the need to constitute this uniqueness by putting it in contrast to animal bodies.

The novelty of Vesalius’ approach to anatomy is furthermore seen in the emphasis he put on his own observations rather than relying on the authority of texts; in this, however, he also reconnected with Galen who had given this advice to fellow and future anatomists repeatedly.¹⁷⁰ The importance Vesalius placed on illustrations in the *De Fabrica* initiated the view of anatomy as a visual project which took centre stage in all subsequent anatomical investigations. But what was his actual contribution to anatomy as a field of knowledge about the body? Taking a closer look at Book VII on the brain serves the purpose of evaluating Vesalius’ contribution to neuroanatomy. In the context of this project, it also provides a valuable insight into the way that Vesalius and his contemporaries negotiated their knowledge of the brain and nerves via a comparison with the brains of animals, as the following quote testifies:

All our contemporaries, so far as I can understand them, deny to apes, dogs, horses, sheep, cattle, and other animals, the main powers of the Reigning Soul – not to speak of other [powers] – and attribute to man alone the faculty of reasoning; and ascribe this faculty in equal degree to all men. And yet we clearly see in dissecting that men do not excel those animals by [possessing] any special cavity [in the brain]. Not only is the number [of ventricles] the same, but also all other things [in the brain] are similar, except only in size and in the complete consonance [of the parts] for virtue.¹⁷¹

¹⁶⁹ Ibid., p. 121.

¹⁷⁰ See Rocca, *Galen on the Brain*, p. 240.

¹⁷¹ Vesalius, *De Fabrica*, Book VII, Ch. VI ‘On the Ventricles of the Brain’, p. 40. All quotations from Book VII are based on Singer’s translation (see note 159), and will be referred to as *De Fabrica*, Book VII + the appropriate chapter. I have not seen the recent translation of the last volume of Vesalius’ *De Fabrica* by William F. Richardson - including Book VII on the brain and the concluding remarks on vivisection – as it became only recently available in libraries. For a comparison with Farrington’s translation, see Andreas Vesalius, *On the Fabric of the Human Body. Book VI: The Heart and Associated Organs. Book VII: The Brain. A Translation of De Humani Corporis Fabrica Libri Septem* by William F. Richardson in collaboration with John B. Carman (Novato, California: Norman Publishing, 2009).

It is indicative of the Vesalian project to point out potential similarities and differences between human and animal bodily structures, regardless of the organ(s) under investigation. Yet, it seems surprising that an anatomist who allegedly set out to prove that the human body was the measure of all animals, should readily acknowledge that there was virtually no difference in the structure of human and animal brains—despite the association of this organ with the faculties of “voluntary movements, sensations, and that Reigning Soul, by which we imagine, mediate, and remember.”¹⁷² We could of course interpret this as an indirect statement of belief that the human *differentiae specifica*e, such as reason and intelligence, cannot be located in the brain. But the question is whether this interpretation really applies to Vesalius. After all, the brain as an organ in its own right did not seem to reveal anything special to Vesalius (other than that the *rete mirabile* was nowhere to be found in humans), but this is not surprising considering his method of dissection in which he sliced the brain away, rather than taking it wholly out of the skull for investigation (as Thomas Willis would do a century later; see Chapter 3). However, regarding the physiology of the brain, Vesalius took over Galen’s account of spirits or *pneuma* being responsible for the faculties of memory, thinking and imagining, which effectively renders the brain the seat of the soul in the Vesalian understanding. Though he voiced his inability to reconcile Galen’s ‘pagan’ view with the soul-centred outlook of Christian theology, it seems that he adhered to Galenic physiology, viewing the authority of theologians in this context as an inhibition to proper anatomical investigations of the brain and body.¹⁷³ Some of his remarks in the *De Fabrica* indicate that the danger of heresy was in fact the main incentive for him to abscond from searching for any material evidence of the soul’s workings in the human body:

¹⁷² Vesalius, *De Fabrica*, Book VII, Ch. I ‘The Brain, like the Senses, and also like Volitional Movement, is made for the Reigning Soul (Princeps Anima)’, p. 1.

¹⁷³ See also Singer’s introduction to *Vesalius on the Human Brain*, p. xvii.

Lest I come into collision here with some scandalmonger or some sort of censor of heresy, I shall wholly abstain from consideration of the divisions of the soul and their locations, since today [...] you will find a great many censors of our very holy and true religion. If they hear someone murmur anything about the opinions of Plato, Aristotle or his interpreters, or of Galen regarding the soul, even in the conduct of anatomy where these matters especially ought to be examined, immediately they judge him to be suspect in his faith and somewhat doubtful regarding the immortality of the soul. They do not understand that this is a necessity for physicians if they desire to engage properly in their art [...]¹⁷⁴

Yet, this did not detain him from utilising the reproach of heresy to dismiss other cerebral localisation theories:

But what impiety can such a description of the uses of the ventricles (as it concerns the powers of the Reigning Soul) produce in ignorant minds not yet confirmed in our Most Holy Religion! For such [ignorant ones] will examine carefully (even though I myself were silent) the brains of quadrupeds. These closely resemble those of men in all their parts. Should we on that account ascribe to these [beasts] every power of reason, and even a rational soul, on the basis of such doctrines of the theologians?¹⁷⁵

If Vesalius had actually thought that the brain was wholly void of functions ascribed to the soul, he would have confirmed this last rhetorical question decidedly in the negative. But his criticism was first and foremost directed at the ventricle theory that had been advocated in medieval psycho-physiology, rather than against any brain-centred embodiment theory as such. His snide remarks about the advocates of the ventricle theory investigating the powers of the soul in animal brains clearly deride the theory, not the methodology. It is well known that Vesalius, relying to a large extent on Galenic embodiment theories, relied just as much on animals to determine what were and were not human-specific features and faculties. After all, Vesalius himself invoked the outer resemblance of human and animal brains to argue that, if the soul's faculties are to be found in the ventricles of the brain, then animals owning the latter ought to be in possession of the first. An even stronger indication of this is given in the

¹⁷⁴ Quoted in O'Malley, *Vesalius*, p. 178; the quote is from Book VI of the *De Fabrica*, on the heart, lungs, and other organs in the chest, where he also briefly discusses ancient notions of the heart as the seat of the soul.

¹⁷⁵ Vesalius, *De Fabrica*, Book VII, Ch. I, p. 6.

last chapter of the *De Fabrica* where he emphasised the value of vivisectioning animals in order to increase the knowledge that had been gained by the dissection of human corporeal structures. Regarding the brain, however, certain limits seemed to apply that were not necessarily due to the use of animals for research.

Well, then, in the examination of the brain and its functions very little is to be observed by vivisection, since in this matter, whether we like it or not, but merely out of consideration for our native theologians, we must deprive brute creatures of reason and thought, although their structure is the same as that of man. And so the student of anatomy, and he that is practised in dissecting dead bodies, and tainted by no heresy, clearly understands to what risks I should expose myself if – a thing which should otherwise above all else gladly do – I were to make any attempt at vivisectioning the brain.¹⁷⁶

Thus, other than observing that sense and motion ceased when the brain was removed, Vesalius had nothing to say about his own observations or thoughts regarding the brain's functions. The careful wording of the above quotation indicates, however, that he would have 'gladly' ventured to conduct a more thorough investigation of the brain had it not been for the 'native theologians'. The latter would not only have been averse to any material interpretation of the workings of the soul, but would have found any implication that the soul's faculties could be located in an animal's brain even more heretical. The idea "that the human body expressed in miniature the divine workmanship of God,"¹⁷⁷ as Jonathan Sawday defines the Vesalian motto, did not sit comfortably with a crude science of the brain that, moreover, used animals as models for investigating it. This dilemma was not unique to the Vesalian enterprise. Fudge also observed for the English context that,

[i]n this way science and religion seem to be at odds: experimentation on live animals in early modern England is a philosophical nightmare. Premised upon the absolute difference of human and animal, on the moral injunction against cutting up the living human which allows the cutting up of the living animal, vivisection is also very clearly

¹⁷⁶ Vesalius, 'Some Observations on the Dissection of Living Animals'. Translated by Benjamin Farrington (*Transactions of the Royal Society of South Africa, Capetown* 20 (1931), pp. 1-14), p. 10.

¹⁷⁷ Sawday, *The Body Emblazoned*, p. 23.

based on a sense of sameness: the living animal is cut up to reveal something about humanity.¹⁷⁸

Accordingly, as Fudge identifies further, “the difficulties [of] sustaining an idea which separates the species,”¹⁷⁹ is most clearly revealed during anatomical and experimental investigations, where “the absolute animality of the human body is revealed even as humanness is expressed. As such the destruction of the boundary which exists between human and animal continues.”¹⁸⁰

However, whether we can speak of a true ‘Vesalian stance’ with regard to his view on the brain is doubtful as Vesalius’ anatomical approach as a whole was rather agnostic, as Singer points out – despite his invocation of the ‘true and holy religion.’¹⁸¹ Indeed, judging by the above quotation from Vesalius, one cannot help thinking that he had rather wished to keep his anatomical research separate, not from any religious incentive per se, but from the concerns of the said ‘native theologians.’ All in all, Vesalius did not revolutionise anatomy in the sense of bringing about a whole new understanding of the human body, neither did he enhance much of the already existing knowledge about the nervous system. His main legacy was to make the body’s interior visible to a larger audience due to the dissemination of his illustrated anatomical work, the basis of which rested on the anatomist’s own observations. Though these observations were still largely influenced by ancient notions, Vesalius came to personify the renewed interest in the specifics of the human body. This was, seemingly paradoxically, exemplified by an increase in the dissection of animal bodies, since these were now not only used to gain an insight into the human body’s interior, but also to point out the differences between humans and animals. The Vesalian anatomical body is thus also a case in point that the early modern period saw an overall heightened occupation with the human-

¹⁷⁸ Fudge, *Perceiving Animals*, p. 106.

¹⁷⁹ *Ibid.*, p. 92.

¹⁸⁰ *Ibid.*

¹⁸¹ See Singer, *Vesalius on the Human Brain*, p. 74 n 12.

animal boundary which ensured that, despite the availability of human corpses, animal dissections remained a stable component of all future anatomical enterprises. We have also seen that Vesalius utilised the contemporary discourse on human uniqueness via a discussion of the human-animal difference to attack certain aspects of Galenic anatomy. Yet, Vesalius' criticism was not aimed against Galen's anatomical method, but served to assert his own professional authority as an anatomist.

Vesalius' own investigations of the human and animal brain might have brought him to the conclusion that the workings of the soul could be made visible in the flesh of the brain, had a material link between the brain and the soul not been viewed as heresy at the time.

Renaissance anatomists like Vesalius were caught between the theological demands of religious authorities whose doctrines dictated certain views of the human body, and their own quest to define this body in anatomical terms. The advent of the new science eventually furnished the practice of anatomy with a more professionally authoritative stance. Rather than accusing anatomists of heresy and censoring their work, theologians themselves actually came to rely upon the findings of anatomical investigations in their own quest to highlight the body as a workmanship of God. This is not to say that anatomists were disconnected from any religious framework, but in seventeenth-century and later anatomical writings, expressions of religious zeal appear increasingly standardized and rhetorical. One thing, however, remained in tune with theological authorities: the soul was to become the most important tool with which to negotiate the true nature of humans, including the difference between humans and animals. It is no coincidence that contemporary philosophers began to think more about possible explanations for, and refutations of, the apparent similarity of human and animal bodies and behaviour. Here, it is mostly the famous French philosopher René Descartes who comes to mind for his notorious concept of the *bête-machine*, but the attempt to introduce the idea of animal automatism in order to (re-)establish a fundamental

difference between animals and humans was in fact well under way by the time that Descartes took up mechanical philosophy to explain corporeal phenomena. The Spanish physician-philosopher Gómez Pereira is a striking Renaissance predecessor to the Cartesian discourse on animal automatism, and his core ideas shall be discussed in the next section.

1.3. An Early Comprehensive Theory of the Beast Machine: Gómez Pereira's *Antoniana Margarita* (1554)

If Renaissance naturalism comprised a movement that sought to reintegrate all living beings with the cosmos, then the Spanish physician Gómez Pereira's (1500 – c. 1558) pre-Cartesian theory of animal automatism stands out as an attempt to maintain a crucial gap between humans and other living beings. Pereira's *Antoniana Margarita* (1554) has been described as one of the first efforts to develop a comprehensive mechanist model of animal behaviour.¹⁸² Yet, in line with the above-mentioned anatomical enterprises by the likes of Vesalius and other Renaissance anatomists, I would further argue that Pereira's aim was less concerned with the actual behaviour of animals, but fits in with a contemporary urgency to ascertain a fundamental difference between human and animal mental processing of bodily functions and movements. It is probably no coincidence that Pereira, being a physician, set out to compare human nature with the rest of the animal world at around the same time that anatomy put human and animal bodies side by side to assert human uniqueness. While the human body was materially profaned in the anatomical theatre, the singularity of human nature was shifted to the level of immaterial faculties of the rational soul which would continue to constitute the

¹⁸² See Javier Bandrés and Rafael Llavona, 'Minds and Machines in Renaissance Spain: Gómez Pereira's Theory of Animal Behavior' (*Journal of the History of the Behavioral Sciences* 28 (1992), pp. 158- 168); Rainer Schäfer, *Zweifel und Sein: Der Ursprung des modernen Selbstbewusstseins in Descartes' cogito* (Würzburg: Verlag Königshausen & Neuman GmbH, 2006), pp. 94-95; and Johann Baptist Ullersperger, *Die Geschichte der Psychologie und der Psychatrik in Spanien* (BiblioBazaar Reproduction Series, 1871).

major difference between humans and animals. Pereira contributed to this discourse by approaching the question of human uniqueness from the other end: by proving that even the most complex actions of animals were due to an inbuilt automatism that was wholly void of the influence of will and reason, he secured these latter capacities as the essence of the rational soul and thus of humanity. Viewed from this angle, corporeal analogies between humans and animals signified nothing, since the true essence of human nature remained immaterial.

Pereira had studied medicine at the University of Salamanca where, via his teacher Juan Martinez Guijarro (later Cardinal Siliceo), he became acquainted with, and was influenced by, the work of the Oxford mathematician and physicist Richard Swineshead (fl.c. 1340-1354) on the motion of bodies.¹⁸³ Swinehead's book *Liber Calculationum*, comprised of sixteen treatises written in the 1340s, provided the mechanical framework of thought that inspired Pereira's model of animal behaviour, just as Descartes was later influenced by mathematics and physics in his mechanical philosophy. While anatomists struggled to reconcile their observations of almost identical animal and human nervous systems with the ongoing preconceived notion of human specialness that was potentially rooted in the brain and nerves, Pereira philosophically addressed the inherent problem of how to explain the complexity of animal bodies and behaviour without resorting to cognitive processes. Tellingly, he concentrated on the faculty of sensation, arguing that animals were in fact 'insensitive'. His project stands in stark contrast to the still influential Aristotelian notion of the sensitive soul that was shared by humans and animals alike—a theoretical notion that suited anatomists better for explaining the bodily mechanisms behind sensation. As they increasingly grounded mental and sensitive faculties in the brain and nerves, anatomists simply had to rely on the model function of animals in order to investigate those faculties on

¹⁸³ See Edith Dudley Sylla, 'Richard Swineshead', in Jorge J. E. Gracia and Timothy B. Noone. *A Companion to Philosophy in the Middle Ages* (Oxford et al.: Blackwell Publishing Ltd., 2003, pp. 593-596), p. 595.

a large variety of bodies. Had they operated with the belief that animals – their most important instruments – lacked the faculty of feeling, they would have deprived themselves of their most important conceptual device for studying the principles of life in humans. Yet, for Pereira, “to accept sensitivity in animals is to accept reasoning and intelligence in animals; because animals do not possess human cognitive abilities, sensations are inconceivable.”¹⁸⁴

Bandrés and Llanova mention that Pereira did not oversimplify animal behaviour to emphasise his standpoint, which most followers of the concept of the beast machine came to do; rather, he confronted head on the possible explanations for its observable complexity. In order to do so, he devised a classification of movement that interestingly looks like the mechanical equivalent of the Aristotelian three-soul model:

The simplest is movement of inorganic objects that he labels ‘natural movement.’ It is governed by the principles of perpetual and invariable motion and this movement is merely a local one, such as the attraction of metal to a magnet. The most complex category is voluntary movement (e.g. the complete freedom of movement of human beings). At the medium level of complexity, Pereira’s category “vital movement” describes animal movement. Vital movement encompasses movement caused by muscular and nervous organs in direct response to interior and exterior forces and which does not involve spontaneous movement.¹⁸⁵

Pereira’s category of “vital movement” is similar to the vital or sensitive soul as advocated by later anatomists such as Willis, encompassing also an early version of action-reaction behaviour as found in instinctive and reflex movement. There are overall remarkable similarities to Willis’ later conception of nervous and cerebral functions, despite the seemingly opposite frameworks of thought. Working with the three- soul model, Willis likewise operated with the concept of “natural instincts” as well as reflexive behaviour, and, like the outlined classification of Pereira’s types of movement as shown below, Willis also separated the category of vital movement further into different types (more of this in Chapter

¹⁸⁴ Bandrés and Llanova, ‘Minds and Machines in Renaissance Spain’, p. 159.

¹⁸⁵ Ibid., p. 161.

3.). Pereira distinguished animal movements into those that were either a reaction to present objects (the equivalent to reflex action likened to the attraction-repulsion model of a magnet), to past objects (indicating a sort of mechanical memory), movements that were produced as a result of previous instruction (acknowledging an animal's potential to 'learn'), and movements that were based on so-called natural instincts (innate drives).¹⁸⁶

One should not go as far as Brandès and Llanova who argue that Pereira actually foreshadowed later theories of what we now call the nervous transmission of external stimuli to the brain and muscles.¹⁸⁷ It is also questionable, whether Pereira, who was not a practising anatomist (though as a physician he might have engaged with dissection during his medical education), envisaged an "activation of the areas of the brain where the motor nerves originate."¹⁸⁸ What is more fascinating is the similarity with which different types of behaviour and internal senses were envisaged anatomically and philosophically at the time; and how an alternative version for animals inevitably appeared alongside the anatomising and philosophising of the human nervous system. Philosophers, like Pereira at the time, had the advantage of being unconstrained by the need to reconcile their thoughts with observations made in hands-on anatomical investigations, which more often than not showed the practical limits of particular theories, for instance regarding the *rete mirabile* or the pineal gland, both of which were dismissed after anatomists investigated these structures through a more thorough comparison of human and animal brains. Yet, there is no denying that there was a mutual influence between anatomy and philosophy. Pereira's mechanical version of memory in animals, for example, drew upon the ventricle theory of the brain: he argued that a seen object left a trace in the brain matter that Pereira called *phantasma*, which was then stored in a posterior ventricle of the brain. These passive memory traces could be activated in the absence of the object, moving then on to the anterior part of the brain. Unsurprisingly, the

¹⁸⁶ Brandès and Llanova, 'Minds and Machines in Renaissance Spain', p. 161.

¹⁸⁷ See *ibid.*

¹⁸⁸ *Ibid.*, p. 162.

difference between human and animal memory is “that man is able to voluntarily provoke the movement of the memory traces to evoke a recall, whereas in animals this movement is due to purely mechanical stimuli.”¹⁸⁹ Interestingly, as most conceptualisations that could not be observed in practice, human memory served here as an analogical model for the way that the function of memory was mechanically envisaged in an animal. Regarding the concept of ‘natural instinct’, however, Pereira used the example of a cat chasing a mouse, explaining the observable behaviour of both—chasing and fleeing—in terms of magnetic principles, i.e. attraction and repulsion.¹⁹⁰

Pereira’s engagement with the question of the rational soul’s knowledge of itself is yet another striking parallel to the later Cartesian philosophy. For Pereira, thought was the means by which the human soul—the Cartesian ‘I’—knew itself. Bandrés and Llanova paraphrase Pereira’s argument as “I know that I know, and whoever knows is, therefore I am.”¹⁹¹ The resemblance to Descartes’ axiom *Cogito ergo sum* (I think therefore I am) is striking enough, making it difficult to believe Descartes’ claim that he had no knowledge of Pereira’s work. Indeed, the best proof for the parallelism of Descartes’ and Pereira’s thought is that Descartes himself “felt obliged, in a letter to Mersenne, to deny that he had been inspired by Pereira’s ideas,”¹⁹² even though he would have found in Pereira a confirmation of his own philosophy. Even when allowing that the subject of the human-animal difference only gained momentum in the early seventeenth century, the extent to which Pereira’s arguments reappear in

¹⁸⁹ Ibid.

¹⁹⁰ Ibid., p. 163.

¹⁹¹ Ibid., p. 164. See also Schäfer, *Zweifel und Ursprung*, p. 95; though Schäfer sees a difference to Descartes in that Pereira assumes the pre-existence of things that are known by the soul, whereas the Cartesian soul is itself the root of all things known; *ibid.*

¹⁹² Bandrés and Llanova, ‘Minds and Machines in Renaissance Spain’, p. 164. The letter to Mersenne dates from the 23rd of June 1641 and states: “Je n’ai point vu *Antoniana Margarita*, ni ne crois pas avoir grand besoin de les voir, non plus que les theses de Louvain, ni le livre de Jansenius, mais je serai bien aise de savoir où il a été imprimés, afin que, si j’en avais besoin, je le pusse trouver ;” in Ferdinand Alquié (ed.) *Œuvres philosophiques de Descartes*. 3 vols. Edited and annotated by Ferdinand Alquié (Paris: Éditions Garnier Frères, 1967), vol. 2 (1638-1642), pp. 339-343: 341. Schäfer, on the other hand, claims that it was Mersenne who first alerted Descartes to Pereira’s work (precisely because it dealt with animal mechanism), arguing that Descartes felt confident enough to decline looking into it; see Schäfer, *Zweifel und Ursprung*, p. 95.

Descartes' later writings can also be seen as a striking testimony to the fact that Descartes' philosophy seized on an already established discourse of the human-animal boundary. In the end, both undermined the common view that the complexity of animal behaviour equalled the same underlying thought processes that are found in humans. Pereira even went a step further by not only denying any sort of mental activity to animals, but also sensation. Descartes seemingly tried to find a way around this by separating bodily sensation from mental perception, claiming that the sensation of animals was only corporeal, though, unsurprisingly, he was not able to resolve the paradox of 'unconscious sensation'. As we will later see, the English philosopher Thomas Hobbes (1588-1679), on the other hand, took the mechanist version of the body to its most extreme conclusion. Significantly, Hobbes was not so much attacked for his belief that even thought processes were due to a mechanical interaction of bodily matter, but because he explicitly included humans in his mechanical doctrines. It is altogether difficult to imagine that Descartes had never even cast a glimpse at Pereira's work, which had made a deep impact on sixteenth-century intellectual circles, and continued to be disseminated and discussed up until the eighteenth century. Up to eight editions of the *Antoniana Margarita* appeared in Italy, Germany, and France, which means that no serious study of animal souls, minds, and animal behaviour could avoid Pereira's work in the following two centuries.¹⁹³ Similar to the later responses to Cartesianism, Pereira provoked arguments against, and alternatives to, his theory of animal automatism.¹⁹⁴ Pereira's writings,

¹⁹³ One edition appeared in 1621 in Lyon, at a time when Descartes became interested in mechanical philosophy and began to formulate his own version of the 'animal machine' which was first expounded sixteen years later in the *Discours de la Méthode*; see Bandrés and Llanova, 'Minds and Machines in Renaissance Spain', p. 165 and p. 167. The last edition of *Antoniana Margarita* was published in 1749 – possibly prompted by a renewed interest in the subject by the published debates on animal souls by Johann Heinrich Winkler, *Die verschiedenen Meynungen einiger Weltweisen von der Existenz der Seelen der Thiere in einer Gesellschaft guter Freunde untersucht*. 6 parts. (Leipzig: Bernh. Christ. Breitkopf, 1741-1745). Pereira's work is thus one of the many strands of influences on subsequent debates on animal souls as well as the difference between animals and humans in philosophical debates in the seventeenth and eighteenth centuries.

¹⁹⁴ In 1556, two years after the publication of *Antoniana Margarita*, an anonymous satirical dialogue - *Endecalogo contra Antoniana Margarita* - appeared in which various animals bring a lawsuit against Pereira because he had dispossessed them of their senses – tellingly, the author lets the animals win their case; see Bandrés and Llanova, 'Minds and Machines in Renaissance Spain', p. 164.

as well as those of his seventeenth-century equivalent Descartes, are a case in point that the field of natural philosophy in the late sixteenth and the early seventeenth century was ripe with theories about the status of humans in nature, which were philosophically discussed and anatomically tested via enquiries into and investigations on animal bodies and souls. Pereira had already engaged with the most important aspect of this debate, and thus constitutes a vivid example of the early modern discourse on the human-animal boundary that reached a climax in Cartesian philosophy.

Conclusion

This chapter has covered a large timeframe in order to show that a certain continuity of a specific discourse about the human-animal boundary pertained in philosophical and anatomical discourses about the human body. The view that humans were the most complex of all animals remained a given since Antiquity, but so did the belief in a structural and functional continuity of humans and animals that could be utilised for anatomical investigations. This chapter also served the purpose of illuminating that the question of the human-animal difference rarely features in traditional accounts in the history of medicine, anatomy and, more specifically, in the history of neuroscience. Carlino elaborates on what I have identified as a rather ahistorical view among historians who are seemingly not able to imagine that a human-centred view of the body is a very modern thing:

The opening up and observation of the inner human body seems to us the most obvious of available techniques for anatomy. But this was not the case for scientists until the time when the school of Alexandria was founded. [...] Texts never refer to the dissection of the human body, not even regretfully as to a desirable but forbidden procedure. Thus physicians and philosophers worked out other more indirect and (later anatomists would say) fallacious techniques through which to pursue their investigative purposes.¹⁹⁵

¹⁹⁵ Carlino, *Books of the Body*, pp. 128-129.

This unspoken methodological legitimation for using animals as substitutes for the human body persisted throughout the history of anatomy, despite the avowed criticisms of later Renaissance anatomists like Vesalius. I have further argued that the heightened occupation with man's place and status in nature from the sixteenth century onwards triggered not so much an exclusive study of the human body, but a more focussed comparison between humans and animals in order to assess the specialness of the human corporeal frame and soul. As we will see in Chapter three, in the specific context of seventeenth-century neuroanatomy, it became ever more difficult to reconcile this methodological reliance on the structural human-animal continuity with the growing belief that the brain and nerves were the executive members of the soul whose faculties were in turn thought to be the true constituents of humanity. Summarising the Renaissance period, Jonathan Sawday maintains that,

[i]n the west, prior to the 'new science' of the late sixteenth and seventeenth centuries, the body's interior could not be understood without recourse to an analysis of that which gave its materiality significance – the essence contained within the body. A belief in the presence of that essence, a belief, that is, in the existence of an *anima*, a soul or a thinking entity, necessarily informed any possible perspective of the body.¹⁹⁶

It is certainly the case that anatomical enterprises came to focus more and more on the material mechanisms of the body from the sixteenth century onwards. Yet, the heightened emphasis on the specialness of the human body eventually found its philosophical conclusion in the discourse on the rational soul. In fact, the rational soul—potentially no longer an essence that explained all of the body's functions, but certainly the remaining essence of human uniqueness—gained ever more significance in the seventeenth century.¹⁹⁷ Debates on the soul, including alternative conceptions that revisited the question of animal souls, gained

¹⁹⁶ Sawday, *The Body Emblazoned*, p. 16.

¹⁹⁷ Regarding mechanism as a philosophical system, Margaret Osler confirms that, in fact, "discussions of the human soul established the limits of mechanization and provided a bulwark against the bugbear of materialism;" Osler, *Divine Will and the Mechanical Philosophy*, p. 179.

new momentum in the seventeenth and eighteenth centuries precisely because of the increasingly avowed understanding of the body as a mechanical vehicle. It is no coincidence that mechanical philosophy elaborated on the human-animal difference to such an extent, considering that anatomy was indeed inadvertently stripping the body's interior of its most fundamental, immaterial, element. Having established anatomically that the structures, and with it possibly the material working principles of the body, were shared by humans and animals alike, anatomists and philosophers were left to concentrate on metaphysical principles to constitute the *differentiae speciffiae* of human beings. Theories like Pereira's animal automatism, as well as Cartesian dualism discussed in the next chapter, made perfect sense in this context, as a detachment of the soul from the (animal) body seemed to offer a fixed and rigid borderline between humans and animals that depended on the possession of an immaterial soul, or lack thereof. Yet, it still had to be determined to what extent the human rational soul was truly responsible for faculties that were variously ascribed either to the body as such or to a corporeal soul, or even to a conjunction of body and rational soul. And here, too, in this seemingly human-centred debate, as Robert J. Richards reflects, "[d]uring the seventeenth and eighteenth centuries, disputes over the nature and capacities of human mind were frequently waged on foreign territory – on questions of animal psychology."¹⁹⁸ The following chapter will discuss in more detail the impact that mechanical philosophy (most notably the Cartesian version) had on the conception of the human-animal boundary philosophically and anatomically. The chapter also engages with another mechanical theory, – atomism, as (re)introduced by the French philosopher-theologian cum mathematician Pierre Gassendi whose influence can in turn be detected in Willis' seventeenth-century anatomy of the nervous system, as discussed in Chapter 3.

¹⁹⁸ Robert J. Richards, 'The Emergence of Evolutionary Biology of Behaviour in the Early Nineteenth Century' (*British Journal for the History of Science* 15 (1982), pp. 241-280), p. 243.

2. Seventeenth-Century Mechanical Philosophies of Human and Animal Bodies

As part of the sixteenth- and seventeenth-century emphasis on studying the physical laws of nature without taking recourse to spiritual principles, attempts were made to explain bodily functions in purely mechanistic terms.¹⁹⁹ Descartes was not the first, nor was he the only one, to apply mechanist principles to the workings of the human and animal body. Physicians, such as the Italian Santorio Santorio (1561-1636), in his *De Statica Medicina* (1614), and of course William Harvey's (1578-1657) famous work *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus* (1628) provide ample proof that by the early seventeenth century, different versions of the mechanical body were well in place.²⁰⁰ Thus, Descartes' conjectures about the functioning of the human nervous body were not the only version of mechanical philosophy available to anatomists and natural philosophers in the first half of the seventeenth century. Apart from Pereira's version of automatism in the case of animals, Pierre Gassendi's revival of ancient Epicureanism's atom theory was also part of a wider movement in which mechanical philosophy sought to replace Renaissance naturalism and its strong emphasis on soul-infused animate bodies.

This chapter focuses mainly on the Cartesian and Gassendian versions of mechanical philosophy, as these offered different frameworks of thought that also handled the subject of the human-animal boundary in different ways. As Gassendi's writings had a larger influence on Thomas Willis's neuroanatomical project, I will introduce his theories immediately preceding the next chapter. First, I will tackle Cartesian philosophy as the seemingly ultimate and groundbreaking version of mechanical thought that created a lasting intellectual legacy

¹⁹⁹See here especially Theodore Brown. *The Mechanical Philosophy and the 'Animal Oeconomy'* (New York: Arno Press Inc., 1981).

²⁰⁰Not to forget the later work of the physiologist-physicist Giovanni Alfonso Borelli (1608-1679), whose conceptions of the body, as laid out in his *De Motu Animalium* (1680-81), became known as iatrophysics. These and other important historical figures related to mechanical views of the body, such as William Harvey (1578-1657), Joannes Baptista van Helmont (1579-1644) and Marcello Malphigi (1628-1694), are discussed in Brown's *The Mechanical Philosophy*.

for all those concerned with the interior of the human body. Moreover, although Descartes did not have as large an impact on hands-on anatomical investigations as is sometimes claimed, he is nonetheless described as a historical figure who, next to Willis, provided the main cerebral model for seventeenth and eighteenth-century anatomy and physiology.²⁰¹ The following discussion of Descartes' philosophical scheme will accordingly evaluate how useful Descartes' view of the brain really was for anatomical investigations, arguing that, although most subsequent anatomical treatises engage with his philosophy, anatomists and experimental philosophers were looking in vain for practice-based anatomical clues in Descartes' writings. Despite his own use of dissections to underpin his philosophy, Descartes' cerebral model was first and foremost a theoretical one that was meant to back up his philosophical notion of the body as a machine-like vehicle for the more important and independent soul. Thus, it is his theorising about the rational soul rather than his anatomical thoughts on the brain and body that marked his influence on subsequent debates.

Due to the scope of my thesis, I cannot engage fully with all of Descartes' writings or indeed with the large amount of secondary literature covering all aspects of Cartesian philosophy. In any case, among historians of Cartesianism, there is no consensus about the way that his writings should be interpreted, which is especially true for his notorious concept of animal automatism. I will therefore provide largely my own interpretation of Descartes' writings before discussing the different views prevailing among historians of the subject. By focussing on the relevant parts of Descartes' theories, this subchapter also intends to reintegrate the mechanical philosophy of Descartes within an overall tendency of the period to assess the status of humans via enquiries on the nature of animals. Here, debates on the relevance of the nervous system as the instrument of the soul played a large role in determining the boundary between humans and animals – physically and metaphysically.

²⁰¹ See Robert L. Martensen. *The Brain takes Shape: An Early History* (Oxford et al.: Oxford University Press, 2004), p. xi.

With this in mind, after a brief biographical sketch, I will put Descartes' philosophical speculations in the specific context of my thesis by focussing on his body- and beast-machine concept. I will evaluate his specific view of the human and animal nervous system and, by using the example of pain, his understanding of the way that humans and animals experience bodily sensations. Lastly, I will look at contemporary as well as modern responses to his philosophies without which, I argue, the phenomenon of Cartesianism as such would not have gained such notoriety. Anti-Cartesians, philosophers as well as anatomists, responded in a way that triggered alternative conceptions of the (nervous) body and the human-animal boundary. Without pre-empting the conclusion, the main thrust of my argument is that the value of the Cartesian separation of cognition and corporeal sensation was a questionable one in the context of the emerging neurosciences. One reason for this is that Descartes treated the brain and nerves as the executive organs of the rational soul in humans but not in animals, and the following account seeks to unravel why this might be the case.

2.1. The Cartesian Beast- and Body-Machine

René Descartes (1596-1650) was born at La Haye (now Descartes) in 1596, attended the Jesuit college of La Fleche at Anjou from 1606 until 1614, and studied law and possibly medicine at the University of Poitiers the following year until 1616.²⁰² Joining the army of Prince Maurice of Nassau, Descartes ended up in the Netherlands where he met the Dutch mathematician and philosopher Isaac Beeckman (1588-1637) with whom he shared an interest in mathematics. Beeckman was to become an important mentor for Descartes, though Descartes' natural philosophy had already been influenced by Galileo Galilei's (1564-1642)

²⁰² For a more detailed overview of Descartes' life and the various strands of influence that shaped his philosophy, see Stephen Gaukroger. *Descartes: An Intellectual Biography* (Oxford: Clarendon Press, 1995).

mechanistic concept of nature in which mathematical rules played a major role.²⁰³ In 1620, he began his works on geometry, optics and the *Regulae ad Directionem Ingenii* (Rules for the Direction of the Mind).²⁰⁴ After journeys back to France and then to Italy, he settled back in Paris where he began a regular correspondence with the theologian, mathematician and philosopher Marin Mersenne (1588-1648) whose ideas on mechanism and natural philosophy helped Descartes develop further his own version of mechanical thought. Descartes' early mechanist vision of the senses and the nervous system was partly outlined in his resumed work on the *Regulae* in which he now focussed on the underlying mechanism of perception and cognition.²⁰⁵ He was thereby less interested in providing an accurate anatomy of the brain and nerves, which he acknowledged to be the body's (and the soul's) most important instruments, but rather wanted to prove that the more traditional Aristotelian and Galenic view of sense faculties could be explained in purely mechanical terms.²⁰⁶ In 1628, he settled again in the Netherlands where he remained, and wrote most of his works, for the next twenty years. In the early 1630s he had begun his famous work *Traité de l'Homme* (Treatise on Man) in which he further set out his mechanist natural philosophy including his view of the human body and the animal as a machine.²⁰⁷ Prior to his completion of *L'Homme*, Descartes had made daily visits to butchers in Amsterdam in order to obtain animal parts for anatomical dissections and had attended at least one dissection of a human corpse in the Leyden

²⁰³ For a more detailed background on the specific relationship between Beeckman and Descartes, see Klaas van Berkel, 'Descartes' Debt to Beeckman: Inspiration, Cooperation, Conflict', in Stephen Gaukroger, John Schuster and John Sutton (eds.) *Descartes' Natural Philosophy* (London: Routledge, 2000, pp. 46-59).

²⁰⁴ Hence referred to as *Regulae*; this work gradually came into being over the period of 1626-1628. It remained incomplete and was posthumously published in 1684. In the following discussion of Descartes' works, I will, if not otherwise stated, use the English translation of Descartes' works in *The Philosophical Writings of Descartes*, 3 vols. (Cambridge: Cambridge University Press, 1984 – 1991. The first two volumes were edited and translated by John Cottingham, Robert Stoothoff and Dugald Murdoch; the third volume featured John Kennedy as an additional translator. I will indicate the use of the respective volumes as [PWD I, II or III] in the footnotes.

²⁰⁵ Descartes' occupation with the physiology of the nervous system and his philosophy regarding the mind-body dualism were apparently driven by an interest in medicine, as mentioned by himself in his *Discours de la Méthode* and in a letter to the Marquis of Newcastle written in 1645. According to Arnaldo Benini and Joyce A. DeLeo, his interest in medicine was also based on his having two physicians in the family; see idem, 'René Descartes' Physiology of Pain' (*SPINE* 24: 20 (1999), pp. 2115-2119), p. 2115.

²⁰⁶ See also Zimmer, *Soul Made Flesh*, p. 37.

²⁰⁷ Hence referred to as *L'Homme*, which was also published posthumously in 1662.

anatomical theatre.²⁰⁸ By this time, he had also begun to combine all of his work into one grand book which he simply called *Le Monde* (The World) and with which he set out to explain all aspects of the physical world. Its publication, however, was postponed when Descartes learned of Galilei's trial at the inquisition in 1633. To avoid the church's censorship of his own work, he turned away from the particular mechanisms of the body and pursued more existential questions in order to base his philosophy on more secure grounds. This new basis, representing also the decisive moment in Descartes' thinking that created an insurmountable gap between humans and animals, was eventually summed up in his famous axiom *Cogito ergo sum*, appearing in the *Discours de la Méthode* (Discourse on the Method), which cleared the French censors and was published in 1637. Other relevant publications include the *Meditationes de Prima Philosophia* (Meditations on First Philosophy) published in 1641, which included six sets of *Objections* from friends and fellow philosophers, followed by a second edition that also included Descartes' *Replies*, and the *Passions de l'Âme* (The Passions of the Soul) in 1649.²⁰⁹ Having been summoned to the court of Christina of Sweden, he arrived in Stockholm in late August/ early September 1649, but died a few months later, in February 1650, of pneumonia.

The following discussion focuses on Descartes' understanding and knowledge of the body machine, with which he is generally thought to have taken the ultimate step towards considering the body as a purely mechanical vehicle for the more important rational soul.

This conceptualisation is often viewed as a prerequisite for the later investigations of

²⁰⁸ In a letter to Mersenne (1 April 1640), Descartes recollected his presence at an autopsy of a female corpse which he had attended in order to see the pineal gland in a human brain; see [PWD III], p.146. See also Stanley Finger, 'Descartes and the Pineal Gland in Animals: A Misinterpretation' (*Journal of the History of the Neurosciences* 4: 3/ 4 (1995), pp. 166-182), p. 180.

²⁰⁹ Prior to sending the *Meditations* to his publisher, Descartes had disseminated the script among other philosophers and friends; the comments he received along with his responses to them were included in the published version *Meditationes de Prima Philosophia: His Adjunctæ Sunt Variæ Objectiones cum Responsionibus Authoris* in 1641. For a detailed chronology of all of Descartes' works see Gaukroger, *Descartes*, pp. xiv-xviii.

experimental philosophers.²¹⁰ Annie Bitbol-Hespériès, for instance, maintains that Descartes made a major breakthrough in physiology because he explicitly rejected “the interpretation which worked in terms of faculties previously used to characterize the functions of the body (the vegetative faculty dealing with the liver, the vital faculty dealing with the heart, and the animal faculty [...] dealing with the brain).”²¹¹ Yet, with the exception of sensation, his rejection was rather concerned with the traditional association of these faculties with corporeal souls, not their underlying functions. Descartes had made himself familiar with Hippocratic and Galenic medicine, the respective works of Plato and Aristotle, and the writings of influential anatomists and experimental philosophers, such as Vesalius and William Harvey.²¹² In his vision of the workings of the body, he maintained the ancient paradigm of spirits being extracted from the blood, and his notion of the heart’s heat furnishing the blood conjures up the Aristotelian notion of the heart as a furnace.²¹³ Methodologically, his avowed programme of dissecting animals to ‘see for himself’ betrays another familiar agenda that had not only been advocated by Vesalius, but went back as far as Galen and Aristotle. His insight that, on a corporeal level, animal and human bodies functioned according to the same principles was also not a novel idea, nor was his specific theory of animals as soulless body machines, as we have seen in the case of Gómez Pereira. Though he reworked this intellectual legacy to some extent, Descartes was nonetheless heir to a philosophical and anatomical tradition that had compared and contemplated the nature of human and animal bodies since Antiquity. What Descartes devised to greater perfection in the context of my thesis were two ideas: firstly, that all aspects of the *human* body acted

²¹⁰ See Gaukroger, *Descartes*, p. 5; Benini and DeLeo, *René Descartes’ Physiology of Pain*, p. 2115; and Cohen-Rosenfield, *From Beast-Machine to Man-Machine*, pp. 28-37.

²¹¹ Annie Bitbol-Hespériès, ‘Cartesian Physiology’, in Gaukroger, Schuster, and Sutton (eds.), *Descartes’ Natural Philosophy* (pp. 349-382), p. 351.

²¹² See Descartes, *Letter to Mersenne* (20 February 1639) [PWD III], p. 134; and Gaukroger, *Descartes*, p. 270.

²¹³ See for instance Descartes, *Treatise on Man* [PWD I], pp. 99-107. Descartes’ notion of the rational soul being independent from the body is reminiscent of Aristotle’s belief that it was a ‘self-sufficient energy’ whose psychic power was incorporeal; see Taylor, *The Works of Aristotle IV*, introduction, p. 15. Taylor also mentions that Aristotle used the metaphors of sailor and ship to describe the relationship between soul and body (*ibid.*, p. 13), which was also picked up by Descartes; see his *Sixth Meditation*, [PWD II], p. 56.

according to mechanical principles, while its owner's true constituent—the immaterial rational soul or the mind—determined his humanity.²¹⁴ The animal, thereby, acted as the perfect backdrop for establishing the concept of the body machine, as it exemplified all bodily functions and aspects of behaviour that did not require an intervention from the soul in humans. Depriving all bodily matter of spiritual principles was necessary in order to divorce it from the rational soul; but, in doing so, the soul came to represent everything that separated humans from animals in the Cartesian scheme. Secondly, by counting sense perception among the faculties of the *res cogitans*, he differentiated between human and animal sense experience to a degree that essentially deprived animals not only of the traditional sensitive soul, but of a number of faculties associated with it. By attributing to the soul all aspects of cognition, Descartes had further wanted to dispel two ongoing beliefs once and for all: that most of the body's functions depended on some sort of soul, and that the difference between humans and animals was in many respects only one of degree. So, while the animal could be utilised as the representative of the human body machine, since it was nothing *but* a body machine, the soul was declared the one human *differentia specifica* that shifted humanity to a wholly different category of living beings. The strict separation of body and soul was in this context a clever device that, theoretically, could have solved the question of the human-animal boundary once and for all, since Cartesian philosophy seemed to offer an explanation for the ongoing question why animals seemed and acted so similar to and were yet so different from humans. In the Cartesian scheme, analogies of bodily structures and even behaviour could be explained with the concept of the body machine; any differences, such as

²¹⁴ Descartes himself equated the rational soul with the mind: "If we are to take 'soul' in its special sense, as meaning the 'first actuality' or 'principle form of man', then the term must be understood to apply only to the principle in virtue of which we think; and to avoid ambiguity I have as far as possible used the term 'mind' for this. For I consider the mind not as a part of the soul but as the thinking soul in its entirety;" Descartes, *Fifth Set of Replies* (to Gassendi's *Objections to the Meditations*) [PWD II], p. 246.

the possession versus lack of speech (for Descartes the clearest sign of reason) were explicable with either the presence or absence of a soul.²¹⁵

Descartes' readers engaged eagerly with his philosophy, even those who disagreed with him, because the questions he attempted to answer covered a familiar and vital ground for all those who contemplated the essence of human nature. Furthermore, Descartes' philosophy was a novelty in that he departed from scholastic theorising by engaging with and even trying to improve medical and anatomical knowledge in his philosophy, blaming "our ignorance of anatomy and mechanics"²¹⁶ for the common reliance on souls to explain bodily functions in humans and animals. His conviction that the body exercised its functions by way of an inert mechanism and disposition of internal organs also justified the use of animals as proximates for the human body. Just as Descartes could envisage the body metaphorically as a machine or mechanism as long as cognition was not involved, in the same way could anatomists and experimental philosophers progress with their mapping of physiological functions onto animal bodies.

So why did anatomists and experimental philosophers not wholeheartedly seize on the Cartesian scheme of the body machine, but continued to evoke souls and vital principles in their investigations of animal bodies? That the Cartesian vision of the body machine and its separation from the soul could not at all times be put into practice anatomically and experimentally will be discussed in the next chapters, but one reason certainly is that Descartes, whose philosophy was a work in progress and subject to changes and adaptations over the years, was not always consistent in his mind-body dualism.²¹⁷ The following outline of Descartes' physiology and philosophy will investigate this inconsistency by focussing on his view of the nervous system as part of the body machine, and the emphasis he placed on

²¹⁵ See also Fudge, *Brutal Reasoning*, pp.151-159.

²¹⁶ Descartes, *Description of the Human Body*, [PWD I], p. 314.

²¹⁷ Martensen also discusses the subject with regard to the physiology of the heart; *The Brain Takes Shape*, p. 33f.

the soul for those faculties that were allegedly independent from the body and thus effectively constituted the human. Inevitably, a constant reflection on the differences between humans and animals took place in Descartes' reasoning on which the following discussion will especially focus. Finally, I will evaluate some of the past and present responses to the Cartesian scheme. Descartes' own exchanges with other contemporary philosophers, but also the modern debates on Cartesianism, are valuable in that they provide an insight into modern and contemporary misunderstandings, oppositions, and reflections on potential flaws in Descartes' reasoning. Unsurprisingly, the theory of animal automatism is among those aspects of Cartesian philosophy that continues to elicit strong responses among his readership.

2.1.1. Mind over Matter: Descartes' Vision of the Soul and the Nervous System

In a letter to Mersenne, dated 18 December 1629, Descartes stated that he would begin studying anatomy proper.²¹⁸ A thorough knowledge of the body's structure was not only pivotal for his argument that all issues relating to the body could be explained in mechanist terms. In his *La Description du Corps Humain* (Descriptions of the Human Body),²¹⁹ as well as the *Meditations*, he furthermore invoked the familiar quest 'Know thyself', which puts Descartes in line with anatomists and philosophers since the sixteenth century, whose dictum betrayed an increasing emphasis on the singularity of human nature (see Ch. 1.2.). As

²¹⁸ “[I]’ay trop d’autres divertissemants: ie veus commencer a etudier l’anatomie”; in Charles Adam and Paul Tannery (eds.) *Oeuvres de Descartes*, 12 vols. (Paris: Léopold Cerf, 1897-1910; hence referred to as AT + Vol.), I: Correspondance Avril 1622- Février 1638, pp. 82-104:102. Annie Bitbol-Hespériès maintains that this constituted a genuine beginning of the study of the body, as there is otherwise no indication of his interest prior to this date; see Bitbol-Hespériès, ‘Cartesian Physiology’, p. 369. Leonora Cohen Rosenfield, on the other hand, argues that since the concept of animal automatism was already mentioned in his private notebooks from 1619 onwards, “he must already have visualized the world of biology as part of the mechanistic pattern;” see Cohen Rosenfield, *From Beast-Machine to Man-Machine*, pp. 3-4.

²¹⁹ Henceforth cited as *Description*. This unfinished treatise was written in the late 1640s and appeared in the posthumously published edition of the *Treatise on Man* in 1664; see Cottingham et al, [PWD I], p. 313.

investigations of the nervous system with the brain as the potential seat of the soul came to represent this emphasis most poignantly, it is no surprise that Descartes spent much of his time discussing the body machine's nervous faculties, such as sensation. The question is then how the nervous mechanical body exercised its function according to Descartes.

Next to the brain and nerves, the main components of the Cartesian nervous body machine are the heart, the blood, and the animal spirits. In the Cartesian scheme, the heart enriches and heats up the blood, thus producing a refined and more agitated version of particles, the finest of which eventually pass through the carotid artery to the brain where the blood's particles become animal spirits, "a certain very fine wind, or rather a very lively and pure flame."²²⁰ Once separated from the blood, the animal spirits pass through the pineal gland and/or the cerebral cavities (depending on the strength of sensual input and the functions to be exercised) and back into the body. The pineal gland was an important anatomical component of Descartes' model of the brain, as it was not only the place where the rational soul connected with the body, but was also held responsible for what he thought were corporeally conceived mental faculties such as imagination, memory and body-related passions, such as hunger, thirst, pain and emotions. Though he generally seized on traditional and current anatomical theory regarding the location and function of the pineal gland, Descartes' brain anatomy did not agree with facts as they were known at that time. Hiram Caton goes even as far as to say that "the histology is sheer invention."²²¹ Descartes, for example, gave the pineal gland an intraventricular position, even though it had been identified as an appendage sitting outside the brain's ventricles since the time of Galen.²²² Its supply with animal spirits via an arterial network had also been refuted, due to the fact that veins, rather than arteries, surround

²²⁰ See Descartes, *Treatise on Man*, [PWD I], p. 100; see also *Descriptions of the Human Body*, [PWD I], pp. 316-319; *Discourse on the Method* V, [PWD I], pp. 134-139; and *The Passions of the Soul*, [PWD I], pp. 331-332.

²²¹ Hiram Caton, *The Origin of Subjectivity. An Essay on Descartes* (New Haven and London: Yale University Press, 1973), p. 90.

²²² See Descartes, *The Passions of the Soul*, [PWD I], p. 340; and C.U.M. Smith, 'Descartes' Pineal Neuropsychology' (*Brain and Cognition* 36 (1998), pp. 57-72).

the gland. Thirdly, his belief that animal spirits inflated the ventricles opposed the observation that the ventricles were filled with fluid, as had been discovered by the Renaissance anatomist Niccoló Massa (1485-1569) a century before.²²³ Descartes' reasoning about the pineal gland was therefore purely deductive in the sense that his anatomical thought was adapted to fit his theory. His argument that the pineal gland was the seat of the soul required its location in the centre of the brain (he also chose it because he thought it was, like the soul, the only single and undivided structure in the brain).²²⁴ According to Descartes, the brain's tissue also consisted of pores which dilated once the animal spirits entered them. Depending on the disposition of the brain and the force of the entering animal spirits, different nerve tubes were then activated. Through these the spirits flowed back to execute certain functions, for instance inflating or contracting muscles for the movement of limbs. In true mechanical fashion, Descartes likened the nervous body machine to a water fountain:

Indeed, one may compare the nerves of the machine I am describing with the pipes in the works of [water] fountains, its muscles and tendons with the various devices and springs which serve to set them in motion, its animal spirits with the water which drives them, the heart with the source of the water, and the cavities of the brain with the storage tanks. [...] External objects, which by their mere presence stimulate the sense organs and thereby cause [the spirits] to move in many different ways depending on how the parts of its brain are disposed, are like visitors who enter the grottos of these fountains and unwittingly cause the movements which take place before their eyes. [...] And finally, when a rational soul is present in this machine it will have its principal seat in the brain, and reside there like the fountain-keeper who must be stationed at the tanks to which the fountain's pipes return if he wants to produce, or prevent, or change their movements in some way [...]

At the centre of Descartes' body-machine analogy stood his conception of automatic, i.e. involuntary, movement, which in some cases was due to "reflected spirits",²²⁶ which often

²²³ See also Gert-Jan Lokhorst, 'Descartes and the Pineal Gland' in the *Stanford Encyclopedia of Philosophy* (Spring 2009 Edition), Edward N. Zalta (ed.), URL= <<http://plato.stanford.edu/archives/spr2009/entries/pineal-gland/>>.

²²⁴ See Descartes, *Letter to Mersenne*, 30 July 1640, [PWD III], p. 149; and *The Passions of the Soul*, [PWD I], p. 340.

²²⁵ Descartes, *Treatise on Man*, [PWD I], pp. 100-101.

²²⁶ See Descartes, *Passions of the Soul*, [PWD I], p. 342.

prompts historians to see this as one of the first accounts of reflex action.²²⁷ The decisive feature of this aspect of behaviour was the lack of intervention from the soul, and in order to emphasise this, he naturally invoked a comparison with animal behaviour:

Thus every movement we make without any contribution from our will – as often happens when we breathe, walk, eat and, indeed, when we perform any action which is common to us and the beasts – depends solely on the arrangement of our limbs, and on the route which the spirits, produced by the heart, follow naturally in the brain, nerves and muscles. This occurs in the same way as the movement of a watch is produced by the strength of its spring and the configuration of its wheels.²²⁸

Overall, however, his neuro-cerebral model must be seen as a mere vehicle for the elaboration of ideas which, though it utilised the empirical knowledge of the day, did not actually contribute to a fuller understanding of anatomical structures and physiological knowledge.²²⁹ Despite his interest in medicine and his strong belief that his mechanical philosophy of the body would prove valuable for further anatomical and medical research, Descartes' overall goal was to put the human soul centre-stage. Furthermore, his enthusiasm for dissecting a variety of animals should not conceal the fact that his anatomical research had not been conducted on the same scale as that of other fully committed anatomists at the time.²³⁰ The comments he addressed to his readers betray that the level of anatomical and experimental investigation that Descartes engaged with did probably not exceed those of other interested members of a learned society, and that minor anatomical investigations must have been fairly frequent at the time: “Indeed, we have all at some time or other seen various animals cut open, and been able to look at the shape and arrangement of their insides, which

²²⁷ See Rey, *The History of Pain*, p. 77.

²²⁸ Descartes, *Passions of the Soul*, [PWD I], p. 335.

²²⁹ Hiram Caton claims that it actually “outstripped” the current anatomical and physiological knowledge; see *The Origin of Subjectivity*, p. 91.

²³⁰ By contrast, Annie Bitbol-Hespériès rejects the idea of Descartes as an amateur in medicine and anatomy, and underlines her claim by mentioning that he had “read many books and performed many experiments”, as well as “the letters that fully qualified physicians wrote to Descartes about medical problems.” She even places Descartes “in a continuous line in the development of anatomy from Vesalius onwards;” idem, ‘Cartesian Physiology’, p. 352 and 353.

very much resemble our own. This is all the anatomy that the reader will need to have studied in order to understand this book.”²³¹

It was his philosophy that, first and foremost, had guided his anatomical gaze, though admittedly this was also sometimes the case with full-time anatomists, as we will see in later chapters. Despite his being the first serious attempt to localise brain functions, Descartes laid greater emphasis on his philosophical scheme, the inconsistencies of which could not be solved anatomically or experimentally. For instance, the Cartesian model seems at first to suggest that all sensation arises in the brain and that the sense organs are mere conductors of stimuli from the outside world. In fact, Descartes’ overall claim regarding the inertness of matter should have allowed no exemption from automatism, i.e. *all* functions of the brain, nerves and animal spirits ought to have been understood as working according to mechanical principles.

The confusion that generally arises over Descartes’ arguments and writings stems from his anatomically unproven claim that the soul was somehow seated in the brain and ultimately relied on corporeal mechanisms to intervene in its functions, but also that a fair share of equally unobservable ‘mental’ faculties, such as imagination, memory, and the passions, were included under the heading of ‘body machine’. Some modern historians and philosophers therefore claim that, strictly speaking, ‘thought’ should also have been included under the category of *res extensa*, despite Descartes’ assertions to the contrary elsewhere in his writings.²³² Others, such as John Cottingham have begun to speak of a Cartesian *trialism* instead.²³³ As Caton summarises the perplexity of modern, but also contemporary, philosophers: “The paradox it poses is this: it seems that men and animals pursue and avoid things because of their perceptions and volitions, whereas Descartes’ theory needs to affirm that the appearance of psychic causation is mere appearance, behind which lies a real

²³¹ Descartes, *Descriptions of the Human Body*, [PWD I], p. 315.

²³² See, for instance, Caton, *The Origin of Subjectivity*, p. 90.

²³³ See John Cottingham, ‘Cartesian Trialism’ (*Mind* (New Series) 94: 374, pp. 218-230).

mechanical cause.”²³⁴ The fact that Descartes allocated sensation to the *res cogitans* complicated matters further. In any event, the implications for the Cartesian conception of the human-animal boundary have always rested on the different interpretations of what Descartes really meant, which has been the source of ongoing debates among (natural) historians and philosophers since the time of Descartes, which I briefly discuss in the next section.

Though his account of visual perception, including ocular anatomy and physiology, is the most sophisticated and comprehensive one (possibly because visual sense perception was easier to explain in mechanist terms than, for instance, the sensation and perception of touch), I will now focus on Descartes’ theorising about the sensation of pain. This is partly because his theorising about the phenomenon of pain is more revealing in terms of the aforementioned inconsistencies of his mind-body dualism, but also because the implied human-animal difference regarding sense perception is more pronounced.

2.1.2. The Problem of Pain

In the *Treatise on Man*, Descartes chose the example of pain, not because pain perception could easily be explained, but because it seemed to illustrate especially well the machine-like responses of the body to a stimulus from the outside world. This is exemplified by the well-known image of the naked boy withdrawing his foot from the flames, which is less about the feeling of pain than the body’s response to it.

²³⁴ Caton, *The Origin of Subjectivity*, p. 90.



Descartes: The path of burning pain. Comme elle est incitée par les objets extérieurs à se mouvoir en plusieurs manières. Wellcome Library, London.²³⁵

The transmission of a painful stimulus to the brain is here depicted and described as a thread, reaching from the foot to the brain, which is being pulled, and it is here that the famous similes of rope and church bell are mentioned.²³⁶ Gaukroger maintains that it is not clear whether the pineal gland – the ‘sensorium commune’ involved in the perception of bodily sensation – is actually involved at all; so, according to him there is no reason to believe that the picture depicts anything other than a purely automatic response. He argues in fact that the structure (F) depicted in the head of the boy is not the pineal gland, but literally only a cavity (therefore, in Descartes’ vision, a mere ‘storage tank’ for the animal spirits). Indeed, the illustration had not been made by Descartes himself, but had been drawn posthumously before the publication of the text, “so we cannot place too much weight on how things appear in the illustration.”²³⁷ One could argue that it would have served Descartes’ purely mechanical account of an automatic response to a stimulus even better, had the illustration depicted an animal. But even if (F) were the pineal gland, it would not necessarily evoke an

²³⁵ This image has originally been printed in Descartes, *L’Homme ... et un Traitté de la Formation du Foetus. Du Mesme Auteur. Avec les Remarques de Luys de la Forge ... sur le Traitté de l’Homme*. Edited by Claude Clerselier with his preface and that of Florentius Schuyf. First edition published in 1662 in Latin under title: *De homine* (Paris: Charles Angot, 1664), p. 27. Wellcome Library London.

²³⁶ See Descartes, *Treatise on Man*, [PWD I], p. 101.

²³⁷ Gaukroger, Descartes, p. 281: see also Smith, ‘Descartes’ Pineal Neuropsychology’, p. 61.

intervention from the soul, because the pineal gland had in fact two functions: it was not only the ‘switch organ’ for the transformation of bodily sensation into mental awareness, but also the place where sensual impressions of any kind were ‘represented’ in corporeal terms, which in some cases resulted in the formation of memory, due to its factual impression in the folds and filaments of the brain. Similar to Pereira’s vision, memory in the Cartesian scheme is a corporeal business depending on the brain’s folds and therefore not a mental capacity that required consciousness or the soul. The said folds and filaments in the brain are shaped by experience moulding the patterns and pores of the brain tissue, so that old motions can be reconstructed more easily—hence the quick ‘reflex’ responses of the body.²³⁸ But the question is what stimulus would involve a *mental* representation of pain in the pineal gland.

Descartes explained it thus:

Suppose, firstly, that the tiny fibres which make up the marrow of the nerves are pulled with such force that they are broken and separated from the part of the body to which they are joined, with the result that the structure of the whole machine becomes somehow less perfect. Being pulled in this way the fibres cause a movement in the brain which gives occasion for the soul (whose place of residence must remain constant) to have the sensation of *pain*.²³⁹

Apparently, it required a forceful enough stimulus to ‘occasion the soul’ and thus have sensation, and it seems obvious that pain would have to be counted as one such stimulus.²⁴⁰

Yet, in animals, the movement of the brain was thought to bring about only the bodily responses, whereas in humans, the soul—and therefore awareness—got involved, since

[w]e know for certain that it is the soul which has sensory perceptions, and not the body. [...] And we know that it is not, properly speaking, because of its presence in the parts of the body which function as organs of the external senses that the soul has sensory perceptions, but because of its presence in the brain, where it exercises the faculty called

²³⁸ See for instance Descartes, *The Passions of the Soul*, [PWD I] pp. 343-344. See also Caton, *The Origin of Subjectivity*, p. 94.

²³⁹ Descartes, *Treatise on Man*, [PWD I], pp. 102-103; italics in the original.

²⁴⁰ See also Descartes, *Passions of the Soul*, part one, §46, [PWD I], p. 345.

the ‘common’ sense [...] We know, lastly, that it is through the nerves that the impressions formed by objects in the external parts of the body reach the soul in the brain.²⁴¹

So, sense perception without awareness is apparently the key to the riddle of the beast-machine. But how does it work? On the one hand, a physical sensation is brought about by events happening to and in the mechanical body; on the other hand, the soul is invoked for an actual sense *experience*. If sense perception therefore refers to mental perception only, then Descartes failed to offer a comprehensive account for the kind of ‘unconscious perception’ that represented itself to an animal’s brain tissue (other than the lengthy account of the interaction of brain, nerves, animal spirits and muscles). His belief that sensation was a ‘form of thought’ leaves in my opinion only one conjecture, namely the one that alludes to Pereira’s insensitive, that is soulless, animal. In a letter to Mersenne, Descartes became even more explicit:

I do not explain the feeling of pain without reference to the soul. For in my view pain exists only in the understanding. What I do explain is all the external movements which accompany this feeling in us; in animals it is these movements alone which occur, and not pain in the strict sense [...]²⁴²

Hence, the animal does not suffer simply because it cannot conceive of itself as suffering.²⁴³

Three hundred years on, C.S. Lewis, in his otherwise religious contemplations on *The Problem of Pain* (1940), made a remarkably similar statement about the way that animals ‘felt’ pain: “Their nervous system delivers all the *letters*, A, P, N, I, but since they cannot read they never build it up into the word PAIN.”²⁴⁴ In both Descartes and Lewis, the

²⁴¹ Descartes, *Optics*, [PWD I], pp. 164-165.

²⁴² Descartes, *Letter to Mersenne, 11 June 1640*, [PWD III], p. 148. In the *Discourse on the Method*, Descartes had emphasised that the essence of the *res cogitans* “does not need any place or depend on any material thing, in order to exist;” Descartes, *Discourse on the Method*, [PWD I], p. 127.

²⁴³ See also Rey, *History of Pain*, p. 78.

²⁴⁴ C.S. Lewis. *The Problem of Pain* (London: Harper Collins, 1940), p. 110; emphases in the original. Rey mentions that theologically, the pain of an animal “is at odds with Augustinian belief that “nobody suffers pointlessly,” i.e. that suffering gained its meaning only in the perspective of an ‘eternal aftermath’.

emphasis was put on the lack of sense experience, despite the analogy of the human and animal nervous system and the equal reaction to pain. In the *Treatise on Man*, Descartes may have explained pain behaviour as an automatic response in both humans and animals, but, as Rey points out,

[w]hat is novel is the interpretation of animal pain as a series of instinctive movements and reflex movements which have all the outward signs of being the same as those man associates with pain, though these are but an illusion of the senses.²⁴⁵

So far, we have identified two forms of bodily response as envisaged by Descartes: one that is exemplified by the said ‘reflex’, i.e. inflexible and wholly stimulus-driven actions covering all animal behaviour and much of human behaviour; and another that was believed to be a form of conscious action, mediated by the soul (human behaviour only).²⁴⁶ Sutton, however, also identifies intermediate forms of interaction, claiming that a soulless Cartesian body machine would not necessarily be ‘hard wired’, as the corporeal faculty of memory shows: “an automaton’s physiology changes over time. Automata with different histories, different experiences marking their brains and bodies, will [...] respond differently [...] after new experience has modified the pores and folds of its brain.”²⁴⁷ This implies that those reflex ‘pathways’ that activate simple automatisms, such as sneezing, yawning, coughing, etc., are in fact unalterable in the Cartesian understanding, but that faculties such as memory involve more complex automatisms. The latter exhibit a certain plasticity and can therefore result in the phenomenon of conditioning and the ability to learn, as had long been observed in

Scholasticism had therefore ascribed an incorporeal but mortal soul to animals, to which Descartes strongly objected because it introduced only a difference in degree between human and animal souls; see Rey, *History of Pain*, pp. 78-79.

²⁴⁵ Rey, *History of Pain*, p. 78.

²⁴⁶ Gaukroger, on the other hand, envisages four different kinds of stimulus responses in Descartes’ case scenarios: next to the two already mentioned, he identifies one that does not require a representation in the pineal gland, and another that does not result in a motor response at all; unfortunately, like Descartes, he provides no examples; see Gaukroger, *Descartes*, p. 280.

²⁴⁷ John Sutton, ‘The Body and the Brain’, in Gaukroger et al. (eds.), *Descartes’ Natural Philosophy*, pp. 696 - 722: 709.

animals. Sutton therefore concludes that a large amount of human and animal responses in the Cartesian sense were “equivalents in principle.”²⁴⁸ But the question remains whether the equivalent of pain in an animal would be a case for a simple or a more complex automatism, and whether it could in any case be void of ‘mental awareness’. As Rey further argues regarding the formation of a pain memory, “the passage where Descartes describes the “reflected spirits” of the image formed in the pineal gland does not deal at all with reflex movements but, on the contrary, concerns a well-adapted response in line with the affective experience and the individual history of the subject who has already felt the pain and fears it.”²⁴⁹ This is in fact the crux of the problem. How can a painful stimulus build up even a corporeal equivalent of memory without involving the necessary association of pain with fear, which, after all, triggers avoidance behaviour in the first place? Descartes’ other examples of bodily responses to a sensory stimulus that do not involve or require a cooperation of the soul seem to suggest that animals in general do not require an awareness of their sensations. One of these examples is visual cognition, which, as Gaukroger points out, must also take place in an animal, otherwise it would not be able to discriminate between objects.²⁵⁰ Caton likewise suggests that cognition and corporeal feeling are “coordinate principles”, arguing further that it is impossible to imagine anything without cognition, or in his words “that it is necessary to cognize extension in all that is imagined.”²⁵¹ However, as indicated above, Descartes envisaged different kinds of representation in the pineal gland - one with, the other without, awareness. In fact, in one letter he explicitly distinguished between human and animal visual representations of objects:

[a]nimals do not see as we do when we are aware that we see, but only as we do when our mind is elsewhere. In such a case images of external objects are depicted on our

²⁴⁸ Sutton, ‘The Body and the Brain’, p. 710.

²⁴⁹ Rey, *History of Pain*, p. 77.

²⁵⁰ See Gaukroger, *Descartes*, p. 282.

²⁵¹ See Caton, *The Origin of Subjectivity*, p. 95

retinas, and perhaps the impressions that they make in the optic nerves cause our limbs to make various movements, although we are quite unaware of them. In such a case we too move just like automata [...].²⁵²

It is, however, questionable whether this familiar example of ‘absent-mindedness’ in humans can be applied to the sensation of pain in an animal, i.e. whether it is possible for a living being to be ‘unaware’ of such a strong sensual input as pain. If not, is even the above-cited example of non-cognitive visual experience applicable to animal sense experience in general? As it was, the sensation of pain proved to be an exception to Descartes’ general differentiation of sensual input resulting in either an automatic response, or a mental reflection cum voluntary movement. That is, Descartes could not uphold the strict separation of pain as ‘understanding’ (through the *res cogitans*) and automatic response (via the *res extensa*) in his writings. In the *Sixth Meditation*, for instance, Descartes chose the example of pain yet again, but this time it served to underline the *unity* of body and mind.

Nature also teaches me, by these sensations of pain, hunger, thirst and so on, that I am not merely present in my body as a sailor is present in a ship, but that I am very closely joined, and as it were intermingled, with it, so that I and the body form a unit. If this were not so, I, who am nothing but a thinking thing, would not feel pain when the body was hurt, but would perceive the damage purely by the intellect, just as a sailor perceives by sight if anything in his ship is broken. Similarly, when the body needed food or drink, I should have an explicit understanding of the fact, instead of having confused sensations of hunger and thirst. For these sensations of hunger, thirst, pain and so on are nothing but confused modes of thinking which arise from the union and, as it were, intermingling, of the mind with the body.²⁵³

So here, pain served as an example to show that body and soul were *not* operating in isolation, but interacting with each other, though Descartes did not provide an explanation as to how the connection between two completely different substances (*res cogitans* and *res extensa*) worked in the perception of pain. It is interesting to note that this particular problem

²⁵² Descartes, *Letter To Plempius for Fromondus*, 3 October 1637, [PWD III], pp.61-62.

²⁵³ Descartes, *Sixth Meditation*, [PWD II], p. 56. Note that the analogy to a ship also occurs in Aristotle’s *On the Soul* (I: III); instead of the Cartesian sailor, having stronger connotations of the ‘I’’s potential control of the ship/body, Aristotle had used the more passive metaphor of passenger.

persists, as even modern- day neurophysiologists remain unable to explain how a purely mental event is immediately converted into the purely physical event of movement – which might or might not be a lasting legacy of Cartesian philosophy.²⁵⁴ However, had Descartes allowed sense perception to be a faculty of the body (as in the traditional concept of the sensitive soul), his account of the interaction of animal spirits with the brain and nerves could have been kept wholly separate from the rational soul. As it was, he explicitly attributed them to the immaterial *res cogitans*, “that is to say that it understands, wills, imagines, remembers and has sensory perceptions, *for all these functions are kinds of thought*,”²⁵⁵ and with this conjured up not only the well-known mind-body problem, but also the problem of unconscious sensation, both of which remained a subject of contention for everyone involved in future investigations of the nervous system. As indicated above, Descartes exacerbated the problem by invoking at times the unity of soul and body to discuss specific examples of sensation and movement, despite his overall emphasis on the independence of the *res cogitans* from the *res extensa*. In his treatise *Descriptions of the Human Body*, for instance, Descartes used the example of nerve injury as proof that even voluntary movement required

²⁵⁴ See here Grant Duncan, ‘Mind-Body Dualism and the Biopsychosocial Model of Pain: What did Descartes really say?’ (*Journal of Medicine and Philosophy*, 25:4 (2000), pp. 485-513). As for the specific case of pain, modern-day physiologists nonetheless claim that Descartes’ “purely deductive theory of pain physiology, devoid of any empiric evidence, influenced the study and treatment of pain for more than three centuries;” see Benini and DeLeo, ‘René Descartes’ Physiology of Pain’, p. 2115. Since Descartes viewed the transmission of sensation as travelling through a single channel from the respective area of the skin to the brain – that is via the animal spirits flowing through the nerves that he envisaged as hollow tubes – he also figured that the cutting of the respective pathway could alleviate pain. In modern terms, Descartes’ theory is understood as ‘specificity pain theory’, which supported Descartes’ propositional remedy of cutting the specific nerves. This theory was valid until Ronald Melzack and Patrick Wall – the famous founders of the McGill Pain Questionnaire – proposed the ‘gate- control theory’ in 1965, with which the modern treatment of pain began; see their respective joint article, ‘Pain Mechanism: A New Theory’ (*Science* 150: 699 (1965), pp. 971-979). This new theory maintains that the processing of pain is not the simple stimulus-response paradigm described by Descartes, but rather a highly integrated event consisting of various aspects: the sensory, discriminative aspect; the cognitive, evaluative aspect; and the motivational, affective aspect. Pain physiology as such is of course mostly based on animal experimentation. Melzack and Wall, however, have been mostly working with patients, which might have prompted the focus on the ‘cognitive’ and emotional components of pain and the move away from a purely physiological account in the Cartesian sense.

²⁵⁵ Descartes, *Descriptions of the Human Body*, [PWD I], p. 314; my italics. See also the *Principles of Philosophy*, where he not only stated once more that, “*thinking* is to be identified here not merely with understanding, willing and imagining, but also with sensory awareness;”([PWD I], p. 195; italics in the original); but identifies thought as the true constituent of humans, for “we see very clearly that neither extension nor shape nor local motion, nor anything of this kind which is attributable to a body [and therefore to an animal], belongs to our nature, but that thought alone belongs to it;” § 8, [PWD I], p. 195.

“the disposition of the organs,”²⁵⁶ and that without the healthy disposition of the body, even the soul was not able to initiate an interaction of the body with the environment. Like Aristotle, Descartes could not explicitly determine to what degree the soul relied on the sense organs or vice versa in order to produce sense perception, despite its declared independence from bodily matter (see Ch. 1.1.).

In any case, by situating the site of the interaction of mind and body in a particular place in the brain, Descartes upheld or else reinvigorated the brain-centred view of the body that determined subsequent research on the localization of cerebral functions. Such research was put into practice by the likes of Willis and subsequent anatomists,²⁵⁷ but the intrinsic difficulty of proving or at least explaining the potential difference in sense experience for animals and humans remained unresolved. Moreover, the possible existence of only one soul that was unique to humans opened up enquiries as to how animals ‘felt’, and how their reactions to a stimulus occurred without any kind of mediating consciousness. As the earlier concept of the corporeality and division of the soul was revisited in later anatomical investigations, we can conclude that the Cartesian denial of animal souls was not to everyone’s satisfaction. The more holistically operating sensitive soul allowed for the notion of pain awareness as corporeal protection in both humans and animals without having to split bodily perception and mental awareness of sense experience.

Overall, despite Descartes’ avowed separation of mind and matter, the difficulty of where to place sensory perception in the Cartesian framework persisted because “it is neither straightforwardly bodily nor straight forwardly intellectual,”²⁵⁸ which contributed to the fact that his opponents also remained unconvinced that animals were completely void of the

²⁵⁶ Descartes, *Descriptions of the Human Body*, [PWD I], p. 315.

²⁵⁷ See also Rey, *History of Pain*, p. 75. The *sensorium commune*, which Descartes located in the pineal gland, would have a long history, and the search for it would go on for most of the eighteenth century; see, for instance, Michael Hagner, *Homo cerebrialis- Der Wandel vom Seelenorgan zum Gehirn*, Frankfurt am Main and Leipzig, 2000 (first 1997).

²⁵⁸ Gaukroger, *Descartes*, p. 351.

subjective *feeling* of sensation. Furthermore, if both human and animal bodies functioned according to the same automatisms, who was to say that only humans required something superadded to their corporeal frame? In any case, “[i]n the analogy between man and animals, the pain which the latter could experience either raised it to the level of man or else reduced man down to the level of the animal: in both cases, man lost his position in nature at the centre and head of creation.”²⁵⁹ Nonetheless, from the Cartesian point of view, depriving animals of souls and sense experience altogether seemed the safer option for constituting the human.

There are admittedly a variety of inferences that can be drawn from Descartes’ writings about the beast and body-machine, but regarding what would become the most fundamental property of living bodies a century later—sensation—Descartes attempted to invoke a difference between humans and animals that in my opinion allows no other interpretation than that an animal’s sense perception as well as its responses were purely mechanical and automatic. That this notion is contested by modern historians and philosophers will be discussed in the next section. Afterwards, a discussion of the response of Descartes’ contemporaries to the notion of the beast- and body machine reveals that the intrinsic difficulties in Cartesian philosophy had already been acknowledged and discussed in the seventeenth century.

²⁵⁹ Rey, *History of Pain*, p. 79.

2.1.3. “What did Descartes really say?” – Debates and Responses to the Concept of the Cartesian Beast-Machine

It is no coincidence that most of the confusion of past and present philosophers result from Descartes’ constant reference to animals to underline the *differentiae specificae* of humans. Gaukroger exemplifies this with a list of (unresolved) questions:

Is he saying that the structure and behaviour of bodies are to be explained in the same way that we explain the structure and behaviour of machines, or that bodies actually are machines? Does he want to show how (a form of) genuine cognition occurs in animals and that this can be captured in mechanistic terms, or does he want to show that cognition does not occur at all, that *instead of* a cognitive process we have a merely mechanical one? In short, does he want to explain animal cognition or explain it away?²⁶⁰

The (in)famous doctrine of the Cartesian beast-machine is admittedly attractive for explaining the low status of animals throughout history, but some historians and philosophers have argued against the standard view and interpretation of Descartes’ philosophy as “the best possible rationalization for the way man actually treated animals.”²⁶¹ Caton, for instance, claims that the doctrine of the beast-machine was not a negative thesis about what animals lack, but rather a positive theory of motions observed in animals (and humans): “Instead of disparaging animals, it is meant to express the proud confidence that mechanism suffices to explain all the behaviour of animals without any diminution or reservation.”²⁶² Considering the extent to which Descartes dwelt on the abilities of the human soul in order to rebalance the downgrading of human nature that was inevitably associated with the mechanical body, it is not easy to see how the avowed absence of the soul in animals, i.e. their reduction to a body machine, could bring forward a positive theory of their behaviour. However, John Cottingham and, more recently Katherine Morris, likewise argue that a close reading of

²⁶⁰ Gaukroger, *Descartes*, p. 279; italics in the original.

²⁶¹ Thomas, *Man and the Natural World*, p. 34.

²⁶² Caton, *Origins of Subjectivity*, p. 39.

Descartes by no means evokes the ‘monstrous’ view generally ascribed to him. Viewing the Cartesian theory of the animal-machine as too ‘vague and ambiguous’ to be held responsible for such a wide-ranging conclusion, both analysed Cartesian philosophy against these mainstream assertions. Cottingham’s overall conclusion is that the proposition “X is an automaton” does not infer that “X is incapable of feeling.”²⁶³ Morris delivers a similar verdict, based on the claim that the mostly ‘Anglophone misunderstandings’ are the result of a change of concepts over time and/or subtle differences in Descartes’ and our modern use of them (e.g. regarding the concepts of ‘thought’, ‘consciousness’, ‘sentience’, ‘feeling’, and ‘sensation’).²⁶⁴ However, as I hope to show in the next section, the conceived vagueness and ambiguity of Descartes’ use of these terms has been a historical constant, that is, even his contemporaries had commented on Descartes’ “fuzziness”²⁶⁵ about the assertion that animals have no sense experience.

The crucial question for philosophers and historians alike is therefore whether Descartes’ special sense of cogitation really includes an awareness of feelings and sensations. According to Cottingham, there is general agreement that Descartes equated thinking (*cogitare* or *penser* respectively) with “toutes les operations de l’âme”²⁶⁶, which includes operations of the will as well as operations of the senses, such as seeing and hearing. To Cottingham, though, there remains an ambiguity when it comes to feeling sensation in general. His conclusion with regard to the proposition that ‘animals do not think’ is that, although Descartes denied animals any sort of cognition, he admitted to them the feeling of sensations, albeit on a level “that falls short of reflective mental awareness.”²⁶⁷ As I indicated above, this does not

²⁶³ Cottingham, ‘A Brute to the Brutes?: Descartes’ Treatment of Animals’ (*Philosophy* 53 (1978), pp. 551-559), p. 553.

²⁶⁴ Katherine Morris, ‘Bêtes-Machines’, in Gaukroger et al. (eds.), *Descartes’ Natural Philosophy*, pp. 401-419.

²⁶⁵ Cottingham, ‘A Brute to the Brutes’, p. 552.

²⁶⁶ As mentioned in a letter to Mersenne in May 1637, [AT I, p. 366].

²⁶⁷ Cottingham, ‘A Brute to the Brutes’, p. 556. See also Morris, ‘Bêtes-Machines’, pp. 402-404. Cottingham argues further that Descartes’ main argument for the absence of consciousness in animals is based on the absence of language – ‘non loquitur ergo non cogitat’ [see also AT VII, p. 246]; and that if he had wanted to

actually resolve the problem at hand, but instead conjures up yet another one, i.e. the paradox of ‘unconscious sensation’. In my opinion, this Cartesian notion of unconscious or non-reflective sensation remains a contradiction in terms, and one is missing in Cottingham’s and Morris’ discussions an actual conceptualisation of this Cartesian concept of a sensation without awareness in cases such as pain.

Having allegedly undone the thesis that Descartes denied ‘feeling’ to animals (without differentiating here between physical sensation and the mental awareness of it, or without explaining how sensation without awareness should be understood), Cottingham then turns to some positive evidence that Descartes actually regarded the statement ‘animals do not feel’ as false. He quotes from letters to the Marquis of Newcastle in which Descartes contemplated the absence of real language in animals, despite acknowledging a form of communication in them. The important parts of these letters, for Cottingham, refer to the animals’ “[i]mpulses of anger, fear, hunger; [and] expression of one of its feelings.”²⁶⁸ As for these passions, Descartes did in fact differentiate between their human and animal versions, that is, regarding human responses to anger, fear or hunger, he stated that “[t]he same may be observed in animals. For although they lack reason, and perhaps even thought, all the movements of the spirits and of the gland which produce passions in us are nevertheless present in them too, *though in them they serve to maintain and strengthen only the movements of the nerves and the muscles which usually accompany the passions and not, as in us, the passions themselves.*”²⁶⁹ Just because the passions were of bodily, hence mechanical, origin, this did not automatically equate human and animal passions since, as with the sensation of pain, an animal’s passions were reduced to the above-described mechanisms. This, I would argue, is decisively undoing the contention that Descartes ascribed feeling, which Descartes ascribed

include the component of sense experience in this equation, he would have written something like ‘non loquitur ergo non sentit;’ *ibid.*, p. 556.

²⁶⁸ Cottingham, ‘A Brute to the Brutes’, p. 557; the quote is originally taken from AT IV, p. 574.

²⁶⁹ Descartes, *Passions of the Soul*, part one § 49, [PWD I], p. 348; my italics.

to the passions, to animals; if anything, the separation of cogitation from bodily sensation, as expressed in a letter to Henry More (see below), rather serves to underline the fundamental difference of human and animal sense experience. Cottingham acknowledges this by pointing out that the strict separation of *res extensa* and *res cogitans* seems to turn an animal's feeling of hunger into nothing more than "a set of internal muscle contractions leading to the jerking of certain limbs, or whatever."²⁷⁰ Yet, he maintains that "to say that X is in pain (angry, joyful) is certainly to attribute a conscious state to X; but this need not amount to a full-blooded reflective awareness of pain that is involved in the term *cogitatio*."²⁷¹ Such unresolved paradoxes are intrinsic in Cartesian metaphysics as a whole, which Cottingham quite rightly terms "a philosophical mess."²⁷² The fact that Descartes himself began at some point to put more emphasis on the unity of body and mind is for Cottingham proof that he was evidently no longer comfortable with his formerly proposed strict dualism.

Unsurprisingly, Cottingham takes the example of pain to underline this, in which "an inevitable 'conjunctio et quasi permixtio' between mind and body prevails – "a mysterious 'intermingling' of what are, remember, logically distinct and incompatible substances."²⁷³ He concludes that "[f]eelings, in other words, are an inexplicable result of the animal side of our nature, our mysterious intermingling with *res extensa*. If this is what Descartes says about human feelings, it is not surprising that he never got animal feelings properly sorted out."²⁷⁴

²⁷⁰ Cottingham, 'A Brute to the Brutes', p. 557.

²⁷¹ Ibid., p. 558.

²⁷² Cottingham refers here to a chapter on human *sensus* and *affectus* in Book IV of the *Principles* which speaks of two different kind of feelings: *pura cogitatio* – intellectual apprehension and *laetitia animalis* (example of joy bound to brain commotions and heart muscles); see Cottingham, 'A Brute to the Brutes', p. 558. In an article of the same year (but slightly earlier), Cottingham had devoted his attention specifically to Descartes' notion of 'thought'; see Cottingham, 'Descartes on 'Thought'' (*The Philosophical Quarterly* 28: 112 (Jul. 1978), pp. 208-214). See also Brian Cummings, who discusses the passions in early modern discourses as an "uneasy borderland between the mental and the bodily, the rational and the physiological, the intellectual and the appetitive"; idem, 'Animal Passions and Human Sciences: Shame, Blushing and Nakedness in Early Modern Europe and the New World', in Erica Fudge, Ruth Gilbert and Susan Wiseman (eds.) *At the Borders of the Human: Beasts, Bodies and Natural Philosophy in the Early Modern Period* (Basingstoke: MacMillan Press LTD, 1999, pp. 26-50), p. 26.

²⁷³ Cottingham, 'A Brute to the Brutes', p. 558.

²⁷⁴ Ibid., p. 559. It is interesting to note that in the later, now frequently used, translations in *Philosophical Writings of Descartes*, Cottingham replaced the word 'feeling' with 'sensory perceptions'. This slight, but

In any way, Descartes' account of how sensation is felt is interesting for its implications that the physical and the psychological aspects of human nature could apparently not be contemplated and investigated without a constant comparison to its animal counterpart. As Gaukroger pinpoints it, "[a]nd what better way is there to explain this, than to envisage something over and above the corporeal faculties that underlies the difference?"²⁷⁵

Unfortunately, Descartes never wrote the part on the rational soul that he referred to in his writings.²⁷⁶ The *Treatise on Man* breaks off before that intended part was written, which is why we do not know much about the exact part that the soul plays in cognition. But even so, it is clear that for Descartes, the *res cogitans* not only played a distinctive role in (human) cognition and sensation, but was also identified as the fundamental *differentia specifica* that separated humans from animals. His contemporaries, however, did not necessarily agree with him.

Prior to the publication of the *Meditations on First Philosophy* in 1641 (originally written between 1638 and 1640), Descartes had circulated them among friends and fellow philosophers for further comments and criticisms. The responses amounted to six sets of *Objections* which were published together with the *Meditations* themselves; the second edition of 1642 included an additional set of *Objections* and Descartes' *Replies* to all of them.²⁷⁷ In the *Meditations*, Descartes had put forward his way of philosophising about the existence of God, the soul and, crucially, about the distinction between body and mind played out via a comparison of humans with animals. The *Objections* engage with these subjects to varying degrees, and in the following discussion I will focus on those parts that are specifically preoccupied with the authors' understanding of the difference between humans and animals that stand in contrast to Descartes' theory of the beast-machine.

fundamental change in translation captures more than anything the difficulty of ascribing meaning to the terms Descartes applied in his writings.

²⁷⁵ Gaukroger, *Descartes*, p. 290.

²⁷⁶ See Descartes, *Treatise on Man*, [PWD I] p. 107; and Robert Stoothoff's preface to it, [PWD I], p. 79.

²⁷⁷ See Cottingham, 'Translator's preface to *Objections and Replies*', [PWD II], pp. 63-65.

In fact, apart from the *First Set of Objections* which tackles theological questions (regarding the existence of God), nearly all sets of objections use the case of animals to clarify questions about Descartes' mechanist thought, or else to counter his arguments. The *Second Set of Objections*, though it does not address the subject of humans versus animals directly, conjures up problems intrinsic in the Cartesian body- and beast- machine concept by asking questions that became a recurrent theme in subsequent debates on the human-animal boundary:

The position so far is that you recognize that you are a thinking thing, but you do not know what this thinking thing is. What if it turned out to be a body which, by its various motions and encounters, produces what we call thought? [...] How do you demonstrate that a body is incapable of thinking, or that corporeal motions are not in fact thought? The whole system of your body, which you think you have excluded, or else some of its parts – for example those which make up the brain – may combine to produce the motions which we call thoughts. You say 'I am a thinking thing'; but how do you know that you are not a corporeal motion, or a body which is in motion?²⁷⁸

The implicit query as to how much of the soul's faculties could and should be ascribed to the brain, nerves and bodily tissue in general, not only determined how subsequent (neuro)anatomists went about their research, including the extent to which they relied on animal models. The potential answers had fundamental philosophical (and theological) implications for the human-animal boundary: if matter produced thought, who was to say that an animal's body-machine could not likewise produce a corporeal equivalent to mind? On the other hand, why not assume that physical laws could also explain the human mind, which would likewise make the question of the human-animal difference on this account one of degree rather than kind. And if that was the case, the fundamental question remained as to what *differentia specifica* of the human soul was left to determine a fundamental difference to

²⁷⁸ *Second Set of Objections*, [PWD II], pp. 87-88. The *Second Set of Objections* are simply attributed to 'theologians and philosophers' in the index to the first edition. The French edition of 1647 further mentions that these were collected by Mersenne; see Cottingham, 'Translator's preface to the Objections and Replies', [PWD II], p. 64. Cottingham suggests that the *Second Set of Objections* were in fact largely written by Mersenne himself.

animals. The above objection to Descartes' theory thus shows how important the brain as the exemplified source of motion, sensation—and potentially thought—had become in overall enquiries about human nature.²⁷⁹ Towards the end of the *Second Set*, the respective philosopher therefore emphasised that Descartes needed to provide more substantial proof that the mind/soul was wholly distinct from the body in order to “counter those people, themselves unworthy of immortality, who utterly deny and even perhaps despise it.”²⁸⁰ In his reply, Descartes admitted that he had not been entirely sure “whether this thinking thing is identical with the body or with something different from the body.”²⁸¹ But, since the mind was so much better known to him than the body, he firmly believed that all things corporeal could be doubted more readily than thoughts.²⁸² Descartes simply repeated in this reply what he had written in his *Meditations* and elsewhere, a strategy that he continued to use whenever he was confronted with criticisms of his philosophy.

If a critic ventured too far from Descartes' proposed philosophical axioms, his replies became dismissive and impatient. Such is the case with the *Third Set of Objections* which might, however, have more to do with Descartes' contempt for the author. They were written by the well-known English philosopher Thomas Hobbes (1588-1679) whose own extreme version of mechanical philosophy, first put publicly forward in his book *Leviathan* (1651), was to confirm the worst nightmares of the afore-cited author of the *Second Set of Objections*, namely that mechanical philosophy might bring forward people ‘themselves unworthy of

²⁷⁹ See here also Elfed Huw Price, *The Emergence of the Doctrine of the ‘Sentient Brain’ in Britain, 1650-1850* (unpublished PhD thesis Oxford, 2005). I thank the author for sending me his thesis.

²⁸⁰ *Second Set of Objections*, [PWD II], p. 91. One such example was the Leveller Richard Overton (c.1599-1664) whose tract *Man's Mortallitie* (1644), an enlarged version appeared in 1655 under the title *Man Wholly Mortal*, in which he opposed the concept of the immortal soul and its importance in constituting humanity. Overton's proposed materialism has fascinating implications for the way that the difference between humans and animals would have been conceived had his ideas gained more influence; for more, see Fudge, who discusses Overton's work in chapter 6 of *Perceiving Animals*, pp. 143-166.

²⁸¹ Descartes, *Author's Replies to the Second Set of Objections*, [PWD II], pp. 93-94. Crucially, there is evidence that his contemporaries were also puzzled by the way that Descartes referred to himself as a ‘thinking thing’; one example is Mersenne to whom Descartes had to explain that “willing, understanding, imagining and sensing and so on are just different ways of thinking, and all belong to the soul;” *Letter To Mersenne, End of May 1637*, [PWD III], p. 56.

²⁸² *Ibid.*, p. 94.

immortality, who utterly deny and even perhaps despise [the soul].’ In his objections, Hobbes got straight to the core of a familiar problem regarding the interpretation of animal behaviour by voicing his doubt that human reactions (choosing the example of fear and flight) differed from those of animals simply because humans had added thoughts.²⁸³ He was in tune with Descartes about the recourse to mechanical principles in explaining sense perception, but went one step further by declaring sentience as purely organic in men and animals alike.²⁸⁴ Unfortunately, Descartes’ dismissive reply does not engage with this particular objection other than stating that, “[i]t is self-evident that seeing a lion and at the same time being afraid of it is different from simply seeing it. And seeing a man run is different from silently affirming to oneself that one sees him. I see nothing here that needs answering.”²⁸⁵ Nonetheless, earlier on, the alleged fallacy of Descartes’ reasoning had prompted Hobbes to maintain that “the thinking thing is material rather than immaterial,”²⁸⁶ implying further that the soul is just something whose existence we infer by means of reasoning, not something that we can be sure exists.²⁸⁷ At some point, Descartes referred to Hobbes’ thinking as “a

²⁸³ *Third Set of Objections* by Hobbes, [PWD II], p. 128. In the *Leviathan*, Hobbes elaborated on this and differentiated between various kinds of thoughts; according to him, the reason why humans excel in some faculties of the mind has to do with mental improvement due to instruction and discipline (and therefore does not apply to all members of humanity). Thus, the difference between the animal and human ability to think is one of degree only; see Thomas Hobbes, *Leviathan, Or The Matter, Form, and Power Of a Common-Wealth Ecclesiastical and Civil* (London: Printed for Andrew Crooke, 1651); see especially the third chapter of part one, pp. 8-11, and chapter eight, p. 32.

²⁸⁴ A more detailed account is found in chapter XXV, ‘Of Sense and Animal Motion’, in Hobbes’ later work *Elements of philosophy* (London: Printed by R. & W. Leybourn for Andrew Crooke, 1656; the Latin original appeared first in 1655 in London), p. 191. In this chapter, Hobbes described sense organs as “Organs of Feeling” (ibid., p. 294) and also points out that “by Sense we *commonly* understand the *judgement* we make of Objects by their Phantasmes [impressions in the brain];” ibid., p. 293; my italics. Any potential misunderstanding is ruled out when he furthermore states that “[t]he perpetually arising of Phantasmes, both in Sense and Imagination, is that which we commonly call *Discourse of the Mind*, and is common to men with other living Creatures. For he th[at] thinketh, compareth the Phantasmes that passe, that is, taketh notice of their likeness or unlikenesse to one another;” ibid., p. 297; spelling and italics in the original. It is understandable then that Descartes included sense perception under the heading of thought in order to keep the mind human, but also that readers of Hobbes and Descartes alike had particular problems with these two extreme versions of mechanist philosophy - the one depriving animals of sense experience altogether, the other equating animal cognition with those of humans.

²⁸⁵ Descartes, *Reply to the Third Set of Objections*, [PWD II] p. 128.

²⁸⁶ *Third Set of Objections*, by Hobbes [PWD II], p. 123.

²⁸⁷ Ibid., p. 129.

violation of all usage and logic” and stressed that “we can use any other term you like [for ‘thought’], provided we do not confuse this substance with corporeal substance.”²⁸⁸

Hobbes’ exchanges with Descartes hint at the various directions that mechanical philosophy could take, much to Descartes’ unease. His animosity towards Hobbes’ deviation from his own philosophical premises became even more pronounced in a letter he wrote to Mersenne after he had received Hobbes’ objections:

Now that I have read at leisure the last communication from the Englishman, I find that the opinion I had of him when I wrote to you two weeks ago is completely confirmed. I think the best thing would be for me to have nothing more to do with him, and, accordingly, to avoid answering him. [...] I beg you, moreover, not to tell him any more than you have to of what you know of my unpublished views; for unless I am very much mistaken, this is someone who is looking to acquire a reputation at my expense, and by sharp practice [...].²⁸⁹

With the *Fourth Set of Objections* we come back to another reference to the problem of the human-animal boundary, made by the French theologian and logician Antoine Arnauld (1612-1694).²⁹⁰ At one point, Arnauld’s objections suggest the wide-spread aversion to the kind of animal automatism that Descartes advocated:

As far as the souls of the brutes are concerned, M. Descartes elsewhere suggests clearly enough that they have none. All they have is a body which is constructed in a particular manner, made up of various organs in such a way that all the operations which we observe can be produced in it and by means of it. But I fear that this view will not succeed in finding acceptance in people’s minds unless it is supported by very solid arguments. For at first sight it seems incredible that it can come about, without the assistance of any soul, that the light reflected from the body of a wolf onto the eyes of a sheep should move the minute fibres of the optic nerves, and that on reaching the brain this motion should spread the animal spirits throughout the nerves in the manner necessary to precipitate the sheep’s flight.²⁹¹

²⁸⁸ Descartes, *Reply to the Third Set of Objections*, [PWD II], p. 124.

²⁸⁹ Descartes, *Letter to Mersenne, 4 March 1641*, [PWD III], p. 173. See also a Letter to Mersenne for Hobbes, dating from the 21 April of the same year, indicating that Hobbes had accused Descartes of stealing his ideas; [PWD III], p. 178.

²⁹⁰ Mersenne acted here as an intermediary to whom both, objections and replies, were sent; see Cottingham, ‘Translator’s preface to the Objections and Replies’, [PWD II], p. 64.

²⁹¹ *Fourth Set of Objections*, by Arnauld, [PWD II], p. 144.

Arnauld did not seem concerned that the animal's fear-flight reaction he just described was also supposed to explain the human mechanical body's repertoire in the Cartesian scheme. According to Descartes, such reflexive and/or instinctive reactions did not require an intervention from the soul in humans either, as the mechanical body was well equipped with everything needed to bring about such actions and reactions. Yet, because of Descartes' constant reference to animals—by way of comparison as well as exemplifying automatic behaviour—one gets the impression that in people's minds, the notion of the body-machine became the rather stringent notion of the *beast-machine*. This might explain why his readers reacted more frequently and strongly to the notion of animal automatism, than towards Descartes' account of the mechanical body per se.²⁹² Viewed in this way, Rosenfield's indicated development *From-Beast Machine to Man-Machine* seems to have been preceded first by a conceptualisation of Descartes' body-machine as a specific form of animal automatism. Descartes, in any case, dismissed the concerns of Arnauld by referring to his *Discourse on the Method*, a summary of which he provided in his reply. To this he added that, if only the focus turned to the *difference* between humans and animals, i.e. the presence versus the absence of mind,

[...] we shall be forced to conclude from this that we know of absolutely no principle of movement in animals, apart from the dispositions of their organs and the continual flow of the spirits which are produced by the heat of the heart as it rarefies the blood. We shall also see that there was no excuse for our imagining that any other principle of motion was to be found in the brutes. We made this mistake because we failed to distinguish the two principles of motion just described; and on seeing that the principle depending solely on the animal spirits and organs exists in the brutes just as it does in us, we jumped to the conclusion that the other principle, which consists in mind or thought, also exists in them. Things which we have become convinced of since our earliest years, even though they have subsequently been shown by rational arguments to be false, cannot easily be

²⁹² With the exception of theologians who were mostly concerned that mechanical philosophy might deprive even humans of a soul, for instance the Belgian theologian Libert Froidmont (1587-1653). In a letter *To Plempius for Fromondus*, 3 October 1637, Descartes mentions that Froidmont had enquired “what is the point of attributing substantial souls to animals, and goes on to say that my views will perhaps open the way for atheists to deny the presence of a rational soul even in the human body;” [PWD III], p. 62.

eradicated from our beliefs unless we give the relevant arguments our long and frequent attention.²⁹³

Considering his conviction that humans had been conditioned to nurture false beliefs and mistaken human-animal analogies, it is significant that Descartes invested much more time in replying to this particular objection. He must have felt that it was this part of his philosophy in particular that went against the common understanding of most people.²⁹⁴ Further evidence for this can be found in Descartes' correspondence, in which Descartes felt obliged to apply his 'false-belief' theory to various people.²⁹⁵

The exchange of letters between Descartes and the English philosopher Henry More (1614-1687) in the late 1640s contains probably the most famous opposition against the beast-machine doctrine.²⁹⁶ More had at first been an avowed advocate and promoter of Cartesianism in England, and it is interesting that his later aversion seems to have been triggered by Descartes' overall mechanist interpretation of animal life.²⁹⁷ More's criticism thus exemplifies how contemporary readers distilled this aspect of Cartesian philosophy into the plain statement that animals were "metamorphos[ed] into marble statues and

²⁹³ Descartes, *Author's Replies to the Fourth Set of Objections*, [PWD II], pp. 161-162.

²⁹⁴ Erica Fudge also emphasises "that the debates about reason outlined by philosophers and divines were at some distance from the lived realities of early modern men and women;" *Brutal Reasoning*, p. 164. Thomas More indirectly refers to this in one of his letters to Descartes: after mentioning the multitude of anecdotes about animal behaviour, he remarks somewhat snidely, "[b]ut I take it that you have come across similar stories; although mine are not to be found in any books;" *More to Descartes, 5 March 1649*, in Leonora D. Cohen, 'Descartes and Henry More on the Beast-Machine – A Translation of Their Correspondence Pertaining to Animal Automatism' (*Annals of Science* 1:1 (1936), pp. 48-61), p. 54.

²⁹⁵ See for instance the letters *To Reneri for Pollot, April or May 1638*, [PWD III], pp. 99; *To Mersenne, 30 July 1640*, [PWD III], pp. 149; *To Regius, May 1641*, [PWD III], p. 181; and *To More, 5 February 1649*, [PWD III], p. 365. A letter to Newcastle also proves the point, for it does not only provide a more detailed response to common understandings on the subject, but also refers to the French philosopher Michel Montaigne (1533-1592), author of the famous *Apologie de Raimond Sebond* (1576; published in 1580 together with his *Essais*); and the theologian Pierre Charron, both of whom had implied that "there is a greater difference between one human being and another than between a human being and animal;" Descartes, *Letter To the Marquess of Newcastle, 23 November 1646*, [PWD III], pp. 302-303.

²⁹⁶ Cohen, 'Descartes and Henry More', p. 48. The following discussion of More's letters and Descartes' replies is based on Cohen's translation.

²⁹⁷ See Cohen who also points out that English writers, with the exception of Kenelm Digby (1603-1665) and Antoine Le Grand (1629- c.1699), of whom I will speak in Chapter 4.1., generally turned against the doctrine; see 'Descartes and Henry More', pp. 49-50.

machines.”²⁹⁸ He also identified the core motivation behind this doctrine, namely “[i]t is simply a way of demonstrating the immortality of our souls [and] that if it does not concede immortal souls to brutes, it necessarily makes of universal animal life insensible machines.”²⁹⁹ Descartes’ reply rests again on the above-mentioned ‘false-belief’ axiom pertaining to the analogy of bodily structures and functions (to which More replied that he was unfortunately not able to free himself “from the snares of this prejudice”³⁰⁰), and on his conviction that all aspects of animal motion and behaviour can be explained in corporeal terms.³⁰¹ Tellingly, he underlined this by reverting to the common notion of the human-animal bodily analogy himself - an argument that was otherwise used against him, but this time he applied a reverse analogy by using the example of convulsions in humans, in which case “the bodily machine alone and involuntarily moves itself about often more vehemently and in more diverse ways than customarily with the help of the will.”³⁰² Apparently, the only way to make people understand how the animal machine functioned was to revert to their own bodily experience of involuntary movements. However, this letter to More also contains a crucial passage that, as we have seen above, modern philosophers and historians see as proof that Descartes did not actually deny sensation to animals: “for to no animal do I deny life, inasmuch as that I attribute solely to the heat of the heart; nor do I deny sense in so far as it depends upon the bodily organism.”³⁰³ I have already discussed my own reflections on this point in the previous section; suffice it to say that the question of difference between human and animal *sensation*, not the ability to reason, became the most important issue in the controversy over the Cartesian beast-machine concept. That reason constituted the major

²⁹⁸ *More to Descartes, 11 December 1648*, p. 50.

²⁹⁹ *Ibid.*

³⁰⁰ *More to Descartes, 5 March 1649*, p. 53.

³⁰¹ But he nonetheless admits that, “although I hold for certain that it cannot be proven that any cogitation exists in brutes, I do not thereby judge that the absence of thought can be demonstrated, since the human mind can never penetrate into the inmost recesses of the animal being.” *Descartes to More - Egmond, 5 February 1649*, p. 52.

³⁰² *Descartes to More - Egmond, 5 February 1649*, p. 53

³⁰³ *Ibid.*

difference between humans and animals was in fact seldom refuted; even More agreed elsewhere that animals were devoid of “free and reflexive reason.”³⁰⁴ But Descartes’ argument that animals did not feel sensation, including pain, in the way that humans do seemed too difficult to swallow for his contemporaries.

The Fifth Set of Objections, brought forward by the French philosopher Pierre Gassendi, is in this context the most interesting one. It is worth discussing at length, for Gassendi’s objections reveal in much greater detail the inherent weaknesses of Cartesian philosophy as identified by a contemporary philosopher. We can also deduce from his objections how Gassendi himself reflected on unresolved issues about human nature that had troubled philosophers since ancient times, as well as the contrast between Cartesian mechanical philosophy and the atom theory that Gassendi promoted. Gassendi’s theory regarding the involvement of the brain and nerves in functions traditionally ascribed to the rational soul was generally more empirical than Descartes’, and it is no coincidence that he applied his anatomical knowledge to refute some of Descartes’ claims about the brain, nerves, and animal spirits. His propositions regarding sense experience provided a real alternative to the Cartesian mind-body dualism, one that was incidentally picked up by Thomas Willis, the leading anatomist of the nervous system in the seventeenth century. One can see why anatomists might favour Gassendi over Descartes, since the latter’s anatomical reasoning often stood in contrast to their own anatomical observations. Moreover, since Descartes linked a fair share of brain functions to the (incorporeal) soul in the case of humans, his mind-body dualism could not as easily be implemented in anatomical and experimental practices that mostly relied on animal bodies. Before engaging with Gassendi’s objections and Descartes’ replies to them, the following provides an introduction to Gassendian philosophy.

³⁰⁴ Quoted in Cohen, ‘Descartes and Henry More’, p. 55 n 3.

2.2. Pierre Gassendi (1592-1655)

Gassendi had studied and received his doctorate in Aix-en-Provence, before taking priestly orders in 1616.³⁰⁵ He went on teaching philosophy at the University of Aix until 1622 and maintained a special interest in physics during that time. Returning to his hometown, Digne, he prepared the first book of *Exercitationes Paradoxicae Adversus Aristoteleos* (Exercises in the Form of Paradoxes in Refutation of the Aristotelians), the seven books of which first appeared in 1624 in Grenoble. Book V claimed to “restore reason to animals”³⁰⁶ and to dispute that there was a distinction between intellect and the imagination – both of which were aimed at Aristotelian philosophy, but interestingly read like a rebuttal of the later Cartesian agenda. From 1626 onwards, after he had come to Paris and mixed with the intellectual elite of the French capital, he set out to rehabilitate certain aspects of Epicurean philosophy.³⁰⁷ His first work on the subject, *De Vita, Moribus, et Doctrina Epicuri Libri Octo* (Eight Books on the Life and Manners of Epicurus) appeared twenty years later, in 1647. In the meantime he had published various scientific papers, including *De Motu Impresso a Motore Translato* (On Motion Impressed by a Moving Mover, 1642) in which he defended Galileo’s new science of motion and published the law of inertia³⁰⁸ two years prior to Descartes, and had been appointed to the chair of mathematics in the College Royal in 1645.

³⁰⁵ The following brief outline of Gassendi’s life and works is based on the first chapter ‘Gassendi’s Life and Times’ in Antonia LoLordo, *Pierre Gassendi and the Birth of Early Modern Philosophy* (Cambridge et al: Cambridge University Press, 2007), pp. 7-33; and on the introduction to *The Selected Works of Pierre Gassendi*. Edited and translated by Craig B. Brush (London and New York: Johnson Reprint Corporation, 1972). Unless otherwise stated, the following quotations and references to texts from Gassendi are also taken from Brush’s edited translation.

³⁰⁶ By way of arguing that every faculty ascribed to the immaterial soul actually relied on the senses and sense organs; see Gassendi’s preface to *the Exercises in the Form of Paradoxes in Refutation of the Aristotelians* (1624), p. 25.

³⁰⁷ It should be noted that Gassendi was not a wholesale Epicurean (more of this later); rather, as LoLordo points out, “he adheres to no sect but rather approves doctrines of one sect or another according to what seems most probable;” idem, *Pierre Gassendi*, p. 24. This kind of eclecticism is also found in Thomas Willis’ anatomical reasoning (see Chapter 3).

³⁰⁸ The term ‘inertia’, meaning a natural resistance to motion in a body, had been introduced to physics by Johannes Kepler (1571-1630); see Brush, *The Selected Works*, p. 115. See also Osler, *Divine Will and the Mechanical Philosophy*, p. 38.

His final years were devoted to his magnum opus, the *Syntagma Philosophicum* (Philosophical Treatise), which was published posthumously in 1658.³⁰⁹ In his Paris years, Gassendi became an associate of Marin Mersenne and got introduced to Beeckman (who, an avowed atomist himself, might have stimulated Gassendi's interest in Epicureanism), Descartes and Hobbes.³¹⁰ Despite their different interpretation of bodily faculties, Gassendi and Descartes both exemplified the vanguard of scientific thought in the early seventeenth century, promoting mathematical laws and rejecting Aristotelian physics in favour of a mechanistic theory in which all causation was reduced to motion. Overall, even though Gassendi's legacy did not outlive Descartes', his contemporaries regarded him as significant both as scientist and philosopher.³¹¹ In 1654, an English physician, Walter Charleton (1619-1707), published a *Physiologia Epicuro-Gassendo-Charltoniana (Or a Fabrick of Science Natural, Upon the Hypothesis of Atoms)*, which consisted mainly of translations from several of Gassendi's works and became an instant success. Anti-Cartesians seemed to have been invariably drawn to the Gassendian camp and, as Gassendi appeared more versed in common anatomical knowledge, it is no surprise that anatomists were greatly influenced by him.³¹²

³⁰⁹ The *Syntagma* appeared first in two large folios in Latin, though its French abridgement by François Bernier. *Abrégé de la Philosophie de Gassendi* (Lyon : Anisson, Posuel et Rigaud, 1684), proved to be more popular and, as Brush maintains, "became the basis of Gassendi's considerable reputation and following in the later half of the seventeenth century;" Brush, *The Selected Works*, p. 281. A collection of Gassendi's works also appeared in the same year in Lyon as *Petri Gassendi Opera Omnia in Sex Tomos Divisa*, 1658).

³¹⁰ See Osler, *Divine Will and the Mechanical Philosophy*, p. 40. LoLordo mentions in a footnote that Hobbes' psychology had been influenced by Gassendi's early views, while Gassendi's move away from strict materialism in the early 1640s was at least partly a reaction against Hobbes; see *Pierre Gassendi*, p. 10. She refers here to Lisa T. Sarasohn's article 'Motion and Morality: Pierre Gassendi, Thomas Hobbes and the Mechanical World-View' (*Journal of the History of Ideas* 46 (1985), pp. 363-379). It is interesting that Gassendi would influence such different-minded people as Hobbes and Willis whose philosophies of the body had not much in common.

³¹¹ Craig Brush ascribes Gassendi's decline into obscurity to his often unclear and lifeless Latin style, which "offends modern taste;" *The Selected Works*, p. xxi."

³¹² See Martensen who argues that the English especially favoured Gassendi's theories over Descartes'; *The Brain Takes Shape*, p. 33.

From Epicurean atomism, Gassendi took over the idea that “atoms are the primary form of matter [...] out of which, in short, all the bodies which exist in the universe are composed.”³¹³ He rejected the Epicurean premise that atoms were ‘eternal’, ‘uncreated’ and infinite in number, but instead assigned their creative and moving power to God, arguing that “[s]o stated, such an opinion has no evil in it [...]”³¹⁴ In this way, he wanted to assure potential critics that atomism, far from being heresy, was in perfect harmony with Christianity, as atoms played out God’s providential design. He also did away with the Epicurean concept of a mortal soul composed of atoms, since a Christian adaptation of atomism “insisted on the existence of an *immortal*, incorporeal human soul.”³¹⁵ Significantly, Gassendi’s discussion of the soul happened mostly in a section of the ‘Physics’ of the *Syntagma* entitled ‘On Living Earthly Things, or on Animals’, in which he also dealt with sense physiology.³¹⁶ The latter subject enabled him to (re)introduce a corporeal sentient soul—*anima*—that was shared by humans and animals alike, burning as vital heat within the body and being carried in the semen from one generation to the next. It encompassed the brain and the nerves, received sensations and enabled humans and animals to perceive objects and to make judgements. However, since humans also had the ability to think beyond the images supplied by the senses, Gassendi reasoned that this faculty must be a part of the immaterial rational soul which he referred to as *animus*.³¹⁷ Tellingly, as Osler mentions, “Gassendi approached the ultimate problem of the animus by contrasting it to the souls of animals, which correspond to the irrational part of the human soul.”³¹⁸ Humans were thus classed as ‘two-soul’d animals’, as Willis would later refer to it, and this does not only conjure up the old Aristotelian

³¹³ Gassendi, *Syntagma: The Physics*. Section I. Book III, p. 399.

³¹⁴ *Ibid.*, p. 399.

³¹⁵ Osler, *Divine Will and the Mechanical Philosophy*, p. 60; italics in the original.

³¹⁶ *Ibid.*, 53. The section is found in Gassendi’s *Physicae*, Sectionis III. Membrum Liber III ‘De Anima’.

³¹⁷ See Osler, *Divine Will and the Mechanical Philosophy*, p. 63ff; and Emily Michael and Fred S. Michael, ‘Gassendi on Sensation and Reflection: A Non-Cartesian Dualism’ (*History of European Ideas* 9:5 (1988), pp. 583-595), p. 585f.

³¹⁸ Osler, *Divine Will and the Mechanical Philosophy*, p. 64.

classification of souls, but also a similar sort of dualism as we find in the Cartesian distinction of *res extensa* and *res cogitans*.³¹⁹ Overall, like Descartes, Gassendi's aim had been to find a natural philosophy that could first and foremost be reconciled with Christian doctrines, one that did proper justice to the Christian immaterial soul. But his sensationalist approach to all bodily functions identified only the abstract intellect as the source of difference between humans and animals. All mental faculties that were tied in any way to the senses were deemed corporeal and were thus ascribed to animals as well, which reduced the gap to humans considerably.³²⁰

It is no surprise then that Gassendi took issue with the more extensive Cartesian gap between body and incorporeal mind, since atomism offered an intermediate form of 'rarefied' corpuscles to account for the mind, including sense experience.³²¹ His philosophy of the body did not share the Cartesian premise that bodily matter was less refined than the soul simply because it was material, nor did it use the mind as the sole basis for negotiating the human-animal difference. In the Epicurean understanding, it was the composition and purification of ever-so-subtle substances in conjunction with sensory input that determined the state of the body *and* the mind's faculties in any living being that was in possession of sense organs. In

³¹⁹ See also Emily Michael and Fred S. Michael, who for that reason refer to Gassendi's scheme as a 'non-Cartesian' dualism; see idem, 'Gassendi on Sensation and Reflection', p. 584. I do not necessarily agree with their description of the Gassendian sensitive soul as being incapable of 'perceiving' (though they add later that Gassendi talked about the perception of one's own cognitive activities; *ibid.*, p. 587), as this would make Gassendi's dualism a decidedly Cartesian one. Judging from the way that he defended his view of animals against Descartes' beast-machine, Gassendi included perception as reflection on sense experience as a faculty of the corporeal soul (see further below in my thesis). However, Osler rightly mentions that "[l]ike Descartes, Gassendi drew a line of demarcation between body and mind, and then, like him, faced the difficult problem of explaining how they are related;" idem, *Divine Will and the Mechanical Philosophy*, p. 70.

³²⁰ See also Robert J. Richards, 'Influence of Sensationalist Tradition in Early Theories of the Evolution of Behavior' (*Journal of the History of Ideas* 40:1 (1979), pp. 85-105). Richards identifies Gassendi as an early representative of discussions about animal instinct and intelligence via a comparative analysis of human and animal behaviour. John Locke (1632-1704) who is more generally associated with sensationalism, had often been referred to as Gassendist; *ibid.*, p. 88. See also Fisher, Saul, 'Pierre Gassendi', *The Stanford encyclopedia of Philosophy*, edited by Edward N. Zalta (URL = <http://plato.stanford.edu/archives/win2009/entries/gassendi/>; accessed 26.08.10).

³²¹ That this aspect of Gassendian philosophy presented the greatest difference to Cartesianism which was indirectly confirmed by Descartes himself in his *Replies* to Gassendi's objections: "[w]hen you judge that the mind is a kind of rarefied body, you can understand that the mind is itself, i.e. a thinking thing, and that a rarefied body is an extended thing; but the proposition that it is one and the same thing that thinks and is extended is one which you certainly do not understand. You simply want to believe it, because you have believed it before and do not want to change your view;" Descartes, *Fifth Set of Replies*, [PWD II], p. 259.

contrast to the Cartesian *res cogitans* or ‘thinking thing’, Gassendi thus took the body as the starting point for all knowledge about oneself and one’s interaction with the environment (“for you have never been without it, and have so far never had any thoughts when separated from it”³²²). This implies that Gassendi operated with a different kind of human-animal analogy, one that focussed on the bodily analogy, rather than on the difference presented by the presence or absence of an immaterial soul.

Starting from the premise that animals shared the corporeal requirements for sense experience, awareness and mental reflection (the difference being only one of degree), he thus shifted the burden of proof onto Descartes whose main operating principle for these faculties was an immaterial one. Seen from Gassendi’s point of view, the Cartesian link between all aspects of thought, sensation and the immaterial soul actually backfired, for “[y]ou will have to prove at the same time that *the souls of the brutes are incorporeal*, given that they think or are aware of something internal over and above the functions of the external senses, not only when they are awake but also when dreaming.”³²³ While Descartes operated with “an unquestionable distinction between humans and animals”³²⁴ that undermined most people’s common experience, Gassendi’s empirical approach used factual knowledge that was based on the corporeal analogy and on an actual observation of animal behaviour.

Needless to say, then, that he joined the ranks of critics who demanded a more thorough proof for the Cartesian claim that “that the power of thought is something so far beyond the nature of a body that neither a vapour or any other mobile, pure and rarefied body can be organized in such a way as would make it capable of thought.”³²⁵ The indirectly proposed alternative of a ‘mobile, pure and rarefied body’ alludes of course to Gassendi’s preferred

³²² *Fifth Set of Objections*, by Gassendi, [PWD II], p. 183.

³²³ *Ibid.*

³²⁴ Fudge, *Brutal Reasoning*, p.153. In her book, Fudge traces the changes in the conception of the human-animal difference by analysing the ‘discourse of reason’ that had dominated learned discussions prior to Descartes.

³²⁵ *Fifth Set of Objections*, by Gassendi, [PWD II], p. 183.

theory of atomism. But it was Descartes' contention that sensory perceptions ought to be placed under the heading of thought and immaterial soul that dissatisfied Gassendi the most (as we have seen, this is an issue that modern-day philosophers are still arguing about).

Unsurprisingly, just as in Descartes' own writings, Gassendi invoked a comparison to animals throughout his arguments, but this time it served to point out the shortcomings of Cartesian philosophy. Commenting, then, on Descartes' claim that sensation or sense perception was a faculty of the *res cogitans*, Gassendi remarked that,

[t]his is surprising, since you had previously maintained the opposite [i.e. that the *res cogitans* is independent from the *res extensa*]. Or did you perhaps mean that in addition to yourself there is a bodily faculty which resides in the eyes, ears and other organs? Is it perhaps this faculty that receives the forms of sensible things and thus initiates the act of sense-perception which you then complete, it being you who really sees and hears and has the other sensory perceptions? This, I think, is what makes you class both sense-perception and imagination as kinds of thought. Fair enough; but in that case you must consider whether the sense-perception which the brutes have does not also deserve to be called 'thought', since it is not dissimilar to your own. This would mean that the brutes, too, have a mind which is not unlike yours.³²⁶

Here, Gassendi cleverly integrated his own conception of sense perception as a bodily faculty into the Cartesian argument, underlined by a reference to the analogy of the nervous system of humans and animals. In fact, this analogy was to remain the strongest argument against the Cartesian claim that the phenomenological experience of humans and animals differed to such an extent. By playfully addressing the Cartesian 'I' as 'You', Gassendi further distanced himself from Descartes' strong identification of the soul with an explicitly human identity:

You may say that you occupy the citadel in your brain and there receive whatever messages are transmitted by the animal spirits which move through the nerves, and sense-perception thus occurs there, where you dwell, despite the fact that it is said to occur throughout the body. Let us accept this; but the brutes have nerves, animal spirits and a brain, and in the brain there is a principle of cognition that receives the messages from the spirits in an exactly similar fashion and thus completes the act of sense-

³²⁶ *Fifth Set of Objections*, by Gassendi, [PWD II], p. 187.

perception. You may say that this principle in the brains of animals is simply the corporeal imagination or faculty of forming images. But in that case you must show that you who reside in the brain are something different from the corporeal imagination or the human faculty of forming images.³²⁷

The mind represented the Cartesian ‘I’ and was thus identified as the true constituent of humans; yet, by locating its faculties in the brain—an organ that humans shared with animals—Descartes had not only undone his contention that the human *res cogitans* was something that operated over and above bodily matter.³²⁸ It also inadvertently shifted the boundary between humans and animals away from the immaterial realm back onto the corporeal level, implying that the difference in facultative powers could once again be interpreted as one of degree, rather than in kind.

“You may cite operations which far surpass those performed by animals. But although man is the foremost of the animals, he still belongs to the class of animals; and similarly, though you prove yourself to be the most outstanding of imaginative faculties, you still count as one of these faculties. You may attach the special label ‘mind’ to yourself, but although the name may be more impressive, this does not mean that your nature is therefore different. To prove that your nature is different (that is, incorporeal, as you maintain), you ought to produce some operation which is of a quite different kind from those which the brutes perform – one which takes place outside the brain, or at least independently of the brain; and this you do not do.”³²⁹

The observation that ‘disturbances’ of the brain (e.g. disease or injury) affect mental faculties such as memory, imagination or thought was further proof for Gassendi that these faculties were linked tighter to the body than to the immaterial soul.³³⁰ Following from that, there was no logical basis to differentiate between human and animal faculties when both shared the

³²⁷ *Fifth Set of Objections*, by Gassendi, [PWD II], pp. 187-188.

³²⁸ “Let us now assume instead that you are in the brain alone, or simply in a small part of it. You will see that the same awkwardness arises. For however small the part in question is, it is still extended, and since you are coextensive with it, you too are therefore extended [...]; *Fifth Set of Objections*, by Gassendi, [PWD II], p. 236.

³²⁹ *Ibid.*, p. 188.

³³⁰ See *ibid.* and p. 186, where he also pinpoints our inability to distinguish between cognition as based on the external senses and apprehension by the mind alone: “When I see the sun with open eyes, sensory perception obviously occurs. And when I then think about the sun with my eyes closed, internal cognition obviously occurs. But how, ultimately, can I tell that I am perceiving the sun with the ‘common’ sense or faculty of imagination, as opposed to the mind or intellect [...]?”

same organs. Thus, when the brain and nerves were involved in sense perception, what sense did it make to imply a difference between human and animal sensation?

You may say that everything which occurs in animals happens by means of a blind impulse of the animal spirits and the other organs, in just the same way as motion is produced in a clock or other machine. This may be true in the case of functions like nutrition or the pulsing of the arteries, which occur in exactly similar fashion in the case of man. But can you cite any sensory acts or so-called ‘passions of the soul’ which are produced by a blind impulse in the case of the brutes but not in our case? [...] You may say that a dog barks simply from impulse and not, as happens when a man speaks, from choice. But in the case of man, too, there are causes at work which may lead us to judge that he speaks from some impulse. What you attribute to choice occurs as a result of a stronger impulse, and indeed the brute, too, exercises choice, when one impulse is greater than another.³³¹

What becomes further apparent is that next to the inconsistencies of Cartesian philosophy, Gassendi’s criticism was also aimed at Descartes’ anthropocentric reasoning. As it is, Gassendi had already taken issue with this kind of thinking in his *Refutations of Aristotelians* of 15 years before. In fact, the criticism directed at both Aristotelian and Cartesian versions of anthropocentrism is so similar that the issue itself—not the philosophical label attached to it—must have been the real bone of contention for Gassendi.³³² He must have felt that to differentiate between humans and other living beings solely from a human-centred point of view was to undermine any attempts at an empirically-based understanding of them.

³³¹ *Fifth Set of Objections*, by Gassendi, [PWD II], pp. 188-189.

³³² There is one remarkable section in which Gassendi contemplated this issue, thereby revealing that the anthropocentric reasoning regarding the human-animal boundary had basically stayed the same since Antiquity—so much so, that Gassendi’s following reflections on the Aristotelian notion of ‘difference’ could also be applied to the Cartesian one:

“Let us speak now of difference [...]. Might it not be true that the things which are concealed from us tend more to bring things together than to differentiate them? Surely we cannot say that such-and-such is the difference between this thing and that unless we know that there is something lacking in that thing which can be found in this. But how are we to know that something is lacking in that thing unless we have delved into its very most inner recesses? For example, take man; [...] You designate the fact that he is rational as his specific and sufficient difference, and you say that man differs from all the other animals because of that fact. That may well be, but in order to distinguish him adequately from all the other animals you must know every animal intimately and perfectly. For if some qualities lie hidden from you, how can you know that that fact is legitimate and sufficient difference?”

Gassendi, *Exercises in the Form of Paradoxes in Refutation of the Aristotelians* (1624), Book II, Exercise V, 4, p. 68.

Operating with a notion of difference did not make sense if that notion was preconceived and rested only on non-observable subjective premises such as the Cartesian *Cogito ergo sum*.

On this account even the seemingly singular human faculties of reason and speech—the core constituents of humanity for Descartes—could be dismantled as illogical:

You say that the brutes lack reason. Well, of course they lack human reason, but they do not lack their own kind of reason. So it does not seem appropriate to call them *άλογα* [‘irrational’] except by comparison with us or with our kind of reason; and in any case *λόγος* or reason seems to be a general term, which can be attributed to them no less than the cognitive faculty or internal sense. You may say that animals do not employ rational argument. But although they do not reason so perfectly or about as many subjects as man, they still reason, and the difference seems to be merely one of degree. You may say they do not speak. But although they do not produce human speech (since of course they are not human beings), they still produce their own form of speech, which they employ just as we do ours. You may say that even a delirious man can still string words together to express his meaning, which even the wisest of the brutes cannot do. But surely you are not being fair if you expect the brutes to employ human language and are not prepared to consider their own kind of language.³³³

Last but not least, Descartes’ scheme, especially with regard to the contradiction of placing the immaterial ‘soul’ in the (corporeal) pineal gland, did not make sense anatomically:

Look what a useless fiction this will turn out to be. For if we adopt it, we shall have to imagine that you exist at the conjunction of the nerves by means of which all the regions informed by the soul transmit to the brain the ideas or images of the things perceived by the senses. But, first, all the nerves do not meet at one point: for one thing the brain joins up with the spinal column, and many nerves from all over the back terminate there; and, for another thing, the nerves which do go into the middle of the head are not found to terminate in the same part of the brain.³³⁴

Digging ever deeper into the philosophical well of Cartesian thinking, Gassendi went about deconstructing most of Descartes’ convictions and arguments. Here was someone who actually engaged in detail with Descartes’ notion of the *res cogitans* and the *res extensa*, finding examples to argue against some of the more fundamental Cartesian statements and backing these up with a more informed understanding of the nervous system. Unfortunately,

³³³ *Fifth Set of Objections*, by Gassendi, [PWD II], p. 189.

³³⁴ *Ibid.*, p. 237.

despite an equally lengthy reply, Descartes did not engage fully with Gassendi's various statements about animals.³³⁵ Similar to the way that he had responded to Hobbes, Descartes' tone in his replies became increasingly contemptuous. The degree of his contempt was revealed when he recommended to Mersenne that Gassendi's objections should be published along with their author's name, a gesture that could not be mistaken, as Descartes otherwise respected the anonymity of the other authors. Gassendi, "evidently annoyed, both by the bitter tone of the answers and by the publication itself,"³³⁶ decided to defend his objections and eventually published an extended series of *Rebuttals Against Descartes* in 1644.³³⁷ The exchange between Descartes and Gassendi as well as their different approaches to constituting the human versus the animal not only epitomises the heated debates that were to rage over the next centuries, they also encapsulate different frameworks of thought about the body that found their way into the practice of anatomy.

Conclusion

As we saw in Chapter 1, the idea of the animal as a machine was not Cartesian in origin. In fact, a revival of earlier versions, such as Pereira's theory of animal behaviour, went alongside a controversy that erupted over the originality of Descartes' ideas.³³⁸ The anatomist Thomas Willis, to whom I will turn in the next chapter, provides important testimony on this matter, because in his *De Anima Brutorum* (1672) he traced the idea of animal automatism to

³³⁵ Other than emphasising that "I do not think that the souls of the brutes are incorporeal," he dismissively stated that "this is not at all the place to consider these topics;" *Fifth Set of Replies*, [PWD II], p. 246; and a little later, "Your questions about the brutes are not appropriate in this context since the mind, when engaged in private meditation, can experience its own thinking but cannot have any experience to establish whether the brutes think or not; it must tackle this question later on, by an *a posteriori* investigation of their behaviour;" *ibid.*, pp. 247-248; italics in the original. Note that this last point is a decidedly less decisive approach to the question of the animal mind than Descartes had maintained in his other writings.

³³⁶ Brush, *The Selected Works*, p. 153.

³³⁷ Published in Amsterdam by Samuel Sorbière. Brush maintains that Descartes did probably not read the *Rebuttals* in their entirety; his only response came in the form of a letter to his translator Clerselier in which he requested that Gassendi's name be omitted from the French translation of the *Meditations* (to which Clerselier did not comply); Brush, *The Selected Works*, pp. 153-154; and Cottingham et al., PWD III, where a translation of the said letter is appended to the *Fifth Set of Objections and Replies*, pp. 268-277.

³³⁸ See Bandrés and Llanova, 'Minds and Machines in Renaissance Spain', p. 165.

the Epicureans, and then mentioned Pereira and Descartes side by side as ‘modern thinkers’ on the subject.³³⁹ The philosopher Pierre Bayle (1647-1706) likewise maintained that Pereira was the first to equate animals with machines, whereas others believed that Descartes had arrived at his theory by philosophical speculation alone.³⁴⁰ As Descartes was reluctant to mention his sources, the matter of his originality remains unresolved, though we can assume that Descartes did not develop his thoughts in an intellectual vacuum.³⁴¹ As Sawday reflects, Descartes’ reduction of the body to a working machine “represented the summation of half a century of voyages into the interior to which Descartes was the heir.”³⁴² Cartesian and Gassendian reflections on the subject were in fact both successors to speculations and debates about human and animal bodies and souls that had come a long way, though such debates reached a new poignancy in the seventeenth century. The point where Descartes decidedly went against traditional thought was his contention that the faculty of sense *experience* was absent in body-machines, and therefore in animals. This, too, mirrors Pereira’s contention of the insensitive animal, and it is no coincidence that this aspect of the Cartesian theory of the beast-machine sparked most of the subsequent controversies. The broad influence these ideas had on subsequent debates are nonetheless mostly traced back to Descartes, since “[t]he

³³⁹ Thomas Willis, *Two Discourses Concerning the Soul of Brutes, Which is that of the Vital and Sensitive of Man. The first is PHYSIOLOGICAL, shewing the Nature, Parts, Powers and Affections of the same. The Other is PATHOLOGICAL, which unfolds the Diseases which Affect it and its Primary Seat; to wit, The BRAIN and NERVOUS STOCK, and Treats of their CURES: With Copper Cuts*. Englished by Samuel Pordage, Student in Physick (London: Thomas Dring et al, 1683; the Latin original appeared first in 1672), p. 3. Henceforth cited as *The Soul of Brutes*.

³⁴⁰ Bayle is the author of the *Dictionnaire Historique et Critique*, a biographical dictionary that was published in the Netherlands in 1697 (an enlarged second edition followed in 1702); it has to be mentioned though that Bayle, according to himself, had never read Pereira’s *Antoniana Margarita*. I have used the following English translation: *An Historical and Critical Dictionary*. By Monsieur Bayle. Translated into English, with many additions and corrections, made by the author himself [...], 4 volumes (London: C. printed for C. Harper et al., 1710). See vol. 4, pp. 2513-2520, for the article on Pereira. It is also worth mentioning that Bayle’s footnotes are far more substantial than the actual text, providing not only a history of the animal soul since antiquity but also a variety of opinions on the subject.

³⁴¹ See also Bitbol-Hespériès, ‘Cartesian physiology’, p. 351.

³⁴² Sawday, *The Body Emblazoned*, p. 28.

division between Cartesian subject, and corporeal object, between an ‘I’ that thinks, and an ‘it’ in which ‘we’ reside, had become absolute.”³⁴³

Apart from applying a mechanist lens to all bodily functions, Descartes did not add to or change many of the common notions of traditional anatomy as based on Hippocratic and Galenic medicine, the works of Plato and Aristotle, and the writings of influential anatomists and experimental philosophers. His aim had been to retell their descriptions of the body in purely mechanist terms by way of adapting older medical theories to his new philosophy of the body.³⁴⁴ Descartes’ close examination of Harvey’s theory of blood circulation, for instance, is, as Annie Bitbol-Hespériès formulates it, “a rewriting of this discovery, because Descartes conveys Harvey’s discovery in a different context from the one in which it was first presented. Descartes’ assumption of a mechanistic context, linked to the definition of a new anthropology, will obliterate Harvey’s own Aristotelian and vitalistic context.”³⁴⁵

Descartes’ rejection of Harvey’s own account of the heart being a pump was not aimed at Harvey’s physiology but at the vital principle that was invoked in Harvey’s conception of the heart’s power to contract and expand. This part of the Harveian scheme was difficult to construe in wholly mechanist terms since the power to contract implied some sort of active source outside the heart. Descartes therefore explained—in a fashion that was nonetheless reminiscent of Aristotle—the motion of the heart in terms of the production of heat in the blood which took place in the heart itself.³⁴⁶ Descartes had nonetheless extended Harvey’s model of circulation to the movement of spirits that he thought could explain every function in the body, i.e. what arteries did for the blood flow was done by the nerves transmitting sensation via the animal spirits (a notion that was maintained in all subsequent anatomical

³⁴³ Ibid., p. 29.

³⁴⁴ See also Sutton, ‘The body and the brain’, pp. 702-703.

³⁴⁵ Bitbol-Hespériès, ‘Cartesian physiology’, p. 351.

³⁴⁶ See Descartes, *Discourse on the Method*, [PWD I], pp. 134-139; and *Description of the Human Body*, [PWD I], p. 316. See also Gaukroger, *Descartes*, p. 271; and Bitbol-Hespériès, ‘Cartesian physiology’, p. 364.

investigations).³⁴⁷ However, as Pierre Gassendi's objections revealed, Descartes' framework of mechanical thought reached a definite limit when he attempted to reintegrate anatomical knowledge of the nervous system within his overall philosophical scheme of the *res cogitans* and the *res extensa*. In the context of the human-animal boundary discourse, one could say that the *Demand for Difference* between humans and animals overruled Descartes' aim to provide a comprehensive and integrative account of corporeal mechanisms. Gassendi anticipated the impossibility and impracticality of assigning most of the brain's functions to an immaterial substance that for this reason could not be investigated anatomically. That anatomical and experimental investigation required animals as substitutes for the human body created in turn a *Demand for Similitude* that Gassendi's scheme accounted for more easily than the Descartes' strict dualism did.

Furthermore, simply comparing the action of the heart with the action of nerves, as Descartes had, did not account for the fact that nervous faculties, in particular sensation, could after all not be measured in the same way as the amount of blood circulating in the body, or the number of heartbeats per minute. It is therefore not surprising that, at least among experimental philosophers and anatomists, not all functions of the body could be explained in mechanistic terms. Even Harvey, who had experimented on living animals to study the heartbeat and blood circulation, maintained his belief in a vital force that stood in opposition to the purely mechanistic framework of Descartes. For those closely studying living organisms, Cartesian mechanism altogether seemed to remain, in Pickstone's words, mostly "intellectual fancy."³⁴⁸ However, Gassendi had shown that alternative conceptualisations of a

³⁴⁷ See also Rey, *History of Pain*, p. 76.

³⁴⁸ John V. Pickstone. *Ways of Knowing: A New History of Science, Technology and Medicine* (Manchester: Manchester University Press, 2000), p. 66. One contemporary epitomising the difficulty that experimental researchers had with the Cartesian scheme was the Danish anatomist Niels Stensen, also known as Nicolaus Steno (1638-1686) who frequently vivisected animals. In a letter to Bartholin he wrote: "The Cartesians take great pride in the truth of their philosophical system, but I wish they could convince me as thoroughly as they are themselves convinced of the fact that animals have no souls!" quoted in Cunningham, *The Anatomist Anatomis'd*, p. 295; see also Maehle, *Kritik und Verteidigung*, p. 87.

mechanical body were possible without sacrificing the concept of an immortal and immaterial soul.

As Descartes had written to More, “although I hold it for certain that it cannot be proven that any cogitation exists in brutes, I do not thereby judge that the absence of thought can be demonstrated, since the human mind can never penetrate into the inmost recesses of the animal being.”³⁴⁹ In fact, those ‘inmost recesses’ were increasingly revealed on the dissection table of anatomists and experimental philosophers whose own mechanical approach to the body (re)grounded the majority of sensual and mental faculties in the corporeal frame. Yet, as the body itself came to be perceived as devoid of any human-specific divine markers, anatomists felt compelled to refocus their anatomical gaze again on potential differences in structure that might explain the superiority of human faculties. With this we enter the realm of neuroanatomy of which Thomas Willis was an important representative in the seventeenth century.

³⁴⁹ *Descartes to More-Egmond, 5 February 1649*, in Cohen, ‘Descartes and Henry More’, p. 52.

3. Neuroanatomy – The Human-Animal Boundary Made Manifest

This chapter investigates how animals were used as anatomical representatives of the nervous human body by focussing on the influential work of the seventeenth-century physician and anatomist Thomas Willis (1621-1675). Similar to Vesalius, who had wanted to initiate a new view of the human body, Willis set out to redo an anatomy of what he felt was an imperfectly described and dissected nervous system. He coined the term ‘neurology’, referring to it as a ‘doctrine of the nerves’,³⁵⁰ and his *Cerebri Anatome cui Accessit Nervorum Descriptio et Usus* (The Anatomy of the Brain with an Added Description and Use of the Nerves) of 1664, the first book entirely dedicated completely to the nervous system, remained a standard work well into the nineteenth century.³⁵¹ In the later published *De Anima Brutorum quae Hominis Vitalis ac Sensitiva est, Exercitationes Duae* (The Soul of Brutes, Which is that of the Vital and Sensitive of Man (1672)),³⁵² Willis amplified his theory regarding the sensitive soul at work in human and animal nervous systems. By (re)assigning a sensitive soul to the body, thus following the Gassendian rather than a Cartesian philosophy of the body, Willis offered an alternative cerebral model to the one proposed by Descartes. Willis’ neurology was not based on a single philosophy, though; on the contrary, his view of the nervous body inherited an eclectic mix of philosophical and anatomical thoughts about souls, bodies and the link between them. His theorising about the functions of the brain and nerves was thus also deeply

³⁵⁰ The term ‘neurology’ and its definition first appeared on p. 106 of Willis’ *Cerebri Anatome*, henceforth referred to as *Anatomy of the Brain*.

³⁵¹ Willis’ *Anatomy of the Brain* went through twenty-three editions altogether; the first quarto edition was followed by three cheaper octavo versions in 1664 alone. It appeared in five more Latin versions between 1666 and 1683 and had been translated into English by Samuel Pordage in 1681 as part of a compilation of Willis’ major works. In the following discussion, quotes will be taken from this English edition: *Dr Willis’s Practice of Physick, Being the Whole Works of that Renowned and Famous Physician: Containing Eleven Several Treatises*. Translated into English, by Samuel Pordage (London: printed by T. Dring, C. Harper, and J. Leigh, 1684 (first 1681)). Regarding the influence of Willis’ anatomical works, see also C.U.M. Smith, ‘Brain and Mind in the ‘Long’ Eighteenth Century’, in Harry Whitaker, C. U. M. Smith and Stanley Finger (eds.) *Brain, Mind and Medicine: Essays in Eighteenth-Century Neuroscience* (New York: Springer US, 2007); and James P.B. O’Connor, ‘Thomas Willis and the background to *Cerebri Anatome*’ (*Journal of the Royal Society of Medicine* 98 (2003), pp. 139-143).

³⁵² Henceforth referred to as *The Soul of Brutes*, the English translation of which is also found in Pordage’s: *Dr Willis’s Practice of Physick* (1684).

intertwined with a discourse about the difference between humans and animals. With his synthesis of ancient and contemporary theories, as well as his novel anatomical method, Willis created a view of the (human) body that put the nervous system forward as the most important organ system. As such he is an important representative of early modern philosophical and anatomical ideas about the nervous system, as well as the human-animal boundary. Before turning to Willis' work on the anatomy of the brain and the working of the sensitive soul in humans and animals, section 3.1. provides a short introduction to Willis' background, anatomical method, and practice of comparative anatomy before analysing his main works *Anatomy of the Brain* and *The Soul of Brutes*. In my analysis of Willis' anatomical writings, I investigate what the nervous system signified for Willis and his seventeenth-century readers, and how Willis' anatomical observations of human and animal nerves and brains influenced his conjectures about the human-animal boundary. Of particular importance is the question how Willis addressed the differences between humans and animals in his theorising about nervous functions.

3.1. Thomas Willis' Anatomical Project

Willis was born in 1621 in Wiltshire, England, and entered Oxford University in 1638. He took up his studies of medicine in 1643, though these were soon disrupted by the civil war that broke out in June of the same year. Willis went on to teach himself the basics of traditional medical theories, and, due to the turmoil of the civil war, received a license to practice medicine as early as 1646.³⁵³ As a physician, he practiced Galenic medicine, mixed

³⁵³ For a more detailed overview of Willis' early years, see the still valuable work by Hansruedi Isler. *Thomas Willis 1621-1675: Doctor and Scientist* (New York and London: Hafner Publishing Company, 1968). A very

with elements of folk medicine, although influences from various new strands in natural and experimental philosophy had led him to break with the Galenic view of the body as such. In the 1640s, Willis had joined forces with fellow natural philosophers or ‘virtuosi’,³⁵⁴ such as the physician Charles Morton (1628-1698),³⁵⁵ the mathematician John Wilkins (1614-1672) and William Petty (1623-1687). Together with Christopher Wren (1632-1723), Robert Boyle (1627-1691), and later Robert Hooke (1635-1703), these natural philosophers began to gather regularly in what they called the ‘The invisible College’ or ‘Oxford Experimental Philosophy Club’.³⁵⁶ At their weekly meetings they conducted and watched experiments and debated new concepts and ideas, ranging from astronomy to botany and anatomy, becoming thus the centre of the *New Science* in England.³⁵⁷ Apart from an adherence to Bacon’s new philosophy of science, the virtuosi enriched the Oxford circle with new thoughts and influences that they had received outside of and prior to Oxford, subsequently also shaping Willis’ ideas and approaches to the anatomy of the brain and nerves. William Petty (1623-1687), for instance, had studied medicine at Leyden, one of the few places where Harvey’s work was taught.³⁵⁸ Apart from an understanding of the body’s circulatory system, Petty also learned at Leyden how to dissect and study the workings of the body. He later shared with Willis an interest in

readable account of Thomas Willis’ life and work within the context of the New Science is provided by the already mentioned work of Zimmer, *Soul Made Flesh*. See also the chapter on Thomas Willis in Stanley Finger, *Minds Behind the Brain*, pp. 85-99.

³⁵⁴ A term derived from the labelling of English noblemen who had collected and filed curiosities and marvels as early versions of museums in the 1500s; in the mid-seventeenth century the term also denoted natural philosophers, due to the influence of William Harvey, Robert Boyle and the Oxford experimental philosophers; see Barbara Shapiro and Robert G. Frank, Jr. *English Scientific Virtuosi in the 16th and 17th Centuries* (Los Angeles: University of California Press, 1979); and Robert G. Frank. *Harvey and the Oxford Physiologists, 1980: Scientific Ideas and Social Interaction* (Berkeley et al.: University of California Press, 1980).

³⁵⁵ Charles Morton had been involved in anatomical studies and animal experiments since the early days of the Royal Society; see Theodore Brown *The mechanical philosophy and the “animal oeconomy”* (New York: Arno Press Inc., 1981), pp.68 ff. Morton later wrote an interesting little treatise that summed up prevalent ideas about animal souls at the time. This unpublished and handwritten account, entitled *Of the Souls of Brutes*, dates from 1684.

³⁵⁶ See Zimmer, *The Soul Made Flesh*, p. 95; and Isler, *Thomas Willis*, p. 31.

³⁵⁷ See Isler, *Thomas Willis*, p. 14.

³⁵⁸ Petty is quite an interesting figure who symbolises the spirit of the New Science more than any other of the experimental philosophers. The recent biography by Ted McCormick captures this spirit despite a focus on Petty’s political and social ideas. See especially Chapter two, ‘The Making of a Virtuoso’, in McCormick’s *William Petty and the Ambitions of Political Arithmetic* (Oxford University Press: Oxford and New York, 2009), pp. 40-83.

several projects related to anatomy and, by introducing him to the works of Gassendi, Hobbes, and Descartes, is possibly the source of Willis' mechanical philosophy of the body.³⁵⁹ Prior to his anatomical investigation of the nervous system, Willis had published medical treatises *De Fermentatione* (On Fermentation), *De Febris* (On Fevers), and *De Urinis* (On Urines) that synthesised the Oxford group's ideas about blood, spirits, and matter. This collection of treatises was eventually published in London in 1659 as *Diatribae duae Medico-Philosophicae* (Two Learned Discourses, Medical and Philosophical), possibly the first medical texts, apart from Harvey's publications, that gained an international reputation.³⁶⁰

The roots of Willis' interest in the nervous system lie partly in his role as practicing physician which had led him to think more about the brain, nerves and animal spirits.³⁶¹ By the 1660s, due to his widespread fame as a physician and anatomist, Willis was often permitted to dissect his patients after their death. Trying to link his direct observations of his patients' brains with the illnesses and mental symptoms which they had suffered in life, Willis had sensed that many traditional and conventional views of the brain were wrong. Another source of his heightened interest in the nervous system had been his teaching of anatomy, medicine and chemistry, and his professorship of natural philosophy at Oxford.³⁶² Though the teaching at Oxford ought to have been restored to its former curriculum in the wake of the Restoration, Willis did not dwell too much on the old Aristotelian and Galenic theories, but described instead his own anatomical dissections and experiments as well as new theories from abroad.³⁶³ In this he resembles Harvey who, forty years earlier, had also used his teaching

³⁵⁹ Though Petty later criticised Descartes for deducing "a philosophical system from a handful of pet experiments and 'notional conjectures' [...] only vast amounts of such data, collected through an exhaustive experimental process [...], could justify the kind of inferences Descartes claimed to make ;" McCormick, *William Petty*, p. 63.

³⁶⁰ See Martensen, *The Brain Takes Shape*, p. 36.

³⁶¹ See Isler, *Thomas Willis*, p. 23; and Zimmer, *Soul Made Flesh*, p. 174.

³⁶² See Isler, *Thomas Willis*, p. 30.

³⁶³ Even in these politically sensitive times, in which many aspects of the new philosophy and science were perceived as threatening to the establishment, e.g. Hobbes applying mechanical philosophy to nation states,

post as a platform to discuss his own newly-found theory of blood circulation, and to relate the experiments with which he had reached his own conclusions.³⁶⁴ In his *Anatomy of the Brain*, Willis related how in his Oxford lectures he had been required to “Comment on the Offices of the Senses, both external and also internal, and of the Faculties and Affections of the Soul, as also of the Organs and various provisions of these.”³⁶⁵ Speculating thus on the brain, the function of nerves and their assumed connection with the soul in his lectures had made him aware of how little he knew. Whatever the impetus, Willis became determined to study the anatomy of the brain and nerves proper, whenceforth “I addicted myself to the openings of Heads especially, and of every kind [...]”³⁶⁶ Willis thus launched a new study of the brain in a project that would take years and involved several members of the Oxford circle. Richard Lower (1631-1691), a medical student of Willis who received his M.D. in 1665, assisted him in the process of dissecting; the physician Thomas Millington (1628-1704) acted as critic and adviser, while Christopher Wren, then Savilian Professor of Astronomy, provided immaculate sketches of the brain and nervous system.

Willis and Lower did not follow the traditional method of dissection in which the brain had been sliced away, thus destroying the pathways of vessels and nerves, but instead opened the skull from its underside, took out the brain as a whole, and turned it upside down, which made the different layers and parts of the brain more visible.³⁶⁷ Zimmer contemplates that, “[l]ooking at the brain in this way forced Willis and his friends to think about it in a new

Willis could get away with his criticism of traditional theories and his challenging deductions about the role of the brain, as he was otherwise conceived as a hero of the Restoration due to his ongoing loyalty to the King; see Zimmer, *Soul Made Flesh*, p. 173, and O'Connor, *Thomas Willis*, p. 140.

³⁶⁴ See Roger French, *William Harvey's Natural Philosophy* (Cambridge: Cambridge University Press, 1994); especially Chapter 4 ‘The anatomy lectures and the circulation’, pp. 71-93. See also Gweneth Whitteridge (ed.) *The Anatomical Lectures of William Harvey: Prelectiones Anatomie Universalis; De Musculis*. With an introduction, translation and notes. Published for the Royal College of Physicians, London (Edinburgh and London: E.& S. Livingstone LTD, 1964).

³⁶⁵ Willis, *Anatomy of the Brain*, preface to the reader, p. 43. In all of the following quotations from Willis’ works, I have kept the sometimes awkward spelling and phrasing in Pordage’s translation, including emphases.

³⁶⁶ Willis, *Anatomy of the Brain*, preface to the reader, p. 43.

³⁶⁷ See Willis, *Anatomy of the Brain*, p. 45 and p. 49. This is probably the reason why Willis began his chapters on the brain with a description of the lower parts, rather than the meninges and outer layers of the brain as had been traditionally done; see Martensen, *The Brain Takes Shape*, p. 110.

light: not as a nondescript mass of flesh glued to the inside of the skull but as an independent organ.”³⁶⁸ They determined that the brain was divided into at least three distinct parts. Earlier anatomists had seen these parts that today are known as the medulla oblongata (the marrow at the base of the brain joining the brain to the spinal cord); the cerebellum, and on top the two hemispheres of the cerebrum. But Willis was the first to demonstrate them as distinct parts and to study them on their own.³⁶⁹ In this he was assisted by the Oxford group’s new methods of preserving body parts and organs, which enabled Willis to observe the brain for much longer than had ever been done before.³⁷⁰ Another novelty was the use of a microscope, designed by Hooke and Wren, with which Willis looked at the more detailed structure of the nerves. As the live brain more often than not revealed the delicate spread of nerves and blood vessels, the vivisection of animals was yet another vital part of Willis’ investigation of the nervous system and its uses. For example, in order to discover and observe hidden connections between nerves and the brain, Willis and Lower once opened the skull of a dog, injected ink and saffron into the carotid artery that supplied the brain with blood and then watched the stained blood travelling into the brain. This enabled them to see for the first time the vast network of vessels that covered the entire brain.³⁷¹ The vivisection of animals was

³⁶⁸ Zimmer, *Soul Made Flesh*, p. 175; see also Willis, *Anatomy of the Brain*, p. 49.

³⁶⁹ It has to be noted, though, that Willis’ use of the anatomical terms, such as *medulla* and *cerebel* or *cerebellum* is not wholly identical to the modern use of them; see here especially Finger, *Minds Behind the Brain*, pp. 91-92. Robert Martensen also points out that the meaning of some of Willis’ terms was somewhat ‘lost in translation’: for instance, whereas Willis used the term *cerebri* in his original writing to refer to the cerebral hemispheres and/or cerebral cortex, Samuel Pordage, who had provided the only English translation from the Latin original, translated *cerebri* as meaning the whole of the brain. The *medulla* in Pordage’s version became an *oblong marrow*, even though for early modern anatomists, *medulla* was the common denotation; see Martensen, *The Brain Takes Shape*, p. 109.

³⁷⁰ Robert Boyle in particular devised the immersion of fresh brains in alcohol (wine spirit) to prevent their otherwise rapid decay; see Ochs, *A History of Nerve Functions*, p.75 n 29.

³⁷¹ Noticing how the four arteries that carried blood from the neck sent out branches that joined together in a peculiar circle at the base of the brain before entering the brain itself, Willis in this way discovered what is now known as ‘the Circle of Willis’. For a recent discussion of this discovery see Cagatay Uston, ‘NEUROwords. Dr. Thomas Willis’ Famous Eponym: The Circle of Willis’ (*Journal of the History of the Neurosciences* 14 (2005), pp. 16-21). Willis himself had never claimed priority for the discovery, as the circle of arteries had been described before by Johann Jakob Wepfer (1620-1695), though not as accurately as Willis who in addition provided the first illustration of a completed circle. Willis and Wepfer, who had exchanged letters and writings, did not conceive of each other as rivals; see here Isler, *Thomas Willis*, p. 104. Wepfer’s anatomy of the brain is well illustrated and discussed in Henry Nigst, *Das anatomische Werk Johann Jakob Wepfers (1620-1695)*

thus crucial for unveiling some functions of the brain or particular distributions of nerves that anatomical observation alone could not provide.

Willis had acknowledged in his dedication that “I had slain so many Victims, whole Hecatombs almost of all Animals, in the Anatomical Court,”³⁷² which implies not only his use of experimentation but also his reliance on comparative anatomy. The term "anatomia comparata" had been introduced before by Bacon, but Bacon meant by this the anatomical investigation of many individuals of one species, i.e. the study of individual variation.³⁷³

Willis, on the other hand, understood comparative anatomy to be a comparison of specific parts in various species of animals with those of humans.³⁷⁴ Apart from the fact that animals were more readily available for dissections, Willis also viewed the

immense bulk of human head as hindrance [...] whereby its most intricate frame and various recesses and Appendices are the less accurately discerned and investigated: all which being reduced into an Epitomy, are plainly represented more commodiously in the dissection of Beasts.³⁷⁵

Thus, next to practical considerations, a close outward resemblance of human and animal brains remained the most obvious reason for a comparative study of the brain, “as certainly from such a compared Anatomy, not only the faculties and uses of every Organ, but the impressions, influences, and secret ways of working of the sensitive Soul it self will be discovered.”³⁷⁶ Willis therefore assumed that in deciphering the brain’s structure in humans and animals, the functions of the brain as such, regardless of species, could be revealed. Yet, considering the higher resemblance to human brains, his favoured choice of animals were

(Veröffentlichungen der Schweizerischen Gesellschaft für Geschichte der Medizin und der Naturwissenschaften XVI; Aarau: Verlag H.R. Sauerländer & Co, 1947).

³⁷² Willis, *Anatomy of the Brain*, [Epistle Dedicatory to Gilbert, Archbishop of Canterbury], p. 41.

³⁷³ See Cole, *A History of Comparative Anatomy*, p. 10.

³⁷⁴ See Willis, *Anatomy of the Brain*, p. 46; and Isler, *Thomas Willis*, pp. 102-103. Willis is referred to by some as the founder of comparative anatomy, though Harvey – who himself had been influenced by Aristotle and in turn influenced the next generations of anatomists- had also used the comparative method in the modern sense; see Isler, *Thomas Willis*, p. 103; and Cole, *A History of Comparative Anatomy*, p. 10.

³⁷⁵ Willis, *Anatomy of the Brain*, p. 46.

³⁷⁶ *Ibid.*

quadrupeds such as sheep, calves, pigs, and dogs. Willis did not elaborate on the possible reasons for the greater analogy of some animal species' brains with those of humans. In the only paragraph where he reflected on this, his reasoning is shrouded in the conventional language of biblical imagery:

For when the first Inhabitants of the new-made World were produced, as one day brought forth Fowl and Fishes at once, another in like manner Man and four-footed Beasts, so there is in either twin species a like form of the Brain; but between that Child of the former, and this of the following day, there is found a great difference as to those parts. For as much therefore as Men and four-footed Beasts have got more perfect Brains, and more alike among themselves, we have ordered our Observations from their Inspection [...].³⁷⁷

The amount of influence that natural theology asserted on seventeenth-century anatomical reasoning has been illustrated by William F. Bynum, who showed that explanations of brain structure were indeed often embedded within a biblical framework.³⁷⁸ Yet, in this case, Willis' own recourse to biblical references suggests that he used it rather as a device to justify the comparative method against those who would otherwise argue, potentially on those same religious grounds, that animals differed too much from humans to serve as models for the human brain and nervous system. In the above-quoted paragraph, Willis strongly emphasised the analogy between humans and quadrupeds—his favoured species of dissection. However, as we will see in the coming chapter, this emphasis started to waver the deeper Willis delved into the more detailed structures of the brain. The more analogies he detected in the brains of humans and quadrupeds, the more his anatomical gaze became somewhat tainted by his conviction that the human brain's superior functions must after all be mirrored in its structure, even when compared to what he formerly referred to as the 'twin animal species' of humans. As Willis had furthermore (re)located into the brain some of the faculties that

³⁷⁷ Ibid.

³⁷⁸ See William F. Bynum, 'The Anatomical Method, Natural Theology, and the Functions of the Brain' (*Isis* 64: 4 (1973), pp. 445-468).

Descartes had assigned solely to the human rational soul, such as sensual awareness, reflective memory and imagination, he could no longer refer to an immaterial substance to explain the higher status of these faculties in humans. As there was also no doubt that humans excelled in most of those faculties that he himself associated with the brain, Willis was led to exploit his observation of ever so slight differences between human and animal brains in order to maintain this vital assertion of a structural hierarchy of complexity, and with it of mental capabilities.

The following analysis of Willis' neuroanatomy will not follow chronologically the chapters of his work, in which a mere description of anatomical structures was followed by ratiocinations of their function. Rather, I am going to focus first on the way that Willis interpreted visible structural differences between human and animal brains and nerves, ranging from the form of the skull to the cerebral cortex and the distribution of nerves in the brain. This will be followed by a discussion of how Willis explained those parts of the brain that showed no notable difference in humans and animals, such as the cerebellum. In the last section, before turning to a discussion of Willis' theory of the sensitive soul at work in the nervous system, I address the difficulties Willis experienced in upholding his theories about nervous and brain functions that could *not* be tied to any specific structure in the brain. As it was, it were precisely these structureless functions on which the ultimate principle of human superior cognitive functions came to rest.

3.1.1. “Unlocking the secret places of Mans Mind”: Willis’ Anatomical Gaze

The Brain is accounted the chief seat of the Rational Soul in man, and of the sensitive in brute beasts, and indeed as the chief mover in the animal Machine, it is the origine and fountain of all motions and conceptions. But some Functions do chiefly and more immediately belong to the substance of this, and others depend as it were mediately and less necessarily upon it.³⁷⁹

With the brain being conceived as the origin of motion, sensation, and the human mind, the incentive to study the anatomy of this organ was a great one. Willis did not, however, focus explicitly on the specific seats of either the rational or the sensitive soul; as it was, he pursued ideas that can only be translated as brain localisation theories in the modern sense. He upheld the notion of the travelling animal spirits that were responsible for sensual input and execution of function, but he rooted the specific tasks of the spirits in different parts of the brain and associated different nerves and nerve branches with them. That humans excelled in all functions associated with the brain was a given for Willis; yet, his brain anatomy inadvertently rooted the difference between human and animal faculties in the actual parts and substance of the brain itself, rather than explaining it with the presence or absence of the rational soul. This in turn required him to seize on even the slightest anatomical dissimilarity in human and animal brain structures in order to mark off the higher mental abilities of humans anatomically. This underlying goal stood in contrast to his comparative approach which he had initially justified with the claim of similarity of the human brain with those of his dissected species. Overall, by comparing the brains of humans and animals, Willis found that they shared the same basic architecture – a cerebrum, a cerebellum and a medulla (oblongata). Superficial structural differences were therefore explained by him in terms of a gradation of faculties. Yet, there is an intrinsic contradiction in his anatomical reasoning that at times created epistemic tensions and also led to sometimes awkward ratiocinations.

³⁷⁹ Willis, *Anatomy of the Brain*, p. 75.

Beginning with the external form of the head, for instance, Willis' interpretation of the size, position of the skull, and facial features in humans and animals indicates that his anatomical reasoning was at times adjusted to fit a more conventional anthropocentric outlook, despite his former emphasis on the 'like form of the Brain' of humans and quadrupeds.

The figure of the Skull in four-footed beasts is narrow and pres[se]d down, but in man, the substance of [the] whole brain is large, there is required a more capacious and almost spherical figure. For as God gave him an upright countenance to behold the Heavens, and also endued his brain with an immortal Soul, and fitted for the speculation of Heaven; therefore his face is erect or lifted up; so the brain it self is placed in a more eminent place, to wit, above the Cerebel and all the Sensories. But in Brutes, and such whole faces are prone towards the Earth, and have a brain unfit for speculation, the Cerebel, however serving to the more noted action and office of the Praecordia, is placed in the highest seat to which the mole of the brain is subjected.³⁸⁰

Moreover, the rather conventional reference to the biblical hierarchy of 'man and 'beasts' also reveals that Willis' anatomical structure-function correlation operated at times rather arbitrarily, since the position of facial features says virtually nothing about the amount of intelligence generated by its owner's brain.³⁸¹ One could assume that a downward head in man might have been interpreted in just the same way as his 'upright countenance' (maybe replacing the 'speculation of Heaven' with a 'contemplation of the Earth'). And yet, for Willis, a difference in shape or size not only meant a difference in how the brain performed its functions. As we will see, his interpretation of animal and human cerebral structures was deeply embedded in an attempt to find anatomical evidence for the superiority of the human frame. An example of this is Willis' interpretation of the cortical and the medullary substance of the cerebrum. On the one hand, Willis assigned to the cerebral cortex the generation and elaboration of animal spirits, and with it the superior faculties, such as memory and imagination. This was based on Willis' observation that the cortex of the human cerebrum

³⁸⁰ Ibid., p. 64.

³⁸¹ As Erica Fudge has shown, the argument of man's 'upright countenance speculating heaven' was an old one, initially derived from Plato and taken up again by the Minister Stephen Bateman (d. 1581) in the sixteenth century. However, whereas Bateman uses the anatomical difference to make a moral point, Willis' use of it is embedded within an exclusive anatomical context. See Fudge, *Brutal Reasoning*, p. 7.

showed a higher structural complexity and, since humans excelled in memory and imagination, Willis reasoned that the cortical structure of the brain must be the origin and seat of those faculties:

Hence these folds or rollings about are far more and greater in a man than in any other living Creature, to wit, for the various and manifold actings of the superior Faculties [...] Those Gyration or Turnings about in four footed beasts are fewer, and in some, as in a Cat, they are found to be in a certain figure and order: wherefore this Brute thinks on, or remembers scarce any thing but what the instincts and needs of Nature suggest. In the lesser four-footed beasts, also in Fowls and Fishes, the superficies of the brain being plain and even, wants all cranklings and turnings about: wherefore these sort of Animals comprehend or learn by imitation fewer things [...].³⁸²

Arguably, on the level of pure anatomical observation, the convolutions as such do not yield enough functional information to interpret them as single evidence of higher or lesser faculties and function. But Willis reasoned that in order to produce complex images, the spirits of the brain had to take complex paths which Willis equated with the winding convolutions of the cortex.³⁸³ This in turn enabled him to equate the higher number of furrows with a higher complexity of the cerebrum's function. As we have seen, Willis was not the first to take up this notion. Since ancient times, the anatomical observation of this particular structure had led to a presupposed hierarchy of mental capacities in living beings. The cerebral cortex thus also stands as an example in which an unobservable, hence structureless, function was tied to a structure that displayed or provided the necessary varied anatomical complexity in living beings, and which also placed human beings at the top of this structural hierarchy. As Zimmer paraphrases Willis' logic, "[w]as it any surprise, then, that a bird had more of these furrows than a fish and a cat more than a bird – or that humans had a maze far beyond anything found in any animal's brain?"³⁸⁴ Yet, it seems as if Willis'

³⁸² Willis, *Anatomy of the Brain*, p. 76.

³⁸³ See *ibid.*

³⁸⁴ Zimmer, *The Soul Made Flesh*, p. 181.

intention was less to discover the actual function of this part of the brain, than to provide anatomical ‘proof’ for the superiority of the human brain.

His reasoning that the larger cortex of humans hinted at a greater elaboration of animal spirits was somewhat contradicted when he turned to the ‘marrow of the brain’, i.e. its inner layer. His observation that the medullary part of the brain was also greater in humans required a similar reasoning, which is why he ascribed to the cortex the generation of spirits, and to the medullary part of the brain their “exercise and dispensation.”³⁸⁵ The argument from size, however, is here reversed, as his anatomical ‘proof’ now consisted in showing that the cortex of lower animals was larger than the inner brain, which shifted the importance away from the cortex and onto the middle brain.

Truly, that this part is rather the Mart or Exchange of the Spirits than its Shop or Work-house, appears from hence, because the Animals which excel in Memory, Imagination, and Appetite, are furnished with a more ample marrow [of] the brain; as is observed in man and the more perfect four-footed beasts: and they who seem to have little need of those Faculties, as the lesser four-footed beasts, also Fowls and Fishes have the *Cortex* of the brain greater, but the medullary part very small. It is a familiar Experiment among Boys to thrust a needle through the head of a Hen, and that she in the mean time, whose brain is so pierced through, shall live and be well a long time. The reason of which is, because the whole substance of the brain in these sort of Animals is almost merely Cortical; wherefore from the suffering such a hurt, (as long as the marrow remains unhurt) the Spirits are generated in a lesser quantity, but their commerce to the necessaries of life, are not therefore presently interrupted.³⁸⁶

That the brains of some animals, most notably those of apes, monkeys and dolphins, clearly matched, or even exceeded the size and convoluted structure of the human brain, sat rather uncomfortably with this incentive to hierarchically order the structure-function correlations.³⁸⁷ Having turned to the description and uses of the nerves near the end of his

³⁸⁵ Willis, *Anatomy of the Brain*, p. 76.

³⁸⁶ Ibid.

³⁸⁷ In 1669, John Ray (1627-1705), British naturalist and natural theologian, dissected a porpoise and noticed the similarity of its brain to those of humans; he accordingly speculated that these creatures were “of more than ordinary wit, and capacity; Ray, ‘An Account of the Dissection of a Porpess, Promised Numb. 74; Made, and Communicated in a Letter of Sept. 12 1671, by the Learned Mr. John Ray, Having therein Observ’d Some Things Omitted by Rondeletius’ (*Philosophical Transactions* (1665-1678), Vol. 6 (1671), pp. 2274-2279), p.

Anatomy of the Brain, Willis seized an opportunity to dissect a monkey, and remarked that the bulk and detailed structure of the brain, came nearer “the figure and magnitude of those parts in a man.”³⁸⁸ The comparative anatomist Edward Tyson (1650-1708), who had dissected a porpoise and a chimpanzee, maintained at the turn of the century that “[t]hose Nobler Faculties in the Mind of Man, must certainly have a higher Principle; and Matter organized could never produce them; for why else, where the Organ is the same, should not the Actions be the same too? and if all depended on the Organ, not only our Pygmie, but other Brutes likewise, would be too near akin to us.”³⁸⁹ If the physical separation of humans and animals could not be upheld, a return to higher principles, i.e. the soul, was in order. The underlying logic with which Willis eventually analysed the more intricate structures of the brain and nerves remained in that sense similar, as these analyses, too, were based on a presupposed difference between human and animal brain functions. Just as “Natural theologians have assumed that which they have ostensibly sought to prove,”³⁹⁰ Willis’ assumptions plainly reveal how he seized on observed anatomical differences to find proof

2277. Bynum also uses the example of Ray to argue that natural theology cannot have been the sole influence of the downgrading of animals, since Ray not only argued elsewhere for a greater analogy of human and animal mental faculties, but also for the immateriality of the sensitive soul; see Bynum, ‘The Anatomical Method’, p. 462. Twenty years later the London physician and fellow of the Royal Society Edward Tyson (1650-1708) published an account of his dissection of a porpoise which was influenced by Ray’s account, but also by Willis’ anatomy of the brain; see Tyson, *Phoecaena, or the Anatomy of a Porpess, Dissected at Gresham Colledge: with a Praeliminary Discourse concerning Anatomy, and a Natural History of Animals* (London: Printed for Benj. Tooke, 1680). See also Lawrence Kruger, ‘Edward Tyson’s 1680 Account of the ‘Porpess’ Brain and its Place in the History of Comparative Neurology’ (*Journal of the History of the Neurosciences* 12:4 (2003), pp. 339-349). Tyson is better known for his *Orang-Outang, Sive Homo Sylvestris: Or, The Anatomy of a Pygmie, Compared with that of a Monkey, an Ape, and a Man* (London: Printed for Thomas Bennet, 1699), which actually described the anatomy of a chimpanzee. However, in contrast to Ray, both of Tyson’s anatomies are a case in point that anatomical knowledge was conceived in terms of difference between humans and animals, the emphasis of which became stronger the closer an animal’s anatomy was to human anatomical structures. Tyson not only furthered the notion of a structural gradation of mental faculties from animals to humans. Bynum even goes as far as to say that “Tyson’s argument on the brain is identical to Willis’: the use of an apparent disjunction of the comparative structure/function relationship to erect an absolute barrier between man and brute;” Bynum, ‘The Anatomical Method’, p. 463. See also M.F. Ashley Montagu, *Edward Tyson, M.D., F.R.S., 1650-1708 and the Rise of Human and Comparative Anatomy in England*. Foreword by George Santon (Philadelphia: The American Philosophical Society, Independence Square, 1943); and Susan Wiseman, ‘Monstrous Perfectability: Ape-Human Transformations in Hobbes, Bulwer, Tyson’, in Fudge, Gilbert and Wiseman (eds.) *At the Borders of the Human*, pp. 215-238.

³⁸⁸ Willis, *Anatomy of the Brain*, p. 133. For reasons that will be discussed in more detail below, Willis was more astonished to see that the monkey’s intercostal nerve was practically identical with those of humans.

³⁸⁹ Tyson, *Orang-Outang, Sive Homo Sylvestris*, p. 55.

³⁹⁰ Bynum, ‘The Anatomical Method’, p. 445.

for those preformulated hypotheses that underlined the difference between humans and animals. Since the novelty of Willis' post-Cartesian anatomy of the nervous system consisted in the fact that he (re)located some mental faculties back into the brain, one could also say that, in this context, his anatomy actually made the search of a structural difference between human and animal brains compulsory.

The comparison of human and animal structures was also invoked in Willis' dismissal of various long-known features of the brain, such as the ventricles, the *rete mirabile*, and the pineal gland. Regarding the ventricles, Willis went against the traditional conceptual importance associated with "the cherished chambers where generations of physicians and philosophers had believed the spirits were corralled."³⁹¹ To him, the ventricles seemed to have no vital function at all and he saw in them "only a vacuity resulting from the folding up of its exterior border, [whence] I see no reason we have to discourse much of their office, no more than Astronomers are wont of the empty space contained within the vacuity of the Sphere."³⁹² His lack of interest in them resulted from experiments he had conducted on animals' brains with dye and ink which showed that the ventricles themselves were not supplied with blood (and therefore not with animal spirits). The only function that Willis could imagine for the ventricles was that they were "a mere sink of the excrementitious Humor."³⁹³ This conjecture might have been influenced by Harvey, who had equally dismissed the ventricles as unimportant and believed "them rather to be made for the reception of excrements."³⁹⁴ In the context of his current project to 'unlock the secret places

³⁹¹ Zimmer, *The Soul Made Flesh*, p. 177.

³⁹² Willis, *Anatomy of the Brain*, p. 79.

³⁹³ *Ibid.*, p. 82.

³⁹⁴ Though Harvey did altogether not like the idea of 'spirits' which stood at the centre of Willis' concept of the sensitive soul. He rather believed that it was the blood itself that should be given the credit for the assumed animal spirits' functions; see William Harvey, *Disputations Touching the Generation of Animals* (1651). Translated with an introduction by Gweneth Whitteridge (Oxford: Blackwell Scientific Publications, 1981), p. 375.

of Man's Mind', Willis' overall conclusion was that the ventricles had nothing to do with the business of the mind.

He also found no evidence for Descartes' account of animal spirits being pumped through the pineal gland, let alone that the pineal gland was the place where the rational soul connected with the brain. After all, as Willis ascertained, the pineal gland was "not only found in Man and four-footed Beasts, but Fowls and Fishes also are endued with the same."³⁹⁵ Remaining open to the possibility that some vital function might someday be ascribed to it, "yet, we can scarce believe this to be the seat of the Soul, or [that] its chief Faculties do arise from it; because Animals, which seem to be almost quite destitute of Imagination, Memory, and other superior Powers of the Soul, have this Glandula or Kernel large and fair enough."³⁹⁶ To him, the fact that even lower animals were in possession of a pineal gland ruled out the possibility of its being the seat of the soul more decidedly than any anatomical description of it could have done. But again, his structure-function correlation was applied somewhat arbitrarily. In *The Anatomy of the Brain*, Willis might have dismissed the pineal gland as the Cartesian location, or rather switch organ, where the rational soul received information from the senses via the animal spirits on the grounds of comparative anatomical reasoning. Yet, in *The Soul of Brutes*, Willis indirectly located the rational soul's faculties in the corpus callosum,³⁹⁷ which Bynum views as an example in which "[t]he theoretical sharpness of Willis' distinctions [of the sensitive and the rational soul] becomes further blurred."³⁹⁸ I will speak of Willis' understanding of the rational and sensitive soul at work in the brain in the next section. For the moment, I would like to dwell a bit longer on Willis' *Anatomy of the Brain*, as his anatomical gaze is highly suggestive of the fact that the material structures of the brain

³⁹⁵ Willis, *Anatomy of the Brain*, p. 87.

³⁹⁶ *Ibid.*; see also p. 58f.

³⁹⁷ Willis, *The Soul of Brutes*, p. 153.

³⁹⁸ Bynum, 'The Anatomical Method', p. 456.

were also classed as a source of difference between humans and animals, despite the methodological approach of using the latter to gain information about the former.

Dismissing those features that had traditionally played a large role in the functions of the human nervous system, Willis paid more attention to the way that blood was supplied to the brain. He found that each major part of the brain was supplied by its own set of vessels, which he not only took as evidence that these distinct parts carried out different functions. The presence or absence of blood vessels in human versus animal brains, as well as the amount of vessels distributed through the brain, also served as anatomical evidence for a difference in mental faculties, since

[...] in an human Head, where the generous Affections, and the great forces and ardors of the Souls are stirred up, the approach of the blood to the confines of the Brain, ought to be free and expeditious; and it is behoveful for its River not to run in narrow and manifoldly divided Rivulets, which scarce drive a Mill, but always with a broad and open chanel, such as might bear a Ship under Sail. And indeed, in this suspect, a man differs from most brute beasts, in which, the Artery being divided into a Thousand little shoots, lest it should carry the blood with a fuller chanel, or more quick course than is requisite, make the Net-like infoldings, by which indeed it comes to pass, that the blood slides into the Brain very slowly, and with a gentle and almost even stream. If that be true, as some affirm, that the wonderful Net also is sometimes found in an humane Brain, I believe it is only in those sort of men, who being of a slender wit or unmoved disposition, and destitute of all force and ardor of the mind, are little better than dull working beasts in fortitude and wisdom.³⁹⁹

Here, the bloodflow certainly fulfilled vital functions in more than one way. The distribution of arteries in human versus animal skulls accounted in fact for the uniqueness of the ‘human offices of the senses’, serving thus as another marker of difference. As is clear from the latter part of the above-quoted paragraph, Willis was also sceptical of the existence of the *rete mirabile* in humans, not least because it had so far been mostly observed only in animals.⁴⁰⁰

He himself had apparently not found it in any of the human brains he had dissected, but, as he could not rule out completely its existence in humans, he felt that it was at least safe enough

³⁹⁹ Willis, *Anatomy of the Brain*, p. 70.

⁴⁰⁰ See also Pranghofer, “It could be Seen more Clearly in Unreasonable Animals than in Humans”, pp. 575-575.

to speculate that only men of ‘slender wit’ or even ‘destitute of all force of the mind’ possessed it, which effectively rendered them more similar to those lower animals in which it was found more frequently. Had the *rete mirabile* been a uniquely human structure, we might guess that its ‘thousand little arterial shoots’ would have served to underline a greater need for a more minute distribution of blood vessels in the brain in order to fulfil more complex functions. In any case, it seems obvious that Willis deliberately interpreted the potential use of each and every structure of the brain by way of assessing the degree to which these structures differed in humans versus animals.

This becomes even more apparent in the way in which Willis assigned functions to the cerebellum, though he applied here a somewhat reverse reasoning. As outlined above, Willis concluded that the cerebrum was the specific part of the brain that housed those faculties in which humans excelled, due to the more complicated structure of the human cerebral cortex. The cerebellum, on the other hand was practically identical in humans and all the animals he dissected, which meant that he could not assign to it specific functions on the basis of structural difference. That is, since its overall structure did *not* differ in humans and animals, he maintained that the cerebellum must have lower, more basic, functions that were shared by animals and humans to an equal degree. Accordingly, for Willis the cerebellum

is a peculiar Fountain of Animal spirits designed for some works, and wholly distinct from the Brain [i.e. the cerebrum]. Within the Brain, Imagination, Memory, Discourse, and other more superior Acts of the animal Function are performed [...] But the office of the Cerebel seems to be for the animal Spirits to supply some Nerves; by which involuntary actions (such as are the beating of the Heart, easie Respiration, Concoction of the Aliment, the protrusion of the Chyle, and many others) which are made after a constant manner unknown to us, or whether we will or no, are performed. As often as we go about voluntary motion, we seem as it were to perceive within us, the Spirits residing within the fore-part of the Head to be stirred up to action, or an influx. But the Spirits inhabiting the Cerebel perform unperceivedly and silently their works of Nature without our knowledge or care.⁴⁰¹

⁴⁰¹ Willis, *Anatomy of the Brain*, p. 91.

This interpretation of function did obviously not rest on an observation of the spirits at work since these could not be observed directly. However, as he mentions specific nerves leading from the cerebellum to internal organs whose workings ‘perform unperceivedly’, we can assume that in this case Willis’ anatomical reasoning rested on an actual observation of the link between one structure and another. Tying in his new insights with former medical case studies, Willis recalled some patients with pains at the back of their head where the cerebellum was located, who had also suffered complaints in their lungs and heart.⁴⁰² In order to test his hypothesis about the cerebellum controlling the function of internal organs, Willis and Lower took recourse to yet another experiment in which a living dog’s chest was opened and the nerves that ran from the cerebellum to the heart were tied. They observed that the dog’s heart filled with blood and that death quickly followed, which confirmed that the brain must indeed control the heart.⁴⁰³ The anatomical connection of the brain and the heart via the cardiac branches of the vagus nerve had already been established by Galen.⁴⁰⁴ It had assumed great importance in the heart-brain debate during the late medieval period and was seen as proof for Aristotle’s cardiocentric theory that had established the long-lasting notion of the heart’s control over the brain. Willis, however, used his experimental evidence to argue for the controlling power of the brain over the heart. This new conception of the importance of the cerebellum for the control of inner organs was in that sense a truly novel one. It seemed to undermine once and for all the ongoing belief that the heart was the most important organ; instead, backed up by his anatomical reasoning, Willis could now assign this status to the brain. He had yet to provide a comprehensive account of how the brain exercised its control over the vital organs, as well as the muscles. But the cerebellum provided him with the

⁴⁰² Willis, *Anatomy of the Brain*, p. 92.

⁴⁰³ See Zimmer, *The Soul Made Flesh*, p. 179.

⁴⁰⁴ See Frampton, *Embodiments of Will*, p. 187.

opportunity to explain vital functions “according to the Rules, Canons, and Laws of a Mechanick.”⁴⁰⁵

Bynum concludes that “his speculations concerning the possible functions of these two regions of the brain were at least consistent with his anatomical findings.”⁴⁰⁶ However, despite the appearance that Willis’ conclusions had been preceded by a close anatomical observation and experimental proof, it seems as if this important link between the cerebellum, the nerves, and the vital organs was anatomically and experimentally pursued only *after* he had hypothetically assigned the cerebellum lower and automatic (i.e. unconscious) functions:

As I only imagined of the use of the Cerebel after this manner, I was led to it at length by a certain thread of Ratiocination; to which after wards happened an Anatomical inspection, which plainly confirmed me in this Opinion. For in the frequent Dissection of the Heads of several sorts of Animals certain Observations did occur, which seemed to put this matter out of all doubt.[...]

But further, it is observed, that in all Animals, although they differ in form and kind, yet the figure of the Cerebel is always very like or wholly the same. The Brain and oblong Marrow are figured in many after a divers manner; for as we have shewed before, there is some difference of these parts found in man and four-footed beasts; but between either of these, and Fowls and Fishes, there is a notable difference as to these parts.

Notwithstanding in all these the Cerebel, furnished wholly with the same lappets or little circles alike infolded one in another, is marked with the same form and proportion; which certainly is a sign that the animal Spirits in this work-house are begotten and dispensed, as it were by a certain dimension, for certain necessary offices, which are performed in all after the same manner; and which cannot be any other than the motions and actions of the *Viscera* and *Praecordia*.⁴⁰⁷

Thus, it was mainly the observation that animal and human cerebellums showed no marked structural difference that suggested to him what part the cerebellum played in the overall functions of the brain. It was not the more simple texture of the cerebellum, but the fact that human and animal cerebellums were so much alike, that evoked its more simple, machine-like, autonomous function. After all, “As to the other Faculties, of which sort are

⁴⁰⁵ Willis, ‘Of Muscular Motion’, in *Dr. Willis’ Practice of Physick*, p. 29.

⁴⁰⁶ Bynum, ‘The Anatomical Method’, p. 452.

⁴⁰⁷ Willis, *Anatomy of the Brain*, pp. 91 and 92.

Imagination, Memory, Appetite, yea local motions and sense are exercised after one manner in those living Creatures, and after another manner in others; wherefore their brains are formed after a divers manner.”⁴⁰⁸ Willis’ reasoning as to how these autonomous functions were performed in the cerebellum with the help of the spirits is one description in his anatomical work that is reminiscent of Descartes’ body machine theory. That is to say, he did not so much confirm the Cartesian beast-machine, but was in line with Descartes’ overall mechanical vision of vital functions in human and animal bodies, in which the animal spirits were at work ‘unperceivedly’.

For indeed those [animal spirits] in the Cerebel, as it were in a certain artificial Machine or Clock, seem orderly disposed after that manner within certain little places and boundaries, that they may flow out orderly of their own accord one series after another without any driver, which may govern or moderate their motions. Wherefore forasmuch as some Nerves perform some kind of motions according to the instincts and wants of Nature, without consulting the government of the will or appetite within the Brain, why may it not be imagined, that the influence of the Spirits is derived wholly from the Cerebel for the performing of these? For it seems inconvenient, that for these offices which should be performed without any tumult or perturbation, the Spirits should be called out of the Brian, which are continually driven into fluctuations as it were with the winds of Passions and Cogitations.⁴⁰⁹

Yet, apart from assigning automatic faculties, such as involuntary motion and “Passions and Instincts merely natural” to the cerebellum, he also listed “Sense” among them.⁴¹⁰ I will discuss his understanding of sensation and sense experience, the chief faculty of the corporeal sensitive soul, in section 3.1.2. But from an anatomical point of view, sense experience, be it corporeal or mental, together with memory, imagination, and emotion, could not be directly observed in the structure of the brain, which must have posed a limit to Willis’ mechanical view of the body.⁴¹¹ Nonetheless, Sawday maintains that, for Willis, “all mental operations

⁴⁰⁸ Ibid.

⁴⁰⁹ Ibid., p. 91.

⁴¹⁰ Ibid., p. 75. He added that, although these faculties “are properly performed in the oblong Marrow and Cerebel,” they also “depend in some measure upon the Brain;” *ibid.*

⁴¹¹ This was also pointed out by afore-mentioned Danish anatomist Nicolaus Steno in his 1665 lecture *Discours sur l’Anatomie du Cerveau* (published 1669). Commenting on Willis’ localisation of the common sensory in the

could be understood as ‘a sequence of anatomical structures’,⁴¹² and accordingly refers to him as the “high priest of mechanism.”⁴¹³ We will see that in his actual discussion of animal reasoning, Willis was in fact closer to Gassendi than to Descartes, and that his overall focus on observable anatomical structures in the end compromised Willis’ attempt to ground the difference of non-physical faculties of humans and animals in the nervous system – with the exception, maybe, of his interpretation of the intercostal nerves, which served him to explain the higher emotive faculties in humans versus animals.

It is not surprising that Willis’ specific ‘doctrine of the nerves’ also engaged with a search for those anatomical proofs that constituted the human and with it the human-animal boundary. Particularly interesting is his interpretation of the intercostal nerve, to which Willis devoted a large part of his *Description and Use of the Nerves*, which was later added to his *Anatomy of the Brain*. His discussion of the intercostal nerve provides a fascinating insight into his attempts to extract metaphysical meaning from the arrangement of structures in humans as opposed to the animal body. Willis observed that this nerve (consisting in modern terms of the anterior divisions of the thoracic spinal nerves), originating from the fifth and sixth pair of nerves and thus from the brain, formed a distinguishable trunk whose branches were “going near the roots of the ribs” and reached down to the Viscera of the lower belly.⁴¹⁴ As they derived from the cerebellum, he concluded that these nerves were mainly responsible for involuntary functions and the workings of the vital organs.⁴¹⁵ However, he further detected

corpus striatum, imagination in the corpus callosum, and memory in the cortex, he stated that “M. Willis gives us a quite extraordinary system; [...] What assurance can he have, then, that would be credible to us, that these three operations exist in the three bodies to which he assigns them? Indeed, the corpus callosum is so unknown to us that anyone with the least inclination can say what he pleases about it.” The quote is taken from the English translation provided in Gustav Scherz (ed.) *Nicolaus Steno’s Lecture on the Anatomy of the Brain* (Copenhagen: Nyt Nordisk Forlag, 1965), p. 127. See also Bynum, ‘The Anatomical Method’, p. 458.

⁴¹² Sawday, *The Body Emblazoned*, p. 255.

⁴¹³ *Ibid.*, p. 257.

⁴¹⁴ Willis, *Anatomy of the Brain*, p. 95 and p. 128. For a discussion of the different conceptualisations of the intercostal nerves, see Rhina Knoeff, ‘The Reins of the Soul: The Centrality of the Intercostal Nerves to the Neurology of Thomas Willis and to Samuel Parker’s Theology’ (*Journal of the History of Medicine and Allied Sciences* 59:3 (2004), pp. 413-440), pp. 415-416.

⁴¹⁵ Willis, *Anatomy of the Brain*, p. 131.

that, in humans only, some shoots connected the intercostal nerve trunk with the diaphragm and the heart, which were traditionally associated with emotion and affects. Whereas animals received their cardiac nerve supply almost wholly from the ‘wandering pair of nerves’ (the vagus nerve), in humans, additional fibers from the intercostal nerve served a more direct communication between the brain and the heart.⁴¹⁶ Willis seized on this anatomical discovery not only to explain the long-known influence of emotions on the palpitations of the heart, but to designate an anatomically observable difference between the emotional and mental life of humans and animals.

Whilst I consider this difference of either kind, it comes into my mind, that Brutes are like Machines framed with a more simple furniture and with less workmanship, and therefore furnished with a motion of one kind only, or determined for the doing [of] the same thing. But in Man divers series of motions, and as it were complications of wheels within wheels, appear [;] and so by reason of these reciprocal affections of the Heart and Brain, which are wont by a long series to be propagated vicissively, a multiplicity of thoughts and Phantasms arises. Hence both the ancient Divines and Philosophers placed wisdom in the Heart. Certainly the Works of Prudence and Vertue depend very much on the mutual commerce which happens to the Heart with the Brain: because, that cogitations about the acts of the Appetite or Judgment may be rightly described, it is behoveful for the flood of the blood to be restrained in the Breast, and the inordinations of it and of the Heart it self to be governed by the Nerves, as it were by Reins [...]. When of late we had dissected the Carcass of a man that was a Fool from his birth, we could find no defect or fault in the Brain, unless that its substance or bulk was very small. But the chief note of difference which we observed between the parts of this man and of a man of judgment, was this, That the aforesaid infolding of the intercostal Nerve, which we call the *Internuncius* of the Brain and Heart, proper to man, was very small in this Fool, and beset with a weaker guard of Nerves.⁴¹⁷

Judgment and wisdom thus depended on the presence of these particular branches of the intercostal nerve which secured not only a healthy communication between the heart, lower

⁴¹⁶ “But these Cardiac branches from the intercostal nerve [...] are peculiar to men, and are wholly wanting in brute beasts;” Willis, *Anatomy of the Brain*, p. 129; see also p. 132 and 144. For a discussion of the accompanying anatomical illustrations of the intercostal/thoracic nerves in Willis’ work; see Knoeff, ‘The Reins of the Soul’, pp. 428-429.

⁴¹⁷ Willis, *Anatomy of the Brain*, p. 132.

viscera, and the brain, but a ‘reigning in’, as it were, of the otherwise overwhelming instincts and passions of the natural body.⁴¹⁸

As mentioned above, in the midst of writing his description of the nerves, Willis dissected a monkey, and found to his astonishment that its intercostal nerve had the same shootings or branches that he thought connected only the human heart with the brain, “a fact which Willis found more striking than the anthropomorphic features of the simian brain.”⁴¹⁹ Unfortunately, Willis did not reflect on the implications of such findings or on the possible limitations that this discovery might put to his overall interpretation of the intercostal nerve’s function. Instead, he proposed that the existence of this structure—formerly deemed peculiar to humans—in monkeys must be “the reason, why this Animal is so crafty and mimical above other Beasts, and can so aptly shew and imitate, not only gestures, but the passions and some manners of man.”⁴²⁰ Hence, in monkeys, the existence of this structure did not serve as potential evidence that they might be in possession of similar mental faculties, but simply enabled them to display the (human) behaviour associated with these faculties. Willis also did not offer an explanation as to why those tiny branches of the intercostal nerve should enable an animal to imitate, but not inhabit, human traits. But, as indicated throughout this chapter, Willis’ anatomical method was meant to show first and foremost that humans were in any case structurally and functionally “more complicated, more finely wrought, than any brute.”⁴²¹ And if that meant that his anatomical gaze had to be made subservient to his preformulated hypotheses, then Willis went along with it. Willis’ descriptions of the nerves are thus rationalised in the same way as his interpretation of the brain’s structures. It was too tempting to utilise the observation of a sufficiently different number and distribution of

⁴¹⁸ See also Knoeff, ‘The Reins of the Soul’, p. 431.

⁴¹⁹ Bynum, ‘The Anatomical Method’, p. 457.

⁴²⁰ Willis, *Anatomy of the Brain*, p. 133.

⁴²¹ Bynum, ‘The Anatomical Method’, p. 458.

nerves and nerve branches as structural evidence that human superiority could be displayed anatomically.⁴²²

The examples of Willis' interpretation of the brain and nerve structures I have discussed are just a few among many suggesting that Willis' comparative human-animal anatomy aimed at an accumulation of knowledge about the nervous system that went beyond the mere description of anatomical structures and their functions. Inherent in Willis' anatomical project was also an assessment of the influence that the soul might or might not have on corporeal functions, which, in the face of striking anatomical similarities, also determined the boundary between humans and animals. It is no coincidence that his works were not only influential among anatomists and medical students. Rhina Knoeff has shown that Willis' particular discovery and discussion of the intercostal nerve was even used by contemporary theologians to emphasise the (pre)existence of the rational soul and with it the God-given difference between humans and animals.⁴²³ In fact, Bynum argues that Willis used those faculties that could not be tied to an anatomical structure mostly as proof that there existed an immaterial principle in humans.⁴²⁴ Yet, he also maintains that "the eagerness with which both natural theologian and anatomist seized upon what slight comparative neurologic variations they could find belies the confidence with which they used brain similarities to posit structureless function," arguing pointedly that for this reason it "would have been convenient for the argument from design and the anatomical method had the pineal gland been unique to

⁴²² Tellingly, this did not always involve the interpretation of a larger number of nerves (or vessels for that matter) as proof for higher faculties. Willis observed, for instance, that the 'wandering pair' of nerves in animals sent forth more numerous branches to the heart than its human equivalent. As animals on the other hand lacked the aforementioned branches of the intercostal nerve, he argued that the more numerous branches of the 'wandering pair' were a kind of substitute for the more elaborate human equivalent, "wherefore when they [the nerve branches] are only of one origination [sic], therefore more are required [...]; Willis, *Anatomy of the Brain*, p. 144.

⁴²³ Knoeff discusses here the work of Samuel Parker (1640-1688) who used Willis' anatomical reasoning on the intercostal nerves to argue that these were given to humans in order to fight unruly passions and desires; see 'The Reins of the Soul', pp. 432-436. Bynum further mentions one William Derham, a friend of the anatomist John Ray, whose *Physico-Theology* (1713) – based on Robert Boyle's lectures of 1711 and 1712 – also drew on Willis' theory of the intercostal nerve to denote the difference "between Man and Quadrupeds in the Nervous KIND"; see Bynum, 'The Anatomical Method', pp. 465-466.

⁴²⁴ See Bynum, 'The Anatomical Method', p. 454.

man.”⁴²⁵ But Willis’ audacious attempt of tying these functions to the more complex anatomical structures of humans somehow also belies his alleged belief that there were functions that could *not* be grounded in the anatomical body. After all, he was an anatomist, not a theologian or philosopher like Descartes for whom all faculties in which humans excelled were due to the rational soul, as we will see in the following discussion of the corporeal soul.

With his *Anatomy of the Brain* and his *The Soul of Brutes* Willis pursued two projects serving the same goal: in the first, he set out to show that the human nervous system was the anatomical equivalent to the rational soul—both of which were used as proof for the superiority of human faculties. In the second, he focused on the sensitive soul, and here, just as in his main anatomical work, he began once more with the premise that humans and animals shared this corporeal component (in the form of animal spirits), but then steered towards the assertion that, in the end, human uniqueness rested on something above and beyond the elaboration of animal spirits, that is, the sensitive soul. In any case, in Willis’ overall discussion of the nervous system and the soul(s) involved, the question of the human-animal boundary took centre stage. Bynum, too, could not help noticing that apart from the question of the anatomical method and potential influence of and on natural theology, Willis explored a subject that was essential to the question of human distinctiveness:

Is man a more complicated animal or is he an animal with something added? Do his superior mental faculties have anatomical representation or do they result from an immaterial principle working more or less independently of his brain, which after all looks much like the brain of a dog or a monkey?⁴²⁶

⁴²⁵ Ibid., p. 466.

⁴²⁶ Bynum, ‘The Anatomical Method’, p. 447.

These questions gained even more importance once Willis turned to a more detailed discussion of the corporeal soul in humans and animals as the instrument of bodily, and in part mental, performance, which will be discussed in the next subchapter.

3.1.2. “Cloathing the Skeleton with Flesh”: Willis’ Discourse on the Corporeal Soul

In his conclusion to the *Anatomy of the Brain*, Willis had advertised his *Discourses on the Soul of Brutes*, which was published in 1672, as “the Crown of the Work” that followed “the naked Anatomical Observations and Histories of Living Creatures.”⁴²⁷ In this, Willis’ work mirrors traditional anatomical accounts that first offered a description of the body and then contemplated the soul as an (im)material entity that determined even more than corporeal structures what faculties a living being might or might not possess. Interestingly, even though the corporeal soul had been traditionally discussed by way of using animal life to exemplify its mechanisms, Willis predominantly referred to this entity that he believed was diffused throughout the nervous system as ‘The Soul of Brutes’. His overall aim was to describe the workings of the nervous system as such (hence the equally denoting ‘Corporeal Soul of Man’). But he might have used the explicit reference to ‘brutes’ in order to emphasise that the faculties of this soul were not going beyond the corporeal boundary, thus avoiding immediate charges of heresy. The notion of corporeal mechanisms (exemplified as animal life) being subordinate to the immaterial rational soul (the constituent of humans) was also a conventional one; if anything, it had been strengthened by Cartesian dualism. And on one level, Willis certainly situated himself within this tradition when he claimed that his ‘Doctrine of the Soul’⁴²⁸ ensured that “the Rational Soul, Superior and Immaterial, may be

⁴²⁷ Willis, *Anatomy of the Brain*, [The Conclusion], p. 158.

⁴²⁸ Willis, *The Soul of Brutes*, p. 2.

sufficiently differenced from it [...] whereby some deserving very ill of themselves, have affirmed the Souls of Man and the Beasts only to differ in degree of Perfection [...].”⁴²⁹ But he also claimed that knowledge of the corporeal soul might assist in identifying “the Ingenuity, Temperament, and Manners of every Man [...] as also the Causes, and formal Reasons of many Diseases, as of the Phrensie [Frenzy], Lethargy, Vertigo, Madness, Melancholy, and others, belonging rather to the Soul than to the Body[...].”⁴³⁰ As he mentions here the soul as opposed to the body (‘rather than’), the reference is clearly only to the immaterial rational soul. And with this, he conjured up a less clear-cut boundary between the souls, especially as he maintained at the same time that “the Corporeal Soul doth extend its Sicknesses, not only to the Body, but to the Mind or rational Soul.”⁴³¹

The implication that the faculties of the rational soul depended more strongly than thought on the sensitive soul and the nervous system (to be discussed in more detail below) posed certain metaphysical dilemmas that needed to be addressed not only by philosophers and theologians. The involvement of corporeal components in the debate about the core constituents of human nature—and vice versa—also presented a problem to the anatomist. In his preface to the *Anatomy of the Brain*, Willis had already acknowledged the implicit difficulties of anatomizing an organ system that could not be subjected to the same degree of mechanical analysis as, say, the circulation of the blood or muscle movement:

In other parts, where matters appear to the Senses, we do not so easily run upon errors [sic]. For in most of the Viscera and Vessels, the Contents and contained humors, as also their passages within the larger Cavities of the containing parts, are discerned by the sight: But in the Brain and Nerves, neither the rushings on or impressions, viz. the Animals Spirits themselves, nor their tracts or footsteps, can any ways be seen. Wherefore to explicate the uses of the Brain, seems as difficult a task as to paint the Soul, of which it is commonly said, That it understands all things but it self [...].⁴³²

⁴²⁹ Ibid., p. 1.

⁴³⁰ Ibid.

⁴³¹ Ibid., Preface, n.p..

⁴³² Willis, *Anatomy of the Brain*, Preface, n.p.. He elaborated on this difficulty at the very beginning of *The Soul of Brutes*.

Nonetheless, after ‘explicating the uses of the Brain’, Willis now set out to ‘paint the Soul’, that is, by way of explaining the corporeal soul, he figured that one ought to be able to identify the faculties of the rational one more clearly. So, before entering into a discussion of the implication that this link between rational and corporeal soul had for the conception of human versus animal faculties, the following paragraph will first investigate what exactly this corporeal soul was that Willis held responsible for all aspects of animal life, and which made humans a ‘Two-soul’d Animal’.⁴³³

Willis outlined his own conception by way of discussing first the various opinions and theories on the subject of souls since ancient times, beginning with the concept of world souls of the Platonists and Pythagoreans (which Willis called “*Platonick Fiction*”⁴³⁴) and “the Heresie of the *Manichees*”⁴³⁵ who asserted that all souls were taken from the very substance of God himself. Next to Aristotle, whose anatomical investigations had marked more clearly the separation of the immaterial from the corporeal souls, Willis identified himself more with those ancient conceptions that located the soul in the blood and associated its substance with fire or other material elements. Willis identified Epicurean atomism in particular, “delivered of old, and of late revived in our Age,”⁴³⁶ as the one hypothesis on which most ‘modern’ philosophers built their doctrines of the soul. However, on one fundamental aspect a remarkable diversity of opinion prevailed, which further testifies to the importance and continuity of the subject: the capacities of animals, whose soul

is by some of them deprived of all Knowledge, Sense, and Appetite; in the mean time, not only Sense, Memory, and Phantasie is granted to her by others, but the use of a certain inferior Reason. And what is more to be wonder’d at, the same end of their Assertion is proposed by either Sect; to wit, That the Soul of the Brutes, both as it may be deprived of its gifts, and also as it is most notably adorned by them, may be very

⁴³³ Ibid.

⁴³⁴ Willis, *The Soul of Brutes*, p. 4.

⁴³⁵ Ibid.

⁴³⁶ Ibid., p. 2.

much distinguish'd, or (that I may use the Idiom of the Schools) diversified from the humane Soul.⁴³⁷

Gómez Pereira is here mentioned as the first among those who were “endeavouring as much as they could, to discriminate the Soul of Beasts from the humane,”⁴³⁸ by denying them ‘knowledge’ and sense: “For otherwise, if Cognition be granted to the Brutes, you must yield to them also Conscience, yea and deliberation and Election, and a Knowledge of universal things, and lastly an incorporeal and rational soul.”⁴³⁹ By reflecting thus on the way that philosophers since the sixteenth century approached the question of the (human) soul, Willis not only distinguished his own opinion on the subject; we also find proof that he explicitly took issue with Pereira’s and Descartes’ rather strict notion of animal automatism:

But indeed these Solutions of difficult Phenomena’s [sic] tho artificially formed by these Authors, seem not to satisfie a Mind desirous of Truth: [...] Wherefore others, also renowned Philosophers, both Ancient and Modern, professing themselves no less adverse to Atheism than the former, Challenge in the behalf of the Beasts, not only the operations of an external and internal Sense, with Perception, Appetite, and spontaneous motions; but besides, grant to them a certain use of Judgment, Deliberation, and Ratiocination.⁴⁴⁰

One of these ‘renowned Philosophers’ that he mostly referred to in his subsequent discussion was Pierre Gassendi from whose ‘experimental philosophy’ Willis significantly quoted at length. Commenting on the ‘wonderful sagacity of Animals’, Gassendi had maintained that

These things could not deservedly be attributed to them, unless they granted them a certain kind of Reason. However it be, we may seem at least to be able to distinguish, by a ready way, that as Commonly a two-fold Memory, To wit, a Sensitive and Intellective, is distinguished, so nothing forbids to Call Reason Sensitive and Intellectual. And truly, as we understand by the Name of Reason, the faculty or beginning of Ratiocination, and that to Reason is nothing else, than to understand one thing by the Knowledg [sic] of another thing, there is nothing more Easily to be observed, than that Brutes do Collect

⁴³⁷ Ibid., p. 3.

⁴³⁸ Ibid.

⁴³⁹ Ibid.

⁴⁴⁰ Ibid.

*one thing out of another, or what is the same thing, do reckon or recount, and therefore are indued [sic] with Reason.*⁴⁴¹

Starting from the premise that animals showed certain traits of reason, it followed that the sensitive soul must be responsible for at least some intellectual functions. As discussed in Chapter 2.2., for Gassendi, the corporeal soul was a subtle flame that like the rest of the body consisted of atoms. On this, Willis borrowed heavily from Gassendi, but criticised that the latter had not explained how exactly this ‘intelligent fire’ could “produce the Acts of the animal Faculty,”⁴⁴² which Willis acknowledged to be the “most difficult Problem.”⁴⁴³ But Willis took it from there and stated that he would not only provide a more detailed account of the substance of the soul, but also, with the help of anatomy, the mechanism behind its functioning.

Willis’ corporeal soul consisted of a vital part emanating from the blood “by a perpetual Circulation in the Heart, Arteries, and Veins,”⁴⁴⁴ out of which the sensitive part evolved, an elaborate ‘heap of Animal Spirits’ or “Nervous Juyce, flowing gently within the Brain and its Appendixes.”⁴⁴⁵ Both, the vital and sensitive part, consisted of material particles that he variously referred to as either a ‘fiery flame’, ‘subtle Atoms’, or ‘Corpuscles’. These particles were furthermore subject to ‘Fermentation’, a chemical process producing heat. Willis’ varied descriptions hint at the eclectic mix of ancient and more recent theories that he availed himself of, which prompted one historian to state that Willis “exchanged Aristotelian qualities, ancient humours, and Galenic physiology for Cartesian corpuscles, chemical constituents, and Harveian circulation,”⁴⁴⁶ to which Martensen adds that he “also managed to

⁴⁴¹ Ibid., p. 4; italics in the original. Willis took the quote from Gassendi’s *Syntagma Philosophicum*, The Physica, Section III.

⁴⁴² Willis, *The Soul of Brutes*, p. 4

⁴⁴³ Ibid.

⁴⁴⁴ Ibid., p. 22.

⁴⁴⁵ Ibid.; see also pp. 4-7. Willis further identified a third part of the soul in the sperm, i.e. the ‘Genital’, “placed apart for the Conservation of its Species;” *ibid.*, p. 22.

⁴⁴⁶ Quoted in Martensen, *The Brain Takes Shape*, p. 37

smuggle in considerable alchemical material.”⁴⁴⁷ But of more interest in the context of my thesis are the functions or faculties ascribed to this corporeal soul, especially in those animal species that Willis deemed ‘more perfect’ and closer to humans. Similar to Aristotle, he maintained that different animal types had different compositions of animal spirits, each of which were suited best to their way of life. Thus, in order to describe the various souls of the different types of animals, “it were first needful to write the History of all Animals, and to deliver the Anatomy of each of them.”⁴⁴⁸ In fact, a large part of his work consisted of a detailed anatomical description of various animals, ranging from ‘bloodless creatures’ such as earthworms, oysters and lobsters to the ‘hot-blooded’ animals, such as quadrupeds, which he placed in the same rank as humans regarding the faculties of the “Inferior or Corporeal Soul.”⁴⁴⁹

The corporeal soul encompassed basically all functions of the animal and human body, but Willis focussed especially on those that depended on the nervous (and muscular) system, possibly because the groundwork had already been done in his *Anatomy of the Brain* to which he made continuous references. As discussed above, the functions associated with the brain included sensation, memory, perception, imagination, as well as reflexive and instinctive actions.⁴⁵⁰ Following Gassendi, Willis equated perception with the mental *awareness* of these capacities, and also allocated some lower faculties of reason to the realm of the corporeal. He thus made a significant move away from Descartes’ rather strict conjectures; yet, as we will see, his discussion of what faculties had to be ascribed to either the rational or the corporeal soul is still somewhat reminiscent of the Cartesian inconsistencies regarding the mind-body dualism.⁴⁵¹ Moreover, by assigning the faculties of ‘knowing and feeling’ to an

⁴⁴⁷ Ibid.

⁴⁴⁸ Willis, *The Soul of Brutes*, p. 7.

⁴⁴⁹ Ibid., p. 17.

⁴⁵⁰ Ibid., pp. 24-25.

⁴⁵¹ Bynum, on the other hand, places Willis somewhere between Gassendi and Descartes for, “he called man a two-souled creature, but he denied animals any form of reason;” ‘The Anatomical Method’, p. 450. There are,

animal's soul, Willis was aware that he needed to maintain a sufficient distinction to the rational soul.

But that some object, that the Soul of the Beast, because it perceives, or knows that it feels, to be immaterial, for that Matter seems to be incapable of Perception, that indeed, had been likely, if that Perception should pass beyond the limits of Material things; or higher, than what inspires them, which things are usually attributed to Natural Instinct [...].⁴⁵²

The implicit danger of assigning 'knowing and feeling' to animals was two-fold: firstly, concerning the above-anticipated objection that the possession of faculties that had been traditionally ascribed to the rational soul might render an animal's soul immaterial as well. Secondly, his assurance that these faculties were due to 'matter' implied, on the other hand, that a large part of human nature was also reduced to the composition and interaction of the brain and nerves. Willis carefully had to navigate his claims regarding the 'soul of brutes' around these pitfalls in order to avoid diminishing the human rational soul and thus face accusations of heresy and/or materialism.

Lester King once described Willis' work as "the clearest and most significant exposition of contemporary doctrine concerning the nature of mind and its relationship to body."⁴⁵³ But Willis' exposition not only tackled the question of how strictly the functions of material (animals) and immaterial souls (humans) could be separated, or which functions should be assigned to either one, but also implicitly discussed the borderlines between humans and animals. Both enquiries became increasingly interwoven, and could only be resolved at the expense of either one. The fact that Willis relied largely on his anatomical investigations

however, different connotations to the term 'reason'. Descartes may have included all features of the intellect under this heading, but Willis went along with Gassendi and equated reason with 'knowledge', 'judgement', 'deliberation' and 'certain forms of ratiocination' – all of which were clearly ascribed at least to the 'hot-blooded' animals, that is quadrupeds.

⁴⁵² Willis, *The Soul of Brutes*, Preface, n.p..

⁴⁵³ King, *The Philosophy of Medicine*, p. 135.

complicated matters further: since animals in his scheme shared with humans the corporeal soul *and* the necessary anatomical components of the nervous system, Willis was forced to constantly counterweigh their analogy to humans with an emphasis on the superior rational soul in humans.

Willis considered the cerebrum and the cerebellum the roots of the sensitive soul, i.e. the place where the animal spirits were procreated, and then descended “by and by into the middle or marrowy parts, and there are kept in great plenty, for the businesses of the Superiour Soul,” while a “sufficient stock of these”, descended further into the spinal cord and the nerves, which, “planted in the Muscles, Membranes, and Viscera” constituted “the proper and Immediate Organs of the Sence [sic] and Motion.”⁴⁵⁴ The ‘middle marrow’, i.e. the corpus callosum, also referred to as the inferior “Chamber of the Soul”,⁴⁵⁵ thus effectively constituted the seat of the human rational soul. As this structure was also involved in the faculties of imagination, sense perception, and memory, his account of these functions seems at first to represent singular human capabilities. But nothing in his description of how the anatomical components, including the corpus callosum, interacted with the animal spirits to produce these functions suggests that their underlying mechanism reached in any way beyond the corporeal boundary; neither was it made plain that these mechanisms acted differently in human and animal brains. Willis simply stated that “So the Sense brings in the Imagination; this the Memory or the Appetite, or both at once, and at length the appetite stirs up local motions, performing the prosecution or driving away of the appearing Good or Evil,”⁴⁵⁶ the faculties of which he clearly ascribed to animals as well. Moreover, the illustrations accompanying his specific accounts of the corporeal soul depict mostly animal brains. However, even the functions that were clearly thought to emanate from the brain and nervous system, rather than the immaterial rational soul, could not easily be verified. His

⁴⁵⁴ Willis, *The Soul of Brutes*, p. 24.

⁴⁵⁵ *Ibid.*

⁴⁵⁶ *Ibid.*, p. 25.

interpretation of the corpora striata, for instance, is a case in point: even though he assigned to these the “the common Sensory,”⁴⁵⁷ i.e. the place of commerce between the cerebrum and the cerebellum through which all spirits to and from the nerves must pass, anatomical proof for its actual function could not be provided.

As to the Offices and Uses of the streaked Bodies, though we can discern nothing with our eyes, or handle with our hands, of these things that are done within the secret Conclave or Closset [sic] of the Brain; yet by the effects, and by comparing rationally the Faculties, and Acts, with the Workmanship of the Machine, we may at least conjecture, what sort of works of the Animal Function, are performed in these or those, or within some other parts of the Head.⁴⁵⁸

One conjecture was “that the Sensitive Soul, as to all its Powers and Exercises of them, is truly within the Head, as well as in the nervous System, merely Organical, and so extended, and after a manner Corporeal.”⁴⁵⁹ As implied in the above quotation, another conjecture was based on the ‘effects’ that this soul had on animal faculties, i.e. the observations of animal behaviour and interactions with their environment. From an animal’s overall ability to defend itself, select appropriate food, and to propagate its species, he judged that these were certain innate “Dispositions and Habits of the Soul,”⁴⁶⁰ which he called “Natural Instinct.”⁴⁶¹ From the point of view of historians of animal psychology and animal instinct, Willis fits the label ‘Cartesian’ perfectly, since “his account of the operations of instinct and animal learning offered little to which the materialist could object and much that later instinct theorists, especially the mechanists, might admire.”⁴⁶² Yet, he also clearly believed that the faculties of some animals went beyond mere inbred instincts and reflex actions, for he devoted a whole

⁴⁵⁷ Ibid., p. 26.

⁴⁵⁸ Ibid., p. 27.

⁴⁵⁹ Ibid.

⁴⁶⁰ His discussion of these comprised Chapter V of *The Soul of Brutes*, pp. 29-32.

⁴⁶¹ Ibid., p. 34.

⁴⁶² Robert J. Richards, *The Evolution of Behavior: Theories of Instinct in the Nineteenth-Century with an Essay on Animal Instinct and Intelligence before Darwin* (unpublished Ph.D. Thesis, University of Chicago, 1978), p. 258.

chapter to ‘the Science or Knowledge of Brutes’. Having spent some time describing the interaction of the brain, nerves and animal spirits, he acknowledged in this chapter,

yet from all this furniture of the Corporeal Soul, and of its powers being put together, it doth not plainly appear, what the same is able to do beyond the Virtue or force of any other machine [...]; it is not declared how this Soul, or any part of it, perceives it self to feel, and is driven according to that perception into divers Passions and Actions [...].⁴⁶³

But before entering into an investigation of this particular problem, Willis felt compelled to make it very clear that things were different for humans. It is also significant in this context that he never spoke of the human corporeal soul in isolation, though this was not necessarily because animals and humans shared this material soul. If humans were invoked in the discussion of the faculties of the sensitive soul, it were mostly to *distinguish* between the faculties of the sensitive and rational soul. Thus, it is not surprising to find prior to his actual discussion of the ‘knowledge of brutes’ a clear reference to the ‘presiding’ rational soul in humans:

In Man indeed it is obvious to be understood, that the Rational Soul, as it were presiding, beholds the Images and Impressions represented by the sensitive Soul as in a looking Glass, and according to the Conceptions and notion drawn from thence, exercise the Acts of Reason, Judgment, and Will. Yet after what manner in Brutes, Perception, a discerning or discrimination of Objects, Appetite, Memory, and other species or Kinds of Inferiour Reasons as one may say, are performed, seems very hard to be unfolded [...].⁴⁶⁴

His manoeuvring between his claims that, first, the animal soul was composed out of matter, but that matter in this case could feel, perceive, know and make judgements;⁴⁶⁵ that, secondly, humans shared this corporeal soul with animals, yet that their own knowledge and judgments was derived from the ‘presiding’ rational soul; thirdly, that some animals were

⁴⁶³ Willis, *The Soul of Brutes*, p. 32.

⁴⁶⁴ Ibid.

⁴⁶⁵ Ibid.

capable of the most intricate actions and cogitations “using the same Organs as man”,⁴⁶⁶ but, because the sensitive soul “*can Know nothing clearly*, nor rise above the Acts and material Objects, it plainly follows, that she is different from the Rational Soul and also that she is much inferiour and Material”⁴⁶⁷ – all this led to a somewhat twisted logic that actually undermined his aim to discuss animal faculties in order to help envision the scope of the (human) corporeal soul.

In his chapter on the ‘Science of Brutes’, Willis had assembled a whole range of examples showing that animal actions were often based on experience, ‘acquired cogitation’, and ‘exquisite knowledge’. In his view, animal cogitation and knowledge were linked to sense perception involving the common sensory (also known as the ‘streaked bodies’), the callous body (*corpus callosum*), and the cortex. At some point he even invoked divine intervention – seemingly because he could not fall back on his anatomy to explain the reasoning faculties of animals.

That we may go on to Philosophize concerning this matter, I profess indeed, whilst I consider the Soul and the Body, to wit, either of them by it self and distinct, I cannot readily detect, in this, or in that, or in any material subject, any thing, to which may be attributed such a Power, with a self-moving energy: But indeed, when I consider the animated Body, made by an Excellent and truly Divine Workmanship, for certain Ends and Uses, nothing hinders me from saying, That it is so framed by the Law of Creation, or by the Institution of the most Great God, that from the Soul and Body mixed together, the same Kind of Confluence of the Faculties doth result, by which it is needful for every Animal, to the Ends and Uses destined to it.⁴⁶⁸

With the implicit reference to the rational soul as God-given and creating faculties beyond the corporeal, he embarked on dangerous grounds. This is probably why, in between his enthusiastic and lengthy account of animal knowledge, he stated that his account was first

⁴⁶⁶ Ibid. and p. 34; see also pp. 35-36.

⁴⁶⁷ Ibid., p. 32; my emphasis.

⁴⁶⁸ Ibid., p. 33.

and foremost directed at showing “what is the utmost thing that living Brutes can know or do, and how far that is below the power of the Rational Soul.”⁴⁶⁹ It is thus not surprising that the chapter about the ‘Knowledge of Brutes’ not only closes with the sentence, “According to this sort of Analyzing, the most Intricate Actions of Brutes, which seem to contain Ratiocination, may be explained, and reduced into Competent notions of the sensitive Soul,”⁴⁷⁰ but is followed by a whole chapter that directly compared the abilities of the sensitive soul with those of the rational one. In his actual discussion of the human rational soul, he also invoked a constant comparison to animals, though this time he greatly diminished the latter’s capacities by reducing them mostly to instinctive behaviour. It is as if he had to keep a constant check on the implicit danger of elevating the sensitive soul in animals to the level of the rational soul in humans.

Bynum argues that Willis “considers the limitations of the anatomical method as an adequate guide in determining the functions of the brain to be proof that man possesses an immaterial principle denied to animals.”⁴⁷¹ Yet, in his discussion of animal faculties, Willis was also hard pressed to provide explicit proof that these faculties *were* based on the interaction of the brain, nerves and animal spirits alone. After all, in his understanding “[t]he Acts or degrees of Knowledge, *Common to either Soul*, are [...] simple Apprehension, Enunciation, and Discourse;”⁴⁷² hence the need to show “how much the Power of the Rational, excels the other Corporeal in each [...]”⁴⁷³ Willis attempted to distinguish the corporeal soul’s faculties from those of the rational one in a similar vein as in his anatomical reasoning regarding the brain’s functions: just as an anatomical structure that was shared by humans and animals alike (e.g. the cerebellum) could not represent higher faculties, in the same way could a faculty that led animals to display behaviour that was similar to that of humans only be

⁴⁶⁹ Ibid., p. 34.

⁴⁷⁰ Ibid., p. 38; italics in the original.

⁴⁷¹ Bynum, ‘The Anatomical Method’, p. 450.

⁴⁷² Willis, *The Soul of Brutes*, p. 38; my emphasis

⁴⁷³ Ibid.

constituted as inferior that is, being directed solely by the sensitive soul. This is why he mostly dwelled on the ability of humans to consider abstract and universal notions, such as “Spirituality [...], God, Angels, It Self, Infinity, and Eternity, and many other notions, far remote from Sense and Imagination.”⁴⁷⁴ In his elevation of the human rational soul, he used these higher functions of the intellect to widen the gap between humans and animals, whose mental abilities, by comparison, now “hardly seem greater than the drop of a Bucket, to the Sea.”⁴⁷⁵ Similar to the Cartesian ‘I’ that constituted the human because it could perceive of its thoughts and of itself, Willis reasoned that nothing corporeal could produce these kinds of thoughts which he took as proof that the rational soul must be immaterial.⁴⁷⁶ This twisted logic was also applied reversely, that is he argued that if the rational soul *was* material, he would have expected to find a corresponding difference between the brains of animals and humans. Ignoring his own former anatomical reasoning regarding the difference in structure between human and animal nervous systems in his *Anatomy of the Brain* (e.g. the convoluted cortex and the intercostal nerve), he now maintained that “we have noted little or no difference in the head of either”⁴⁷⁷ which he took in this context as further proof that the difference in intellect must be due to something above and beyond the corporeal.

Having allegedly fulfilled his aim to differentiate sufficiently between the sensitive and the rational soul, he now had to explain the link between them in humans, i.e. “by what necessitude, these twins are conjoined, and intimately come together, in the same Body.”⁴⁷⁸

Here again, despite his former dismissal of the Cartesian localisation theory regarding the seat of the soul, Willis accommodated “this purely Spiritual, to fit as in its Throne, in the principal Part of Faculty of it, to wit, in the Imagination made out an handful of Animal

⁴⁷⁴ Ibid., p. 39.

⁴⁷⁵ Ibid. See also King, *Philosophy of Medicine*, p. 140.

⁴⁷⁶ See also Willis, *The Soul of Brutes*, p. 39.

⁴⁷⁷ Ibid., p. 44. Nonetheless, at the end of this chapter, in which he had discussed the superiority of the human rational soul, he added an illustration of the human brain, “to Crown the work;” *ibid.*

⁴⁷⁸ Ibid., p. 39.

Spirits, most highly subtil, and seated in the Middle or Marrowie part of the Brain.”⁴⁷⁹

Grounding the intellectual functions of the rational soul in this way in the corporeal imagination and the ‘Offices of the Sense’, he had somehow undone his own claim that human intellectual functions acted independently from the corporeal soul. Yet, despite facing similar problems, his avowed rejection of philosophical doctrines like Cartesianism that held the immaterial rational soul also responsible for sense experience⁴⁸⁰ implies an actual need to have sensual faculties firmly located in anatomical structures. From a physician’s point of view, Willis could in this way not only account for the difference in intellect amongst humans, as this was not down to the rational soul but to its intermingling with the same sense impressions to which animals were subjected to. More importantly, it justified the second part of his work that, as the title page to *The Soul of Brutes* suggests ‘unfolds the Diseases which Affect it [the corporeal soul] and its Primary Seat; to wit, The BRAIN and NERVOUS STOCK, And Treats of their CURES.’ He must have hoped that the link between intellectual faculties and the corporeal soul might eventually enable physicians to explain and cure what would become known as ‘nervous diseases’, including insanity. In any case, in Willis’ scheme, the faculties of the rational soul depended on sensual input and imagination,

without the help of which, it can know or understand nothing. For it draws its first Species and fundamental Idea’s by which it rears all its manner of Knowledge, from the Imagination; wherefore that the Mind of one Man understands more, and reasoneth better, than that of another, it does not thence follow, that Rational Souls are unequal, but every disparity, concerning the Intellect, proceeds immediately from the Phantasie, but mediately and principally from the Brain, being variously disposed.”⁴⁸¹

“[...] yea, what is to be lamented, [the imagination] seduces in us the Mind or Chief Soul, and snatches it away with it self, to role in the Mud of Sensual Pleasures: *So that Man becomes like the Beast*, or rather worse; to wit, for as much as Reason becoming Brutal, leads to all manner of Excess.”⁴⁸²

⁴⁷⁹ Ibid., p. 41.

⁴⁸⁰ Ibid.

⁴⁸¹ Ibid.

⁴⁸² Ibid., p. 43; my emphasis. In Chapter VIII, he discussed in more detail the various affections and passions of the sensitive soul.

Thus, as Lester King aptly put it, “[u]nfortunately, these two distinct kinds of soul tend to run a collision course. And to avoid collision, Willis had to whittle away at the functions of the rational soul, whose properties he relegated more and more to the animal soul.”⁴⁸³ This becomes especially apparent in his specific discussions of the passions and the senses, to which he had devoted a further four chapters. With the senses being allocated to the corporeal and anatomical realm, his claims regarding the capacities of the sensitive soul became once again more pronounced. At one point, for instance, he referred to animal spirits as “the instruments of thoughts”⁴⁸⁴ and later emphasised even more explicitly that “sensible Impressions, at least that may be of use to any Animal, are perceived, and from this manifold way of Sension [sic], proceeds the Knowledge of all things [...]”⁴⁸⁵ He added that, according to philosophers, “*All Knowledge is made by the Sense*”⁴⁸⁶ which he probably would not have dared in his discussion of the rational soul’s faculties. Willis’ reference to the phrase ‘all knowledge is made by the sense’ indicates that the link between sense experience and thought was not a novel one, but what Willis had shown was that this could be backed up anatomically. The importance he placed on sense experience was picked up by his former student John Locke, who will be discussed in the next section.

Willis also identified the nerves as “the Organ of Feeling,”⁴⁸⁷ and significantly made pain a business of the interaction of animal spirits and nerves, both of which conceptualisations became the core of eighteenth-century experimental investigations of the nervous system (see Chapter 4):

⁴⁸³ King, *The Philosophy of Medicine*, p. 142.

⁴⁸⁴ Willis, *The Soul of Brutes*, p. 47.

⁴⁸⁵ *Ibid.*, p. 58.

⁴⁸⁶ *Ibid.*; italics in the original.

⁴⁸⁷ *Ibid.*, p. 60.

[...] as all pain is a hurt or violated Action, or a troublesome sension or feeling, depending on a Convulsion, or a Corrugation of the Nerves [...] 2. But whensoever pain is excited any where about the nervous parts of the Head, its formal reason consists in this, That the Animal Spirits being drawn one from another, and put to flight, cause the containing Bodies to be pulled together and wrinkled, and so stir up a troublesome sension or feeling [...].⁴⁸⁸

Although the abstract notion of a rational soul - immaterial, invisible and therefore a convenient carrier of all things 'human' that remained unobserved - left enough virtual room for the higher mental faculties in humans, its assumed reliance on the organs of the senses and the sensitive soul rooted some of those faculties nonetheless firmly in the body. Willis' early sensationalist framework of thought facilitated speculations as to how much of the will, the intellect and the emotions in fact depended on either the rational soul or the sense organs, and how much of these faculties in the end might have to be granted to animals. The next section explores in more detail how the emphasis on this link between sense faculties and intellect conceptualised the human-animal boundary in the philosophical work of John Locke. Locke had been influenced by Gassendi's empiricism but, more importantly, also seized on Willis' anatomical work. Just as Willis' anatomical discourse presented an alternative to Descartes' vision of the brain and nerves interacting with the rational soul, Locke's philosophy of the mind offered a view of sense perception that was firmly grounded in the physical body.

3.2. The Influence of Willis' Neuroanatomy on Philosophical Thought at the End of the Seventeenth Century: John Locke's Theory of Sensationalism and Le Grand's Advocacy of Cartesianism

⁴⁸⁸ Willis, *The Soul of Brutes*, 'The Second Part Pathological', pp. 105-106.

The philosopher John Locke (1632- 1704) was among the first to follow Willis' lead and to elaborate on the concept of perceiving sensations as interactions of the nervous system with external objects.⁴⁸⁹ His theory about the mental reception of bodily sensation, also known as sensationalism, provided a theoretical foundation for a much tighter link between mind and bodily feeling than Cartesian philosophy had allowed. By denying the existence of innate principles and ideas, Locke in fact moved in a direction that went opposite the one that Descartes had instigated. As it was, Lockean philosophy inadvertently made significant steps towards obliterating the immaterial soul as an entity needed to create cognition, memory, emotion and intellect. Similar to Gassendian philosophy, which had a considerable influence on the way that Locke developed his theory of sensationalism, Locke maintained that the connection between the nervous system and the outside world was all that was needed to explain these faculties.⁴⁹⁰

Locke had studied logic, metaphysics and classical languages at Oxford in 1652, before becoming interested in medicine and experimental philosophy due to the influence of his friend Richard Lower (who had assisted Willis in his anatomy project).⁴⁹¹ Locke was in close contact with members of the Oxford group that formed the core of the Royal Society, such as Robert Hooke and Robert Boyle (who acted as Locke's scientific mentor). More importantly, he had visited the lectures of Thomas Willis at a time when Willis had begun to implement his ideas about the brain and nerves in his teaching.⁴⁹² Moreover, Locke's copies of Willis'

⁴⁸⁹ The theory was further amplified by David Hartley's (1705-1757) *Observations on Man* (London: printed for S. Richardson, 1749) in which he explicitly linked mental perception with the 'vibrations' of nerves; a materialist psychology which was certainly influenced by anatomical and physiological investigations. For Hartley's doctrine of nerve vibrations, see Robert B. Glassman and Hugh W. Buckingham, 'David Hartley's Neural Vibrations and Psychological Associations', in Harry Whitaker et al. (eds.), *Brain, Mind and Medicine*, pp. 177-190.

⁴⁹⁰ For debates regarding the amount of influence of Gassendian philosophy on Locke, see Fred S. Michael and Emily Michael, 'The Theory of Ideas in Gassendi and Locke' (*Journal of the History of Ideas* 51:3 (1990), pp. 379-399).

⁴⁹¹ For more detailed information on Locke's life and work, see Roger Woolhouse, *John Locke: a Biography* (Cambridge et al.: Cambridge University Press, 2007) and E. Jonathan Lowe, *John Locke* (London and New York: Routledge, 2005).

⁴⁹² See Woolhouse, *John Locke*, p. 52.

lecture notes are not only believed to be the main source for establishing the development of Willis' notions of the physiology of the brain,⁴⁹³ but contain entries that indicate the beginning of Locke's later philosophy of the mind.⁴⁹⁴ Locke conducted his later medical studies under the famous English physician Thomas Sydenham (1624-1689), who is generally believed to have had the largest influence on his medical thinking. However, Locke's physiological notions about sense experience and the nervous system, as outlined in his *Essay Concerning Humane Understanding* (1690),⁴⁹⁵ reveal that Willis' anatomical work had a large share in the development of Locke's specific ideas about sensation. As Peter Nidditch has shown, Locke had begun thinking about how human knowledge, thinking and the intellect were derived from the senses at least twenty years prior to the publication of his *Essay*.⁴⁹⁶ As his notebooks reveal, by the time that Locke left Oxford in 1666, he had not only made himself familiar with Gassendi's *Syntagma Philosophicum* (most notably the *Physics*), but that he had also acquired a copy of Willis' *Anatomy of the Brain* (1664).⁴⁹⁷ As Lega maintains, "[a]natomic discoveries became stepping stones that allowed Locke to move beyond Descartes and develop the philosophy that would shape the Enlightenment and modern neuroscience."⁴⁹⁸

⁴⁹³ See Bradley C. Lega, 'An Essay Concerning Human Understanding: How the Cerebri Anatome of Thomas Willis Influenced John Locke' (*Neurosurgery* 58 (2006), pp. 667-576), p. 569. See also Kevin Dewhurst, *Willis' Oxford Lectures* (Oxford: Sandford Publications, 1980).

⁴⁹⁴ The famous association of an infant's blank mind with a 'tabula rasa' is one such entry from Willis' lecture notes, though the concept originally goes back to Aristotle; see Antoinette Stettler, 'Sensation und Sensibilität: Zu John Lockes Einfluß auf das Konzept der Senibilität im 18. Jahrhundert', (*Gesnerus* 45 (1988), pp. 445-460), p. 450; and Andrew .N. Williams, "'To observe well ... and thence to make himself rules": John Locke's principles and practice of child healthcare' (*Medical Humanities* 33 (2007), pp. 22-34).

⁴⁹⁵ The following quotes are taken from the first edition, *An Essay Concerning Humane Understanding*. In Four Books (London: Printed for Thomas Basset, 1690). For more detailed information on its various editions and publication history, see the introduction by Peter H. Nidditch to *John Locke: An Essay Concerning Human Understanding*. With an introduction, critical apparatus and glossary (Oxford: Clarendon Press, 1975).

⁴⁹⁶ See Nidditch, *John Locke*, pp. xii-xiii.

⁴⁹⁷ See Michael and Michael, 'The Theory of Ideas in Gassendi and Locke', pp. 384f; and Stettler, 'Sensation und Sensibilität', p. 447.

⁴⁹⁸ Lega, 'How the Cerebri Anatome of Thomas Willis influenced John Locke', p. 569.

In Book II of his Essay, where he dealt with the notion of ‘Idea’, Locke introduced the subject with a decisive statement that located the mind firmly within the realm of the corporeal. He identified at first two ‘Fountains of Knowledge’,

First, Our Senses [...] This great Source, of most of the Ideas we have, depending wholly upon our Senses, and derived by them to our Understanding, I call *SENSATION* [;] Secondly, The other Fountain, from which Experience furnisheth the Understanding with Ideas, is the *Perception of the Operations of our own Minds within us* [;] which Operations, when the Soul comes to reflect on, and consider, do furnish the Understanding with another sett of Ideas, which could not be had from things without [;] so I call this *REFLECTION*.⁴⁹⁹

The second statement seems to go along traditional lines of thought about the rational soul, but Locke voiced his doubts that ‘thinking’ is “the proper Action of the Soul” [...] For to say, that actual thinking is essential to the Soul, and inseparable from it, is, to beg what is in Question, and not to prove it by Reasons [...].”⁵⁰⁰ He therefore maintained that the ‘soul’, or whatever the thinking substance was, could not actually think “before the Senses have furnished it with Ideas to think on.”⁵⁰¹ It is therefore not surprising that he equated perception with thinking, and he used the example of ‘absent-mindedness’ not as an example to denote an animal’s lack of thought as Descartes had done, but to argue that without sensual input, thinking was not possible at all.⁵⁰² Hence, he believed that perception “is, in some degree, in all sorts of Animals.”⁵⁰³ Though he did not go as far as to say that there was no difference in thought or perception between humans and animals, the difference to him was one of degree, not of kind.

Unsurprisingly, contemporary thinkers saw Locke’s physicalism, that is his proposition that the mind’s faculties, most notably ‘understanding’, were solely due to the interactions of the

⁴⁹⁹ Locke, *An Essay Concerning Humane Understanding*, Book II, Ch. I. § 3, pp. 37-38; emphases and spelling in the original.

⁵⁰⁰ *Ibid.*, § 10, pp. 39-40.

⁵⁰¹ *Ibid.*, § 20, p. 44.

⁵⁰² *Ibid.*, Ch. 9 § 3, p. 61.

⁵⁰³ *Ibid.*, p. 63.

brain and nerves, as an attack on the soul, and traced the underlying physiological ideas to Willis' anatomical work and to the philosophical claims of 'several Gassendists'.⁵⁰⁴ Nonetheless, Locke's ideas regarding sensation gathered increasing support from empirical studies of naturalists and philosophers during the eighteenth century.⁵⁰⁵ Although Locke's philosophy allowed for a considerable difference between human and animal abilities to think and perceive, by maintaining that the human mind draws on the same resources available to the animal—the nervous system—sensationalism implied that every living being in possession of nerve and brain tissue must have some sort of mental faculties.⁵⁰⁶ This premise not only fostered heightened functional investigations of the nervous system, but also raised questions regarding the existence of 'mind' in animals via debates on animal souls, although these discussions would eventually form the basis for the modern concept of instinct.⁵⁰⁷ At the turn of the century, different conceptions of 'mind' in animals included, for instance, neo-Aristotelian theories which maintained that animals were endowed with intelligence, but of a kind inferior to human reason, that is, their bodily 'souls' could manipulate sensory images, but not abstract ideas or thoughts. Animal movements were explained as patterns of behaviour directed by innate images and designed for the species' welfare. Another conception was the still prevailing Cartesian notion that denied animals any cognitive faculties and considered the action of animals to be the immediate result of neural or cerebral organisation.

One protagonist responsible for upholding the strict mechanist notion on animal automatism beyond the seventeenth-century was Antoine Le Grand (1629-1699). Born in the French town

⁵⁰⁴ See Lega, 'How the Cerebri Anatomie of Thomas Willis Influenced John Locke', p. 573. See also John W. Yolton, *Locke and French Materialism* (Oxford: Clarendon Press, 1991), p. 67.

⁵⁰⁵ The most prominent advocates of Locke's ideas were David Hume (1711-1776); Étienne Bonnot de Condillac (1715-1780); and Erasmus Darwin (1731-1802); see here especially Robert J. Richards. 'Instinct and Intelligence in British Natural Theology: Some Contributions to Darwin's Theory of the Evolution of Behavior' (*Journal of the History of Biology* 14: 2 (1981), pp. 193-230), n. 27; and Stettler, 'Sensation und Sensibilität', p.450-452.

⁵⁰⁶ See also Robert J. Richards, 'Influence of Sensationalist Tradition on Early Theories of the Evolution of Behavior' (*Journal of the History of Ideas* 40: 1 (1979), pp. 85-105).

⁵⁰⁷ Also discussed in more detailed in the above-cited works by Robert J. Richards.

Douai, he came to England as a Franciscan missionary in 1656, teaching philosophy and theology. The roots of Le Grand's conversion to Cartesianism are not clear, but he is best known for promoting and defending Descartes' philosophy against critics in England. His substantial work *An Entire Body of Philosophy, According to the Principles of the Famous Renate Des Cartes* (1694)⁵⁰⁸ consists of three original works, translated by Richard Blom, that were altered, extended and corrected by Le Grand himself: *Institutio philosophiae secundum principia Domini Renati Des-Cartes* (1672); *Historia naturae variis experimentis & ratiociniis elucidata* (1673); and the *Dissertatio de carentia sensus et cognitionis in brutis* (1675).⁵⁰⁹ Le Grand is an outstanding exemplar of Cartesian thought who, in his interpretation and application of Descartes' principles, tried to eliminate all residues of doubt as to the strict dualism of body and mind. Needless to say that in his view, there was an equally insurmountable gap between humans and animals. Because Le Grand applied Descartes' philosophy and physics to "metals, plants, insects, animals, and the human body in detail,"⁵¹⁰ he elaborated crucial Cartesian thoughts in a more detailed manner and on a much wider scale than Descartes himself had done. It is therefore not only his *Dissertation Of the Want of Sense and Knowledge in Brutes* that is of particular interest, though this treatise is arguably the most detailed account of the Cartesian beast machine in its time. The *Institution of Philosophy* and the *History of Nature* likewise provide a detailed insight into the fundamental Cartesian division of things material and things spiritual which, in the course of Le Grand's writings, was continuously negotiated in terms of the human-animal boundary. Because of his contact with members of the Royal Society (*The History of Nature* was dedicated to Robert Boyle) and his links to Cambridge and Oxford University, Le Grand's

⁵⁰⁸ Anthony Le Grand, *An Entire Body of Philosophy, According to the Principles of the Famous Renate Des Cartes, In Three Books: I. The Institution...II. The History of Nature...III. A Dissertation of the Want of SENSE and KNOWLEDGE in BRUTE ANIMALS, in II. Parts, giving a Mechanical Account of their Operations*. Translated by Richard Blome. (London, Printed by Samuel Roycroft, 1694).

⁵⁰⁹ See Patricia Easton's article 'Antoine Le Grand', in *The Stanford Encyclopedia of Philosophy* [URL: <http://plato.stanford.edu/entries/legrand/>, accessed 10.08.09].

⁵¹⁰ Easton, 'Antoine Le Grand', p. 3.

writings and promotion of Cartesianism were widely received in England. The publication of his works in other languages such as German, French and Dutch, altogether contributed to the dissemination of Cartesian thoughts on a wider European scale, which in this context conveys not so much the impact of Cartesianism but, since most responses circled around the Cartesian concept of the beast/ body machine, also the contemporary and European-wide occupation with the human-animal boundary at the time. That the Cartesian concept of the beast machine had not had as much success as Descartes' followers would have wished is easily discernible in Le Grand's passionate comments at the beginning of his *Dissertation Of the Want of Sense and Knowledge in Brutes* that he had originally written in 1675 – three years after Willis' *The Soul of Brutes*:

So far hath the Opinion concerning the *Knowledge* of BRUTE ANIMALS prevailed amongst *Men*, and so infixt hath it been in their *Minds*, that they who dare think otherwise, and refuse to patronise a *Cause* which to them appears so clear, can hardly escape the censure of *Folly* and *Temerity*. In this *Opinion* almost all *Philosophers* agree, and whether induc'd by the industry and vivacity of *Sense*, which they observe from *Beasts* to be indued with, or fancying that they see some *Idea's* of *Reason* in them, they make no scruple to attribute *Knowledge* and *Ratiocination* to them, and pronounce them capable of those *perceptions* and *apprehensions*, which in reality distinguish *human kind* from all other *Creatures*, not being able to imagin how without the help of *Reason*, BRUTE ANIMALS should bring such wonderful *things* to pass, and discover in their *actings* such a world of *Ingenuity* [...].⁵¹¹

To trace a direct link between Willis' theories and the way that a Cartesian like Le Grand responded to prevailing ideas about animal sense faculties, would require a more thorough analysis of Le Grand's vast writings on the subject. However, it is clear that Le Grand attempted to reinstitute the lack of sense perception, knowledge and understanding of animals in order to eliminate what he perceived as a threat to human superiority. This threat came in the form of new anatomical findings, but also of sensationalist theory, which implied no

⁵¹¹ Le Grand, *Dissertation on the Want of Sense and Knowledge in Brutes*, part I, p. 225; just as in the Portage translation of Willis' work, I have kept the original spelling and emphases.

difference between the mechanisms of human and animal reason, at least on a theoretical level, for both were thought to be guided by images derived from sense experience alone. Thus, Cartesian dualism and Lockean sensationalism, offered different versions of the body interacting with the soul and/or the outside world, inadvertently shaping the way that the boundary between humans and animals was conceived in the time to come.

Evolutionists in the first half of the nineteenth century, for instance, eventually merged mechanist and sensationalist notions by arguing that animals rationally developed new habits, which through generations of practice gradually became innately determined and mechanically fixed instincts.⁵¹² However, such theories also relied on the findings of those who had been mapping the body anatomically and physiologically in the previous centuries, such as Thomas Willis and the protagonist of the next chapter, Albrecht von Haller.

Conclusion

As we have seen in my analysis of Thomas Willis' *Anatomy of the Brain*, preconceived differences between animal and human nervous functions were 'read' into any observed anatomical structure, even before a theory about the structure's potential function was fully developed. In fact, pre-formulated hypotheses about the human nervous system very much influenced the way that structural differences in the animal nervous system were conceived in the first place. When Willis observed that a human brain had on average more convolutions than an animal brain, for instance, he equated this structure with higher mental faculties, even though this particular cerebral structure (or any other cerebral structure for that matter) did not reveal its specific function by observation alone. One could argue that this kind of reasoning represents a *Demand for Difference* between humans and animals that guided Willis' anatomical gaze throughout his investigations of the nervous system. Just as Fudge

⁵¹² See Richards, 'Influence of Sensationalist Tradition', pp. 200-201.

identifies the enacted difference between humans and animals in the new science as a myth “which is based on faith rather than proof,”⁵¹³ Bynum, too, has identified Willis’ reasoning about the structure-function correlation of the brain and nerves as “the desire to discover anatomical representation of man’s superior mentality when the terms of analysis theoretically precluded it.”⁵¹⁴

The study of brain convolutions reached a climax in the late nineteenth century, supported by evolutionary theory which presupposed a gradation of structural development (and intelligence) in various species. But seventeenth-century comparative anatomists had no point of reference for explaining a difference in structure between humans and animals, other than the anthropocentrically conceived hierarchy of living beings as grounded in natural philosophy and natural theology. In the face of striking analogies between human and animal brains, Willis, and anatomists like Ray and Tyson, sought for ways to maintain the hypothesis that lesser versus more structure equals lower versus higher faculties, and accordingly interpreted any observed difference in structure in terms of an animal’s inferior mental capacities. With this chapter I have provide evidence that anatomical observations were adjusted to fit pre-formulated hypotheses regarding the human-animal boundary, and that these represent a continous *Demand for Difference* between humans and animals. Willis’ handling of structural differences, on the other hand, was kept flexible enough to justify the use of animals as substitutes for the human body, thus representing a *Demand for Similitude* within the context of anatomical and physiological research.

When Willis turned his discussion to the matter of souls, ‘the Crown of his work’, he continued to invoke a constant comparison between humans (rational soul) and animals (sensitive soul). His claim that the rational soul relied on the corporeal mechanisms associated with the nervous system made his other claim, that human intellectual faculties

⁵¹³ Fudge, *Perceiving Animals*, p. 93.

⁵¹⁴ Bynum, ‘The Anatomical Method’, p. 459.

differed to a large extent from those of animals, practically unaccountable. Bynum's analysis of the influence of natural theology on anatomy in the seventeenth century pinpoints exactly those underlying contradictory issues regarding the human-animal boundary in natural philosophy, of which Willis' neuroanatomical investigations constitute a prime example:

[F]rom the mixture of anatomy, physiology, metaphysics, and theology which constitutes his work two sometimes conflicting views of man's nervous system emerge: 1) that it is much more complicated and refined than the nervous system of any other animal, anatomical proof that God created man as a rational creature and animals as irrational creatures; 2) that the nervous systems of man and the quadrupeds are so analogously constructed, so similar in form and function, that some immaterial principle in man must be postulated in order to account for the mental differences between men and animals.⁵¹⁵

However, the fact that Willis did not rely on the rational soul to account for the mental difference between humans and animals, but ventured to find anatomical proof, suggests a move away from theology as the main frame of reference. That his whole anatomical undertaking as well as his discussion of the soul was explicitly linked to a negotiation of the human-animal boundary also suggests that the latter issue remained an integral part of any enquiry into human nature, be it philosophical or anatomical.

By the end of the seventeenth century, the belief in the rational soul's influence on the workings of the body had been steadily undermined, not least because of John Locke's elaboration of Willis' sensationalist framework of thought. Cartesians like Antoine Le Grand tried to reinvigorate the dualism of body and soul/mind that offered a fixed boundary between humans and animals, but their influence on anatomy and physiology was a fading one. After all, ascribing sense experience to an immaterial entity like the *res cogitans* offered no incentive or even possibility to observe and study phenomena like sensation. The intensified experimental approach to the question of sensation as inaugurated by the protagonist of the next chapter, Albrecht von Haller, also appears to have signified a gradual shift towards the

⁵¹⁵ Bynum, 'The Anatomical Method', p. 447.

redefinition of sensation as an exclusively corporeal phenomenon. Yet, since the metaphysical concept of 'soul' continued to be negotiated within physiological experiments, it could not be settled whether 'sensation' involved an intervention of the soul/mind or was an exclusive property of nerve tissue. However, within the context of eighteenth-century experimental investigations of the nervous system, the sensationalist approach to the question of the soul provided an interesting transitional conceptualisation of the human-animal continuity because the meaning of 'soul' was here mainly equated with properties of the 'mind' as based on sensory experience alone. Locke's material notion of sensation and the mind sparked a European controversy, which was intensified by the Swiss physiologist Albrecht von Haller, whose concept of 'sensibility' will be discussed in the next chapter. Haller had studied under Boerhaave, whose students were in turn well acquainted with Lockean ideas. As Lega describes, the nerve dissections that students undertook under Boerhaave had "stimulated their appetite for Lockean materialism."⁵¹⁶

⁵¹⁶ Lega, 'How the Cerebri Anatome of Thomas Willis influenced John Locke', p. 574.

4. Constituting the Human via the Animal in Eighteenth-Century Neurophysiology: Albrecht von Haller's Sensibility Experiments⁵¹⁷

Sensibility is the essential characteristic of the animal. What feels is an animal, what does not feel, is not. Feeling with regards to the human means that a change is perceived by the soul if an impression is made on the body [...] The organ of feeling is the nerve.⁵¹⁸

I have argued in the previous chapters that knowledge about the functions of the nervous system was not tangible, since the non-physical aspects of nervous functions (such as the cognitive experience of sensation) could not be observed in the corporeal structure. In this chapter, I will focus on the experimental investigations into the function of nerves. Here, too, the use of animals did not provide all the answers since, again, the cognitive dimension of sensation had little possibility of rigorous verification in an animal. That investigators nonetheless relied on animals as representatives for human bodily sensation was not only fostered by methodological necessity due to the prohibition on vivisectioning humans, but was in fact aided by the unresolved question of whether animals actually did experience bodily sensation as humans do. However, in the following discussion I will show that this question was in fact settled by the Swiss physiologist Albrecht von Haller (1708-1777) and his 'sensibility trials'. Haller was a pioneering figure in eighteenth-century neurophysiological research for two main reasons. First, he had a large influence on establishing animal experimentation as a viable method to gain knowledge about (human) neurological functions.

⁵¹⁷ Earlier versions of this chapter have been published in two Journal articles: Stephanie Eichberg, 'Ambivalente Analogien: Die Auslotung der Mensch-Tier-Grenze im neurophysiologischen Experiment des 18. Jahrhunderts' (*Traverse. Zeitschrift fuer Geschichte – Revue d'histoire* 15:3 (2008), pp. 17-28); and 'Constituting the Human via the Animal in Eighteenth-Century Experimental Neurophysiology: Albrecht von Haller's Sensibility Trials' (*Medizinhistorisches Journal* 44 (2009), pp. 274-295).

⁵¹⁸ "La sensibilité fait le caractère essentiel de l'animal. Ce qui sent, est un animal, ce qui ne sent pas, ne l'est point [...] Sentir à l'égard de l'homme, c'est appercevoir dans l'âme un changement à l'occasion de l'impression que les corps [...] L'organe du sentiment c'est le nerf;" Albrecht von Haller, 'Sensibilité', in *Supplément à L'Encyclopédie, ou Dictionnaire Raisonné des Sciences, des Arts et des Métiers*, par une Société de Gens de Lettres, 4 Vols (1777), (Amsterdam: M. M. Rey, 1776-1777, vol. IV (1777): pp. 776-779), p. 776; my translation. The 23 volumes of *Encyclopédie* (including the four volumes of the supplement), edited by Denis Diderot and Jean le Rond d'Alembert, were published between 1751 and 1777.

Secondly, he also helped to establish sensation as the most fundamental property of living bodies. In analysing some of his experiments on the nervous system, I seek to establish what sensibility or sensation signified in eighteenth-century physiology and how it was assessed or measured during experimentation. Similar to my analysis of Willis' anatomical investigations, I also investigate how Haller 'read' nervous functions, i.e. how he interpreted the observable behaviour of an experimental animal. The main question is, again, how Haller addressed the differences between humans and animals in the context of his investigations. How the concept of sensibility was negotiated and established in Haller's experimental investigations has been aptly illustrated in the recent comprehensive account of Haller's research by Hubert Steinke.⁵¹⁹ But the difficulties accompanying Haller's experimental attempts to elucidate knowledge about (human) nerve properties via animal models has so far not been analysed in depth. I will demonstrate that in Haller's research the concept of sensibility had to be adapted to accommodate both the immaterial aspects of sensibility and the alleged difference in sense experience between humans and animals. My main argument is that the adjustment of the human-animal boundary was an essential aspect of Haller's experimental practice, which had an influence on the formation of (neuro)physiological concepts as well as on our understanding of bodily feeling.

⁵¹⁹ Hubert Steinke, *Irritating Experiments: Haller's Concept and the European Controversy on Irritability and Sensibility, 1750-90* (Amsterdam and New York: Rodopi, 2005 (Clio Medica 76)). A Discussion of Haller's concepts of irritability and sensibility also features in a recent article by Dominique Boury, 'Irritability and Sensibility: Key Concepts in Assessing the Medical Doctrines of Haller and Bordeu' (*Science in Context* 21: 4 (2008), pp. 521-535). However, in contrast to Steinke, who acknowledges the problem of the human-animal analogy in his book, Boury does not mention this aspect.

4.1. Albrecht von Haller (1708-1777)

Haller received his medical training first in Tübingen, then in Leyden under Herman Boerhaave (1668-1738) where he graduated in 1727. In 1736 he was appointed Professor of Anatomy, Botany, and Surgery at the newly founded University of Göttingen. Between 1739 and 1744, he published Boerhaave's lectures with critical commentaries which some see as a departure from his teacher's mechanical thought. However, Leyden was the only medical school at the time that followed an uninterrupted tradition of animal experimentation, with anatomist Jan Swammerdam (1637-1680) and Boerhaave at the height of this tradition.⁵²⁰ Haller was certainly influenced by this tradition as his own experimental research in Göttingen testified. Apart from a physiological textbook published in 1747,⁵²¹ the eight volumes of his magnum opus *Elementa Physiologiae* (1757-66)⁵²² also reveal that his main interest was the physiology of the human body. In Göttingen, he found ideal conditions to pursue this interest, most notably exemplified by the experimental queries that led to his orations *De Partibus Corporis Humani Sensilibus et Irritabilibus* (1752).⁵²³ As Mary A. Brazier has rightly stated, the years Haller spent in Göttingen certainly marked "the experimental part of his career,"⁵²⁴ though the European controversy that ensued after the publication of *De partibus* sparked a more thorough account of his experiments in the later published *Memoirs sur la Nature Sensible et Irritable des Parties du Corps Animal* (4 vols.,

⁵²⁰ See Steinke, *Irritating Experiments*, p. 39.

⁵²¹ Albrecht von Haller, *Primae Lineae Physiologiae in Usum Praelectionum Academicarum* (Göttingen: A. Vandenhoeck, 1747).

⁵²² Albrecht von Haller, *Elementa Physiologiae Corporis Humani*, 8 vols. (Lausanne and Bern: M.-M. Bousquet & Ce. and S. D'Arnay etc., 1757-66).

⁵²³ As the English translation is sometimes inadequate, if not otherwise stated I use my own translation based on the contemporary German edition: 'Untersuchung der empfindlichen und reizbaren Theile des menschlichen Körpers von Albrecht von Haller', (*Der Königl. Schwedischen Akademie der Wissenschaften neue Abhandlungen aus der Naturlehre, Haushaltungskunst und Mechanik*, vol. 15 (1756), pp. 14-39).

⁵²⁴ Mary A.B. Brazier, *A History of Neurophysiology in the 17th and 18th Centuries* (New York: Raven Press, 1984), p. 118.

1756-60).⁵²⁵ That there was a European controversy already indicates that Haller did not do his research in isolation. Haller was a member of several European academies and elected president of the Göttingen Royal Academy of Sciences. As a true eighteenth-century universal scholar, he upheld a vast correspondence with scientists all over Europe.⁵²⁶ Because of this extensive European network that helped him develop, test and critically evaluate his and his contemporaries' ideas about bodily functions, Haller is an important representative of Enlightenment knowledge about human versus animal nervous functions.

4.1. The Importance of Experiment for Haller's Research

As we have seen, the driving force for comparative research within the life sciences has not only been the quest for understanding the mechanisms of the human body. Implicit in this research was an actual comparison of human and animal bodies, the difference of which was seized upon to determine specific human constituents. But for the most part, in anatomical dissections, the physical similarity between animals and humans could be directly observed and provided accordingly a legitimate basis for this mode of research. The dissection of animals, which were after all easier within reach of the anatomist, had therefore since Antiquity without any serious eruption of disputes been an acceptable means of obtaining knowledge about the human body. As Chapter 3 has shown, difficulties arose when, in the seventeenth century, anatomists increasingly turned their attention to the relationship between anatomical structures and their potential function. Apart from the overall fact that internal

⁵²⁵ Albrecht von Haller, *Memoires sur la Nature Sensible et Irritable des Parties du Corps Animal*. 4 vols. (Lausanne: M.-M. Bousquet & Ce. and S. D'Arnay etc., 1756-60).

⁵²⁶ See Stefan Hächler, Luc Lienhard and Martin Stuber (eds.), *Hallers Netz. Ein europäischer Gelehrtenbriefwechsel zur Zeit der Aufklärung*. Studia Halleriana, vol. 9. (Basel: Schwabe, 2005). Concerning the European controversy on irritability and sensibility, Haller's main research project, see the table showing the wide-ranging correspondence that Haller was engaged in at the time, in Steinke, *Irritating Experiments*, p. 129.

processes, such as the workings of inner organs, the circulation of the blood, but also nervous faculties such as sensation, could often only be observed and studied in the living organism, the dissonance between pre-formulated hypotheses about (human) bodily functions, and the actual observation of respective anatomical structures on animal bodies remained an unresolved problem. Though the vivisection of animals had equally since antiquity served as a means of instruction, new discoveries about vital properties could not as easily be verified in comparison to the human body.⁵²⁷ Disciples of the New Science who increasingly shifted their attention from structure to function and whose findings were primarily based on investigations of animal bodies thus had to juggle the necessary acceptance of the animal-to-human transference of anatomical observations and experimental results with their ongoing conviction that animals were fundamentally *different*. Nevertheless, since the seventeenth century, animal anatomy and physiology remained a steady source for the formation of knowledge about human bodily function. On the level of methodology, the necessity to legitimise the use of animal models had led to an ever-increasing emphasis on the species' similitude within science until the development of neurological concepts gave the analogy question a new dimension. Research on the brain and nervous system raised unsettling questions about consciousness as a last point of reference from which the alleged difference between humans and animals could be asserted. Once the brain became the acknowledged site of mental processes and the nerves the carriers of sensation, physiologists struggled with the need to extend the human-animal analogy to incorporate an affinity of nervous functions and yet maintain a crucial distinction to the human mind and bodily feelings. The relevance of nervous properties as the principles of life for constituting the human was therefore not necessarily established in relation to its animal counterpart; often enough it was embedded within a specific search for markers of difference between humans and animals. Experimental

⁵²⁷ See here especially Maehle, *Kritik und Verteidigung*, pp. 15-44.

neurophysiology, even more than neuroanatomy, thus provided a platform for testing hypotheses about the ostensible difference between the species and for debating unresolved issues related to humanity that went beyond physiological investigations.

Eighteenth-century science saw a rising occupation with these issues: a heightened interest in sensation as an alleged function of nerves, a systematic use of experimentation as a means to gain knowledge about vital phenomena, and a methodical use of animal models as a substitution for the human body. As I have mentioned above, Albrecht von Haller is a key figure in this development because, firstly, his research on sensibility represents the eighteenth-century shift from motion to sensation as the most fundamental property of living bodies. Secondly, Haller's experiments set the standard for conceiving the physiological mechanisms of feeling (sensation) which, in an experimental context, translated into an analysis of pain expressions in animals. Thirdly, he openly referred to his experiments as an undisputable proof for illuminating *human* bodily functions.

So, how important was the method of experimentation for Haller's physiological investigation? In his foreword to the *Elementa Physiologiae*, Haller maintained that the 'Art of Dissection' is the only means to understand the physiology of the body properly, lamenting at the same time the separation of physiology from anatomy.⁵²⁸ He further argued that those who restricted themselves to dissecting the dead bodies of humans would never know or fully understand bodily *functions*, such as the circulation of the blood. To them, the complete physiology of the body would always remain a mystery.⁵²⁹ At no point in his *Elementa* did Haller infer a complete analogy of human and animal bodies as an underlying logic for the recourse to animal experimentation. He argued rather cautiously and long-windedly that a thorough knowledge of the function of animated bodies also needed to be

⁵²⁸ Haller, *Elementa Physiologiae*, vol. 1, preface, pp. 1-2.

⁵²⁹ *Ibid.*, p. 2.

established in animals, such as “four-footed beasts, birds, fish, and even insects.”⁵³⁰ As the dissection of dead animals was not sufficient for elucidating function either, one had to ‘open up’ the living ones. His emphasis on the need to ‘sacrifice’ the lives of many animals seems to display an in-built defence against moral accusations, as he speaks of it as “a cruelty that has so far brought more advance to the true and established physiology than all the other arts that are part of our science.”⁵³¹ Here, and not for the first time, the dominance of animal experimentation over anatomical dissections was explicitly stated.⁵³² Such statements are generally deemed important only within the context of nineteenth-century physiology that became entirely associated with the investigation of function via experimentation, whereas anatomy continued to be seen as the ‘art’ of dissecting dead bodies for elucidating structure. Andrew Cunningham, for instance, sees in Haller an exemplar of the ‘old art of anatomy’ and places him in contrast to the French School of experimental physiology that came into being at about 1800.⁵³³ He claims that Haller exclusively referred to himself as an ‘anatomist’ but seems to have overlooked Haller’s own linkage between physiology and experiment.⁵³⁴ Even though Haller did not institute a continuous experimental tradition, mainly due to his departure from Göttingen in 1753 and premature death of some of his pupils,⁵³⁵ the

⁵³⁰ Ibid., p. 3.

⁵³¹ Ibid., pp. 3-4.

⁵³² The understanding that vivisection could illuminate corporeal functions better than dissection, and that physiological speculations often informed anatomical observations, goes back as far as Galen; see Maehle, *Kritik und Verteidigung*, pp. 63-65.

⁵³³ See Andrew Cunningham, ‘The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800 - I: Old Physiology – the Pen’ (*Studies in History and Philosophy of Biological and Biomedical Sciences* 33 (2002), pp. 631-665). In his recent book, *The Anatomist Anatomis’d*, he upholds his stance by emphasising that Haller’s research on sensibility was first and foremost about a classification of bodily tissues according to type (irritable versus sensible), arguing that “[t]his experimental finding – about anatomical *seats* and their relation to nerve *distribution* – is clearly anatomical in nature;” *ibid.*, p. 153; italics in the original. I am still not convinced that a strict separation of anatomy and physiology can be upheld for the kind of research I have analysed in my thesis. In the case of Willis, for example, we saw that his anatomical reasoning was clearly informed by preformulated hypotheses about the possible functions of his observed structures. Just as in Haller’s case, I would argue that Willis did not simply dissect corporeal structures and then retreated to his study to ponder structure-function correlations; at the dissection table of both, descriptions of structures and contemplations of their functions were coincidental and mutually influential. See also pp. 156-165 of *The Anatomist Anatomis’d* where Cunningham provides his understanding of physiology as ‘a theoretical science and sub-discipline of anatomy.’

⁵³⁴ See also Steinke, *Irritating Experiments*, pp. 75-77.

⁵³⁵ *Ibid.*, p. 58.

experimental methodology of the later French physiologists closely mirrors that of Haller. Recent trends in the history of experimentation therefore suggest a new timeframe for incorporating early modern anatomists *and* physiologists for their systematic use of the practice.⁵³⁶ The potential for establishing an experimental tradition lies also in Haller's early emphasis on a frequent repetition of trials and elimination of variables to ensure the description of unchanging phenomena as 'nature herself has produced them'.⁵³⁷ This, too, is an essential feature of 'laboratory practice' as normally associated with later physiologists, such as François Magendie (1783-1855) and Claude Bernard (1813-1878). The way that experiments were conducted on the nerves in later investigations, especially with regard to sensibility, remained altogether remarkably similar to Haller's experimental trials.⁵³⁸

In Haller's research on sensibility, the meaning of the concept and its relation to the body, as well as the analogy between humans and animals was, for the first time, negotiated and enacted in a systematic manner. In noting that the phenomena of sensibility and irritability had been known prior to Haller's investigation, Owsei Temkin has observed that "the significance of Haller's contribution lies in the method by which he approached the subject."⁵³⁹ However, viewed in its specific historical context, one could also say that Haller's experimental method captured nothing more than an eighteenth-century understanding of what sensibility ought to be and possibly look like in non-human subjects while experimentally investigating the function of nerves. Furthermore, as Haller's preconceived notions of 'sensibility' inhabited a realm beyond the physical, it remained a concept that could not be fully grasped within a strict scientific framework in which

⁵³⁶ See for instance Marino Buscaglia, 'The History of the Experimental Method in the Life Sciences as an Illustration of Versatility in Interpretation', in: Jacques Montangero et al. (eds.) *Conceptions of Change over Time* (Genève: Jean Piaget Archives Foundation, 1993, pp. 45-64).

⁵³⁷ Haller, *Elementa Physiologiae*, vol. 1, p. 12. Haller himself stated that the 'experimental law' of repetition had been introduced by the Italian anatomist Giovanni Battista Morgagni (1682-1771); see also Maehle, *Kritik und Verteidigung*, p. 54.

⁵³⁸ See for instance François Magendie, *Leçons sur les Fonctions et les Maladies du Système Nerveux* (Paris: Ébrard, 1839).

⁵³⁹ Owsei Temkin (ed.), *A Dissertation on the Sensible and Irritable Parts of Animals by Albrecht von Haller* (London, 1755) (Baltimore: Johns Hopkins Press, 1936), p. 1.

observable phenomena could ideally be measured, classified and reproduced. Physiologists of the nineteenth century were, for instance, still struggling to overcome the need to accommodate the mental aspects of sensation and motion within specific functional concepts, such as in Marshall Hall's reflex theory.⁵⁴⁰ The use of animal models played a large role in this struggle as the association of sensation with 'mind', or soul in Haller's time, necessarily limited animal experiments to the study of external bodily signs. Before turning to Haller's experiments on sensibility, the various debates surrounding the meaning of sensation, its link to the soul and its implication for the conception of the human-animal boundary in the eighteenth century shall be discussed.

4.2. Sensation as the Constituent of Life

“Whereas in 1700 life was equated to motion, with heart and muscle as its organs, in 1800 life was envisaged as sensibility, a quality inherent in the nerve and the nervous system.”⁵⁴¹ Haller represents or might have even induced this eighteenth-century shift from motion to sensation as the most fundamental property of living bodies, although he was certainly not the first to show an interest in sensation. As we have seen in Chapter 3.2., among the debates prior to Haller's experimental enterprise on the nervous system and the brain, *sensationalism*, the theory about the mental reception of bodily sensation, maintained that there was a direct, that is corporeal, link between the mind and bodily feeling. This implied that every living being in possession of nerve and brain tissue must have some sort of mental faculties. However, one obstacle to the immediate acceptance of this aspect of the sensationalist

⁵⁴⁰ See Ruth Leys, *From Sympathy to Reflex. Marshall Hall and his Opponents* (New York and London: Garland, 1990).

⁵⁴¹ Steinke, *Irritating Experiments*, p. 20. Regarding the importance of sensibility for physiology and medicine throughout the eighteenth- and nineteenth; see also Stettler, 'Sensation und Sensibilität', pp. 456-457.

doctrine in physiology was the unresolved question of the ‘soul’ which, despite Locke’s influence, was still assumed to play a major role in the workings of the nervous system. Since the possession of a soul continued to be denied to non-human species, it remained difficult to assert experimentally how exactly the nervous system functioned as a mediator between body and soul/mind. As I suggested above Haller’s experimental approach to the question of sensibility appears to have signified a gradual shift towards the redefinition of sensation as an exclusively corporeal phenomenon. However, since the metaphysical concept of ‘soul’ continued to be negotiated within physiological experiments, it could not be settled whether ‘sensation’ involved an intervention of the soul/mind or was an exclusive property of nerve tissue. Haller’s research thus serves as a good example for the mutual influence of these dominant doctrines, i.e. the doctrine of the soul versus the doctrine of the nerves, within physiological and metaphysical debates alike.

What, then, was Haller’s understanding of sensation? The tenth and the twelfth book of his *Elementa* elaborate on ‘sensibility’ (vol. 4 § 1 *Sensus quid sit*) and ‘feeling in general’ (vol. 5 §1 *Tactus in universum*). He thus acknowledged right from the beginning the twofold meanings attached to the term ‘feeling’ (*sentire*)⁵⁴², i.e. its relation to the external sense of touch and the inner perception of it. ‘Sensibility’ is, on the one hand, described in terms of its structural location, which is conceived in the medullar part of the nerves originating in the brain. The function of sensibility is to alert the body to the intensity and quality of a physical contact with another object. Its purpose is obviously to safeguard the body from physical harm, and sensibility as a functional entity was in this sense already deemed synonymous with pain – the unit of measurement used in Haller’s animal experiments. Feeling, as described in the *Elementa*, is ‘a business of the nerves’,⁵⁴³ as it had been for Willis, with sensibility being closely related to the sense of touch. A whole paragraph is devoted to the

⁵⁴² Haller, *Elementa Physiologiae*, vol. 4, p. 269.

⁵⁴³ Ibid. vol. 4, pp. 269-270; and vol. 5, p. 1.

skin as the surface of the body that receives the first sensual impression of any contact with external objects which in turn brings about changes in the body—but also in the soul. And it is at this point that the gap induced by experimental inquiries becomes obvious, that is, the theoretical musings about the conscious impression of sense experience in humans, which were altogether vague and inconsistent, remained detached from the more detailed descriptions of bodily changes in the animal during experimentation.

The changes that the title of *De Partibus Sensilibus et Irritabilibus Corporis Humani* (1752) underwent in the translated editions already imply Haller's inconsistency in referring to human and animal bodies interchangeably in his orations (as well as throughout the *Elementa*). The Latin and the German edition both refer to the human body in its title, whereas in the French translation of 1755 and its English counterpart of the same year, publishers deliberately used the term 'animal' instead.⁵⁴⁴ As will be seen in his discussion and evaluation of experiments and experimental results, Haller continuously switched between human and animal bodies.

A notebook entry from 12 November 1750 marks the actual beginning of Haller's explicit experimental investigation of irritability versus sensibility.⁵⁴⁵ In order to determine the separate function of nerves and muscles, Haller changed the quality of experimentation by administering different stimuli in a more systematic manner and applying irritation with greater care. What he also did was change the types of animal species. Having mainly used frogs before, from then on he mostly worked on cats and dogs in his experiments. This is interesting because it suggests his belief that the latter species would display a greater and possibly more human-like variety of bodily responses. In his orations, Haller mentions a total number of 190 animals of various kinds that he had experimented upon since 1751 and

⁵⁴⁴ See Steinke, *Irritating Experiments*, p. 144.

⁵⁴⁵ *Ibid.*, p. 60.

devoted a short paragraph to his mode of experimenting.⁵⁴⁶ Assuming he must have instantly recognised the alleged nervous property ‘sensibility’ once it was before him, what signs in the animal body did he expect to see?

I exposed the parts in question in living animals of several kinds and of varied age; I waited till the animal had ceased to struggle and complain. I then irritated the exposed part by blowing, heat, spirit of wine, the knife, lapis infernalis, oil of vitriol, and butter of antimony. Then I observed with care whether the animal upon being touched, lacerated, cut, burned, and torn, would loose its calmness and composure; whether it would throw itself from side to side, pull the limb towards it and whether its wound was twitching, or the limb twitched convulsively - or if nothing of the sort would happen.⁵⁴⁷

In elucidating which body parts were sensible and to what degree, Haller had to be able to read and interpret the behaviour of different types of animals to whom different painful stimuli were administered. Haller’s mode of stimulating as well as his choice of stimuli suggest that prior to his experimental investigations he must have had a more or less clear understanding of the kind of physical responses that could be expected. The quote reinforces the notion that Haller identified pain as one mode of sensibility, or rather the bodily signs that are associated with it. The fact that pain was the unit of measurement with which the degree of sensibility was assessed implies furthermore that Haller needed to look beyond the nerve or body part under investigation. It was not the visible reaction of the nerve that Haller described in his experiments but the animal body as a whole that needed to be scrutinized for any possible sign of sensibility/pain that manifested itself. By 1751, Haller had experimented on a great number of animals, so the common reactions to pain must have been familiar to him. To determine the *degree* of sensibility, however, was yet another matter. The rough-hewn means of irritation that brought about equally coarse reactions in the experimental subject left no room for fine-tuned differentiations of the various grades of sensation. In the

⁵⁴⁶ Haller, ‘Untersuchung der empfindlichen und reizbaren Theile’, p. 15. Maehle mentions in his book an overall estimation of 560 animals that Haller experimented upon while investigating irritability and sensibility; see Maehle, *Kritik und Verteidigung*, p. 36.

⁵⁴⁷ Haller, ‘Untersuchung der empfindlichen und reizbaren Theile’, p. 18.

end it was either the presence or the absence of an animal's reaction to a stimulus that gave evidence of sensibility. Thus, when Haller spoke of using the greater sensitivity of the skin as a constant in 'measuring' sensation, he appears to have used it solely as a means to rule out the possibility of weakened or deadened sensual perception as an acquired artefact during the experiment:

Among the parts of the human body, the skin is sensitive to a very strong degree: for one can irritate it wherever one wants, the animal moans, is shaking itself and gives all the signs of pain of which it is capable. The skin has therefore served me as a measure of testing sensibility: and when the animal stays calm while irritating a specific part but shows signs of pain when the adjacent skin is irritated, I conclude that the respective part must be of lesser sensibility.⁵⁴⁸

It is in this context interesting that Haller mentions the great sensitivity of the *human* skin but switches to a description of bodily responses of *animals* to underline his argument. The way he described the animal's behaviour also implies that Haller was seeking reactions that were similar to those of a human being in pain. Although the whole experimental enterprise was conducted to shed light on human sensual experience, it is often not clear whether Haller speaks of human or animal bodies in his writings. However, his actual definition of sensibility in his orations is given in terms of a slight but fundamental difference between human and animal sense perception:

I call that a sensible part of the human body which, on being touched, transmits to the soul the impressions of this contact; in animals, about whose soul we have no understanding, I call those parts sensible that, on being irritated, bring about obvious signs of pain and indisposition. On the contrary, I call that insensible, which being burnt, torn, pricked, or cut till it is quite destroyed, occasions no sign of pain nor convulsion, nor any sort of change in the situation of the body. For it is very well known, that an animal, when it is in pain, endeavours to remove the part that suffers from the cause that hurts it; it pulls back the leg if it is hurt, shakes the skin if it is pricked, and gives other evident signs by which we know that it suffers.⁵⁴⁹

⁵⁴⁸ Ibid., p. 19.

⁵⁴⁹ Ibid., pp. 16-17.

It is interesting to see how he endeavoured to emphasise the difference of animal and human conceptions of sensibility/pain, although to him at least the physical response to pain showed no difference. But sensibility in humans is described in terms of the soul which in this context is equated to the conscious perception of touch. Human sensibility is altogether captured in only one sentence and relates at the same time to the second meaning or trait of ‘feeling’ – consciousness. As this aspect of feeling could not be established in his experimental subjects, Haller elaborates in much greater length and detail on the *bodily* changes occurring in the animal. Thus, his definition of corporeal sensibility within an experimental context appears to be more straightforward, since the material reality of the (animal) body under investigation made him focus on reactions that could actually be observed and described.

Steinke observes that in Haller’s writings, irritability and sensibility as concepts could both be described from three different angles, that is, they were either “represented as a specific visible reaction, as a functional entity, or as a property of a specific structure.”⁵⁵⁰ Although for Haller, pain was apparently only one particular mode of sensation, “in order to make this functional entity coincide with an observable reaction, he had to restrict it to the feeling of pain.”⁵⁵¹ This makes sense as only a painful stimulus would bring about an observable reaction in the first place. It is at this level that sensibility is represented as a specific ‘visible reaction’ which raises once more the question what preconceived notions Haller had regarding the kind of reactions his experimental, i.e. non-human, subjects would and should ideally display.

With irritability, one can presume that Haller had no difficulties in stating the obvious. In observing and describing the contraction of an irritated muscle which, due to its assumed lack of sensibility, would produce no other changes in the body, an experimenter did not

⁵⁵⁰ Steinke, *Irritating Experiments*, p. 102.

⁵⁵¹ *Ibid.*, and p. 63.

necessarily need a particular framework of reference for defining motion.⁵⁵² Describing sensibility in terms of ‘visible reaction’, however, required a different mode of ‘reading’ and interpreting the various responses of his experimental animals. On a theoretical level, Haller’s understanding of sensibility testifies to the limitations of using animals for his investigations since the concept of sensation was still inextricably linked to the ‘soul’ or the ‘mind’.

However, Haller’s experimental or rather behavioural criterion for sensibility – the feeling of pain - rested on the inference that the external signs of unrest in animals were caused by the same mental states which caused corresponding movements in humans. Although Haller never openly affirmed an analogy of human and animal minds, his insistence on the conscious perception of sensation left no other conjecture. Thus, in assessing sensibility, an analogy to the human experience of pain was necessary to ascertain not only the physiological but also the psychic functions in animals. Yet, the crux of using animal models was precisely that doubts would always remain regarding a positive knowledge of the existence or non-existence of a soul (i.e. psychic functions) in animals. Functions such as sensation, which were deemed at least partly psychic, could only be assessed by closely observing *external* bodily actions and behaviour. As it was, only humans could positively confirm the existence and degree of sensation by an introspective examination and articulation of their own consciousness. Robert M. Young accordingly notes in his article on ‘Animal Soul’ (1967) that within the framework of Cartesian dualism, the interpretation of animal mind continued to depend on an “inescapable anthropomorphism.”⁵⁵³ The debates over Haller’s physiological concept of sensibility are thus especially interesting for their implications regarding the animal mind. The impossibility of extracting full knowledge about certain nervous functions from animals testified to the limits of the experimental method, but

⁵⁵² In contrast to the concept itself; see Hans-Jürgen Möller’s analysis of the different and changeable meanings of irritability, in *Die Begriffe "Reizbarkeit" und "Reiz": Konstanz und Wandel ihres Bedeutungsgehaltes sowie die Problematik ihrer exakten Definition* (Stuttgart: Gustav Fischer Verlag, 1975).

⁵⁵³ Robert M. Young, ‘Animal Soul’, in: Paul Edwards (ed.) *Encyclopedia of Philosophy*. 8 vols. (New York: Macmillan, 1967), vol. 1, pp. 122-127: 125.

also left room for contemporary speculations and discourses on the animal soul, the animal mind, and an equation of feeling in humans and animals.

4.3. The Soul and Sensibility

As we have seen in Haller's research on sensibility, within physiology, the soul still loomed large as a conceptional device for interpreting the outcome of experimental results with regard to the human body. As discussed in Chapter 2, the Cartesian division of mind and body, and the notorious concept of the *beast-machine*, prompted philosophical contemplations on souls in general and animal souls in particular throughout the eighteenth century.⁵⁵⁴ In these debates, the human soul was mainly referred to as the rational soul, though non-Cartesians continued to invoke the Aristotelian notion of a sensitive, i.e. bodily, soul shared by humans and animals alike.⁵⁵⁵ Impressions on the soul, i.e. conscious perceptions, were also increasingly linked to the functions of nerves and brain, which, because of the structural analogy of human and animal nervous systems, provided the actual foundation for debates on animal souls.⁵⁵⁶ However, because of the many connotations of the term 'soul', which altogether encapsulated notions of immortality, consciousness, emotion, and intellectual functions, its definition, like the human-animal boundary, necessarily had to remain flexible. Hans-Werner Ingensiep's investigation of the changing conceptions of the

⁵⁵⁴ See Maehle, *Kritik und Verteidigung*; and idem, 'Cruelty and Kindness to the 'Brute Creation: Stability and change in the ethics of the man-animal relationship, 1600-1850', in: Aubrey Manning and James Serpell (eds.), *Animals and Human Society. Changing Perspectives* (London and New York: Routledge, 1994, pp. 81-105), pp. 87-89.

⁵⁵⁵ As, for instance, in the 'sentient principle' of the Edinburgh physiologist Robert Whytt (1714-1766); see Roger K. French, *Robert Whytt, the Soul, and Medicine* (London: The Wellcome Institute of the History of Medicine, 1969).

⁵⁵⁶ As in the afore-mentioned collection of treatises by Winkler, *Die verschiedenen Meynungen einiger Weltweisen* (1741-1745).

animal soul within philosophy convincingly establishes that from around 1700 onwards the soul becomes, in his terms, a field of projection for the prevailing concepts of human nature.⁵⁵⁷ His timeframe overlaps with the shift from motion to sensation as the principle of life, the growing interest in the nervous system, and the rising use of animal models within physiological investigations. It is therefore no coincidence that Ingensiep interprets the disputed notions of the animal soul as the first ‘biological’ controversy of the modern period, considering that the concept of ‘soul’ and its synonyms were heavily negotiated within the life sciences.⁵⁵⁸

The question is how Haller himself conceptualised the influence of the soul on bodily functions in his writings. Next to his account of the external senses, book seventeen of the *Elementa* deals with the internal senses and it is here that Haller gave an, albeit short, insight to his conception of the mind. In the very first sentence he acknowledged that the subject was full of speculations and hypotheses.⁵⁵⁹ As in many of his theoretical musings, he remained vague and unspecific but believed that greater knowledge about the soul could be achieved once opportunities were more often seized to posthumously dissect humans who had suffered from a mental disorder or had lost their memory. Significantly, comparing the brains of animals and humans presented a viable alternative for Haller. As Haller kept switching between matters of the body (brain) and workings of the mind (soul), it is never quite certain to which one he refers in a specific context. But if we take his last statement as a claim that

⁵⁵⁷ Hans Werner Ingensiep, ‘Tierseele und tierethische Argumentationen in der deutschen philosophischen Literatur des 18. Jahrhunderts’ (*NTM N.S.* 4: 2 (1996), pp. 103-118), p. 117. Though Ingensiep looks mainly at German debates, he argues convincingly that within a European context the lines of thought were remarkably similar, not least because of a mutual exchange of thoughts and theories among philosophers and physiologists of various countries.

⁵⁵⁸ Andrew Cunningham claims that from 1800 onwards the ‘soul’ was altogether rejected in any form from the discussions. See ‘The Pen and the Sword: Recovering the Disciplinary Identity of Physiology and Anatomy before 1800, II. Old Anatomy – the Sword’ (*Studies in History and Philosophy of Biological and Biomedical Sciences* 34 (2003), pp. 51-76), p. 58; whereas Ingensiep asserts that by the beginning of the nineteenth century, a fundamental discourse on whether animals have a soul no longer took place mainly because it was taken for granted that animals *did* have a soul; see Ingensiep, ‘Zur Lage der Tierseele und Tierethik im Deutschland des 19. Jahrhunderts’, in Friedrich Niewoehner (ed.), *Die Seele der Tiere*. Wolfenbuetteler Forschungen, vol. 94. (Wiesbaden: Harassowitz, 2001, pp. 283-331), p. 285.

⁵⁵⁹ Haller, *Elementa Physiologiae*, vol.5, p. 529.

comparative physiology could elucidate the human mind, then one could argue that Haller indirectly expressed his belief in the existence of an animal mind that was, at least in terms of structure and function, fundamentally similar to that of humans. With his notion of irritability as a sole property of muscles, he had in effect already removed one of the fundamental properties of living bodies, motion, from the exclusive realm of the human will and mind.⁵⁶⁰ It was, however, unthinkable to him and his contemporaries that *feeling* would be triggered by chemical or mechanical changes in the nerves and brain only. Although the transmission of sensation through the nerves to the brain was described by him in terms of a mechanical action, the phenomenon of sensation as such was still tightly knotted to relevant impressions received by the soul. Feeling for him was first and foremost a conscious process. Haller never tried to offer an explanation of how the conscious processing of touch or pain worked and openly acknowledged this to be out of his, the physiologist's, command. But his insistence on the intervention of the soul in vital phenomena, which could not be explained in terms of physical laws, ensured that the prevailing metaphysical connotations of soul and mind upheld the gap between the species more than the scientific-mechanistic notion of the 'mind' as seated in the brain alone would have done. Theoretically, the latter contention reduced the species' gap considerably by equating a similarity of brain structure with a similitude of mental faculties. This was even implied in David Hartley's *Observations on Man* and later in Franz Joseph Gall's (1758-1828) and Johann Caspar Spurzheim's (1776-1832) *Organology* at the end of the century. Such notions, however, prevailed for only a short time and were not fully accepted until their revival in modern neuroscience.⁵⁶¹ In Haller's time, various theories

⁵⁶⁰ See for instance Haller's comments on the heartbeat in his *Elementa Physiologiae*, vol. 1 §11 'Anima non habitat in corde', p. 485.

⁵⁶¹ Haller had in fact criticised Hartley for his too mechanical outlook on the soul; see Margarete Hochdoerfer. *The Conflict between the Religious and the Scientific Views of Albrecht von Haller (1708-1777)* (Lincoln, Nebraska: University of Nebraska Studies in Language, Literature and Criticism, no. 12, 1932), p. 28. For a discussion of Gall's phrenology theory and contemporary debates see Michael Hagner, *Homo cerebrialis*, pp. 89-124; and Alan Richardson, *British Romanticism and the Science of the Mind* (Cambridge: Cambridge University Press, 2001), pp. 20-22.

discussed the link between nerves, sensibility and the soul – all of them having different implications for the human-animal analogy.⁵⁶² The German physician Johann August Unzer (1727-1799), for instance, offered an interesting solution to Haller's inconsistency regarding the definition of sensibility. His treatise *Grundriß eines Lehrgebäudes von der Sinnlichkeit der thierischen Körper* (1768)⁵⁶³ maintained Haller's separation of irritability as a property of (muscle) fibre and sensibility (*Empfindlichkeit*) as a property of nerves. But whereas Haller insisted on a link between sensibility and impressions received by the soul, Unzer distinguished between external and internal sensual impressions as two different forms of nervous power (*Nervenkraft*); the one being a sole property of the nerves (body), the other being perceived by the soul. He referred to both impressions as 'feeling' (*Gefühl*) but linked the reception of external sense experiences to the *Sensorium*, the material 'switch organ' (*Umschaltungsorgan*) of impressions received by the external senses. Sensitivity (*Sinnlichkeit*) was in this sense simply conceived as a property of the nerves, the brain and the spinal cord (which he termed *Sensorii*). In this understanding, the feeling of animals was described as a specific condition of the nerves after an (external) impression had been made on them. One could argue that the analogy question could and would have been easily dissolved by this careful separation of sensibility (*Gefühl der Nerven*) and sensitivity (*Empfindung der Seele*),⁵⁶⁴ since the question of whether animals have souls or not would have become irrelevant. But Unzer's proposition did not replace Haller's theorem and the

⁵⁶² For instance those of the afore-mentioned Edinburgh physiologist Robert Whytt and the French physician Théophile Bordeu (1722-1776), both of whom had different conceptions of sensibility and criticised Haller for his mechanist view; see French, *Robert Whytt, the Soul, and Medicine*; and Elizabeth L. Haigh, 'Vitalism, the Soul, and Sensibility: The Physiology of Théophile Bordeu' (*Journal of the History of Medicine and Allied Sciences* 31: 11 (1976), pp. 30-41).

⁵⁶³ Johann August Unzer, *Grundgebäude von der Sinnlichkeit der thierischen Körper* [Nebst einem Vorberichte wegen der auf Subscription zu druckenden neuen Auflage der medicinischen Wochenschrift „Der Arzt“ (Lüneburg und Rinteln: Gotthilf Christian Berth, 1768). Unzer is best known as the founder of the medical journal ‚Der Arzt‘ (1759-1764); see Mathias Reiber, *Anatomie eines Bestsellers: Johann August Unzers Wochenschrift „Der Arzt“* (Göttingen: Wallstein Verlag, 1999).

⁵⁶⁴ Unzer, *Grundgebäude von der Sinnlichkeit der thierischen Körper*, p. 7.

debate over the involvement of consciousness/ the soul in nervous functions remained unresolved and continued well into the nineteenth-century.⁵⁶⁵

All in all, once the physiological analogy between humans and animals could no longer be denied, debates about human-animal interrelatedness continued to be centred on the possible existence of a 'soul' in animals, debates that were triggered or at least intensified by a rising preoccupation with the nervous system in physiology. I have mentioned before that the term 'soul' has always carried various notions, most of which constituted specific human attributes. Being used interchangeably with vague terms, such as 'mind', 'reason', 'intellect' and 'emotion', suggests that a clear-cut definition of 'soul' or even 'mind' was missing altogether. For this reason, references to the soul or mind provided not only a field of projection for human attributes, but also served as markers of species difference. The inability of defining such immaterial entities thus constituted one of the main reasons for ongoing debates about the human-animal analogy: if there was no mutual understanding or consent about what actually constitutes the 'human', an understanding of species difference was likewise difficult to obtain.

Conclusion

Haller's systematic experimental approach to the nervous system raised an awareness of the importance of experiments to verify hypotheses, and it also stressed the necessity of using animals as models for the human body. On a corporeal level, Haller associated sensibility with the transmission of sensations through the nerves and with their reception in the brain. This conception of life forces, together with the experimental approach to the material and metaphysical concepts related to the nervous system, indirectly changed the conception of the

⁵⁶⁵ As Richardson's book *British Romanticism and the Science of the Mind* testifies.

human-animal boundary. As Roselyne Rey has shown, the major conclusion drawn by Enlightenment physiology was “that everything that lives and feels is capable of suffering.”⁵⁶⁶ Haller’s experiments exemplify this insight more than any theoretical hypotheses about the mechanical body versus the impact of the rational soul. It is no coincidence that Haller cannot be classed among either the mechanists or the vitalists. His position is at best ambiguous. Steinke maintains that “[i]f we have to locate Haller’s physiology within eighteenth-century medical systems, it is probably best seen as a non-reductionist mechanism,”⁵⁶⁷ a kind of intermediate position between vitalist and mechanist notions of life forces. However, Haller’s experiments also show that regarding the human-animal analogy, he nonetheless maintained a certain dualism of body and mind. Operating with different levels of sensual experience (bodily versus mental) was the only way that allowed for a similarity between human and animal bodies, but also helped to maintain the conception of the mind as the *differentia specifica* of humans. In this he seemed to follow his teacher Boerhaave, who is otherwise considered “the most prestigious eighteenth-century spokesman” of mechanism in anatomy and medicine.⁵⁶⁸ Yet, Haller’s experimental approach to the question of sensibility required at the same time the animal’s full consciousness during the experiment which, again, raises the question as to how Haller, and later experimentalists, ‘read’ the signs of the animal body in order to determine an animal brain’s reception of sensation—especially since the phenomenon of sensibility was at that point still associated with sentience in the sense of ‘knowing’ and ‘feeling’. As we have seen, in order to evaluate a nerve’s sensibility, Haller measured the degree of pain as manifested by the animal to assess the degree of sensibility. The analogy to humans was here not necessarily presupposed but mainly drawn after the experiment. Since the animal’s reactions to a painful stimulus

⁵⁶⁶ Rey, *The History of Pain*, p. 122.

⁵⁶⁷ Steinke, *Irritating Experiments*, p. 114. Anita Guerrini, on the other hand, maintains that Haller was “philosophically a vitalist;” idem, *Experimenting with Humans and Animals*, p. 63.

⁵⁶⁸ Haigh, ‘Vitalism, the Soul, and Sensibility’, p. 30.

were interpreted by Haller as being similar to human responses to pain, their nervous system was assumed to be of a similar design. Thus, despite the metaphysical difference between the species, the conclusion was drawn that the bodies of humans and animals had the same elementary configuration – including a similarity of nervous processes such as pain.⁵⁶⁹ Haller was nevertheless aware of the difficulty that arose by simply transferring to the human physique the observations made on the animal body. The contemporary belief in the soul mediating between body and mind, and possibly a prevalent religious sensibility were partly responsible for his unease.

Overall, Haller's experimental approach encapsulates two main dilemmas within comparative (animal-to-human) research on the nervous system. Firstly, his acknowledgment of the human 'soul' being the medium for transmitting pain raises the aforementioned transferability problem. If the animal was denied this marker of 'humanity', then the experimental results observed on the animal body were not adequate to describe human 'sensibility'. Secondly, even if animals had been assigned a soul, something as immaterial as the soul or the mind could not be directly observed or experimented upon. This meant that experimental research on the physical side of pain altogether amounted to "substantial evidence that pain was mediated by specific nerve endings and pathways. [...] But it also led to a minimization [or rather neglect] of the importance of emotion in pain perception."⁵⁷⁰ The latter may have also resulted from the fact that the articulation of 'emotion' could of course not be provided by experimental (non-human) subjects.

The same difficulty was encountered within the specific context of research on the brain which reached a climax in the first half of the nineteenth century. The development of neurophysiology as a discipline was altogether accompanied by fierce debates about the role of the 'sentient' brain, the mind-body interaction, and negotiations of the specific criteria that

⁵⁶⁹ See Steinke, *Irritating Experiments*, p. 145.

⁵⁷⁰ Andrew Hodgkiss, *From Lesions to Metaphor: Chronic Pain in British, French and German Medical Writings, 1800-1914* (Amsterdam and Atlanta: Rodopi (Clio Medica 58), 2000), p.7.

constituted the human.⁵⁷¹ As mentioned before, similar to the theory of sensationalism, F. J. Gall's mechanistic approach to 'the science of the mind' invoked the contention that due to the similarity of brain structure, animal minds possibly differed from those of humans only in degree not in kind. With intensified comparative research on the brain and nervous system, a gradation of cerebral organisation became in fact the new demarcation criteria for a human-animal division, though this notion was not fully articulated before the late nineteenth century. Although phrenology itself was soon considered outdated in public, Gall's neuroscientific principles were taken up by succeeding experimentalists, who declared human intellect to be simply the result of brain action.⁵⁷² As with the consciousness of sensation, it is difficult to assert how this proposition was to be established experimentally since 'intellect' (like the rational soul) was and is still believed to be exclusively human.

The scientific mode of research as based on observation and experiment within the life sciences generally reached a limit whenever scientists attempted to find a material basis for metaphysical concepts. It could be argued that the inability of defining immaterial entities related to the mind such as reason, intellect or emotion also constituted one of the main reasons for ongoing debates about the human-animal analogy. As mentioned above, if there was no mutual understanding or consensus about what actually constitutes the 'human', an understanding of species difference or affinity was likewise difficult to obtain. Thus, the traditional association of the (human) mind with the brain could not but set limits to the experimental method as such, not only because the operations of the mind, like the soul, could not be observed on the organ itself, but also because scientists could not reach consensus regarding the unstable categories they continued to investigate in humans *and* animals. It might be for these reasons that physiology continued to focus on the organic roots

⁵⁷¹ See here especially Price's thesis on *The Emergence of the Doctrine of the 'Sentient Brain'*.

⁵⁷² See Hagner's chapter on Gall in *Homo cerebrialis*, pp. 89-118.

or functions of the mind, which would also account for the failed attempt to take the analogy of humans and animals beyond the physical borders of the body.

Final Conclusion

In Chapter 1, I have provided a historical introduction to the problems pertaining in seventeenth- and eighteenth- century research on the nervous system by focussing on the anatomical and philosophical discourses about the nature of bodies and souls of humans and animals since Antiquity. A heightened interest in the anatomical body in the Renaissance period revived ancient theories, but due to an increased focus on the superiority of the human body, also identified the rational soul as the main marker of difference between humans and animals. This development in turn influenced new discourses in mechanical philosophy, most notably the theories of Descartes and Gassendi, as discussed in Chapter 2. That theories about animal automatism emerged alongside the anatomising and philosophising of the human body and soul, show that all approaches and theories that attempted to explain the mechanisms of the human body also had implications for the way that the difference between humans and animals was conceived. The negotiation of this difference, on the other hand, inadvertently shaped the way that seventeenth-century anatomists conducted their comparative research on the nervous system. Chapter 3 focussed on the first systematic mapping of the nervous body in the seventeenth century. I have here mainly focussed on the “founder of neurology”, Thomas Willis, whose eclectic use of many of the theories and philosophies discussed in chapter 1, makes him an ideal representative of contemporary views of the nervous system and the different conceptualisations of the soul. As we have seen in my analysis of Willis’ *Anatomy of the Brain* and *The Soul of Brutes*, the metaphysical difference between animals and humans was oftentimes already ‘read’ into observed neuroanatomical structures, even before a theory about the structure’s potential function was fully developed. In fact, pre-formulated hypotheses about the human nervous system, i.e. the influence of the soul, very much influenced the way that structural differences in animal

versus human brains were perceived in the first place. Hypotheses on the function of nerves or parts of the brain remained purely speculative but nonetheless influenced anatomical investigations to such a degree that the anatomical gaze was almost made subservient to pre-formulated conjectures about the role that the nervous system played in humans versus animals. While the actual practices in comparative anatomy and physiology relied on a close bodily analogy of humans and animals, metaphysical conjectures about the soul continued to uphold these pre-formulated hypotheses.

A point that is often mentioned alongside discussions of mechanical philosophy is that it also had practical consequences for the legitimacy of experimenting on animals, thus preparing the way for Enlightenment physiology. On a theoretical level, the view of bodies as machines must certainly have been attractive to physiologists, as they were mainly concerned with uncovering the physical laws underlying the functions of organs and bodily tissue. Leonora Cohen Rosenfield has likewise maintained that “the first continental champions of animal automatism were physiologists”⁵⁷³ and that they and their descendants clung to the doctrine for much longer than the general public. However, as I have shown in Chapter 4, depending on the type of bodily investigation, this notion could not always be upheld. Furthermore, the analogy between animal and human bodies and behaviour which formed the necessary prerequisite for functional experiments on animal bodies indirectly functioned as a counterargument against the theory of pure animal automatism. As the French Jesuit Father Gabriel Daniel (1649-1728), an avowed opponent of Descartes, had observed: “Animal behavior that corresponds to rational human conduct must be non-mechanical. Why should mechanical reflexes induce in beasts movements that in man require an effort of the will?”⁵⁷⁴ This last question would later determine the specific research agenda of behavioural and evolutionary psychologists. But before that, anatomical observations and experimental

⁵⁷³ Rosenfield, *From Beast-Machine to Man-Machine*, p. 25

⁵⁷⁴ *Ibid.*, p. 87.

research on bodily functions had already indirectly challenged the Cartesian notion of the beast-machine by relying on the corporeal analogy of humans and animals. That their investigations of the (animal) body often encompassed the realm of the psychological underlines this even further. One aim of my thesis was to show that the debates on human versus animal nervous faculties and souls actually gained greater momentum *because* of the rise of anatomical and physiological investigations. And also that researchers on the brain and nerves could not maintain a too mechanical view of animals if they wanted to maintain the model function of animals for human nervous functions. As we have also seen in Chapter 4, one consequence of investigations of the nervous system was that it became increasingly difficult to class faculties such as sense experience as the sole *differentiae specificae* of humans.⁵⁷⁵ While Willis had conducted a deliberate search for differences in structure that might account for an assumed difference in sense experience, Haller's experimental enterprise rested on the unspoken assumption that nervous faculties such as sensation were experienced in the same way by animals as they were by humans. In the end, though the practice of comparative anatomy revealed that certain structures differed in human and animal brains, these "were not sufficiently distinct from that of a dog or a sheep to bear the weight of the actual mental differences between man and brute."⁵⁷⁶ Moreover, the way in which these differences were interpreted in relation to their respective alleged functions, exceeded the anatomical reasoning as based on an *observed* difference in structure alone. As I indicated above, in Willis' case it almost seems as if the anatomical gaze was made subservient to pre-formulated notions of functional difference. When the philosopher Ludwig Wittgenstein stated that our eyes are often "dazzled by the ideal"⁵⁷⁷, he might as well have referred to the context of early modern anatomy, where it was indeed possible to 'see'

⁵⁷⁵ See also Galert, *Der Schmerz der Tiere*, p. 16.

⁵⁷⁶ Bynum, 'The Anatomical Method', p. 453.

⁵⁷⁷ See Ludwig Wittgenstein, *Philosophical Investigations*. The German text, with an English translation by G.E.M. Anscombe, P.M.S. Hacker and Joachim Schult. Fourth edition (Oxford: Wiley-Blackwell, 2009), no. 100, p. 50.

according to interpretation. Thus, in between the structure and the function stood the anatomist's interpretation. The study of animal nervous systems was therefore not just a means of gaining knowledge about the human brain, but was also a comparison in the literal sense of the term *vis à vis* a negotiation of differences between humans and animals. The correlation between differences in structure and differences in mental abilities in humans and animals was therefore a vital part of the successes, but also of the limitations of anatomy and physiology. The prevailing mind-body divide, however flexible the corporeal boundary might be, in the end helped maintain the difference between humans and animals, for it were mostly the bodily mechanisms of nervous faculties that were thought equal, but not the mental experience of it. The heated debates about mental abilities in animals can in this context only be understood as a search for further differences, while the life sciences detected more and more corporeal analogies.

Within the specific context of research on the brain, which reached a climax in the first half of the nineteenth century, the issues I have discussed in my thesis continued to be negotiated. The development of neurophysiology as a discipline in its own right was accompanied by fierce debates about the role of the 'sentient' brain, the mind-body interaction, and negotiations of the specific criteria that constituted the human.⁵⁷⁸ Similar to Locke's theory of sensationalism, discussed in chapter 3.2. , Franz Joseph Gall's (1758-1828) and Johann Caspar Spurzheim's (1776-1832) *Organology* invoked the contention that due to the similarity of brain structure, animal minds possibly differed from those of humans only in degree not in kind. With intensified comparative research on the brain and nervous system, a gradation of cerebral organisation became in fact the new demarcation criterion for the human-animal division, though this notion was not fully articulated before the late nineteenth

⁵⁷⁸ See Price, *The Emergence of the Doctrine of the 'Sentient Brain*, and Leys, *From Sympathy to Reflex*.

century.⁵⁷⁹ Although phrenology itself was soon considered outdated in public, Gall's neuroscientific principles were taken up by succeeding experimentalists, who declared human intellect to be simply the result of brain action.⁵⁸⁰ As with the consciousness of sensation, it is difficult to assert how this proposition was to be established experimentally since 'intellect', like the 'rational soul', was and is still believed to be exclusively human. Neuroscientific discoveries remained limited because scientists continued to scrutinise animal bodies in search of a material basis for they deem only existent in humans.

Modern neuroscience is still battling with what I have called the *Demand for Difference* versus the *Demand for Similitude*, as is seen in Lynch's 'Ethnography of a Neurosciences Laboratory' that I briefly mentioned in my introduction. In his study, Lynch investigated how laboratory discourses and ritual practices turn the bodies of animals into "bearers of a generalized knowledge" about the human body.⁵⁸¹ During an experiment, the anatomical and physiological properties of a rat's brain, for instance, are generalized in such a way that it represents the brains of all mammals, including the human brain. The animal's bodies, or body parts, thus become an object of human identification; without this process of transformation, the experimental enterprise would extract no other knowledge than that about the properties of the specific animal's nerve or brain tissue. Lynch describes in this context how scientists transform the 'naturalistic' animal which outside the laboratory is furnished with "scientifically unfounded attributions which have little possibility of rigorous verification", such as "human-like feelings, perceptions, sensitivities, and even 'thoughts',"⁵⁸² into the 'analytic' animal as a product of pure human intervention. Although the handling of

⁵⁷⁹ See Richardson, *British Romanticism and the Science of the Mind*.

⁵⁸⁰ See Hagner, *Homo cerebrialis*.

⁵⁸¹ Lynch, 'Sacrifice and the Transformation of the Animal Body', p. 266.

⁵⁸² *Ibid.*, p. 267.

animals by scientists is culturally informed, Lynch concludes that in the modern laboratory, Descartes' theory of the animal machine "has become a self-fulfilling prophecy."⁵⁸³

Focusing on the early days of neuroscientific research in my thesis, I have provided evidence that pre-modern researchers applied similar strategies in their anatomical and experimental projects. I have identified some of the emerging mechanisms which enabled researchers, ranging from the first thorough observations and descriptions in neuroanatomy in the seventeenth century to the ever increasing experimental investigations of brain and nerve functions in the eighteenth century, to use animal bodies as substitutes for the human body, while at the same time retaining a sense of human difference and uniqueness. Apart from Lynch and those few exceptions discussed in my introduction, the issue of the human-animal boundary remains overall absent in historical analyses of research practices in the life sciences. I intended to present some case studies that might fill this gap to some extent. I have restricted my analysis to the fields of neuro-anatomy and physiology, not only because the scope of my project required a restriction of some kind, but mainly because research on the nervous system provides a particularly rich field for analysing, as well as emphasising, the impact of the human-animal boundary on research practices and results. I maintain that the aspect of the human-animal boundary was a crucial component for the emerging discipline of neuroscience and needs to be taken into account for a more comprehensive history of the nervous system.

⁵⁸³ Ibid., pp. 269-70.