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*The Constructivistly-Organised
Dimensional-Appraisal (CODA) Model and Evidence
for the Role of Goal-directed Processes in Emotional
Episodes Induced by Music*

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The Constructivistly-Organised
Dimensional-Appraisal (CODA) Model and
Evidence for the Role of Goal-directed Processes
in Emotional Episodes Induced by Music

A thesis submitted in fulfilment of the requirements for the degree
of Doctor of Philosophy

Thomas M. Lennie

January 2023

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Abstract

The study of affective responses to music is a flourishing field. Advancements in the study of this phenomena have been complemented by the introduction of several music-specific models of emotion, with two of the most well-cited ones being the BRECVEMA and the Multifactorial Process Model. These two models have undoubtedly contributed to the field. However, contemporary developments in the wider affective sciences (broadly described as the ‘rise of affectivism’) have yet to be incorporated into the music emotion literature. These developments in the affective sciences may aid in addressing remaining gaps in the music literature, in particular for acknowledging individual and contextual differences.

The first aim of this thesis was to outline contemporary theories from the wider affective sciences and subsequently critique current popular models of musical emotions through the lens of these advancements. The second aim was to propose a new model based on this critique: the Constructivistly-Organised Dimensional-Appraisal (CODA) model. This CODA model draws together multiple competing models into a single framework centralised around goal-directed appraisal mechanisms which are key to the wider affective sciences but are a less commonly acknowledged component of musical affect. The third aim was to empirically test some of the core hypotheses of the CODA model. In particular, examining goal-directed mechanisms, their validity in a musical context, and their ability to address individual and contextual differences in musically induced affect. Across four experiments which include exploratory and lab-based designs through to real-world applications, the results are supportive of the role of goal-directed mecha-

nisms in musically induced emotional episodes. Experiment one presents a first test battery of multiple appraisal dimensions developed for music. The results show that several of the hypothesised appraisal dimensions are valid dimensions in a musical context. Moreover, these mechanisms cluster into goal-directed latent variables. Experiment two develops a new set of stimuli annotations relating to musical goals, showing that music can be more or less appropriate for different musical goals (functions). Experiment three, using the new stimuli set from experiment two, tests the effects of different goals with more or less appropriate music on musically induced affect. These results show that goal-directed mechanisms can change induced core-affect (valence and arousal) and intensity, even for the same piece of music. Experiment four extends the study of goal-directed mechanisms into a real-world context through an interdisciplinary and cross-cultural design. The final experiment demonstrates how goal-directed mechanisms can be manipulated through different algorithms to induce negative affect in a Colombian population.

The main conclusions of this thesis are that the CODA model, more specifically goal-directed mechanisms, provide a valuable, non-reductive, and more efficient approach to addressing individual and contextual differences for musically induced emotional episodes in the new era of affectivism.

Declaration

I declare that the material contained within this thesis has not previously been submitted for a degree at Durham University or any other university. The research in this thesis has been conducted by me unless otherwise stated in the list of publications which includes author contributions.

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In a similar vein, I would like to acknowledge the community in Durham University that has made my PhD time so enjoyable. Dr. Kelly Jakubowski and Dr. Liila Taruffi, in particular, for the role they have played in running the Music and Science Lab. The Music and Science Lab has always provided a supportive and friendly environment to try out ideas, and through the people within it I have

fostered many dear friendships that I had not expected when I embarked.

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Finally, I would like to thank all those who gave their time to participate in my experiments.

Dedication



Figure 1: Philip Hull (-2020)

Fondly known by those around him as Cap'n Hull. Phil was a fantastically knowledgeable and kind educator and academic. He inspired curiosity and wonder in staff and students alike with his love of music and cultures. He was an incredibly important person in my own academic journey and someone I remember fondly as a mentor and a friend. He will be greatly missed but not forgotten by those he inspired to know more about the world and gifted the ability to inquire.

List of Publications

Here presents a list of my publications that have contributed to this thesis. For each publication where multiple authors have contributed, I provide an extended author contributions section to clearly define the role of this author and how the work contributes to the overall thesis. Any modifications to the original published article are also clearly noted.

Chapter 2 is published in:

Lennie, T. M., & Eerola, T. (2022). The CODA model: a review and skeptical extension of the constructionist model of emotional episodes induced by music. *Frontiers in psychology*, 13:822264. doi: 10.3389/fpsyg.2022.822264

Author Contributions: TML synthesized the literature, developed the key aspects of the CODA model, wrote the dominant part of the text, and contributed to visualizations. TE contributed to musical background theories, reshaped the CODA model, the visualizations, the overall structure of the argument, and contributed to writing the text. Both authors contributed to the article and approved the submitted version.

Article Modifications: This article has been modified from the published version to include references to other sections of the thesis. Additionally section 2.5.2.2.6 was added for clarity and the opening paragraph to section 2.5.2.2.2 was amended following viva corrections. Otherwise the article appears as is. The article's

supplemental material can additionally be viewed in the appendix where indicated.

Chapter 3 is published as a pre-print at:

Lennie, T. M. (2023). *An exploratory evaluation of appraisal dimensions in emotional episodes induced by music*. OSF. <https://osf.io/vf462/>

Author Contributions: TML synthesised the literature, developed the experimental design, analysed the data, and wrote the article.

Article Modifications: This article has been modified from the pre-print only to include references to other sections of the thesis. Otherwise the article appears as is.

Chapter 4 is under review:

Lennie, T. M., (2022). *The role of goal-directed mechanisms in emotional episodes induced by music*. [Manuscript submitted for publication]. Dept. of Music, Durham University.

Author Contributions: TML synthesised the literature, developed both experimental designs, analysed the data, and wrote the article.

Article Modifications: This article has not been modified and appears as published.

Chapter 5 is under review:

Juan Sebastián Gómez-Cañón, Thomas Magnus Lennie, Tuomas Eerola, Pablo Aragón, Estefanía Cano, Perfecto Herrera, Emilia Gómez, (2023). *Polarization through Colombian not-so-popular music and algorithms: appraisal guided musically induced emotions*. [Manuscript submitted for publication]. Music Technology Group, Universitat Pompeu Fabra.

Author Contributions: JSGC developed the initial experimental idea for studying the negative effects of music in a Colombian population. TML developed and expanded the idea to apply to psychological phenomena. JSGC developed the backend for hosting the experiment and translated the design from English to Spanish (Colombian). TML researched and selected appropriate scales of measurement for the study, with the exception of the ‘Colombian specific political questionnaire’ which was developed in tandem with JSGC during the pilot phase. JSGC handled data collection. JSGC and TE conducted the data analysis. TML guided and offered feedback on the initial and subsequent analyses. JSGC & TML co-wrote the initial draft of the text. JSGC wrote the text relating to music emotion recognition, developed research aim (R2) and hypothesis (H3). TML wrote text related to goal-directed and social psychological phenomena, developed research aim (R1) and hypotheses (H1 and H2), wrote the results for linear mixed model analyses with TE, the discussion in relations to (R1, H1, and H2). Helpful comments and active discussion between JSGC and TML were on-going throughout the writing process.

Article Modifications: The only modification made relates to changes in spelling, from American English to British English, for consistency within the thesis. Otherwise the paper appears as published.

Appendix D is additional published material:

Timmers, R., and Bannister, S., and Lennie, M. T., (in press). Aesthetic emotions in music–theory, measurements, and cross-cultural comparison. In Bogunovic, B., Timmers, R., and Nikolic, S. (Eds.), *Aesthetic emotions in music*. OUP.

Author Contributions: A synthesis of this published chapter is provided in the discussion 6. This synthesis is entirely the work of this author TML and seeks to highlight the contributions the CODA model has made to further areas of research within the music psychology community.

Individual contributions to the published chapter are; RT proposed the initial idea for the article and wrote section D.1.3. SB wrote the introduction D.1.1 and section D.1.2. TML wrote section D.1.4 and the initial draft of the conclusion D.1.5. The final conclusion encompassed comments and edits from RT and SB.

Article Modifications: The full article appears in the appendix D as published.

Chapter 1

Introduction

The phenomena that is music goes as far back as 40,000 years to current knowledge (Spitzer 2021). It has been described as the ‘language of emotions’ (Cooke 1959). If one assumes that the simple practice of music shows some form of emotional engagement, the emotional power of music pre-dates settled homo-sapiens and agriculture by approximately 30,000 years (Bentley 2011). The idea of music’s importance in evolutionary terms is still actively discussed (Patel 2008) with conclusions ranging from Pinker’s (Pinker 1997) ‘auditory cheesecake’¹, through Darwin (Darwin and Prodger 1998) who claimed that music served several specific purposes in natural and sexual-selection to “singing neanderthals” in the origins of language (Mithen 2005), and the ethological origins that musicality afforded us (Tomlinson 2015). Regardless of the evolutionary perspective, music is undeniably an important part of our lives (North and Hargreaves 2008) largely due to its power to move us emotionally (Juslin and Sloboda 2010).

The affective experiences that music can induce are as numerous and varied as emotion itself. Individuals use music for so many purposes and music’s pervasiveness in our lives from cradle to grave makes it hard to imagine a world without it. It is unsurprising then, that music’s ability to influence our emotions is cited

¹The idea that music has no evolutionary survival function but just happens to be a pleasurable by-product of the culmination of several important evolutionary mechanisms

as the most common reason people engage with music (Juslin et al. 2008, 2016). As Beethoven is alleged to have remarked “Life would be flat without it”; now comically appropriated to ‘Without music life would B^b’. Music can seemingly take over the body when it makes us want to dance (Witek 2014). It can be overwhelming (Gabrielsson 2011) and move us to tears (Sloboda 1991). It can send shivers down our spines (Fleurian and Pearce 2021; Sloboda 1991). It can help us regulate our mental and emotional health as adolescents (Laiho 2004; Saarikallio 2007) and adults (Saarikallio 2011). It forms part of our identities representing cultural, political, and personal values (Boer et al. 2012). It can help us relax (Labbé et al. 2007; Witte et al. 2020). It can aid in parent-infant bonding (Cross 2016). It can bring back strong memories (Gabrielsson 2011), such as the “darling they’re playing our tune” phenomena (J. B. Davies 1978). It can trigger musical imagery (Jakubowski et al. 2017), visual imagery (Taruffi and Küssner 2019), and autobiographical memories (Janata, Tomic, and Rakowski 2007; Jakubowski and Ghosh 2021). And it can be our companion when we feel alone (a ‘social surrogate,’ K. Schäfer and Eerola 2020), something many people gravitated towards over the COVID-19 pandemic (Granot et al. 2021). Here I list just a few of the many phenomena that have been studied in music but one can certainly see that music is a phenomenologically rich experience and is an intrinsic part of being human.

Whether music is used for developing a self-identity, as a social bonding tool, to create an atmosphere, for healing, or for pure amusement and aesthetic pleasure; what is omnipresent across all these examples is *emotion*. In such a world, there are few (emotional) places that music cannot touch. This is not to oversell the power of music. It is of course notable that many, if not most, of an individual’s musical experiences are (for lack of a better word) unremarkable, even if they are worthy of the additional cognitive resources that come with giving our conscious attention to something. Moreover, this is not to forget that different individuals may themselves have different propensities for engaging with or liking music. There are those that cannot pass a day without actively seeking out and engaging

with music while there are similarly those who remain broadly indifferent to music. How do we as researchers begin to explain such a rich and diverse set of possible reactions to music?

In the traditional psychological context, the study of music and emotion begins in earnest with the seminal work of Meyer (1956), though the scholars of ancient Greece devote pages to its emotional and spiritual understanding (Budd 2002). Over the past few decades the topic has amassed a wealth of literature around it. Over the course of this PhD (2018 to 2023), 2,788 papers have been published on the topic (according to Web of Science²). This has culminated in two volumes of a handbook specifically for the topic (Juslin and Sloboda 2010), and notable chapters in several other more general affective (Barrett, Lewis, and Haviland-Jones 2016; Davidson, Sherer, and Goldsmith 2009) and music specific (Hallam, Cross, and Thaut 2016) handbooks. Subsequently, several theories have been developed to explain the phenomena of emotions evoked by music. Developed from Meyer's (1956) expectation-arousal theory, later theories expanded to include more explicit cognitive mechanisms (e.g., Huron's (2006) ITPRA theory). Contemporary models more broadly define themselves as describing music evoked emotion as an interaction between music, listener, and context (Scherer and Zentner 2001). Yet, as alluded to later in this chapter 1.3 and explicitly exemplified in chapter 2, these music specific models diverge from their contemporary equivalents in the utilitarian affective sciences by claiming that music to a greater or lesser degree is devoid of goals (Kant 1790) and therefore cannot be described by utilitarian models (Juslin and Västfjäll 2008) - where goals are an essential component (Frijda 2007a). The diverse and often unique range of emotional qualities that music can evoke does indeed need a specific mechanistic explanation (described in 2) but as I argue theoretically and show empirically through this thesis, such theories should still be based on the same mechanisms that guide general (affective) cognition - i.e., they should include a goal-orientated component. In doing so, I will ar-

²The search used the key terms 'music' and 'emotion'. Results are stated as of 23rd January 2023

gue this allows theoretical models to better understand individual and contextual factors in affective reactions to music. A greater theoretical and methodological focus on these factors was recently described as ‘the way out of this circular logic’ (p. 15) that affective responses to music otherwise generate (Céspedes-Guevara and Eerola 2018).

This chapter will set the ground work for such an explanation of musical affect. First, I explore a brief history of the development of affective psychology. Next, I describe the most commonly agreed upon components of affect before discussing how different theories disagree about which components are the *most* important. I will highlight how many of these disagreements are derived from epistemic assumptions about how emotion should be described; often equated to discrete or dimensional interpretations of what an emotion is. I will put forward a framework to examine different models of emotion. Finally, I will outline a skeptical approach that can, and should, be taken toward the study of affect.

1.1 What is an emotion(-al episode)

1.1.1 A brief history to the present day

When psychologist William James (1884) first asked the question ‘What is an emotion?’, he gifted the affective sciences its most infamous example: the bear in the woods. James used his example to demonstrate what have become widely known as somatic theories. That is physiological reactions to a stimuli are interpreted by the brain as an emotion - my heart begins to race and I begin to tremble leads to the emotion of fear, a theory that later became know as the James-Lange Theory³. This theory was criticised by physiologist Walter Cannon (Cannon 1927) who claimed that while physiological reactions are an important component of emotion, the body’s physiological reactions were too similar to account for the variety or differences in emotion - a racing heart and trembling

³The name was coined by John Dewey who noted that Dutch psychologist Carl Lange also developed similar ideas during the 19th century

can be associated with passion, fear, excitement, or anger. Instead, he suggested, physiological reactions and ‘feelings of’ are separate components but occur simultaneously. Later theories, pioneered by Stanley Schachter and his student Jerome Singer (1962; Schachter 1964), showed how these two systems (physiological and cognitive) work together to create emotion. They suggested that physiological arousal is important in facilitating an individual’s focused cognitive appraisal - seeing the bear leads to heightened physiological arousal but appraising the bear as dangerous leads to labeling the reaction as fear. The incorporation of this cognitive component into the scientific understanding of emotion led to the development of cognitive specific theories of emotion. Appraisal theory pioneered by Magda Arnold (Arnold 1960) with several proponents following in her footsteps (e.g., Richard S. Lazarus 1966; 1991; 1986; Oatley and Johnson-Laird 1987; Scherer 1984; C. A. Smith and Ellsworth 1985), proposed that cognition, either conscious or unconscious, was necessary for emotion, controlling the quality⁴ and intensity of an emotion (Solomon [1976]1993; Frijda et al. 1986). These theories differentiated themselves from Schachter (1964) by no longer claiming cognition equated to conscious experience. Most recently some have claimed emotional reactions can occur separately or before cognition occurs (Zajonc 1980); emotions are merely putting a name to arousal. The debate goes on (Richard S. Lazarus 1981) but this concludes our brief history of affect, as many contemporary theories (basic, appraisal, constructionist, and social⁵) can be said to find their origins within this.

1.1.1.1 The present day

This history has led to the development of four competing contemporary theories. I will discuss each one briefly here and introduce the names associated with these groupings but leave differences for the discussion on disagreements below and

⁴Quality here referring broadly to the type of emotional outcome, positive and negative outputs, and action tendencies depending on the theory.

⁵I choose these four because they are a common grouping of theories in general affective science (Gross and Barrett 2011) and additionally cover the four common approaches that have been applied to musical affect (Warrenburg 2020b).

critiques of the theories are offered in Chapter 2.

- *Basic emotion* theories (Tomkins 1962; Ekman, Levenson, and Friesen 1983; Izard 1992; Panksepp 1992) are most closely associated with Darwinian ideas rather than the history presented above. They hold that the world of affect is organised around a subset of specific discrete terms (e.g., fear, anger, sadness). This subset of discrete emotion terms have developed as evolutionary prepared response patterns to specific evolutionary pressures. Each of these terms has a specific underlying mechanism and produces a distinct response - ‘affect programs’. Other, *less basic* emotions are built out of the blending of these affect programs. Some theories (Damasio 1994) do additionally allow for some modification of these affect programs through cultural and cognitive processes, as the affect programs are reactivated over time.
- *Psychological Construction* theories (Russell 1980, 2003; Barrett 2006) come directly from the Jamesian tradition but are more closely associated with Schachter and Singer’s (1962) two-factor model. These theories do not claim a subset of possible emotions. Instead they focus on bodily changes driven by perception. Bodily changes interact, typically simultaneously, with cognitive perceptions as contextual information. Some theories are more explicit about what the cognitive mechanisms are but all point towards a possible infinite amount of emotions.
- *Social Construction* theories (Mesquita, Boiger, and De Leersnyder 2016) see emotions as emerging through socio-cultural processes and an individual’s role within these processes. Different theories in this tradition see emotions as ranging from socio-culturally variable triggers for *basic* emotions to learned socially constructed meaning. The key element to all these theories is that emotions are seen as having a social function.
- *Appraisal* theories (Arnold 1960; Oatley and Johnson-Laird 1987; Clore and Ortony 2000; Scherer 1984, 2009a; Frijda et al. 1986; Frijda 2007a; Ellsworth

2013) are developed from a tradition that places the cognitive component as central to an affective response. Theories vary considerably within the appraisal tradition between appraisals as Darwinian evolved mechanisms that lead to *basic* emotions, to appraisals as dimensions with an infinite number of possible emotion states. However, all theories see cognitive evaluations of a stimulus's meaning as central to the process.

This origin story of affect beginning with James (1884) also contributed to more than just the field of emotion. It led to the development of psychological (and neurological) theories about how brains are thought to process information generally, known as dual-process theories. Dual-process theories suggest that the brain processes sensory input through two different routes (referred to in multiple ways: intuition [thinking-fast] & reasoning [thinking-slow] (Kahneman 2003, 2011); stimulus-driven & goal-directed (Moors and Fischer 2019); reflective & impulsive (Strack and Deutsch 2004); rule-based & associative (Sloman 1996); or the more impartial, System 1 & System 2 (Stanovich and West 2000); or bottom-up & top-down mechanisms). Dual-process theories are historically closest to Schachter's (1964) theory. These processes have been tracked neurologically in real-time using fMRI studies (Goel et al. 2000; Goel and Dolan 2003). While, one can see through this historical development that the James-Lange theory has been mostly abandoned in contemporary perspectives, it has not been forgotten. The problem with the James-Lange theory is one of causation (the directional arrow points from physiological sensation to emotion). In the context of recent neurological evidence, a mediated version of James-Lange theory incorporating bio-feedback loops and theories of embodiment shows how bodily changes can modulate the experience of emotion (Dalglish 2004). Such mechanisms are supported by dual-process theory's interpretation of how bottom-up and top-down mechanisms interact and take priority over one another, even if such experiences need to be labelled by later cognitive processing. This contemporary context of neurological bio-feedback loops and interactive bottom-up and top-down cognitive mechanisms, also begins the view of emotions as more dynamic systems. They

encapsulate the state of an organism that is constantly in flux and continuously re-informed by new information. Such dynamic systems are readily applied to many phenomena in the psychological literature, such as that of decision-making (Busemeyer and Townsend 1993) and memory (Schutte, Spencer, and Schöner 2003). Moreover, dynamic systems work well with contemporary descriptions of cognition, such as that of 4E cognition (Newen, De Bruin, and Gallagher 2018), which describe the dynamic relationship between brain, body, and environment.

1.1.2 Defining an emotional episode

This brief history suggests a reasonably logical and productive, if as yet unresolved, end point to the history and development of the affective sciences. One that has led to the inclusion of several different components to an emotional episode (physiological, cognitive, etc.). Yet, the term emotion remains poorly defined (Scherer 2005). A lay person, if asked, may state “Yes, of course I know what an emotion is. Everyone does! Its...” and some scholars have attempted to synthesise such *folk* concepts to refine definitions of emotion (Frijda et al. 1995). Yet, the components of an emotion and the taxonomy of affective states that an emotional episode should be distinguished from (e.g., mood, or attitudes) are still hotly debated (Frijda 2007b) and a consensus has not emerged nearly 140 years after James first posed the question.

I use the term emotional episode through this thesis to delineate a period of time that begins with a ‘stimulus event’⁶ (Scherer 2005) that is evaluated as relevant to an organism. This leads to coordinated changes in other affective components and will have a behavioural impact, be it a mental behaviour such as driving greater cognitive attention and generating new goals or a physical behaviour such as an expression. An emotional episode will become a subjectively experienced affective state. This can be, but does not necessarily need to be, labelled to be subjectively experienced. For example, a feeling may be present such as to

⁶explain Scherer’s definition a stimulus event

approach or avoid a stimulus. Similarly, a physiological aspect may be subjectively experienced, such as a racing heart or a lack of breath. A stimulus event need not be an external one. For example one's own actions could be the stimulus event for feelings of satisfaction or shame. The alternative term 'emotion', I suggest, implies prerequisite a discrete term or a definitive end point where labeling occurs. The term emotional episode is thus substantially broader and more encompassing of the dynamic view of (affective) cognition that has emerged in recent years. It represents an on-going process that is continuously re-informed by changes in other components of emotion. It can be labelled, though this is not required. It can be subjectively experienced multiple times and in a multitude of ways through recursive evaluations. Importantly, it can contain all or some of the components of emotion at different time-steps. I discuss this in greater detail in Chapter 2, however, it is beneficial to define an emotional episode now to help distinguish it from other terms and what it is not.

I wish to separate an emotional episode from general (affective) cognition. Some philosophers have used the term emotion to refer to 'dispositions' instead of 'episodes' (Mulligan and Scherer 2012). I suggest, in line with others (Frijda 2007b; Dukes et al. 2021), that all cognition is emotional. That it uses the same components as an emotional episode to draw inference and act upon/within a world. However, no one would say that their subjective experience of life is equivalent to an on-going full-blown emotional episode. An episode should be demarcated from the general pragmatic everyday functioning of life (Reisenzein 2007). An episode is a short-lived occurrent event that is responsive (as opposed to long, diffuse affective states - e.g., moods). It is evaluated as relevant to an organism's goals (be it physical safety or ideological values) and it should be directed at something; hence distinguished from attitudes or preferences because they lack intentionality without a situated context (Scherer 2005). Finally, I suggest that an emotional episode is subjectively experienced as such whether labelled as a discrete emotion term or not.

1.1.2.1 The components of an emotional episode

Affective theories that draw on different epistemological traditions often highlight different aspects of the history of the study of emotions and subsequently different components. In doing so it has led to disagreements about how to represent emotions (discrete, dimensional, clusters, fuzzy-sets) and/or their components, their representation as natural scientific kinds or as methodological artifacts, the relationship between emotion categories (fear, anger, and joy) or specific classes of emotions (aesthetic, utilitarian, and epistemic), and ultimately which component should be seen most commonly as the causal component (motor, neurological, cognitive, etc.). That said, what is true of nearly all emotion theories is that they agree a prototypical emotional episode has several components. I hope to offer here a clear statement about which components of emotion are acknowledged in this thesis and by most theories generally (Scherer 2005; Frijda 2007b), and hopefully something towards an agreeable account for most affective scholars.

The components of emotion are said most commonly to include a *cognitive* (evaluation of a stimulus), *feeling* (subjective experience of other emotion components), *motivational* (action readiness or tendencies; e.g., preparedness to fight or flee), *somatic* (central and peripheral nervous systems), and *motor* (behaviours, facial and vocal expressions) component.

1.1.2.2 Disagreements in the components of an emotional episode

These components are common to many theories of emotion (Scherer 2005; Frijda 2007b; Moors 2009) and do suggest progress towards a consensual definition, if a slow one. There are nonetheless several disagreements between theories even within these less contentious components that should be noted.

1.1.2.2.1 Definitions of components Different theories have different definitions of components. The cognitive component is highly relevant to this thesis and is therefore discussed here for explanatory purposes. See Frijda (2007b) and

Moors (Moors 2009) for further discussion on contention between the inclusion of components. Most readily the definition of the cognitive component can be explained by what it is compared to. In some theories cognitive can be defined as referring to mental processes generally, as when compared to somatic or motor components. Alternatively, when compared to the feeling component, cognitive is given a more narrow and deliberate definition referring to non-automatic and non-associative processes. Such problems in definition are one source of disagreement and can lead to differences in whether to include the cognitive component or not. For instance in our brief history Lazarus (1966) offers a broad definition of cognitive and includes the component as essential, while Zajonc (1980) gives a narrow definition and excludes it.

1.1.2.2.2 Order of components Different theories can be said to disagree about the ordering of the components. Many theories identify a specific linear sequence to an emotional episode (see Moors 2009 for illustrations of these causal processes) and subsequently disagree over the order components occur in. Theories that stress a strictly evolutionary approach (e.g., Ekman, Levenson, and Friesen 1983; Ekman and Cordaro 2011; Panksepp 1992) do not describe a single component as causal. Instead, stimuli are described as relating to evolutionary challenges our hominid predecessors once faced. These challenges activate distinct, evolutionarily shaped, and culturally universal responses. These theories nearly all claim that the motor component (as an adaptive response) is the cause of emotion but because they demarcate the response as evolutionarily predefined, little is said about the causal process. However, many of these theories differ in where they look for these distinct responses. Ekman (1983) for example, suggests facial expressions, while Panksepp (1992) suggests neurological sub-systems. Differences in the consequent emotional response has led to differences in the number and type of emotions⁷ considered as evolutionarily shaped. Alternatively, those that follow in the Jamesian (1884) tradition, linking bodily perception of feeling (Russell

⁷The term emotion specifically used here because basic emotion theories predict discrete emotions

2003), place the somatic component first in the order of causation. Finally, appraisal theories Richard S. Lazarus (1966), suggest that the cognitive component is the pre-requisite to emotional responses driving changes in other components. For instance, Frijda (Frijda 2007a) marks the motivation component, as action tendencies. Some authors have argued it is the synchronization of components that demarcates an emotional episode (Scherer 2005). Interestingly, one could argue that the evolutionary theories intuitively imply a goal for survival, without an evaluative capacity being applied to the goal - it is biologically hardwired. The evaluative aspect added by cognitive theories does offer a substantial degree more flexibility to this process without diminishing any evolutionary perspective. I shall return to this point in the next chapter.

1.1.2.2.3 Components as the to-be-explained phenomena Related to the above, further disagreements arise in which components should be seen as the to-be-explained phenomena of an emotional episode. As stated above the strictly evolutionary theories place the motor component as the explainable phenomena (while also allowing it to be the cause and the mechanism simultaneously). Alternatively, James (1884) suggests feeling is the to-be-explained phenomena, though he called it emotion. Subsequent theories from this tradition including appraisal theory (Scherer 2009a; Moors 2013), and constructionist theories (Russell 2003; Barrett 2006) (which are both born of an understanding of physiological and cognitive), all similarly seek to explain feeling. The disagreement between these theories in explaining the feeling component (the component they suggest is the to-be-explained phenomena), is the causal component as in 1.1.2.2.2. However, these theories can also disagree in how the *affective space* is organised (i.e., how the to-be-explained component is organised).

1.1.2.2.4 Dimensional or discrete components Theories disagree about how *affective space* should be organised. As stated above, different theories take different components as the to-be-explained phenomena; a distinct pattern of action tendency (Frijda 2007a), appraisal value (C. A. Smith and Lazarus 1991),

core-affect (Russell 2003), motor expression (Ekman, Levenson, and Friesen 1983). *Basic* emotion theories (Ekman, Levenson, and Friesen 1983; Izard 1992) suggest that the to-be-explained phenomena (the motor component in these cases) should be organised into a select group of discrete lexical categories. This suggests that a certain number (different numbers for different theories) of “special” emotion categories that have the most evolutionary importance (e.g., fear, anger, happiness) form the basis of emotional life. From combinations of these categories all other emotion categories can be built. The alternative perspective suggests that *affective space* is best described in dimensional terms (e.g., Russell 2003; Scherer 2009a; Moors 2013). The number and type of dimensions differs wildly between theories. For example, Russell (2003) suggests two dimensions of valence and arousal, while appraisal theories postulate several dimensions (e.g., novelty, valence, goal-relevance, goal-congruence, coping-potential, agency) to explain how the affective space is differentiated. These can be described as ‘sub-emotional’ dimensions (Moors 2009). Some theories postulate that these dimensions can lead to a possibly infinite number of discrete emotions (Scherer 2009a, 2009b). Others distinguish their dimensions from specific discrete emotion terms altogether (Russell 2003, 2009); in a similar vein to James (1884) ‘If one should seek to name each particular one of them [emotions] ..., it is plain that the limit to their number would lie in the introspective vocabulary of the seeker’ (p. 485; brackets added). Again, it is interesting to note the flexibility that a dimensional approach to components offers over a discrete one. However, I save the critique of a discrete approach for the next chapter.

1.1.2.2.5 Emotional or rational reasoning It is an additional point to note that most theories define an emotion with a specific onset and offset, as described in 1.1.2.2.2. Subsequently, this claim suggests that an emotional episode and the behaviour that it elicits should be seen as separate to general cognition and everyday pragmatic behaviour, sometimes separated as hot and cold cognition or emotional and rational cognition. Some theories (Frijda et al. 1986; Solomon

[1976]1993) however, do not claim such a distinction exists. Frijda (Frijda 2007b) uses the example of to lose the soap in the shower. This may include all the same components as an emotional episode, including a motivation to find the soap, as well as action tendencies that become apparent in feelings, driving somatic responses, and eventually the action of getting on to ones knees and fumbling to find it. This scenario would not be described by many as an emotional experience or at least not as emotional as say losing a loved one. This idea is explored more fully in Chapter 2, where clear distinctions between an emotional episode and general (affective) cognition are made. However, it suffices here to sum up the point with a quote; ‘One does not have emotions; one is emoting, sometimes more, sometimes less’ (Frijda 2007b, 442).

1.1.3 Concluding comments on an emotional episode

The definition of an emotional episode developed here is born from that of the wider affective sciences. It acknowledges the many disagreements that still exist in the literature. As such this definition of an emotional episode can be described as broadly in line with many other affective models that describe emotion as a process (Russell 2003; Scherer 2009b) and with the wider affective literature. For example, work on emotion regulation is similarly described as a ‘dynamic’ process (Gross 2015). Though the individual components and their descriptions can be seen as a parsimonious grouping of existing descriptions of an emotional episode it can be noted that this definition does provide a novel direction within the affective sciences. Simply, it seeks to unify rather than divide further. This captures the notion that distinctions between subfields in the affective sciences (e.g., models of mood-regulation versus general affective models) may not be as useful to the wider affective sciences as the approach to adopting a more unifying model.

There are of course many meaningful reasons to distinguish these subfields (Barrett, Lewis, and Haviland-Jones 2016) and subfield specific models can be highly useful to their individual disciplines for addressing specific points of interest. One

must therefore be careful to be able to distinguish actions or behaviours (if one should choose to measure these as their affective outcomes). For example, someone may shout angrily for many different reasons. They may wish to communicate to another that they are angry (emotional intelligence) or they may wish to shout to achieve a cathartic release (mood-regulation). Both may be true simultaneously. This in itself does not undermine this definition of an emotional episode. Instead, these important distinctions can be retained instead by identifying an individual's goals in different situation. For instance, Gross (2015) suggests that an episode of emotional regulation will continue 'until the goal is no longer active, either because the goal has been achieved or because another goal has displaced it' (p. 132). Thus allowing this definition of an emotional episode to be uniquely unifying while preserving the importance individual subfields as separate emotional experiences.

1.2 What makes a theory of emotion

I have defined an emotion episode as distinct from other associated affective terms (mood, feeling, disposition etc.). I have discussed the most parsimonious list of components that underlie an episode. I have noted disagreements between affective theories in the organisation, definition, and prioritisation of these components. An emotion episode implies that there is a specific *stimulus event* (input) that leads to a synchronised change in more than one of the components of an emotional episode, i.e., a consequent to-be-explained component (output); noting of course, the substantial disagreement between theories about which component this should be. I have indicated above that some definitions of an emotional episode (Solomon [1976]1993; Frijda 2007b) are not separable from general non-affective cognition, at least at a componential level. Yet, the fundamental purpose of a model or theory of emotion(-al episodes) is to answer the question of 'elicitation' (Moors 2009): which stimuli lead to an emotional episode and which mechanisms/representations support an organism in calculating this? There must therefore be a meaningful

distinction made between more or less emotional episodes, such as in Frijda's (Frijda 2007b) example of the soap.

It is useful to examine what questions, such as the above elicitation example, should be addressed by a model of emotion(-al episodes). This will allow for a better discussion of the usefulness of the model proposed in this thesis and evaluation of the supporting empirical evidence in Chapter 6. A theory of emotional episodes typically focuses on causation ('elicitation,' Moors 2009) as its primary contribution. Yet, there are two further aspects that should be considered that all emotion theories can agree on, regardless of their epistemic or methodological approaches. There is 'the intensity problem' and 'the differentiation problem' (Moors 2009, 631). Moors (2009) argues that each of these problems subsumes different sub-questions related to different levels of explanatory description. Marr (1982) in his discussion on visual perception, according to Moors (2009), address this as three levels of analysis; functional, algorithmic, and implementation levels. Moors links these levels of analysis to refine distinct questions about causation (elicitation), intensity, and differentiation (Table 1.1).

Table 1.1: Overview of questions that should be addressed by theories of emotion causation, linked to Marr's levels of analysis; from Moors 2009, p. 633

<i>Marr's levels of process description</i>	<i>Problems related to emotion causation</i>		
	<i>Question 1: Elicitation</i>	<i>Question 2: Intensity</i>	<i>Question 3: Differentiation</i>
A. Functional level: Relation between input and output	Question 1A: Which stimuli elicit emotions and which do not? What are the conditions under which emotions are elicited	Question 2A: Which stimuli elicit weak versus strong emotions?	Question 3A: Which stimuli elicit positive versus negative emotions? (anger, fear, sadness, joy, etc.)
B. Algorithmic level: Mechanisms and format of representations (codes)	Question 1B: What are the mechanisms and representations that determine emotion elicitation?	Question 2B: What are the mechanisms and representations that determine the intensity of emotions?	Question 3B: What are the mechanisms and representations that determine the quality of emotions?
C. Implementational level: Neurological structures or routes	Question 1C: What is the neurological basis of emotion elicitation?	Question 2C: What is the neurological basis of emotion intensity?	Question 3C: What is the neurological basis of emotion differentiation?

Using table (Table 1.1) one can see how different theories discussed in 1.1.1 may differ. First, theories may differ in the questions they seek to answer. Nearly all theories focus on the question of causation. However, do they also approach the intensity and differentiation questions? For example, in the elicitation questions, Russell (2003, 2009) and Schachter (1964) are both classifiable as psychological constructionist theories. That is, they both place the answer to the elicitation question on the same component. Russell, places the answer to the elicitation problem in the somatic component - a change in one of the two psycho-physiological dimensions. Schachter similarly attempts to place the elicitation question in the somatic component. However, Schachter does not answer the elicitation problem - which stimuli lead to an emotional episode? Instead, arousal is simply labelled by the cognitive component - the differentiation problem. Yet which stimuli lead to arousal is not addressed (the elicitation problem) because the cognitive component should not precede the somatic component. Russell (2003) alternatively addresses this through the incorporation of 'affective quality' (evaluations of a stimulus) that can precede changes in 'core-affect'.

Second, and alluded to above, I have shown how different theories seek to answer the questions of elicitation, intensity, and differentiation with vastly different solutions (e.g., discrete or dimensional components).

Finally, theories may differ in their level of analysis yet address the same question. For example, basic emotion theories versus psychological constructionist theories look to answer the elicitation problem at different functional levels. Many basic emotion theories (Panksepp 1992; Ekman, Levenson, and Friesen 1983; Izard 1992) only address the level of implementation of the elicitation question⁸ while psychological construction theories look towards the algorithmic level. Barrett (Barrett 2006, 2017), refers to associative mechanisms that compute perceptual input and previous knowledge and constrain one another until a ‘stable’ discrete emotion category is decided upon. This is largely a discipline specific and methodological problem: what does neuroscience study? (the brain); what methods are typical for the discipline? It is likely that differences in methodological approaches have also driven differences in the representation of an emotion they choose (positive-negative valence vs. anger, fear, joy). This distinction between theories should not be emphasised as a disagreement between theories. It is important for a theory to be able to reference how their theory works at different levels of analysis but a single level explanation is not sufficient to explain the phenomena. To put it simply, staring in to the ‘intracranial darkness’ of the brain will not explain the algorithmic of functional levels even if it is still a necessary component of these processes (Tallis 2011). There are of course different ways to look at brain processes and some lend themselves much more readily to understanding the algorithmic processes when modelled in less regressive ways (e.g., predictive processing, Koelsch, Vuust, and Friston 2019).

⁸Damasio (1994) is an exception to this

1.3 The role of Skepticism

I have added to the working definition of emotion described here that the role of an emotion theory or model is to answer specific questions (Moors 2009) that aid the scientific understanding of emotional phenomena. As I have shown, different levels of analysis (Marr 1982; in Moors 2009) and methodological approaches (Nelson and Russell 2013) have led to wildly different analyses and conclusions. So, how can one approach the study of (musical) emotions from a meaningful perspective? The answer could lie in the concept of ‘skepticism’!

The first developed form of skepticism is said to begin with Socrates. The Greek *skeptikos* meaning “an inquirer” in search of truth (Popkin 2020, November 18). Skepticism was later realised most clearly by René Descartes in “Cognito ergo sum” (Cartesian Skepticism⁹). In more contemporary forms, modern skepticism has been framed with less radical conclusions about epistemology. Instead it is turned towards the questions of science, empirical knowledge, and metaphysics. This is exemplified in one of several contemporary forms as ‘scientific skepticism’ referring to the suspension of judgement through the systematic comparison of competing ideas (Kurtz 1992). One can immediately see the enormous importance scientific skepticism has played in the development of the scientific method. Something I, and I presume the reader, holds dear. This is not intended to be an essay on philosophical history. Even so, acknowledging the approach that has served science so well, at least as far as a counter to dogma, provides a strong grounding for an approach to a subject (affect) where *a priori* assumptions have driven so many diverging conclusions.

My thesis adopts two Skeptical perspectives, that will be explored more succinctly in the following chapters. First, and towards theories of emotion generally, I make a skeptical argument against of the taxonimisation of discrete emotions as a real, scientifically-valid set or category to be meaningfully distinguished from one another. It seems reasonable to suggest that emotions exist as discrete entities

⁹Meaning to challenge or doubt one’s own beliefs, sometime called Cartesian doubt

because it *feels* close to how we experience emotions; or at least describe emotions most regularly in daily life. Second, and towards music specific theories of emotion, I am skeptical that musical emotions are devoid of goals. All wider theories of emotion acknowledge goals as fundamental to emotions. Only in philosophical rhetoric do we find the idea that aesthetic emotions (including music) are ‘disinterested’ (Kant 1790). Yet, there is no empirical evidence for this, to my knowledge. On the contrary, the opposite appears more substantiated by previous research and, as I will show, my current findings too. Philosophical rhetoric has, nonetheless, become dogma and held the field of musical affect back. These two skeptical approaches to the question of musical emotions will shape my narrative in chapter 2.

1.4 The aims and structure of this thesis

- The first aim of this thesis is to provide a useful outline of what contemporary developments have occurred in the wider affective sciences and to critique current popular models of musical emotions through the lens of these recent developments.

Given the diversity of theories and the numerous levels of disagreement, there are a number of approaches to reviewing them. In the next chapter, I group three contemporary affective theories from the wider affective sciences as skeptical theories, based on their conjecture that discrete emotion terms have not shown sufficient evidence to form a valid scientific-set or taxonomy. I discuss the theoretical similarities and differences in these skeptical theories before turning the skeptical lens towards theories of musical emotions/affect. These music specific theories all have equivalent models in the wider affective sciences. Two mainstream and highly cited music specific theories are explored and critiqued based on the most parsimonious conclusions that can be drawn from a review of the wider affective sciences. An additional, recently published adaption of Barrett’s (2006, 2017) psychological construction is also reviewed and critiqued in the supplemental ma-

terial. In conclusion, they are skeptically critiqued for being explicitly described as, to a greater or lesser degree, devoid of goals. This is in part due to a narrow conception of goals in a Jamsian survival sense (remember the bear?). In doing so, they have neglected contemporary advancements in the affective sciences; most notably those that can be described as relating to goals.

- The second aim is to develop a model of musically induced emotional episodes. One that incorporates skeptical critiques of the previous literature and one that seeks to manage different theoretical perspectives by drawing together multiple emotion theories into a single model.

In my review of the wider and music specific affective literature, it is a recurring theme that different models share substantial points of agreement. My model seeks to be useful not only by updating current music emotion models to include the most recent developments in the affective sciences but also by allowing for greater comparison across different theoretical and methodological approaches. This is achieved by drawing together multiple approaches through their key points of equivalence and most notably by reinstating the role of goal-directed processes into our understanding of musically induced emotional episodes. In doing so, I wish to suggest that musical emotions are much closer to our everyday emotions than has been previously acknowledged. Moreover, by acknowledging such ideas, the world of affective music cognition is given the scope to explore and engage with new techniques and methodologies that can inform progress in the field. This leads to the CODA model: comprising several directly testable hypotheses before concluding with several direct recommendations for future research.

- The third aim seeks to empirically test those of the model's predictions which directly relate to current gaps in the music emotion literature.

This is done through three experiments. The first experiment, acts as a proof of concept and tests the validity of the appraisal dimensions proposed in this model. It uses an online experiment and ecologically valid music stimuli to identify similar patterns of rating in appraisal before applying a principal component

analysis to look for broader trends. The second experiment follows the findings of the first noting the importance of goals in people's engagement with music. In a direct test of the role of goal-directed appraisal mechanisms, it tests their effect upon core-affect ratings in an online experimental design. The findings point towards support for goal-directed mechanisms, their influence upon core-affect in music induced emotional episodes and provides support for other interpretations of musically-induced core-affect. The third experiment, builds on the findings of the first and second experiment. First it clarifies the grouping of appraisals around social and contextual features in the first experiment and secondly, the importance of goal-directed mechanisms. It extends the previous experiments by applying musical appraisal to real-world contexts. Moreover, this experiment shows how such theoretical work can inform other disciplines, such as Music Emotion Retrieval in this case.

Following the three experimental chapters, a discussion on how such goal-directed mechanisms can be incorporated into other areas, beyond MER is offered. Specifically, this focuses on applications towards cross-cultural studies and aesthetic phenomena. Finally, I discuss the findings and implications of this research.

Chapter 2

The CODA Model: A Review and Skeptical Extension of the Constructionist Model of Emotional Episodes Induced by Music

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“This is all I have to say about the emotions. If one should seek to name each particular one of them..., it is plain that the limit to their number would lie in the introspective vocabulary of the seeker... and that all groupings would be equally real and true. The only question would be, does this grouping or that suit our purpose best?”

— William James (1980; p. 485).

Preface

This chapter builds on the definition of emotion put forward in the introductory chapter and the importance of a skeptical approach. It comprises the theoretical review of both contemporary utilitarian and music specific models of emotion. This theoretical review culminates in a new model “The CODA Model” that comprises the *best bits* of existing models of emotion. This theoretical review and model has subsequently guided the following empirical research of this PhD. As I will show through the subsequent chapters, the contribution of this model has been far reaching, including but not limited to novel contributions in the fields of affective science generally, music specific affective science, Music Emotion Retrieval (MER), and discussions of aesthetic emotions.

Abstract

This paper discusses contemporary advancements in the affective sciences (described together as skeptical theories) that can inform the music-emotion literature. Key concepts in these theories are outlined, highlighting their points of agreement and disagreement. This summary shows the importance of appraisal within the emotion process, provides a greater emphasis upon goal-directed accounts of (emotion) behaviour, and a need to move away from discrete emotion “folk” concepts and towards the study of an emotional episode and its components. Consequently, three contemporary music emotion models (BRECHEMA, Multifactorial Process Approach, and a Constructionist Account) are examined through a skeptical lens. This critique highlights the over-reliance upon categorisation and a lack of acknowledgement of appraisal processes, specifically goal-directed appraisal, in examining how individual experiences of music emerge in different contexts. Based on this critique of current music-emotion models, we present our skeptically informed CODA model - Constructivistly-Organised Dimensional-Appraisal model. This model addresses skeptical limitations of existing theories, reinstates the role of goal-directed appraisal as central to what makes music rel-

evant and meaningful to an individual in different contexts and brings together different theoretical frameworks into a single model. From the development of the CODA model, several hypotheses are proposed and applied to musical contexts. These hypotheses address theoretical issues such as acknowledging individual and contextual differences in emotional intensity and valence, as well as differentiating between induced and perceived emotions, and utilitarian and aesthetic emotions. We conclude with a sections of recommendations for future research. Altogether, this theoretical critique and proposed model points towards a positive future direction for music-emotion science. One where researchers can take forward testable predictions about what makes music relevant and meaningful to an individual.

2.1 Introduction

The discrete emotion paradigm (e.g., joy, anger, sadness) in music and emotion science has dominated theory generation and methodological practice over the last 30 years. Juslin (2019) has presented a popular interpretation of the discrete model - the BRECVEMA. Nonetheless, multiple theories representing different perspectives exist. Warrenburg's (2020b) review of music-emotion theories notes remaining theoretical issues such as contextual and individual differences can be informed by direct testing of constructionist theories using emotional 'granularity' of discrete terms (e.g., hot-anger, cold-anger). However, a focus solely on music-emotion theories has neglected developments in the wider affective sciences, specifically skeptical emotion theories (Moors 2017), which emphasise the role of goal-directed appraisal in contextual and individual differences. Here, we argue that for music and emotion science to advance and address these remaining theoretical issues, the field must incorporate skeptical ideas, in turn, allowing the *relevance* and *meaning* of a stimulus to be central in music-emotion research. We assert, in line with Warrenburg and others (Céspedes-Guevara and Eerola 2018), that a focus on context is needed for greater understanding of individual differences and the mechanisms underpinning them. However, we argue using a

skeptical approach that emotion categories - ‘folk’ terms - do not form a meaningful scientific set, undermining the study of underlying mechanisms. Instead, we seek a construction built upon the components of general cognition. Specifically, we incorporate *goal-directed appraisal* that encompasses embodied and enactive cognition within a constructionist framework. This approach allows for directly testable hypotheses, and grants a robust interpretation of relevance and meaning in musical affect.

This paper will first explore recent theoretical developments in emotion science. We will review two contemporary skeptical theories of emotion: *Psychological Constructionism* (PC, Russell 2003, 2012), and *Dimensional-Appraisal theory* (D-A, Moors 2013, 2014; Scherer 2009b, 2009a). An additional skeptical model is discussed in the supplemental material (Moors, Boddez, and De Houwer 2017). Following this, two music specific emotion models (BRECHEMA, Juslin and Västfjäll 2008; Juslin 2019; and Multifactorial Process Approach, Scherer and Coutinho 2013) are explored. A recent musical adaptation of constructionist theories (Céspedes-Guevara 2021) is additionally discussed in the supplemental material. We discuss the effect of skeptical theories on music-emotion models offering critiques of each from a skeptical perspective. Next, we ‘build on what has come before’, i.e., introduce our skeptically informed *CODA* model - a *Constructivistly-Organised Dimensional-Appraisal* model. Our model re-evaluates the role of appraisal within the music-emotion process, using a goal-directed approach that incorporates embodied and enactive forms of cognition. Moreover, it draws together competing frameworks into the same model. We outline several hypotheses regarding remaining theoretical issues, such as individual and cultural differences, perceived and induced emotions, situational effects, and one-dimensional valence. These are accompanied by new methodological techniques that can be integrated into current research paradigms. Finally, we argue the greatest benefit of adopting a skeptical approach is to move the future of music-emotion science towards the study of emotional episodes, where the relevance and meaning of music to an individual can be studied as a dynamic process, ultimately, aligning music

research with the wider field of cognitive-affective science.

2.2 Contemporary perspectives in emotion psychology

We will first explore a brief critique of classical theories that skeptical theories have offered as a driving force in their construction, (see also Moors' 2017 exploration of the scientific process in emotion theory construction; for a music specific critique of classical theories see Céspedes-Guevara and Eerola 2018). We will next explore each skeptical theory individually, identifying the alternative mechanisms they offer, notably appraisal mechanisms. Finally, we consolidate their key points of agreement and disagreement and highlight their contribution to emotion psychology.

2.2.1 Critique of classical emotion theory

Classical theories of emotion (Ekman, Levenson, and Friesen 1983; C. A. Smith and Lazarus 1991) sought to explain lexical categories as the emotional phenomena through causal mechanisms. Discrete emotions are characterised as brief, physiologically intense, pleasurable or un-pleasurable events, that are directed at something. The mechanisms to explain these phenomena can exist at different levels: observable (e.g., stimulus input / behavioural output), cognitive (e.g., mental representations of action tendencies), or brain (e.g., neural circuits). Emotions are typically cited to include cognitive, motivational, somatic, motor, and subjective components (Frijda 2009). We note disagreements about numbers of categories (Scherer 2000) and locations of different components of analysis (e.g., somatic = brain level).

Classical theories each suggest different mechanisms to get from stimulus to emotion. Basic emotion theories (Ekman, Levenson, and Friesen 1983) suggest that features of evolutionary relevant stimuli, trigger evolutionary hardwired affect

programs (brain level). Alternatively, classical discrete-appraisal theories (C. A. Smith and Lazarus 1991) suggest stimulus features are processed through cognitive evaluations that form patterns for different discrete emotions (cognitive level). Appraisal theorists disagree about whether these evaluation patterns are innate or born from a predisposition (Ellsworth and Scherer 2003) but all discrete-appraisal theories concede that for a stimulus to generate an emotion it must impact upon a person's goals. The overlap between classical theories is that emotions (observable level) are explicitly differentiated from other phenomena through 'the nature of their causal mechanisms' (Moors 2017). A key distinction between these classical theories is the flexibility that appraisal theory offers to the emotion process.

Skeptical theories argue that discrete emotion categories have not proven to be a scientifically meaningful set (i.e., there is no deep ground that links them together) because the mechanisms proposed have not provided the necessary and sufficient conditions for a scientific set to be formed. Instead, the phenomena to be explained should be moved to the *emotional episode* (Russell 2003, 2012). The evidence to support this claim has come from large-scale meta-analyses and methodological critiques. Against basic affect-programs, large meta-analyses focusing on psycho-physiological (Cacioppo et al. 2000) and autonomic (Clark-Polner et al. 2016; Quigley and Barrett 2014; Siegel et al. 2018) responses for emotion categories report weak evidence for the existence of emotion circuits. In addition, cross-cultural studies in indigenous societies (Crivelli et al. 2016; Russell 2017a) show accuracy ratings well below the predicted universality thesis 70% (Haidt and Keltner 1999). Methodological critiques further question these already weak results. Nelson and Russell (2013) critique facial expressions paradigms highlighting the confirmatory nature of forced-choice paradigms artificially inflating results. Similar critiques have been directed towards classical-appraisal theory, both towards data (Kuppens et al. 2017) and methodology (Moors and Scherer 2013) though no large scale meta-analyses of discrete-appraisal patterns has been conducted. Most notable is the conflation that can occur between self-reported appraisal and emotions; people may instead be expressing conceptual rather than

causal relationships (Parkinson 1997).

It follows that skeptical theories instead suggest the infinite number of possible emotions and shades of emotion are more meaningfully organised into multidimensional space. This idea however, is not incompatible with classical theories of emotion (Xin Hu, Wang, and Zhang 2022). Skeptical theories further reject shifting the dependent variable from discrete emotions to “granulated”, “fuzzy-set”, or “families” of emotions in which these subsets of emotion terms produce similar but not identical profiles. Skeptical theories instead argue that “organising emotional episodes into these families is not scientifically interesting because there is no deep ground, such as a dedicated mechanism, to confer a special status to these families” (Moors 2017). For example, subdividing the anger category into *hot-anger* and *cold-anger* as Huron (2015) suggests provides no exclusive underlying mechanistic support. It is this focus upon alternative, and importantly testable mechanisms, that marks skeptical theories as distinct. Simply, boundaries between emotions “serve no scientific purpose” (Russell 2003, 1279).

2.2.2 Skeptical theories and the key role of appraisal

2.2.2.1 Psychological Construction

Psychological Construction (PC) theory (Russell 2003, 2012) suggests that emotion behaviours are driven by the same mechanisms as non-emotional behaviours, thus not driven by a single dedicated mechanism. It does not state what these mechanisms are and instead posits that the problem of how most emotion components are caused is a question for behaviour science, while subjective experience should be understood through studies into consciousness. Russell constructs his theory around three types of affect “core-affect”, “affective quality”, and “emotional meta-experience”, corresponding to three levels of observation.

Core-affect is seen as an ongoing neuro-physiological process in which two dimensions, “arousal” (activation values) and “valence” (hedonic values), form a single experiential composite representative of basic feeling. Changes in core-affect are

described as evoking “a search for its cause and therefore facilitating attention to and accessibility of like-valenced material. Core-affect thus guides cognitive processing according to the principle of mood congruence and is involved in motivation, reward, and reinforcement” (Russell 2012). There are findings for multiple neural mechanisms underpinning core-affect (Posner, Russell, and Peterson 2005) such as pleasure circuits (Berridge and Kringelbach 2013; Kringelbach and Berridge 2015), and a “generalised arousal system” (Pfaff 2006). This is a positive step in linking neural circuits with core-affect for a refined definition¹. This reasserts that emotions are distributed and cannot be localised to distinct brain networks (Barrett and Satpute 2013) and implies a more ambitious framework than that outlined by basic emotion theory.

Affective quality can be conceptualised as evaluations of a stimulus (e.g., liking and attitudes). Like core-affect, affective qualities are fundamental and cannot be separated at a psychological level from other artifacts in subjective stimulus representation. Affective quality is separable from, and can occur independently of, core-affect (e.g., a cold cognitive assessment of a stimulus) and forms part of general cognition (Russell 2003).

Emotional meta-experience represents the conscious experience of emotion components, or a perception of a specific emotion. It is a *meta* experience in that it includes other bottom-up and top-down experiences (e.g., core-affect, appraisal, beliefs, plans). It is stated that while there is some overlap between emotional meta-experience and emotional episode, they are not completely equivalent (Russell 2012). A similar idea is explored by LeDoux (2008) in the concept of “feeling” where feeling must be attended to and preserved in working memory to become conscious. Yet, an emotional episode does not imply an emotional categorisation or the explicit use of one or more emotion components. Simply, an emotional episode is an enclosed moment of time that is subjectively acknowledged as emotional, it has a clear on-set, and is typically directed at something. An example

¹This term is also often referred to as reappraisal though this concept is less well defined and can be associated with both D-A (Dimensional-Appraisal) and discrete-appraisal.

of an emotional episode can be seen in the classic work of William James (1890) when a bear is encountered on a walk in the woods. However, where James would have attributed the emotional experience to physiological bodily sensations, in PC no single emotion component need define the episode, what Colombetti's (Colombetti 2014, 57) describes as 'self-organizing patterns of the entire organism'.

Although no specific mechanisms are hypothesised by Russell to facilitate this emergence into consciousness, he suggests that core-affect's evolutionary history is linked closely to the evolution of "flexible" behaviour that is not driven explicitly by the stimuli. This includes goal-setting and causal knowledge of the action to attainment link. He draws upon the work of Cabanca (2010) who argues that consciousness first emerged as an awareness of pleasure and displeasure and the work of Balleine and Dickinson (1998) who argue for consciousness as a link between *basic motivational systems* and cognitive goal-relevance systems to refine this concept.

Several criticisms of Russell's theory have emerged for one-dimensional valence such as an inability to explain mixed emotions (Hunter, Schellenberg, and Schimmack 2008; Maksimainen, Eerola, and Saarikallio 2019; Eerola and Peltola 2016); the lack of predictive power in one-dimensional valence for behaviour (e.g., fear and anger may produce different approach/avoidance behaviours, Frijda 2009) and the bivalenced conception of some affective lexis (Zeelenberg and Pieters 2006). Russell (2012) counters this through the inclusion of multiple affective qualities (evaluations of a stimulus). However, an alternative 'multifaceted micro-valences' interpretation remains possible - i.e., the contribution of multiple 'qualitatively different types of valence' (Shuman, Sander, and Scherer 2013, 5–6).

2.2.2.2 Dimensional-Appraisal

An alternative skeptical theory, Dimensional-Appraisal (D-A) theory (Moors 2013, 2014; Scherer 2009b, 2009a), defines appraisals as cognitive mechanisms that influence other components of an emotional episode through associative motivational

mechanisms. The term appraisal in a psychologically context was first used by Arnold (Arnold 1960) however its origins in the role of emotion go back to ancient Greece (Moors 2013). There is a history in psychology that placed appraisal solely in the realm of the cognitive (Colombetti 2014) however, we wish to explicitly separate the modern (dimensional) interpretation of appraisal from its predecessor (discrete). Dimensional-appraisal is distinct from discrete-appraisal in that appraisals do not form appraisal patterns that equate to discrete emotions. Instead, appraisals each contribute independently, and therefore partially, to further components of emotions (e.g., action tendencies). Each appraisal can feedforward and influence other components before other appraisal values have been generated (“immediate efference”), while each further emotional component can also feedback into appraisal mechanisms (“recurrence”² Scherer 2009b). Both of these concepts allow flexibility in the emotion process where a strict linear sequence does not have to be followed. These processes together imply appraisals can be seen as ongoing parallel processes. Appraisals can operate in both a rule-based and associative manner (Moors 2020). Rule-based processes are typically employed the first time a stimulus is encountered while associative processes occur when the same or familiar stimuli appear. An assessment of stimulus familiarity is clearly an important determinant, yet different stances on which process takes precedence in which situations are taken by different theories.

Appraisals are typically subconscious processes. Evidence for the automatic processing of *novelty*, *goal-relevance*, *intrinsic valence*, *goal-congruence*, *control*, and *agency/intentionality* (Moors 2020) has emerged. Features of appraisals can appear in consciousness and inform subjective experience, as can features of all components of an emotional episode. Appraisal can be seen as a general cognitive mechanism, often utilised by non-emotional behaviour research (Eder and Hommel 2013). The difference between emotional and non-emotional episodes is defined as a gradual process, mediated by an appraisal value of higher goal-relevance and a

²This term is also often referred to as reappraisal though this concept is less well defined and can be associated with both D-A and discrete-appraisal.

subsequent action tendency with a greater control priority. D-A theory is linked closely with Russell's (2003) concept of *affective quality* where the mechanisms (appraisals) can be conceived as ongoing non-emotional processes that under certain conditions (high goal-relevance) can produce an emotional episode.

D-A suggests that emotional components are closely related through causal mechanisms. To validate this causal-mechanistic approach D-A theorists seek to test the relationship between individual appraisal criteria and other components of emotion. For example, Moors suggests higher goal-relevance would cause a greater intensity of action tendencies, while goal in/congruence would produce motivational avoidance/approach tendencies (Moors and Scherer 2013). Hypothesis generation is still ongoing however, some authors (Scherer 2009b) suggest that different appraisal factors receive different weightings based on other appraisal factor outputs. Stimuli are continuously reappraised through this process (*recurrence*). Identifying the underlying neurological structures of appraisals is an active area of research (Brosch and Sander 2013; Kafkas and Montaldi 2014). Moreover, sophisticated modelling techniques that can capture the dynamic nature of emotional processes over time have also been proposed, such as non-linear dynamic system theory (Scherer 2009b; Colombetti 2014). Such models have been highly successful in the neurological literature (Friston et al. 2000) and have begun to be applied to the psychological literature attempting to bridge these two disciplines (Lewis 2005), notably by incorporating appraisal. Finally, dimensional-appraisal in its contemporary form has removed itself from its disembodied origins (Arnold 1960) and is placed neatly with contemporary understandings of meaning making such as 4E cognition Colombetti (2018).

2.3 Key elements of skeptical theories

It can be seen that there is a substantial amount of overlap between these skeptical theories (Moors 2017). First, all theories contend that the phenomena to be explained should be moved away from discrete emotion 'folk' terms, or granular

interpretations of the same concept, and should instead be placed upon the components of an emotion episode. See Barrett (2017) for a more mediated view of PC where emotion terms and their conceptual organisation do form sets that are born from predictive processing of emotion components – including goals. The emotion concepts do not have a physical reality in the brain but they do have a cognitive reality, perhaps equivalent to emotion schema.

Second, these theories conclude that the components of emotion and their innumerable possible subdivisions are more logically represented by multidimensional space. The distinction between these theories lies in how closely the components are seen as causally related and whether the individual components of an emotional episode will form a meaningful scientific set of their own. PC suggests that there is almost no relationship between these components, D-A suggests there is. The parallel-competitive dual-process model discussed in the supplemental material remains moot on this point.

Third, the most distinctive point across skeptical theories is the unique position that “goals”³ hold. From this perspective it seems strange that goal-directed accounts have had such little impact upon the science of music and emotion. This neglect is historically likely to have emerged because of the emphasis appraisal (discrete and dimensional) places upon goal-relevance, something that art/aesthetic emotions – including musical emotions – was not presumed to have. This is most evident in the pervasive disembodied Kantian notion of *disinterest*, an idea that Huron (2016) describes as incompatible with current biological stances (p. 242). In the next section we will show how goals, and appraisals generally, appear highly relevant to musical emotion process, though broadly neglected by current models. We finish this paper by taking these critiques and presenting a skeptically informed model that places goal-directed appraisal back into music emotion theory.

Finally, we point the reader to other applications of skeptical theories where PC

³Goals defined here broadly, as learnt as well as innate and encompassing the desires, motivations, wishes, and needs of an individual (Moors 2020).

and D-A have been merged in attempts to bridge gaps between emotion and cognition literature. We offer a detailed exploration of one skeptical goal-directed model in the supplemental material (Moors, Boddez, and De Houwer 2017; Moors and Fischer 2019).

2.4 Two mainstream models in music and emotion

Before continuing into our next section, it is important to ask why we need music specific models of emotion. The emotional power of music has long been accepted as an important element of the musical experience however, philosophers as far back as Plato and Aristotle (Gabrielsson and Lindström 2010) up to the present day (Kivy 1981, 1989; J. Robinson 2005) have disagreed on the how and why of this “mysterious” experience. For example, the unique experience of sad music can be untypically positive (Eerola and Peltola 2016) and the aesthetic experiences associated with many art forms seem to lack the “typical” relation to survival functions (Juslin and Västfjäll 2008) that has been the back bone of utilitarian emotion science (Ekman, Levenson, and Friesen 1983). This has led some authors to conclude that music does not induce “real-life” emotional responses (Konečni 2008a), or at least not survival driven (basic) emotions (Kivy 1989). However, much of the evidence suggests that music can induce a huge variety of emotions (Zentner, Grandjean, and Scherer 2008; Juslin et al. 2011; Coutinho and Scherer 2017), and that these emotions have an evolutionary underpinning (Juslin and Laukka 2003; Céspedes-Guevara and Eerola 2018). What is certain is there is something different about music induced emotional experiences, or at least art induced emotions (Schindler et al. 2017), and a desire to explain these has led to the development of music specific emotion models. Yet, as we shall see in the CODA model we present later it is completely possible to group musical emotional experiences around the general mechanisms of emotion, moreover the mechanisms of general cognition.

We will now explore two popular models in music and emotion science (Juslin and Västfjäll 2008; Juslin 2019, BRECVEMA) and (Scherer and Coutinho 2013, Multifactorial approach) that have guided much of the theoretical and methodological thinking in the field over recent years. These two models are chosen specifically because Juslin’s model represents the most cited music emotion model and one that relegates the role of appraisal to a mediating mechanism in specific circumstances. In comparison Scherer and Coutinho’s model represents the most comprehensive attempt to incorporate appraisal into musically induced emotions. Nevertheless, there are of course several notable models that have contributed substantially to scientific understanding (J. Robinson 2005; Konečni 2008a; Flaig and Large 2014; Koelsch et al. 2015). A recent musical adaptation (Céspedes-Guevara 2021) of Barrett’s (2006, 2017) constructionist model is also explored in the supplemental material. We identify domains of overlap and isolate problematic areas within these theoretical constructs. We will show how appraisal has been incorporated into these models, both explicitly and implicitly, but to a large degree remains subordinate to other mechanisms. In doing so, we argue from a skeptical perspective that re-conceptualising the importance of appraisals in current models is key to understanding musical emotions where the emphasis upon a stimulus’ relevance and meaning to an individual is acknowledged.

Nonetheless, it is fair to acknowledge that all models discussed have proved highly popular for capturing emotions in lab situations and also to some extent in real and even cross-cultural settings. However, the importance of acknowledging individual and situational differences is a recurring theme in meta-analyses and reviews (Céspedes-Guevara and Eerola 2018; Eerola and Vuoskoski 2013; Warrenburg 2020b). It is a task well suited to appraisal theories that highlight goal-directed relevance and meaning.

2.4.1 Emotion induction mechanisms for music (BRECHEMA)

Juslin and Västfjäll (2008) proposed a set of eight mechanisms for the induction of emotions via music, which included *brain stem reflex*, *rhythmic entrainment*, *evaluative conditioning*, *emotional contagion*, *visual imagery*, *episodic memory*, and *musical expectancy*. Juslin (2013) later added *aesthetic judgment* to the mechanisms, dubbed as BRECHEMA (initials from mechanisms). Each mechanism has a separate descriptive process referencing underlying brain areas, survival value, information focus, possible onset during ontogenetic development and the degree of dependence on culture and learning. Mechanisms differ in their availability to consciousness and induction speed. The central mechanisms such as contagion, brain stem reflex, episodic memory, and musical expectancy have been empirically explored (Juslin, Harmat, and Eerola 2014; Juslin, Barradas, and Eerola 2015) leading to differentiated emotional responses, both using self-reports and physiology. The mechanisms have been used in numerous studies to eliminate unwanted triggers of emotions (such as memories or conditioned responses). However, the framework has been criticised for lack of specificity for mechanisms such as contagion (Malmgren 2008; Thompson and Coltheart 2008; Madison 2008); the unacknowledgement of musical functions in process (Madison 2008); convoluting utilitarian and aesthetic emotions (Scherer and Zentner 2008; Moors and Kuppens 2008); the fundamental role of appraisal in other emotion theories (Konečni 2008a); the lack of music as an “intentional object” (J. Robinson 2008); issues between perceived and felt emotions (Thompson and Coltheart 2008) and for its applications to contextual and cross-cultural understandings of music-emotion (Trehub 2008). What interestingly unites all these commentaries is their explicit mention of appraisal in the music-emotion process.

This wide consensus likely emerges because Juslin and Västfjäll (2008) make no use of cognitive appraisals in their model of musical emotions. In fact, as Madison (2008) and Holochwest and Izard (2008) note, they actively seek to remove cognitive appraisal from the process, representing appraisal as the philosophical

“straw man” (Madison 2008). Yet, as we note in our skeptical review, appraisal appears fundamentally necessary to the emotion process and has been clearly acknowledged in the music-emotion literature (Eerola 2017; Scherer and Coutinho 2013; Céspedes-Guevara 2021; Herbert and Dibben 2018).

Clear overlap between Juslin’s mechanisms (Juslin and Västfjäll 2008) and appraisal are evident. Here we follow Céspedes-Guevara (2021) in documenting where these overlaps exist. Low-level cognitive processes (*brainstem reflexes*) can be thought of as *novelty* appraisal check, associated with orientation (Eerola 2017). *Musical expectancy* (Huron 2006) can be seen as equivalent to *intrinsic pleasantness* (Céspedes-Guevara 2021). Additionally, given the emphasis Huron (2006, 2019) places upon “mere exposure” and implicit learning in musical expectancy – simply explained as, familiarity breeds liking and can occur without conscious effort - it seems likely *familiarity* would also be highly relevant. It is important to specify that, if mere exposure and implicit learning influence intrinsic pleasantness, a degree of cultural variation should be observable, assuming that the mechanisms themselves are inter-culturally reliable. Evidence for the cross-cultural reliability of low-level BRECVEMA mechanisms (Barradas 2017) and appraisals (Fontaine, Scherer, and Soriano 2013; Nordström et al. 2017) exists but appraisal has not been explored in a cross-cultural music context.

Juslin’s (2019) most recent model suggests that cognitive appraisal is part of musical emotions but only at very low levels (e.g., brain-stem reflexes, contagion) where the *goal* is within the organism’s design (e.g., protection, social understanding); distinct from high-level cognitive goals involving plans and motivations. There are examples where music induces an emotion by manipulating an organism’s goals (e.g., loud music while trying to study). However, Juslin counters that these do not represent the typically induced musical emotions - 2% according to an experience sampling study by Juslin et al. (2008; in Juslin 2019) - and do not place the emotion within the music like other mechanisms. Juslin therefore includes goal-relevance in his most recent works but suggests that although a goal

may be present (e.g., relaxation) it is usually not the mechanism that causes the emotion. For example, *Jane's goal is to relax. She plays her favourite song and relaxing feelings are induced by the visual imagery mechanism.* The goal is then achieved but is not the cause of the emotion. Adopting this position suggests goal-relevance can become a mediating mechanism of higher cognitive processes but other mechanisms are likely to determine most of the variance in emotional processes. Juslin contends that without goal-relevance almost all mechanisms could be seen as appraisals. Presumably, the problem being this forces together very distinct mechanisms (e.g., visual imagery and entrainment).

Nonetheless, a diverse range of sources acknowledge the ways that people use music for goal-achievement; *distraction, energising, and mood enhancement* (Sloboda and Juslin 2010) and *social bonding* (Clayton 2017). Van Goethem (2010) noted that *mood-regulation*, part of the umbrella *mood-enhancement* motivations, accounted for over half of people's listening motives. Juslin would possibly argue as above that these outcomes are achieved through alternative mechanisms. However, skeptical theories would rebut this because, without goals to explain (musical) emotions the emphasis falls wholly upon the music. Goals are fundamental to general cognition and the ongoing interaction between organism and environment.

Consider again Jane's experience. This time, in the same physical context (at home, alone) and with the same music *Jane has the goal to set a romantic scene for an impending date; Jane produces visual images of moonlight walks along the beach and feels excited.* In another example, *Jane is upset that her date has canceled. Playing the same music elicits comfort and acceptance,* possibly with a mediating mechanism like visual imagery or another mediator, like episodic memory. What is clear in these examples, is that Jane's goals in different scenarios have changed her emotional experience of the same piece of music in the same context. Furthermore, different goals can be seen to lead to the activation of other mediating mechanisms and behaviours in an emotional episode. Importantly, from

a skeptical viewpoint these mechanisms utilise existing non-emotional cognitive mechanisms to produce the most valuable behaviours for achieving one's goals. In moving the dependent variable from the diverse number of discrete emotions that Jane may have experienced in any of these scenarios to musical behaviours (e.g., moving in time) or conscious experience (e.g., visual imagery) we can explore the relationship between emotional components to assess how the utility of a particular behaviour allows it to take precedence over other possible behaviours through goal-directed mechanisms.

Juslin (2019) extends his discussion on 'aesthetic judgement' a mechanism commonly described through appraisal (Egermann and Reuben 2020). In Juslin's account aesthetic and utilitarian emotion are distinguished solely by this underlying mechanism. Simply, aesthetic judgments produce aesthetic emotions and all other mechanisms do not. Two types of affective responses are possible, 'preference for' and 'emotion specific'. Juslin states in the absence of any other mechanism 'preference ... and aesthetic judgment will be consistent with each other' (Juslin 2019). Aesthetic judgment can also differ from preference, underpinning Juslin's explanation of all mixed-emotional responses. For example, *Jane experiences sadness through episodic memory, while aesthetic judgments produce feelings of beauty*. Yet, Juslin also suggests 'conditioning' and 'contagion', as more implicit mechanisms, may be immune to such effects from aesthetic judgments. The suggestion therefore, that aesthetic emotions account for mixed emotions (e.g., guilty-pleasures) or positive associations with sad music becomes problematic. If an aesthetic response (beauty) can override the contagion of sadness, the prediction that low-level mechanisms are more robust to the influence of aesthetic judgments is undermined. In a similar vein to Scruton (1999), Juslin notes that aesthetic emotions can be negative. He believes these negative aesthetic responses mix with other mechanisms to create so called 'guilty pleasures'. Yet, no explanation of how different mechanisms interact, take precedence, by what degree or in what circumstances is offered.

Aesthetic judgments take a privileged position in Juslin's model through their uni-

directional influence upon other mechanisms. Furthermore, assuming that most musical emotions are to some degree aesthetic, means this mechanism should be active in almost all examples and be the default music-emotion mechanism, while other mechanisms become predominantly mediating variables in different contexts. This is difficult to justify in a theory that takes such a strong evolutionary stance (Juslin and Laukka 2003) but offers no theoretical argument for the evolutionary development of aesthetic judgments as superior to other evolved mechanisms. Sceptically, one would argue that evolutionary evolved appraisals, are better understood through an individual's goals. Instead of aesthetic appraisals, aesthetic goals like distraction (Saarikallio et al. 2020), or meaning enhancement (Sloboda and Juslin 2010), become the studied phenomena while the aesthetic terms Juslin ascribes to aesthetic appraisal (e.g., beauty) become folk terms relevant only to the socio-cultural environments in which they emerge.

2.4.2 An alternative multifactorial process approach

An alternative appraisal focused interpretation of emotional induction mechanisms for music was put forward by Scherer and Coutinho (2013). This theory critiqued the BRECVEMA (Juslin and Västfjäll 2008) suggesting many of Juslin and Västfjäll's proposed routes can be subsumed under appraisal, as discussed above from Céspedes-Guevara's (2021) perspective. Most notably in Scherer and Coutinho's critique of BRECVEMA is the lack of distinction between levels of function (Marr 1982; Bechtel and Shagrir 2015) or discussion on their interaction. Instead, Scherer and Coutinho (2013) expanded on previous work (Scherer and Zentner 2001) that emphasises the multiplicative interaction of structural, performance, listener, and contextual features ('production rules'). Within these factors they propose five routes that can lead from music's structural features to fuzzy-set emotions via the mediating factors of listener, performer, and context. These routes include memory, entrainment, contagion, empathy, and appraisal. We will focus here specifically on the appraisal route as it is the main focus of the article and because many of these mechanisms have been covered in Juslin's

(2019) BRECVEMA. It is however worth noting a few key distinctions in some mechanisms. Empathy forms a significant expansion upon the contagion mechanisms, which can be placed solely within expressive cues. Empathy instead must include an understanding of another's motivations and appraisals of a situation (p. 139). Moreover, entrainment while seen as separate to memory and appraisal systems is suggested to have an influence upon and be influenced by these other systems through 'disinhibition' ('facilitation of preexisting emotions').

Appraisal forms a key component in this interaction. It evaluates the structural features of the music (both psychophysiological and macro level features) for their relevance to a listener. Appraisal further drives and coordinates the sub-components of emotion and can be both an automatic and "effortful" process. The appraisals mechanisms hypothesised are grouped around their broader functions including relevance to the organism, implications, coping potential, and normative-significance (cultural norms and personal values). They discuss examples for each appraisal mechanism in relation to how the appraisal can be linked to musical features but also describe several examples in relation to musical activities. It is noted that because of the different goals that musical and non-musical situations may provide, different appraisals may be more or less present in musical situations. According to Scherer and Coutinho appraisal cannot alone account for the emotional experience of music but appraisal should be included. They propose that appraisal processes allow for the distinction between fuzzy-set emotion categories (utilitarian, aesthetic, and epistemic) along with patterns across other emotion components. Music emotions are subsumed under the categories of aesthetic and epistemic emotions though blending between categories is possible.

A skeptical perspective suggests several benefits that are incorporated by Scherer and Coutinho's (2013) account. Specifically, a more inclusive account of appraisal's role within the music emotion process allows the musical mechanisms to be linked with those of affective processing in general. Furthermore, appraisal allows for the incorporation of the wider context in which musically induced emo-

tions occur. However, while Scherer and Coutinho's approach draws heavily from a specific framework within the skeptical perspective (Scherer 2009b, 2009a), three core critiques should be acknowledged from the wider collection of skeptical theories that should be noted.

First, Scherer and Coutinho (2013) are critical of the basic emotion approach and claim that discrete emotions should not be the active point of study. We adopt this stance in the current proposal as well. Scherer and Coutinho sought to solve the problem by proposing their own 'fuzzy-set' categories (utilitarian, aesthetic, epistemic). However, this again leads the conversation back to how the emotion space is organised instead of focusing on the emotional episode and its mechanisms.

Second, Scherer and Coutinho note the importance of appraisal in coordinating other sub-components of the emotion process through their interactive nature. However, a focus towards the end goal of a specific emotion (discrete or fuzzy-set) restrains the analysis of this process to a linear operation. One that leads directly from input (musical stimulus) to output (fuzzy-set emotion). The wider skeptical approach instead seeks to study the dynamic and recursive emotion process. This focuses the empirical lens towards the interaction between emotion sub-components over time.

Third, Scherer and Coutinho emphasise the importance of goal-conduciveness within the music emotion process. Their approach is again situated in distinctions within the emotion space and draws heavily on Kant's (1790) perspective of 'disinterested pleasure' (this being defined as relevant to aesthetic and epistemic concerns but more closely aligned with a lack of goals). However, understanding aesthetics through the lense of 'disinterested pleasure' does not sit well in the current biological science (Huron 2019). To situate music in a context, an ultimate goal of appraisal theory, Moors et al. (2017) notes that the appraisal process is better understood through the competition of multiple competing goals, an approach that allows greater individual variation within the appraisal framework.

Moreover, recent developments in embodied and enactive goal-directed accounts of meaning construction suggest goals are an active part of our musical lives (Schivavio, Schyff, Kruse-Weber, et al. 2017). The diverse and well documented reasons people have for engaging with music (Saarikallio 2011; Randall and Rickard 2017; T. Schäfer et al. 2013) can be constructed around the affordances of the acoustic environment (discussion and examples in CODA model).

Finally, though not explicitly related to skeptical perspectives, the authors note that the explicit focus on the cognitive aspects of the emotion process does not allow for a broader perspective of how different levels of analysis may fit together. This is an approach that Eerola (2017) has previously mapped between the BRECVEMA and constructionist models and one we seek to expand on in our model with the incorporation of dimensional-appraisal. Other notable attempts to integrate the constructionist model have been made. Julian Céspedes-Guevara (2021) outlined his interpretation which incorporates some aspects of appraisal theory, but is more influenced by Barrett's (2006, 2017) adaption of constructionist theories focusing on categorisation. Barrett states that 'valuation' (meaning appraisal; 'organisms continually and automatically evaluate situations and objects') and the 'conceptual act' (the segregation of core-affect into different states through linguistically categorising sensorimotor information) are key to understanding emotion. Yet, little is said about appraisal beyond its consistency with her notion of contextual sensitivity 'the fundamental assumption of appraisal views: the meaning of a situation to a particular person at a particular point in time is related to the emotion that is experienced.' (p. 33). This is closest conceptually to Clore and Ortony's (2000) conception of appraisal where categorisation is supported by mechanisms that allow for adaptive goal differentiation. Céspedes-Guevara's (2021) model is described in full and evaluated from a skeptical perspective in the supplemental material.

2.5 The CODA model

Here, we present our skeptically-informed constructionist-appraisal model. Ultimately, the goal of this model and the discussion of its hypotheses is placed upon explaining the emotional experience of the listener. Nevertheless, we hope it provides the scope for expansion where other perspectives (e.g., performer or composer) can be considered. First, we re-evaluate the goal-directed role of *dimensional*⁴ appraisal in a musically induced emotional episode. We establish the value of dimensional appraisal in the ongoing construction of relevance and (musical) meaning to a listener, as well as the dynamic, weighted and bidirectional relationship appraisal has with other multidimensional components of emotion as an individual interacts with the (musical) world. In the discussion of this model, we highlight its contribution to resolving existing gaps in the literature through specific hypotheses and implications for future research. In conclusion, we point to how these ideas will allow researchers to ask different questions about the nature of emotion, ones that explore the continuous generation of relevance and meaning of a stimulus to an individual.

2.5.1 Building on what exists

This model is intended to build on previous research. We have demonstrated that substantial gaps in existing music-emotion models remain. To help resolve them, we use evidence from skeptical theories to extend current understanding of emotional episodes induced by music. Skeptical theories counterpoint the limited adaptations of discrete theories postulated by the existing music-emotion models discussed in this paper (Juslin 2019). Furthermore, we have shown how discrete approaches, with a predominant focus upon differences within the stimulus (e.g., acoustic cues and their relationship to discrete emotions) have generated an ever increasing number of mediating mechanisms to be incorporated, thus leading to

⁴Dimensional in italics here to highlight the conceptualisation of appraisals as dimensional by all skeptical theories but avoid explicit reference to D-A theory as more important than other skeptical theories in our interpretation of a skeptical model of musical emotions.

reductive theories.

Alternative music emotion models (Scherer and Coutinho 2013; Céspedes-Guevara 2021) favour more skeptical notions. Scherer and Coutinho (2013) explore the role of appraisal while Céspedes-Guevara (2021) has moved the field closer to constructionist accounts such as Barrett’s (2017) adaption of PC. Such ideas have been invaluable in showcasing the need for identifying new methodologies (Céspedes-Guevara and Eerola 2018) beyond stimulus-driven approaches. However, the continued focus on categorisation has hindered the nuanced role of relevance and meaning to an individual in music emotion models. A process dimensional-appraisal (dynamic cognitive evaluations) is well adapted for, when placed within a larger framework that acknowledges other levels of analysis (Eerola 2017).

2.5.2 Key elements: the CODA model

Here, we summarise our new model the *Constructivistly-Organised Dimensional-Appraisal* model - the CODA model (Figure 1). Our model stresses the cyclical and interactive nature of appraisal within emotion process; hence its name referencing the concept of ‘once more from the beginning’. From a skeptical perspective, we build on top of dimensional constructionist accounts of emotions offering a concise framework which not only captures emotional processes but frames it within the mechanisms of general cognition in a dynamic structure that recursively re-informs itself.

This section will outline the key elements of our model including **core-affect**, **appraisals** (multidimensional appraisal space, appraisal dynamics, and their bi-directional and weighted nature), **component interactions** over time, and finally **meta-experience**. The discussion of each of these elements is framed within the ongoing construction of relevance and meaning that occurs between an organism and its environment.

2.5.2.1 Core affect

Core affect refers to the neurophysiological state described by Russell (2003, 2009, 2012) where changes in core affect drive attention through the process of attributing these changes to a stimulus. Changes in core-affect in music are typically linked with psychoacoustic cues (Céspedes-Guevara and Eerola 2018). Céspedes-Guevara and Eerola's (2018) meta-analysis rebuts previous attempts to link acoustic cues to 'folk' terms (Juslin and Laukka 2003). Instead, they show the foundations of musical expression in vocalisations is predominantly correlated with changes in arousal. Valence however, produced significantly fewer unambiguous patterns that map to psychoacoustic cues, coinciding with findings that valence is expressed differently in different genres (Eerola 2011). Overall, evidence points towards an understanding of core-affect that is beyond reductive psychoacoustic mappings to physiological states.

To explain such meaning construction we invoke embodied and enactive accounts of music, suggested by multiple authors (Clarke 2005; Schiavio, Schyff, Céspedes-Guevara, et al. 2017; Reybrouck and Eerola 2017) - i.e., goal-directed. A goal-directed dimensional-appraisal account of cognition (see Appraisals) allows for a more dynamic, embodied and enactive conception of core-affect's interaction with acoustic cues for an individual in a situational context and identifies several mechanisms that inform the construction of valence. For clarity, this is not to suggest all embodied and enactive cognition is goal-directed. It is to suggest that goal-directed mechanisms are inherently embodied or enactive to different degrees depending on the goal.

One of the most common critiques of core-affect is its inability to represent mixed emotions. This is an important caveat for a theory of musically induced emotions where mixed emotions are commonly acknowledged (Hunter, Schellenberg, and Schimmack 2008; Hunter, Schellenberg, and Schimmack 2010). It has been postulated that mixed emotions are captured by core-affect as a rapid switching between different activities in a dimension (Russell 2017b; Eerola 2017) this activ-

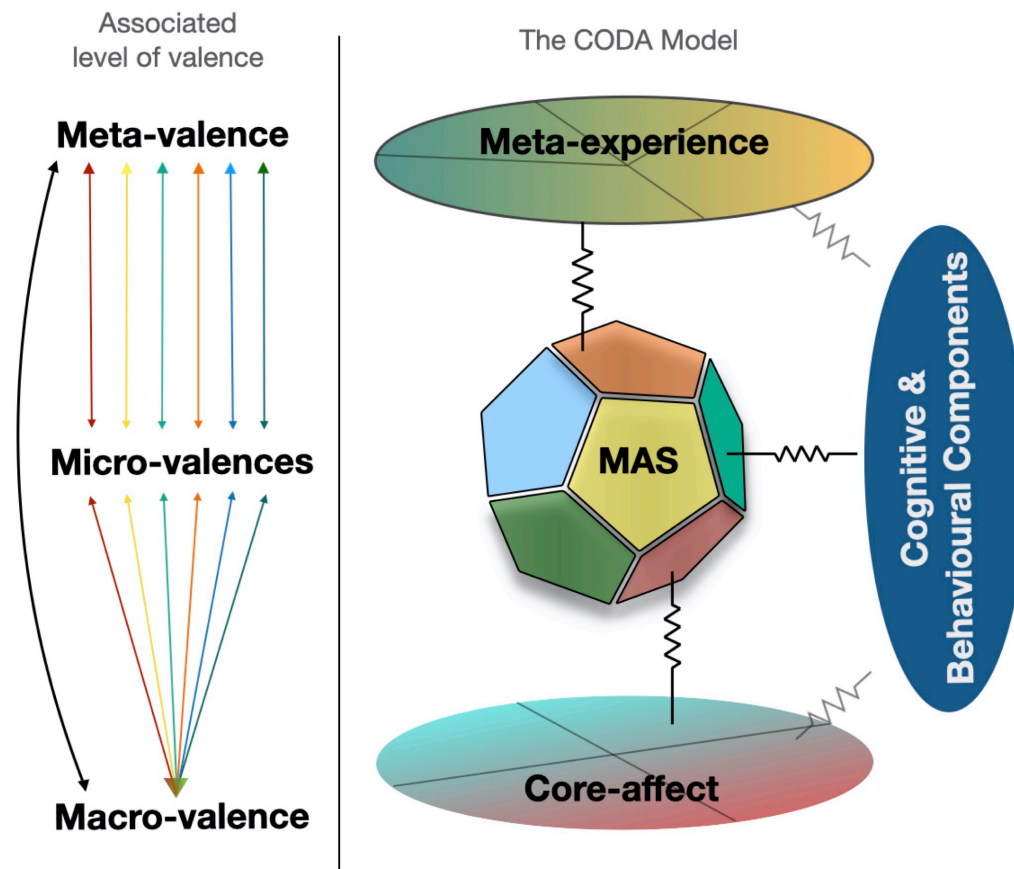


Figure 2.1: Schematic outline of the CODA model with the associated levels of valence for each dimensional component of the model

ity linked with perceiving multiple *affective qualities*⁵ of a stimulus with different valences (e.g., appreciation of the composer but not the performer) co-occurring with changes in core-affect. Appraisal models compatible with this idea have also been put forward. One that additionally seeks to differentiate the intensity of mixed emotional experiences is Roseman (2017).

2.5.2.2 Appraisals

In our skeptical critique of two models of musical emotions, we argue explicitly for a stronger and more nuanced incorporation of goal-directed appraisal. Here we outline explicitly what this would entail. We describe the multidimensional nature of appraisal space, the individual dimensions of this multidimensional space, these dimension's micro-valenced nature and parallel processing, and finally, the weighted contribution of appraisal dimensions to other components of an emotional episode.

2.5.2.2.1 Multidimensional Appraisal Space (MAS) The polyhedron at the centre of our model (Figure 1), represents multidimensional appraisal space (MAS). We place MAS as a key cognitive-affective component in the construction of *relevance* and *meaning* for an individual. MAS consists of n -dimensions (appraisals). MAS can be seen as a dynamic and ongoing perceptual interaction between a person and their physical and social environment. The interaction between MAS and other cognitive components can be seen as a weighted probability function of each appraisal dimension dependent on the interaction between external and internal factors. As the interaction between external and internal conditions develops, the weighted nature of any appraisal can change (i.e., their non-linear nature). This weighted interaction between MAS and other components is discussed in terms of individual dimensions. Thus, between two consec-

⁵Separate from core-affect but represented in the same two-dimensions. Affective quality is a cold cognitive assessment of a stimulus with regards to its ability to cause changes in core-affect. It is therefore located within the stimulus not the person (Russell 2003). It is made through evaluations, attitudes, liking/disliking and is often combined with other information processing constructs.

utive time steps the probability of an appraisal producing the same result is not fixed. Simply, changes in any single dimension will lead to changes in MAS and consequently the continuous development of individual *shades of meaning*.

MAS can evaluate multiple types of information, verbal-like, sensory, perceptual and symbolic. These evaluations can be both *rule-based* (active computation - but still typically unconscious) and *associative* (learned or memory-based associations between a stimulus and an appraisal output). The output from MAS represents graded distinctions between rule-based and associative processing where each appraisal can occur in a rule-based or associative way. This graded distinction can change between time-steps.

For an example, we return again to Jane. *Jane's first experience of heavy-metal music comes with expectation that dancing would accompany live music (associative processing) but the novelty of the type of behaviour (moshing) that emerges and the conduciveness of using such behaviour for enjoyment are rule-based processes.* The output of MAS can then be seen as a graded distinction between more or less associative processing. This example can be further expanded beyond what music affords to show how graded distinctions of processing can occur within music too. *Jane may be unfamiliar with the timbral structure of the new music (e.g., more dissonant chord progressions) and process this in a more rule-based fashion. The rhythm however (fast and regular), remains similar to other stimuli Jane has heard and can be processed in an associative way.* Such examples can be easily extended to cross-cultural perceptions of music.

In constructing MAS we align our thoughts with others (Schiavio, Schyff, Cespedes-Guevara, et al. 2017; Scherer 2009b) who highlight the importance of new non-regressive methods such as dynamic system theory (DST) and other time series analyses in capturing the ongoing and bi-directional nature of an individual's interaction with the world, including its sonic environment.

2.5.2.2.2 Dimensions of MAS (appraisal dimensions) Appraisals represent the dimensions of MAS (Figure 2). This does not represent a comprehensive list of all possible appraisals. There are numerous theories (Frijda 2017; Clore and Ortony 2000; Ellsworth 2013; Scherer 2009b; Oatley and Johnson-Laird 1987; C. A. Smith and Lazarus 1991; C. A. Smith and Ellsworth 1985) that predict varying numbers and types of appraisals. Our model is conservative in discussing only appraisals with significant agreement across theories. This core set of appraisals include goal-relevance, goal-congruence, certainty, coping potential, and agency (Moors et al. 2013, 121). In addition to these core appraisals novelty and expectation appraisals are included for their importance in the music literature (Huron 2006), though these appraisals are not included by all appraisal theories (C. A. Smith and Lazarus 1991). All appraisals discussed here also show evidence for an underlying neurological structure (Brosch and Sander 2013). We acknowledge that additional appraisal dimensions remain possible but emphasise the conservative starting point for our appraisal model. For instance, the CODA model does not include the appraisals of valence (C. A. Smith and Ellsworth 1985; Scherer 1986) or norm/self-compatibility (Scherer 1986) as in Scherer and Coutinho’s (Scherer and Coutinho 2013) musical appraisal model because it does not fill these two criteria.

Novelty, (familiarity) is key to musical understanding (Meyer 1956; Huron 2006) and has an underlying neurological structure (Brosch and Sander 2013; Kafkas and Montaldi 2014). Neurologically novelty is a dual-route system. Independent systems (novelty and familiarity) converge and interact in fronto-parietal areas forming an assessment of ‘relative-familiarity’ (Kafkas and Montaldi 2014), which cannot be deconstructed at a psychological level. Novelty is highly influenced by previous musical exposure and is continually reinforced by *expectations*. Neurologically this system is tied to memory circuits which use novelty and familiarity signals heuristically (Kafkas and Montaldi 2014 - see micro-valences for heuristic processing; Gigerenzer and Gaissmaier 2011). Novelty plays a key role in attention orientation, along with *goal-relevance*; both linked with processing in

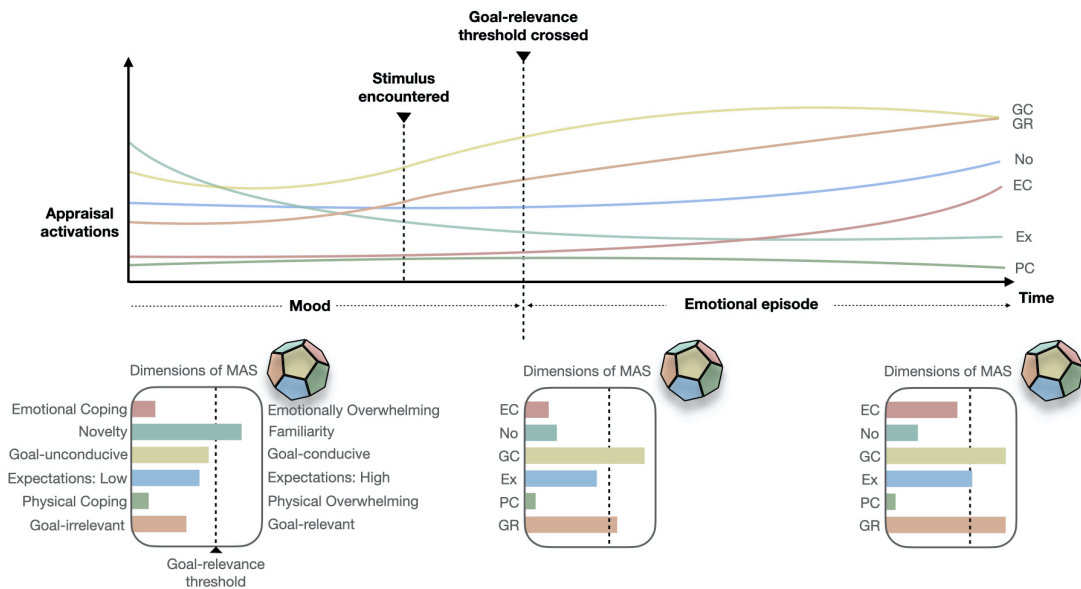


Figure 2.2: A visual representation of the dynamic changes in appraisal dimensions of the multidimensional appraisal space (MAS) in the CODA model. Only a few key appraisals are plotted for illustrative purposes. MAS is truly representative of n dimensions. The timeline shows a hypothetical encounter with a stimulus that drives changes in appraisals. As the goal-relevance appraisal crosses a threshold general cognitive processes become a subjectively perceived emotional episode. The plots below the timeline offer snapshots of MAS at different time stamps and highlight the activation of each appraisal dimension. Note that the extremes of each dimension are not clearly positive or negative. Appraisal dimensions code: Goal-relevance = GR, Goal-conduciveness = GC, Novelty = No, Expectations = Ex, Emotional coping = EC, Physical coping = PC.
 (#fig:figure 2)

fronto-parietal areas key in information integration (Kafkas and Montaldi 2014; Brosch et al. 2013; Balleine and Dickinson 1998). Novelty appraisals can assess situational and sensory information types but remains, in many forms, an unexplored element of emotional episodes induced by music (see affordances in *goal-relevance* and hypotheses).

Expectations, like novelty, is one of the first musical appraisals to be linked with meaning generation (Meyer 1956; Huron 2006), tied to melodic and rhythmic musical elements cross-culturally (S. A. Mehr et al. 2019) and guided by novelty towards heuristic access of existing schema. Expectations are also informed by music's functional, situation and extra-musical components. For example, extra-musical expectation is violated in musical fusions like the use of a didgeridoo in a western orchestra playing an interpretation of the Australian pop tune 'Down Under' (Australia Jun 14, 2019). There is evidence that musical functions can be perceived across cultures too (S. A. Mehr et al. 2019), noting that systematic, but probabilistic, variance in acoustic features are predictive of functions (dance, healing, lullaby, and love songs) at above chance levels. This does not imply pre-determined biological responses but instead a close link between acoustic cues and affordance (see *goal-relevance*).

Goal-conduciveness represents an evaluation of how conducive/obstructive an event is to an individual's current goals. It is closely tied to the type of goal a listener has (e.g., choosing to listen to music and hearing music without explicit choice) and the situation in which a listener encounters the music (e.g., a noisy environment where a chosen piece of music cannot be heard). It can equally be applied to sonic goals and the conduciveness of the music (e.g., a lack of tonal complexity when searching for new musical insights (Gabrielsson 2011)).

Certainty is an individual's assessment of the likelihood of a perceived outcome, be it acoustic, functional, situational, or extra-musical. This dimension is likely to become more significantly weighted in relation to other appraisal dimensions as the degree of certainty decreases, closely tied to familiarity. For instance, the

certainty of enjoyment in a live show is reduced if it is too crowded or loud. Certainty can be applied to the music too, for example chord progressions in an unfamiliar pop song. Note that such an appraisal incorporates extra-musical knowledge of the formulaic nature of pop music. Certainty can play a key role in prioritising competing goals (i.e., prioritising a less important goal over a more relevant one because the likelihood of a positive outcome is more certain).

Coping-potential can be both physical (e.g., the ability to remove oneself from a deafening loudspeaker) and emotional (e.g., suddenly hearing a song you associate with a loss). We highlight the variety of types of information coping-potential can appraise (not only verbal-like). Others have considered the term in aesthetic ways. Silvia (2005b, 2005a, 2006) describes coping potential as ‘ability-to-understand’. He has shown how this appraisal, along with novelty, is key to aesthetic experience. One can see how an individual’s ability to follow the progression of a song or tap along with the pulse can change the emotional experience and behaviours (e.g., dancing) they produce.

It is interesting to consider that a lack of emotional coping-potential in a musical context is not always negative. In many examples feeling emotionally overwhelmed is described as positive (Gabrielsson 2011, ch. 6) and prized for its uniqueness. Strong emotional experiences (i.e., highly *goal-relevant*) can lead to the development of new goals (affordances) (Gabrielsson 2011, ch. 15) such as seeking out a recording of the track or listening to it repeatedly (aesthetic) or music as an aid for sleep (utilitarian).

Agency, in a musical context refers to the composer, a performer, or oneself (Scherer and Zentner 2001). For example, a listener may attribute a strong emotional response to a song they have heard many times before to the way a particular performer plays it, or to the sonic quality of the environment. Alternatively, the lack of emotional engagement with a well-known and liked song may be attributed to one’s existing state (e.g., “*I’m just not in the mood for this type of music right now*” - less goal-relevant).

Goal-relevance is an evaluation of the utility (i.e., the value) of different *affordances* (goal-directed actions). *Affordance* in this instance refers to cognitive processes of evaluating the utility of different actions (including mental actions) that different stimuli offer, as opposed to the stimulus-driven affordances proposed by Gibson (1977). Thus, we imply an *embodied* and *enactive* account of cognition similar to affordance in 4E cognition (see Newen, De Bruin, and Gallagher 2018) where goal-directed action is fundamental to a dynamic system of meaning construction. We associate affordances closely with the many motivations people have for engaging with music and functions music serves, noted in several chapters of multiple handbooks (Juslin and Sloboda 2010; Hallam, Cross, and Thaut 2016; see Maloney 2019 for a review). These can include desires, beliefs, wishes, needs. Yet, the number and type of goals associated with music could be endless. We distinguish, as Alan Merriam did (1964), between the many uses of music and its functions (the broader reasons and purposes it serves). Musical affordances can represent both innate evolutionary concepts (Madison 2008) as well as personal, social, and socio-culturally constructed goals (Boer et al. 2012), including aesthetic goals (Menninghaus et al. 2019; Zickfeld et al. 2019; Moors and Kuppens 2008). Moreover, affordances can encompass the associative and symbolic meaning attached to music (e.g., the lyrical narrative or the mimicry of bodily motions). Evidence for the link between goals and affordances can be seen in Schäfer et al. (T. Schäfer, Tipandjan, and Sedlmeier 2012; T. Schäfer et al. 2013) linking musical functions to the formations of musical preferences.

Goal-relevance, like *novelty*, is closely tied to attention and physiological orientation (Brosch et al. 2013; Scherer and Moors 2019; see also Nieuwenhuis, De Geus, and Aston-Jones 2011 for the link between goal-relevance, P300 event-related potential, and increased cognitive and behavioural ‘responsivity’). In line with Moors et al. (2017), we propose that a goal-relevance threshold marks the distinction between emotional and non-emotional cognition as a graded continuum upon which individuals differ. Goals can be processed subconsciously, and often represent multiple competing goals. Cybernetic models have similarly been de-

signed around multiple competing goals directing cognitive control and behaviour (Inzlicht, Bartholow, and Hirsh 2015). Contextual modifiers are an important source of information in distinguishing goals, where different situations may afford new goals that take precedence over existing ones. Furthermore, the types of goals that are prioritised more frequently may differ both individually and cross-culturally (Saarikallio et al. 2020).

The importance of a goal-directed system in the construction of musical behaviours and meaning has been highlighted in other theoretical work on musical development. ‘Teleomusicality’ (teleo from Greek - goal, Schiavio, Schyff, Kruse-Weber, et al. 2017) suggests how music specific (sound oriented) goals become apparent in infants and develop in complexity. We too note that ‘musical actions (including listening) are always motivated (goal-directed)’ (Schiavio, Schyff, Cespedes-Guevara, et al. 2017, brackets in original). The dynamic and non-linear construction between embodied perception and action in shaping this is paramount to individual musical meaning attribution. However, we expand on the concept by allowing for a dimensional, rule-based, and associative interpretation of *goal-relevance*, allowing greater flexibility in the way ongoing meaning construction can be modelled and furthermore offer testable hypotheses.

2.5.2.2.3 Appraisals as micro-valences Here we suggest that the dimensions of MAS (appraisals) can be viewed as ‘micro-valences’ (Shuman, Sander, and Scherer 2013). Valence distinctions are an important contribution of our model (left side; Figure 1). Different levels of valence are associated with different levels of the CODA model and therefore different levels of processing. Each appraisal dimension represents a micro-valence. That is each appraisal dimension makes a qualitatively different valenced contribution to subsequent processes. For instance, the novelty-familiarity appraisal dimensions can be seen as a form of valence, where too much or too little novelty is negatively processed but an appropriate amount of novelty is positive (Berlyne 1971). The valenced contribution of individual appraisal dimensions can interact bidirectionally with macro-

valence (valence in core-affect) and meta-valence (the emergence of macro and micro-valences in consciousness). These valences are ongoing processes, in line with the cognitive components associated with them (appraisal dimensions). By incorporating micro-valence with one-dimensional macro-valence we counter several critiques of one-dimensional valence (Shuman, Sander, and Scherer 2013) that have been applied to Russell's (2003) model (see Psychological Construction).

Evidence for this dynamic and bidirectional interaction comes from Kuppens et al. (2012). They demonstrated how several appraisal dimensions influence core-affect, and vice-versa, in everyday life. Individual differences in the strength of these relationships were also noted, suggesting that individuals, situations, and stimuli can influence the way appraisals interact with macro-valence. Shuman et al. (2013) suggest that micro-valences interact with macro-valence as the product of a weighted sum. Variability in the relevance of micro-valences suggests changeable weightings in different circumstances. Evidence for such heuristic information processing comes from Gigerenzer and Gaissmaier (2011) who note *recognition* (memory informed appraisal bias, where similar appraisal outputs to similar stimuli weight certain appraisals more highly), *one-clever-cue* (identifying the most salient cue), and *trade off* heuristics (equal weighting of appraisals). Which process takes priority is informed through *ecological rationality* where in different situations 'with sufficient experience, people learn to select proper heuristics from their adaptive toolbox' (Gigerenzer and Gaissmaier 2011). In other words, a goal-directed interpretation of heuristic selection - the heuristic with the most utility to achieve one's goals (see Gigerenzer 2021 for an example of goal-directed *embodied heuristics*). Heuristic processes can lead to different contributions of negative and positive appraisal weightings to other components. For instance, a piece of music with too much melodic novelty in an otherwise agreeably appraised piece may influence an individual's overall macro-valence more negatively.

Individual differences are evident in these processes too. Evidence for both *positivity offset* & *negativity bias* has emerged (Cacioppo, Gardner, and Berntson

1999). Individuals with greater positivity offset may develop a liking for a neutral stimulus (e.g., a new song) after fewer exposures. The strength of these biases is relatively stable across individuals (Ito and Cacioppo 2005). Other research suggests individuals may systematically differ in appraisal weightings, such as optimistic and pessimistic individuals' ratings of certainty and control (Lerner and Keltner 2001, study 2) or sensation seeking individuals (Shuman, Sander, and Scherer 2013). Such types of inherent *appraisal bias* have also been noted at a cultural level (Scherer and Brosch 2009).

Micro-valences may also influence micro-valences at later time steps (Shuman, Sander, and Scherer 2013), for instance, more effective processing of congruent information. Certain appraisal outcomes may constrain other appraisal outcomes (e.g., an appropriate degree of novelty may lead more naturally to a positive appraisal of coping potential - *ability to understand* Silvia 2005a). Finally, appraisal outcomes can carry across situations. Evidence for this comes from Lerner and Keltner (2001, study 4) who show certainty and control appraisals influenced judgments of risk perception in unassociated situations. However, more research is needed to understand how appraisals may constrain future appraisal outcomes and therefore how micro-valences may constrain future micro-valences. What is important to note is how wide-ranging the source of micro-valences can be. For example, hormones, diurnal cycles, the immune system, or drugs (Russell 2009) can all play a role in shaping macro-valence. Diurnal cycles have been shown to influence music choice (Park et al. 2019). The contribution of each of these will be based on biological, individual, and situational factors yet remain clearly interpretable through a goal-directed interpretation.

Micro-valences may play a role in understanding mixed emotional responses to music. Indeed, Russell himself (2017b) notes that mixed emotions can be explained by incorporating multiple assessments of *affective quality*, a concept we and Russell link closely with appraisal⁶. Multiple aspects of an object or situation can

⁶Russell ties the concept closely with evaluations, attitudes, and liking. The distinction lies in Russell's contention that affective quality is a cognitively cold assessment that can be

be evaluated differently leading to mixed feelings (Huron 2016). For example, a positive appraisal of the acoustic elements with a negative appraisal of the song’s message, may lead to a guilty pleasure. The extent to which micro-valences contribute to mixed emotional experiences may vary considerably across individuals and situations. Moreover, meta-valence (below) may be another component that can produce mixed emotions, either through multiple emotion ‘scripts’ emerging in consciousness (e.g., fear and excitement on a roller-coaster) or through different valences emerging in different emotion components as changes happen over different time scales (Russell 2017b).

2.5.2.2.4 Parallel processing of appraisals The appraisal dimensions of MAS are ongoing and processed simultaneously. The hierarchical nature of appraisal processing (Scherer 2009b), where certain appraisals are processed before others (novelty, goal-relevance) when a new stimulus is encountered, does not change the fact that all appraisals are ongoing. Thus changes in one appraisal produces changes in MAS as a whole, even if other appraisals are yet to be processed. We remind the reader how appraisals may constrain each another. Furthermore, re-appraisal can occur as appraisals are processed and feedback from other components is received.

Appraisal dimensions can provide evaluations of multiple aspects of a situation (e.g., the music, the venue, the audience, the performers, musical functions) or a stimulus (e.g., the lyrics, individual instruments). The processing of multiple aspects is not simultaneous, though may appear so at a conscious level. Continued attention (guided by bottom-up and top-down processes, e.g., core-affect, novelty, goal-relevance) will likely lead to further appraisal of more aspects (i.e., facilitated by increased cognitive and/or physiological responsivity, Nieuwenhuis, De Geus, and Aston-Jones 2011). These appraisals can change over time as the stimulus or situation develops allowing a greater focus on different aspects of an episode to

represented in the same two dimensions as core-affect. Our model implies multi-dimensionality (instead of the multivariate bi-polarity present by Russell, 2017b) which can shift between hot and cold cognition while keeping the explanatory capacity of one-dimensional valence.

be more or less prominent at any given moment.

Appraisal outputs can be stored in working memory incorporating multiple appraisal outputs (e.g., the violin solo, the lyrics, the venue, the performance etc.). In this sense appraisal aspects can be conceptualised in more or less gestalt ways. Individual differences in these may emerge. For instance, a listener with greater musical experience may individually appraise sections of an orchestra or particular instruments more readily than the non-experienced listener. Huron (2016) has noted the importance of *plural pleasures* in aesthetic experience where multiple components of hedonic value (aspects of appraisal) are often combined for a better experience.

2.5.2.2.5 Appraisal weightings Appraisal dimensions make a weighted contribution to other components. This idea links closely to recent developments in dimensional-appraisal theories that allow for more sophisticated and non-linear modelling techniques (Scherer 2009b). We construct this idea around similar models of perception (e.g., the lens model, Brunswik 1956) commonly cited within the perception of acoustic cues in music (Juslin and Laukka 2003) and vocal expression (Scherer 1986). It appears logical, even actively beneficial, to propose that both the stimulus-driven and goal-driven sides of the model would behave in the same weighted (partly redundant) way. Moreover, we note how the weighted nature of appraisals can change over time. As noted in the above sections, the ongoing development and change in weightings may be closely tied to other appraisals and their bi-directional interaction with other components.

2.5.2.2.6 Appraisal and 4E cognition The CODA model identifies itself as in line with contemporary stances in cognition. Critical to the CODA model is the idea that affective and general cognition are not separable (Frijda 2007b; Dukes et al. 2021). This is most notably developed through the CODA model's wider and more encompassing definition of appraisal processes that are more in line with 4E, and in contrast to previous narrow conceptions of appraisal applied

to music (critiqued above; Section 2.4). The suggestion that appraisal can be as representative of 4E concepts, such as embodied or enactive cognition is not new. For instance, Frijda’s (2007a) classic idea of ‘action readiness’ as a central component in affective experience sums up the embodied aspect well. The CODA model specifically adds that goal-directed appraisals can be seen as representative of 4E in a musical context too. Such examples could include embodied goals (to achieve a desired level of arousal), enactive goals (to dance), or even extended goals (to go and find the music to learn a particular song). To be clear, this is not to suggest that all 4E cognition is goal-directed but it does suggest that goals are inherently represented in 4E (e.g., embodied goals). Moreover, the CODA model by expanding the the types of information that can be appraised, suggests that 4E cognition can become the focus of appraisal. Take again Frijda’s action tendencies, the action tendencies as an embodied feeling can also become the focus of appraisal (“which action in most conducive to a goal?”). This substantially expands upon previous attempts to adapt appraisals for music and emphasises the flexibility of adopting such ideas.

2.5.2.3 Meta-experience

As Russell describes, *emotional meta-experience* is the conscious experience of a specific emotion (2003). This categorisation is based on other components of emotion (e.g., core-affect, appraisal, the antecedent event) and is formed around prototypes. No specific mechanism (e.g., brain-stem, contagion, etc.) is needed to account for any given ‘folk’ term because they represent the coherent experience of an individual (Colombetti 2014) and their construction of the concept (a discrete emotion). The explicit categorisation of an emotion is not required in an emotional episode but may emerge. It is distinguished from a general *meta-experience*, which implies the conscious awareness of multiple components, in that one does not explicitly need language to consciously experience these components, nonetheless it can certainly include labeling.

Concerning levels of valence (left-side; Figure 1), we note that individual micro-

valences are accessible to conscious meta-experience as well as macro-valence in the form of a single composite of core-affect. Note however, that core-affect is not separable at higher levels of processing. This is represented by the non-orthogonal crossing lines, suggesting as valence reaches extremes arousal automatically increases (Kuppens et al. 2017).

2.5.2.4 Component interactions

Our model contends that appraisals form a variably weighted bi-directional *dynamic interplay* with other cognitive components. This is represented by the resistors between components. The weighted interaction between different components depends on several factors. Some of these factors are likely to be biologically driven while other factors such as individual and contextual factors may also influence the strength of these component interactions through changes in appraisal. For instance, conceptual knowledge of a situation and music's functions within it as amenable to dancing, along with a pre-existing desire to dance (*goal-relevance*), appraising the *novelty* of the music as well-balanced with sufficient physical *coping potential* to keep up with the music may strengthen interactions with *action tendencies* and *motor components*. In this example it becomes evident how appraisal can shape continued meaning generation. Evidence for such interactions has emerged between appraisals and behaviours (Brosch and Sander 2013), physiological responses (Aue and Scherer 2008, 2011), facial expressions (Scherer, Mortillaro, and Mehu 2017), vocal expressions (Nordström et al. 2017; Laukka and Elfenbein 2012; Belyk and Brown 2014), and core-affect (Kuppens, Champagne, and Tuerlinckx 2012; Shuman, Sander, and Scherer 2013). We note that the interaction between components can occur with minimal weighting to appraisals and have included these interactions too (right-side; Figure 1). However, we contend this route is atypical of musical emotion experiences hence represented with a lighter shading.

2.5.2.5 Concluding remarks

Our model captures how appraisal facilitates a music-elicited emotional episode through the ongoing construction of relevance and meaning between an organism and their (musical) environment. It has been informed by skeptical theories of emotion that seek to move beyond the reductive construction of emotion. It has explicitly played down the distinction between cognitive and emotional mechanisms, noting the move towards affective-cognition in the wider cognitive sciences (Dukes et al. 2021). It has highlighted the key role of goals in meaning construction and has expanded on existing models by specifying the dynamic structure of appraisal. There is of course much to be said for how such a model is well suited to explore the non-prototypical and less stereotyped cases of emotional episodes. These may include misattribution (identifying the wrong antecedent object, such as performer instead of composer) or atypical appraisal (a fear of crowded spaces often sought by typical concert goers). However, the following hypotheses and implications are focused towards adapting the existing literature for music.

2.5.3 Hypotheses & Implications

The CODA model proposes several hypotheses. These generally pertain to testing the value of goal-directed appraisal in emotional episodes induced by music. These hypotheses and their implications nonetheless deserve some explicit development with regards to their predictions and methodologies.

2.5.3.1 Micro-valences, weighted dimensions & component interactions

Hypotheses for appraisal's bidirectional interaction with core-affect comes from Kuppens et al. (2012). An experience sampling methodology (ESM) in real-life situations showed how appraisal and core-affect interact, focusing on the contribution of individual appraisals over appraisal patterns or interactions. The results indicated the valence-appraisal interaction was strongly marked

by *motivational-consistency* (goal-conduciveness), as well as *coping-potential* (emotional and problem-focused) and *expectancy*. Supplementary to their hypotheses, it was also observed that an appraisal of *agency* showed small effects on valence ratings. The interaction between valence and appraisal was further conceptualised by more pleasant pre-exiting core-affect leading to more positive appraisal ratings. Arousal-appraisal interactions were characterised by *coping-potential* (problem-focused) and *agency*. The hypothesis for a *motivational relevance* - arousal interaction was not met. However, arousal influenced appraisals of *motivational relevance* and *expectancy*. The authors concluded that arousal plays a strong role in the pursuit of goals (p. 6). All together the evidence stresses a *dynamic interplay* (Kuppens, Champagne, and Tuerlinckx 2012) between components. No such appraisal based study yet exists in music to our knowledge. We hypothesise that the appraisals presented in our model will be relevant to music and its situational context. Moreover, appraisal dimensions will show bi-directional interactions with core-affect. Such a study would be straightforward to conduct as ESM is well developed in music research (e.g., Saarikallio, Randall, and Baltazar 2020).

This interaction between appraisal and core-affect can be further conceptualised by the non-linear relationship between arousal and valence that more naturally represents a V-shape (Kuppens et al. 2017, Study 1). This is where more extreme ratings of valence (+ or -) naturally partner stronger subjective arousal ratings. An alternative hypothesis for the appraisal to arousal interaction noted by Kuppens et al. - one that highlights the micro-valenced nature of appraisal. Again such studies would be easy to generate through ESM, lab based, or online studies. Highly valenced (+ or -) music would show a V-shaped relationship with arousal. These effects may be amplified by the degree of goal-relevance a participant relates to the music and/or situation. Moreover, the V-shaped relationship between valence and arousal will show individual and cultural differences in the gradient of this V-shaped relationship.

One problem with Kuppens et al.'s (Kuppens, Champagne, and Tuerlinckx 2012) study is that it is not clear whether individuals' ratings can be considered emotional episodes or moods. Moods in contrast being more diffuse, longer lived, and not directed at something (Russell 2003). However, given that the same mechanisms in our model are hypothesised to underpin both cognitive and emotional cognition (i.e., degrees of more and less emotional cognition), this is not problematic for our interpretation. Instead, we suggest the evidence from Kuppens et al.'s study merely shows individual and contextual differences in more or less emotional cognition yet appraisals, are present in both conditions.

Appraisals also showed substantial correlations with each other (Kuppens, Champagne, and Tuerlinckx 2012). Though not the study's main focus, this suggests there are meaningful interactions between appraisal dimensions. We suggest, that changes in these interactions (the way appraisals constrain / amplify other appraisals) are to be seen as continuously changing weightings through the interaction between organism and environment. Extension to the proposed ESM experiments would benefit from more dynamic time-series analyses and Bayesian weightings. The studies proposed above can capture the importance and interaction of appraisal components as a snapshot in the music emotion process, although we have noted numerous times the process of ongoing meaning construction is a dynamic one. Such approaches have been developed for longitudinal ESM and diary studies (Asparouhov, Hamaker, and Muthén 2018).

We hypothesise the appraisal interaction with core-affect and meta-experience will be characterised by micro-valences. What is unclear, is to what degree these micro-valences contribute to a macro-valence, or if this differs by individual, stimuli, situation or goal. Nonetheless, active testing that appraisals can contribute as micro-valences in the construction of meaning with music is another purposeful extension of the proposed experiment above and one that can be extended to more dynamic models.

Further evidence to inform hypotheses for micro-valences comes from Scherer, Dan

and Flykt (2006). They looked at nine appraisal criteria and three-dimensional affective space (arousal, valence, potency) using the International Affective Picture System. They found the strongest valence correlation was with an *intrinsic pleasantness / goal-conduciveness* composite (.99), as predicted. However, the observation of multiple correlations between appraisals and valence can be seen as supportive of micro-valences. Taken together with Kuppens et al. (2012) provides clear support for a micro-valenced interpretation of appraisal's interaction with core-affect. Beyond core-affect, a large-scale cross-cultural study (Soriano et al. 2013) using self-report measures of various components of emotion; including appraisal, action tendencies, bodily reactions, expressions, and feelings, similarly found strong support for the idea that appraisals are principally valenced structures (Fontaine, Scherer, and Soriano 2013) and that these valences load on to a 'valence superfactor' (Scherer and Fontaine 2013). Such a study in a musical context can be constructed using vignette methodologies. An methodological approach that has proved highly robust for appraisal (M. D. Robinson and Clore 2001).

Micro-valences may also form part of inter-individual distinctions in emotional episodes through their effect on other components (e.g., why one person may find a piece of music more pleasant and energising than another). Individuals with different goals (wishes, desires, beliefs) will appraise the same stimuli differently. Appraisals will therefore manifest themselves differently in the effect they have on other components, most prominently in valenced terms. Kuppens et al. (2012) notes individual differences in the relationship between appraisal and core affect. That is, people differed in the strength of effect appraisals had on core-affects. How different appraisals are weighted in different situations and by different individuals will form a key component in understanding contextual modifiers and would be observable through ESM or vignette methodologies (see The goal-directed hypothesis).

2.5.3.2 The goal-directed hypothesis

Why can the same piece of music in the same situation leave one person cold and another overcome with emotion? Our hypothesis is that the degree of goal-relevance / conduciveness influences the *intensity* of emotional episodes. That is, general cognitive processes must reach above an individually variable threshold of goal-relevance to become an emotional episode. The degree of goal-relevance will subsequently inform the intensity of that emotional episode. The change between less and more emotional cognition⁷ is therefore gradual (Moors, Boddez, and De Houwer 2017). The intensity of an episode is therefore not fixed and can change over time. This can happen through greater weighting of a single goal, multiple simultaneous goals, or the generation of new goals as an individual continues to engage more deeply with a stimulus. Furthermore, individual thresholds for goal-relevance are variable. That is, given different situations or prerequisite situations an individual's threshold for appraising something as goal-relevant changes. New stimuli may not be (subjectively) relevant enough to divert cognitive resources to it. We add that the degree of goal-relevance / conduciveness should show marked changes in autonomic reactions (sympathetic and para-sympathetic) and increase cognitive attention (orientation response) (Kreibig, Gendolla, and Scherer 2012; Nieuwenhuis, De Geus, and Aston-Jones 2011) beyond the relationship with psychoacoustic cues.

Individuals may prioritise different goals in the same situation as different expectations, thresholds, and predispositions for affordances exist (Moors 2020). Musical behaviours like dancing are more common for some while attentive listening is for others (Saarikallio et al. 2020). Emotional behaviours are thus guided by the utility of that behaviour for achieving one's goals. For instance, dancing may enhance social bonding or physiological engagement for some, while others may not want to dance with the knowledge that a lack of coordination and timing (coping-potential) could distance them socially from their peers. Alternatively, a

⁷Often referred to as a distinction between cold and hot cognition to try and separate cognitive and emotional mechanisms. This is a distinction we do not seek to endorse.

more pressing goal can take away the emotional engagement with a musical piece. For instance, the student who is anxious about their impending exams may not be able to enjoy their favourite music (mood-enhancement). Personal responses are a dynamic goal-driven process of meaning generation.

Interestingly, one could hypothetically also have a meta-appraisal of goal-relevance, in acknowledging a piece of music as perfect for an alternative goal or different situation. This meta-goal appraisal conceptualises one of the ways ongoing embodied and enacted learning allows for the development of new affordances. This notion ties in neatly with Huron's ITPRA model (Huron 2006) which notes the relationship between imagination and appraisal. The interaction between affordances and imagination may prove an interesting and informative new direction for research linked closely to musical training and culture.

Such hypotheses require new goal-directed methodologies (Moors, Boddez, and De Houwer 2017). This is experimentally equivalent to demonstrating the same piece of music for the same person can produce different behaviours based on different affordances. Such designs could be constructed around the functions music affords to different individuals or across different cultures (T. Schäfer et al. 2013) and be conducted through self-report methods. The identification of musical functions are a prerequisite to this (Gabrielsson 2011; Saarikallio et al. 2020; Maloney 2019; Boer et al. 2012), including aesthetic (Zickfeld et al. 2019) and sonic (Schiavio, Schyff, Cespedes-Guevara, et al. 2017) affordances where music's value is explicitly tied into its function (T. Schäfer, Tipandjan, and Sedlmeier 2012; T. Schäfer et al. 2013) and has shown systematic, albeit probabilistic, links with acoustic features (S. A. Mehr et al. 2019). What is key to these designs is to allow these elements to vary systematically.

A common criticism directed at appraisal theory (Scherer and Moors 2019; and many music emotion studies Eerola and Vuoskoski 2013) is the prevalence of self-report methodologies. Yet, such methodologies are still indicative of the underlying phenomena and allow for an informed baseline to emerge from which other ap-

proaches (biological, neural) can be compared (Eerola and Vuoskoski 2013). Even forced-choice designs can be informative when well managed (Nelson and Russell 2013). To expand the methodological arsenal further, implicit methodologies have been developed. Moors and Jan De Houwer (2001) used a variation of the affective priming tasks to show how automatic appraisal of goal-conduciveness can influence an individual's responses. Similar results have been found using transcranial magnetic stimulation (Fischer et al. 2020). Goal-priming could be used in musical contexts. For instance, Céspedes-Guevara (in Warrenburg 2020b) shows how a composer's notes can influence audiences' interpretation of the music, implying an implicit goal to understand the composer's intended emotional communication, though many other goals could be constructed by individuals in a concert setting. Goals could be designed into a variety of musical scenarios, such as, hypothetical or real musical situations where typical musical functions are described. Similarly, showing differences between stimulus-driven outputs to goal-directed ones in approach / avoidance tasks would provide support for a goal-directed interpretation. Approach / avoidance musically could be considered several ways (e.g., listening time, purchasing cost etc.). The study of musical affordances over discrete emotions is paramount and applications may be particularly relevant when studying maladaptive listening behaviour Carlson et al. (2015) where goal-directed approaches to behaviour suggest changing the values of expectations, over changing the stimulus.

2.5.3.3 Perceived vs. induced emotions

The distinction between perceived and induced emotions could be as simple as assessing a stimulus' goal-relevance. That is, a subjectively identified emotional episode emerges when a stimuli is seen as relevant enough to an individual to cross a goal-relevance threshold. A perceived assessment can emerge from an externally-directed goal (i.e., directed by the experimenter) to assess stimuli and pigeon-hole them into discrete categories. A participant can evaluate the available evidence: e.g., in a music experiment - acoustic cues, changes in core-affect, physiological

changes, appraisals, etc. However, devoid of much goal-relevance, evaluations remain relatively culturally standardised and the activity remains subjectively cognitively *cold*⁸.

2.5.3.4 Utilitarian and aesthetic emotions

Within our approach, there is a desirable future where utilitarian and aesthetic emotions are also described within the same general components of cognition. One where aesthetic affordances, through a goal-directed mechanism, become the “to be studied phenomena”. This allows researchers to side-step arguments about which emotions are aesthetic or not and look towards behaviours and the interaction between components in the ongoing generation of meaning as the distinguishing features between aesthetic and utilitarian perspectives. Examples of the importance of goals have emerged in the aesthetic literature. Menninghaues et al. (2019) makes clear reference to the importance of goals and other appraisals in their conception of aesthetic emotions and notes their links with aesthetic functions and subjective feeling. However, Menninghaues et al. still continue to group their mechanisms around the organisation of the emotion space (e.g., awe, interest, beauty). Meanwhile, we contend that the conversation must move beyond how the emotion space is organised.

Alternatively, we promote the study of aesthetic affordances through the reasons people have for engaging aesthetically. Again, we highlight the importance of moving beyond Kantian notions of disembodied and ‘disinterested’ (Huron 2019) and readily acknowledge the incorporation of goals (Menninghaus et al. 2019; Zickfeld et al. 2019) in achieving this transition. However, we seek to adopt goal-directed action in its dynamic, embodied and enactive construction. Such goal-directed accounts may lead to distinctions in aesthetic affordances such as when attentive listening is afforded while removing the need for additional mechanisms.

⁸Cognitively *cold* here used only to refer to the subjective experience. It is not to imply a meaningful distinction between cognitive and emotional mechanisms.

2.5.3.5 Recommendations

We finish with several recommendations for future research.

- As a priority future studies must place a direct focus on “nuisance variables” (familiarity, situation, individual differences) as systematically manipulated. These variables are not only understudied but directly pertain to music’s relevance and meaning.
- Instead of exploring the full CODA model, individual parts of the model can be empirically tested (e.g., one or two appraisals) or interactions between just two components (e.g., goal-relevance and core-affect, physiological measures or attention).
- New methodologies with a focus on “nuisance variables” meaningfully moves the field beyond labeling emotions, and towards the emotional episodes. Such methodologies can be further extended to incorporate more implicit measures - EEG, TMS, reaction time, go no-go tasks.
- Extending methodologies, including self-report, to incorporate dynamic time-series analyses, allowing greater insight into the development of an emotional episode. Several examples of these types of analyses for different methodologies are noted through the paper as a template to guide future experiments.
- Develop new tools, allowing researchers to describe experiences differently, occurring at different levels and through different drivers. This approach advocates collecting descriptors of emotional responses that constitute these episodes, one where people can explain them in their own terms and giving reasons for them, rather than imposing structure of affects and mechanisms that dictate the choice of emotions and underlying drivers.
- Active testing of appraisals in relation to music requires careful review of the current literature, including aesthetics, and the development of new instruments. Such instruments should suit self-report formats and coding of free

verbal/written reports. Current examples are limited by their focus upon grouping around discrete terms (Zentner, Grandjean, and Scherer 2008).

- Research into appraisals should not be limited in scope. Embodied mechanisms such as entrainment, physiological responses, behaviours, and musical features can also be active features of appraisal.
- Direct comparisons with existing models in terms of coverage, realism, contribution to knowledge, and acknowledgment of the multiple influencing factors (structural, performance, listener, and context, Scherer and Zentner 2001).
- Direct testing of goal-relevance as a mechanism to differentiate perceived and induced emotions.

2.6 Conclusion

This paper explored a skeptical perspective of current emotion science. Through studying key skeptical theories we accentuate the need to move away from ‘folk’ terms and circular discussions about which emotion is present. Instead, we acknowledge the skeptical transition towards studying the emotion episode and its multidimensional components to better understand the underlying cognitive mechanisms. Furthermore, we examine goal-directed accounts of appraisal within the skeptical framework as directives for the relevance and meaning of a stimulus to an individual. We next examined two music-emotion models and investigated these models through the wider skeptical lens. We highlight how current theoretical constructs still seek to explain the underlying mechanisms through categorisation. Furthermore, how the role of goal-directed appraisal, though uncontroversial in the wider affective sciences, remains to be meaningfully acknowledged within the construct of musical frameworks of emotion.

To address the gaps in music-emotion science we build on previous accounts (Céspedes-Guevara 2021; Eerola 2017) and present the CODA model of musi-

cally induced emotional episodes. This model takes a skeptical approach and seeks to re-evaluate and recentre the role of goal-directed appraisal within music-emotion models. In doing so, we have developed a multidimensional appraisal framework that, through goal-directed processes, links our model to embodied and enactive schools of thought and is closely tied to the concept of musical affordance (sonic and situational). Importantly, we content that this model places emotional episodes induced by music explicitly within the wider framework of general cognitive/affective mechanism which allows for music-emotion science to be examined more universally as situated within the study of the human experience.

Finally, we offer several hypotheses derived from the CODA model. These hypotheses address current theoretical issues such as distinctions between aesthetic and utilitarian emotions, perceived and induced emotions, as well as individual and situational differences in emotional intensity and valence. To test our hypotheses, we develop existing and new methodologies before offering a list of critical recommendations for future research. Altogether, we show that the future of music and emotion science must reconsider the prevalence and impact of an individual's motivations in the generation of musical emotional episodes – a question that can only be addressed by looking at an individual's goals. Simply, we insist that the important questions are no longer *why this emotion?*, but *why this music, in this moment, for this individual?*

Chapter 3

An exploratory evaluation of appraisal dimensions in emotional episodes induced by music

Lennie, T. M. (2023). *An exploratory evaluation of appraisal dimensions in emotional episodes induced by music*. OSF. <https://osf.io/vf462/>

Preface

This prepublication study forms the first empirical test of the thesis. It sought to identify a ‘proof of concept’ for multiple appraisal dimensions as a meaningful component of musically-induced emotional episodes. In identifying key appraisal dimensions and wider appraisal structures this study sought to guide the focus of future studies in this thesis. The validity of several appraisal mechanisms are tested and factor analysis is used to develop a latent appraisal structure. The relationship between appraisal with other components of emotion, and the impact of individual differences on these appraisal dimensions is explored. Specifically, goal-directed appraisals emerge as key components of musically-induced emotional

episodes for continued study.

Abstract

This study explores appraisal dimensions at a conceptual level in the context of music. It collects and refines several appraisal terms that have been applied to the study of appraisal mechanisms by different theories into a test battery for musical appraisal. Stimuli are collected from the DEAM data set (Aljanaki, Yang, and Soleymani 2017). This is representative of the whole affective space (core-affect) and consist of more and less stereotyped examples. It next tests the ability of the test battery of appraisal dimensions to distinguish a dataset of musical stimuli that vary in core-affect (valence and arousal). Following a comparison of different appraisal dimensions and a dimensional reduction by factor analysis, appraisals are grouped into three latent factors (Goal-congruence, Novelty, and Goal-relevance). These latent appraisal factors are modelled using linear mixed modelling to predict differences in core-affect and ratings of interest in the music. The results show that appraisals are strong predictors of ratings of valence and interest in musical stimuli. Specifically, appraisals of goal-congruence and goal-relevance are the strongest predictors. The results are discussed in the context of support for an appraisal model of musically-induced emotions and suggestions for further study into the role of goal-congruence and goal-relevance are made.

3.1 Introduction

I have reviewed several contemporary theories of emotion and developed a new model (The CODA Model) to address such questions. This model is predominantly based in the literature on appraisal theory and emphasises its ability to address such questions of individual and contextual differences (*What makes music relevant and meaningful to an individual, in a situation?*). Ultimately it advances a more nuanced understanding of the emotional experience of music. Yet, music-

specific adaptations of appraisal remain almost entirely theoretical to this author's knowledge, save a few token place holders that have been incorporated through different reviews of the wider literature and applied to music psychology. More typically the incorporation of appraisal refers to a single appraisal, as in Huron's (2006) theory of musical expectation¹. These approaches while acknowledging the role of appraisal have not been based in the full theoretical tradition or led to a greater focus upon appraisal theory in the music psychology literature. As such, no explicit methodological application of appraisal theory proper has been developed for music.

As discussed in the previous chapter, the predictions of appraisal theories are numerous and span hypotheses for several other components of emotion (subjective feeling, discrete emotions, physiological and somatic responses, and action tendencies). In this experiment, I focus on subjective feeling as core-affect (valence and arousal). The relation between appraisal and subjective feeling forms the largest set of predictions put forward by The CODA Model in this thesis. Moreover, subjective feeling is also the most readily applicable to the wider findings in the music psychology literature which often takes subjective 'felt' experience, be it core-affect or discrete terms, as the measurement of interest - *'the to be explained phenomena'*.

3.1.1 The relationship between music and subjective feeling.

Substantial progress has been made in predicting individuals' subjective experience of music. Often key aspects of a musical stimulus are used to predict the emotional effects that music induces, as can be seen in meta analyses (Juslin and Laukka 2003; Céspedes-Guevara and Eerola 2018) and advancements in music emotion recognition (MER) models (Yang and Chen 2011; Aljanaki, Yang, and Soleymani 2017). While progress has been made, the most consistent findings

¹Huron does note in his ITPRA theory that appraisal (meaning cognition generally) is a later component but makes no explicit mention of what these other appraisals might be.

for psychoacoustic cues lie in the dimension of arousal; the psychoacoustic cues for valence have been notoriously difficult to identify leaving valence substantially harder to predict from psychoacoustic features alone (Céspedes-Guevara and Eerola 2018). This is true not just of music but vocal prosody too (Russell, Bachorowski, and Fernández-Dols 2003; Juslin and Scherer 2005; Scherer, Clark-Polner, and Mortillaro 2011). Some have argued (Juslin and Scherer 2005; Scherer, Clark-Polner, and Mortillaro 2011) this is a limitation of the number of cues studied. Advancements in MER models do show improvements for valence predictions with an increasing number of cues, yet arousal remains substantially easier to predict (Yang and Chen 2011; Aljanaki, Yang, and Soleymani 2017). Alternatively, others have suggested that valence is a more cognitively driven component (Céspedes-Guevara and Eerola 2018; Lennie and Eerola 2022) - i.e., within the realm of appraisal.

In a music context the research that has incorporated appraisal, albeit single appraisal terms, does often show a clear relationship between self-reported appraisal responses and ratings of valence. There is a clear benefit in exploring appraisal theory fully following the hypotheses put forward by (Lennie and Eerola 2022).

3.1.2 Key concepts in an appraisal theory of musically-induced emotional-episodes

As argued in Chapter 2, appraisals are dimensional constructs and inherently form a multidimensional space. Furthermore, they contribute to other components of an emotional-episode and further emotional processing in a dimensional way. This relates most readily to appraisal dimensions as micro-valenced constructs. Finally, I have suggested that adopting an appraisal directed approach to the study of emotional episodes induced by music will lead to a more nuanced understanding of individual and contextual factors. There are, however, a few additional considerations to discuss in developing a first test of appraisal in a musical context.

3.1.2.1 The structure of appraisal theory

Appraisal theories of emotion have most readily been built on and applied to studies of utilitarian emotion. Notable divergences from this have been made and often promote the idea that non-utilitarian emotions (e.g., aesthetic or epistemic emotions) are devoid of goals, as seen in the review in Chapter 2. Nonetheless, the grounding theoretical structure of appraisal remains based on its utilitarian underpinnings. Conclusions about the structure of appraisal often come from various forms of dimensional reduction, grouping appraisal-dimensions in relation to their wider relevance and meaning to an organism's survival (e.g., a stimuli's 'implications and consequences' for an organism, as an example of one category). This appraisal structure is commonly grouped into four key appraisal categories (relevance, implications, coping potential, and norm-compatibility; Scherer and Coutinho (2013)). Yet, it remains to be seen, or empirically validated to this author's knowledge, that the same structure should exist in other forms of emotional construction - those related to aesthetic or epistemic emotions, at least, if one is to draw such distinctions between types of emotion. Not all authors do draw these conclusions which has led to the *a priori* assumption that the same categories should exist in all cases. The key point here and outlined in Chapter 2 is that the same underlying mechanisms should support all types of emotional responses. The justification is that one should not have to invent new underlying emotional mechanisms to explain emotional responses. However, it does not rationally follow that all mechanisms are needed for an emotional-episode to occur. Or that all mechanisms should carry the same importance (weighting) in all emotional episodes. As noted in Chapter 2, much research has suggested that a subset of different mechanisms are sufficient for an emotional-episode to occur, even if further components are subsequently incorporated into an emotional-episode at later stages of processing. This experiment takes forward all four wider appraisal factors and as many sub-categories as possible, given the design, the focus specifically on music listeners, and time-limitations.

3.1.2.2 Adapting appraisals for a musical context

The theoretical ground work for how appraisals may relate to music specific contexts has been explored by Lennie and Eerola (2022), as well as others (Scherer and Coutinho 2013; Céspedes-Guevara 2021). However, a methodological tool that could be used to represent these appraisal dimensions in the form of individual measures has not been developed in a musical context. The most common approach for measuring appraisals is to use self-report measures (Scherer 2019; Scherer and Moors 2019). It is also conveniently the most common tool used to measure subjective feeling in music psychology (Zentner and Eerola 2010) and is therefore the approach adopted here. Specifically, this refers to identifying individual statements (representative of their corresponding appraisal dimension) that can be applied to music. Such a tool can vary widely in different contexts (Scherer and Moors 2019). Some scholars elect to use the appraisal terms themselves (Scherer, Dan, and Flykt 2006), while others allow the terms to vary depending on the context (Nordström et al. 2017). For instance, an appraisal of ‘Coping Potential’ could be described implicitly as the ability to get away from a threatening situation or the ability to change a specific situation, or it could be described explicitly as an individual’s ability to cope with a situation. In a musical context for instance, being stuck in a crowded room where the music is painfully loud could refer to an individual’s physical² ‘Coping Potential’ in different situations.

Needless to say, the lack of a tool to address how underlying appraisal dimensions may relate to music is a huge limitation. Some authors have put forward suggestions about the terms these appraisal dimensions may be measured through. There is, however, substantial disagreement between different theories about the terms that should be used, the sub-categories or wider factors they relate to and the number of categories needed for a musical interpretation of appraisal. To address these issues and aid the development of an appraisal tool for music, I re-

²Some scholars additionally distinguish between physical and emotional ‘Coping Potential’ (C. A. Smith and Lazarus 1991; Kuppens, Champagne, and Tuerlinckx 2012)

viewed some specific adaptations of appraisal dimensions (Silvia 2005a, 2005b, 2006; Scherer, Dan, and Flykt 2006; Scherer and Fontaine 2013), including theoretical suggestions for music specific contexts (Scherer and Coutinho 2013; Céspedes-Guevara 2021) and some key experiments from general applications of appraisal theories, to guide the development of an initial test battery of musical appraisal dimensions. The theories reviewed all relate to self-report measures of appraisal and span a diverse collection of approaches to the application of different measures. This comparison between terms can be seen in the Appendix B.0.1. As outlined in several appraisal theories (Ellsworth and Scherer 2003), including those for music (Scherer and Coutinho 2013), appraisals can be seen as representative of four broader categories (relevance, implications, coping potential, and norm-compatibility). Each of these categories comprises of a sub-set of appraisal dimensions that relate to these wider concerns of the individual. Some of the key points of distinction between different adaptations of appraisal theories for music and aesthetics more generally can be summarised as;

1. Different theories make multiple suggestions for question formats/terms to be representative of a single appraisal sub-category. In some cases theories have even used the same terms to represent different appraisal dimensions.
2. Not all theories acknowledge all sub-categories. Some theories suggest terms are to be seen as representative of a whole appraisal factor, instead of a specific sub-category. Other theories differ in the number of sub-categories they acknowledge.
3. Some appraisal dimensions are hypothesised to be less accessible to consciousness than others (e.g., goal-relevance vs. external standards for social norms). In cases where appraisal dimensions are considered less accessible to consciousness authors often use implicit statements, while theories that do not distinguish appraisal as such may use more explicit statements of measurement.

3.1.2.3 Micro-valences

The theoretical construction, adapted from (Scherer and Fontaine 2013), and evidence for appraisals as micro-valences (Shuman, Sander, and Scherer 2013), has been discussed in detail in Chapter 2. To briefly remind the reader, micro-valences represent the contribution of individual appraisal dimensions to further cognitive processing as valenced concepts. Through top-down and bottom-up processes these micro-valences (appraisal dimensions) form a ‘macro-valence’ at higher levels on processing. The macro-valence is representative of the single valence dimension we commonly refer to in the core-affect model (Russell 2003). What is not clear, is to what degree these micro-valences contribute to a macro-valence, or if this differs by stimuli (i.e., music) and/or situation. It may be that other factors (e.g., lyrics) are more closely related to felt valence, though as stated previously this seems less likely to be in the acoustic qualities of the music (Céspedes-Guevara and Eerola 2018).

3.1.2.4 Appraisal and interest

Some scholars have applied appraisal theories to predicting aesthetic interest - interest in an aesthetic object (Silvia 2005a, 2005b, 2006). Examples of this can be seen in the review of appraisal terms in the Appendix B.0.1. The first empirically robust construction of this idea was pioneered by Berlyne (1970). His seminal work on experimental aesthetic suggested an inverted U-shape underpins the relationship between arousal levels and preference for the art. Levels of arousal were determined by certain appraisal variables (e.g., complexity, familiarity). Though divergent results have accumulated since its publication (Menninghaus et al. 2019), including within music (Hargreaves and North 2010), the significance of his finding that appraisals (what Berlyne called “collative” variables) are an important component of preference lives on (Menninghaus et al. 2019) including within the music literature (Chmiel and Schubert 2017). More recently these ideas have been developed in relation to discrete terms, as “interest” in aesthetic objects (Silvia 2005b). Two brief critiques of Berlyne’s work can

help clarify how his ideas have developed. First, psychological science has moved far beyond the singular study of arousal-theory as a motivational driver³. For instance, Maslow's (1948) nuanced interpretation of the motivational hierarchy, or the broader definition of goal-relevance (Chapter 2) offered in this thesis, contrast with this the single focus on arousal-theory. Second, Berlyne's construction of "preference for" an aesthetic object, a concept that is still relevant to the study of aesthetics today (Palmer, Schloss, and Sammartino 2013), may not be adequate to capture the multidimensional or multicomponential nature of hedonics (see limitations of one-dimensional valence and mirco-valences 2.5.2.2.3). One could argue that such critiques can be applied to Meyer's (1956) seminal work on music providing reasonable justification for the exploration of such a hypothesis with music. For the purposes of this experiment it is sufficient to say that the evidence supports a relationship between appraisal and interest and that further study into this relationship can be beneficial to the wider study of aesthetics (e.g., Menninghaus et al. 2019).

In some theories of emotion the term 'interest' is not taken to be a 'true' emotion. This is most true of emotion theories that seek to explain discrete emotion terms (see critique in 2.2.1) and is usually justified by the statement that interest does not represent a clearly valenced term. Similar examples can be seen in discussions on terms such as surprise. Yet, in discussions on aesthetic emotions terms such as interest and surprise are seen as highly important emotions (Tan 2000). The discussion on whether interest or similar terms should be seen as 'true' emotions is beyond the scope of this chapter. The theory presented in this thesis clearly seeks to move beyond discrete terms. A less contentious statement about interest, one that allies with a dimensional construction of emotional-episodes over the relevance of discrete terms as presented in this thesis, can be made. That is, ratings of interest can be viewed as a place holder for continued cognitive processing or the allocation of further cognitive resources to an aesthetic object, and subsequently

³It is of course worth noting that the development of arousal theory (the balance between stimulation and relaxation) was a development of motivational needs beyond purely homeostatic concerns with hunger or sex

necessary but not sufficient for an emotional-episode.

3.1.3 Aims

This experiment takes a theory driven interpretation of appraisal dimensions in an exploratory design. Specifically, it seeks to test the validity of appraisal dimensions in the context of music. Furthermore, following research in utilitarian and aesthetic contexts, this study explores the relationship between appraisal dimensions and core-affect (valence and arousal) and the relationship between key appraisal and aesthetic interest in a musical context.

3.1.4 Hypotheses

Though this work is exploratory by nature a few tentative hypotheses can be drawn from the existing literature and presented in an associative way.

First, that appraisals are inherently micro-valenced structures leads to the hypothesis;

H1: Appraisal dimensions will most readily be associated with ratings of valence.

Second, stemming from the literature on interest;

H2: Appraisals associated with the wider appraisal groups ‘Novelty’ and ‘Coping Potential’ will be associated with ratings of interest.

3.2 Method

3.2.1 Participants

66 participants (Female: N=43; Age ranges from 18-69, mean age=34.5, sd=11.3) were collected through Prolific using the criteria UK national since birth and still resident in the UK. The largest proportion of the participants represented Music-loving non-musicians (n=34) and amateur musicians (n=17) with a G-MSI musical

training score (mean=20.47), slightly lower than the British average (Müllensiefen et al. 2014).

3.2.2 Scales

As noted in the introduction section a review of several appraisal terms that have been used in previous utilitarian and aesthetic experiments, or suggested as terms for musical appraisal were reviewed (Appendix B.0.1). From this review a collection of several possible appropriate terms to measure appraisals were developed. These appraisal dimensions are theoretically grouped around the four broader appraisal categories (relevance, implications, coping potential, and norm-compatibility). These four broader appraisal categories are commonly applied to music (Scherer and Coutinho 2013; Céspedes-Guevara 2021). Although the CODA model (Lennie and Eerola 2022) does not theoretically describe all these possible appraisal dimensions (e.g., intrinsic pleasantness) or acknowledge all wider appraisal groupings (e.g., norm-compatibility), I remind the reader that the CODA model represents a conservative list of appraisal dimensions⁴ and acknowledges that further appraisal dimensions are possible. As such it seems prudent to include as many appraisals as possible in an initial test battery.

The chosen terms for each appraisal dimensions were developed from the existing expert suggestions in the literature (see Appendix B.0.1) and evaluated for their relevance to the experimental design (an online listening study) by the author and two other music experts at Durham University. I note there are also several additional foci appraisal can take, such as, the appraisal sub-category ‘adjustment’ (an individual’s ability to change the situation they are listening in; e.g., leave a concert) or ‘causal attribution’ (who is generating the music: self/other). However, the foci of such appraisal terms do not seem relevant to the online listening experiment presented here and are subsequently removed. The appraisal devel-

⁴The CODA model identified only appraisals that are acknowledged by nearly all appraisal theories (core appraisals, Moors et al. 2013) and show evidence of an underlying neurological system

oped here represent general applications that could be recognizable to a typical music listener. In cases where multiple terms appeared equally as valid for an individual appraisal dimension all were included in the question design with no theoretical reason to discard them at this point. This led to a total of 14 appraisal terms, representative of eight appraisal dimensions and the four wider appraisal groupings, presented in Table 3.1.

In addition to the appraisal dimensions, participants were asked to provide ratings of valence, arousal, and interest given the existing literature on appraisal and its links to these key components of an emotional-episode. Arousal was described as “how sleep - awake do you feel the music to be”. Valence was described as “how positive - negative you feel the music to be”. Interest was described as “how interesting - uninteresting do you feel the music to be”. All 17 scales were rated on a Likert scale (1-7).

Table 3.1: Selected appraisal terms and their relationship to different appraisal categories

Appraisal Group	Sub-category	Question format	Scale
Relevance	Novelty	<i>How predictable in the music?</i>	<i>Unpredictable / Predictable</i>
		<i>How familiar is the music?</i>	<i>Unfamiliar / Familiar</i>
		<i>How complex is the music?</i>	<i>Simple / Complex</i>
	Intrinsic Pleasantness	<i>How pleasant is the music?</i>	<i>Unpleasant / Pleasant</i>
	Goal-relevance	< <i>How expressive is the music?</i> >	<i>Unexpressive / Expressive</i>
Implications / Consequences	Expectations	< <i>Did the music have a strong effect on you?</i> >	<i>No Effect / Strong Effect</i>
		<i>Did you expect to hear music like this?</i>	<i>Did not expect / Expected</i>
	Goal-congruence	<i>Did the music produce a desirable outcome?</i>	<i>Undesirable / Desirable</i>
		* < <i>How satisfying is the music?</i> >	<i>Unsatisfying / Satisfying</i>
Coping Potential	Control	* <i>How comprehensible is the music?</i>	<i>Incomprehensible / Comprehensible</i>
Norm-compatibility	Internal-standards	* <i>Do you find the music aesthetically beautiful?</i>	<i>Un-beautiful / Beautiful</i>
		* <i>Do you find the music aesthetically challenging?</i>	<i>Unchallenging / Challenging</i>
		<i>Does the music represent your personal ideas of good music?</i>	<i>Poor / Good</i>
	External-standards	<i>Does the music conform to socially accepted ideas of good music?</i>	<i>Violates / Conforms</i>

Note:

^aMultiple appraisal formats are suggested if there is not sufficient evidence to conclude that one may offer a better interpretation for musical appraisal.

^bIn line with other appraisal theories, this musical interpretation suggests that some appraisal formats may be representative of an appraisal group instead of a single sub-category. These appraisals are marked *.

^cSome appraisal formats are implicit measures of appraisals, less available to consciousness. These appraisals are marked <>.

3.2.3 Musical stimuli

Stimuli were selected from the DEAM dataset (Alajanki, Yang & Soleymani, 2016). This dataset consists of 1800 royalty-free 45-second samples from 10 genres of music. All samples contain the same sampling frequency (44100Hz). The dataset provides mean and standard deviation (SD) ratings of valence and arousal for

each excerpt. Excerpts were chosen to represent five broad typically studied Western music genres (Classical, Electric, Jazz, World/International, Pop/Rock) (Rentfrow, Goldberg, and Zilca 2011). For each of the five selected genres, more and less ambiguous stimuli were selected using SD ratings for both valence and arousal. High-SD was defined as > 2.0 and Low-SD was defined as < 1.0 for both valence and arousal rating leading to four categories of variance (high-sd-arousal; low-sd-arousal; high-sd-valence; low-sd-valence). For each of the variance categories, three excerpts were chosen for each genre. This led to a total of 60 musical stimuli. All selected tracks had no lyrics, or indiscernible lyrics/in a very different language for UK participants. The full list of tracks can be viewed in the appendix B.0.2. Valence and arousal scores collected in this experiment show that the stimuli represent a diverse range of the affective space as core-affect (see appendix B.0.3).

3.2.4 Procedure

- 1) Participants were initially given the experimental instructions, descriptions of valence, arousal, and interest and a volume check, before being asked to keep the volume constant for the remainder of the experiment.
- 2) Participants were randomly presented one example of each high and low standard deviation tracks for valence and arousal in each of the five genre categories. This means each participant rated 20 tracks of the possible 60. The tracks were evenly presented in their randomisation.
- 3) Finally participants were asked to fill in the G-MSI (Müllensiefen et al. 2014) musical training questionnaire, asked to provide their self-descriptive musicality level (Non-musician; Music-loving nonmusician; Amateur musician; Serious amateur musician; Semi-professional musician; Professional musician), their genre preferences (Rock and/or Heavy; Pop and/or Electro; Classical and/or Ethnic; Other) and some demographic questions (Age, and Gender).

3.3 Results

All data was analysed in RStudio. G-MSI scores were calculated in accordance with (Müllensiefen et al. 2014). Where appropriate additional analyses can be found in the supplemental material. The R scripts and data can be accessed from (https://github.com/lenni3/Exploratory_Appraisals_in_Music).

3.3.1 Appraisal dimensions

First each measured dimension was assessed for its internal consistency using Cronbach's alpha. Nearly all appraisal terms produced good or better ratings of internal reliability ($>.70$). The terms 'Effect' (the 'goal-relevance' appraisal sub-category) and 'Challenge' (the 'internal-standards' appraisal sub-category) had very low alpha scores suggesting they were not good psycho-metric terms and individuals had different understanding / uses of them. These two appraisal dimensions were removed from further analyses. Confidence intervals suggest reasonable homogeneity across rating scales within the group of participants. This suggests that the data is fairly robust for assessing how variables related to individual differences (Age, Genre preferences, Genre type of the music, etc.) may differ with regard to individual's appraisal of the music.

3.3.2 Correlations

Following the removal of the two appraisal dimensions that did not fulfill the criteria for a valid scale, correlations between appraisal dimensions and the dependent variables were considered (Figure 3.2). Several appraisal terms were used to represent the same dimension as it was not clear whether supporting one interpretation over another was theoretically justifiable. It may also be that appraisal dimensions differ with regards to music and overlap significantly in the variance they explain. Finally, identifying how appraisals correlate with the dependent variable can also be informative given previous work on the overlap between core-affect and interest with appraisals.

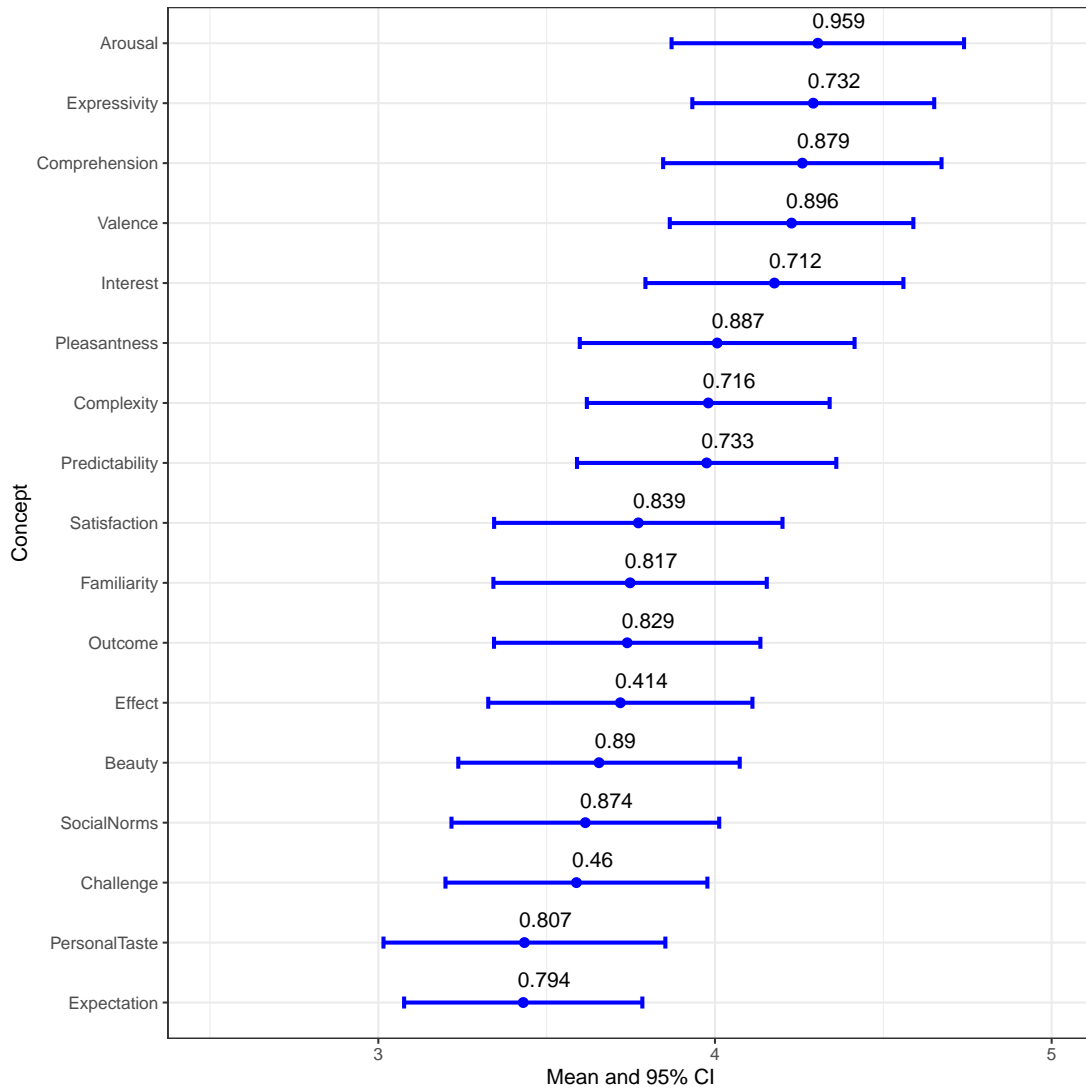


Figure 3.1: Confidence interval and Cronbach alphas for scales of measurement

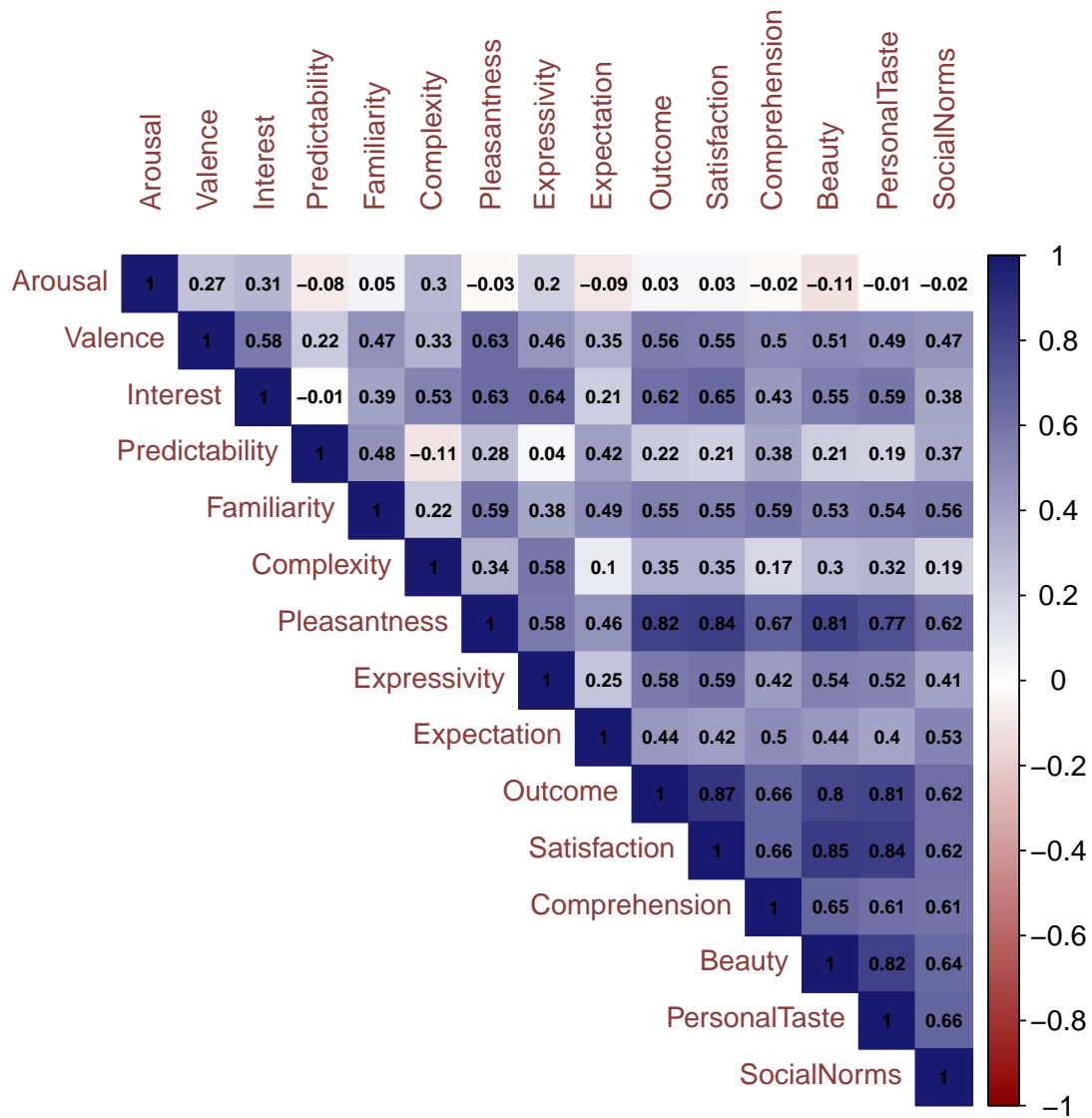


Figure 3.2: Correlation table for individual appraisal dimensions with arousal, valence, and interest

The results show a clear correlation between the dependent variables ‘Valence’ and ‘Interest’ with several appraisal dimensions. Arousal alternatively shows almost no correlation with appraisal dimensions with the exception of weak correlations with ‘complexity’ and ‘expressivity’. Individual appraisal dimensions showed several correlations ranging from weak to strong. Several of the strongest correlations ($>.80$) emerged between terms that were representative of the same underlying appraisal dimension. ‘Satisfaction’ and ‘Outcome’ correlated highly (.87). Both terms were theoretically representative of the same appraisal dimension (goal-congruence). Appraisal terms can be averaged to form a composite scale managing such high intercorrelations (Scherer, Dan, and Flykt (2006)) while minimising the loss of data collection. ‘Satisfaction’ and ‘Outcome’ were averaged to form a composite scale called ‘Goal-congruence’. ‘Beauty’ and ‘Personal Taste’ similarly correlated highly (.82) while both are theoretically representative of the same appraisal dimension (Internal-standards). These two scales were averaged to form a composite scale ‘Internal Standards’. Though there was a similarly high correlation between all four of these scales ($>.80$) they are theoretically associated with different appraisal dimensions and different theoretical levels of the appraisal model. They were therefore kept to allow for the hierarchical structure of the appraisal model to be preserved. As much evidence from utilitarian research has supported this construction (Davidson, Sherer, and Goldsmith 2009), the author sees no reason to assume *a priori* that musical emotions represent a smaller set of theoretical cognitive levels based on an exploratory study. Moreover, such high correlations may be a by-product of the DEAM data set or the selected stimuli, though they were representative of a less stereotyped collection from the affective space.

3.3.3 Exploratory factor analysis

The new set of ten appraisal dimensions were used in a parallel analysis to estimate the number of components and factors to be used in this exploratory analysis. The appraisal dimensions here produce a 2 component and 3 factor analysis. The

scree plot can be viewed in the Supplemental Material B.0.4. An exploratory factor analysis was run following (Watkins 2018) assuming a 3 factors solution and using an “oblimin”⁵ rotation and a principal factor solution. The exploratory three factor solution shows that items load on to factors sufficiently ($|\text{factor loadings}| > 0.30$). Two variables (Comprehension and Social norms) showed small cross-loadings but differences between loadings were substantial enough not to be of concern to the interpretation or independence of the factors ($> .12$; see Appendix B.0.5). The Tucker Lewis Index produced an acceptable fit ($\text{TLI} = 0.972$; $> .9$, Bentler and Bonett (1980)) and the Root Mean Square Error of Approximation was acceptable towards good ($\text{RMSEA} = .0649$ with 90 % confidence intervals of 0.0587 0.0712; L. Hu and Bentler (1999)). All sum of squared loading were > 1 indicating the factors are meaningful using Kaiser’s rule.

Each factor was named based on the strength of the loadings and the theoretical discourse on appraisal theory, discussed in greater detail in the discussion on this experiment 3.4.1.2. Factor 1 was named ‘Goal-congruence’ and accounts for 36% of the variance. Factor 2 was named ‘Novelty’ and accounts for 13% of the variance. Factor 3 was named ‘Goal-relevance’ and accounts for 18% of the variance. Individual factor loading for each item and correlations between factors are presented in Figure 3.3.

3.3.4 Modelling latent appraisal variables

Following the factor analysis the latent variables were assessed in several linear mixed model (LMM) analyses. First, to assess the ability of variables associated with individual differences to predict the latent factors and second, the latent factors’ ability to predict individually felt ratings of arousal, valence, and interest.

To explore the relationship between individual differences and appraisal, the first batch of LMMs looked at how mediating variables influence the latent appraisal

⁵Oblimin rotation assumes that the latent factors are correlated; as one would expect with appraisal dimensions.

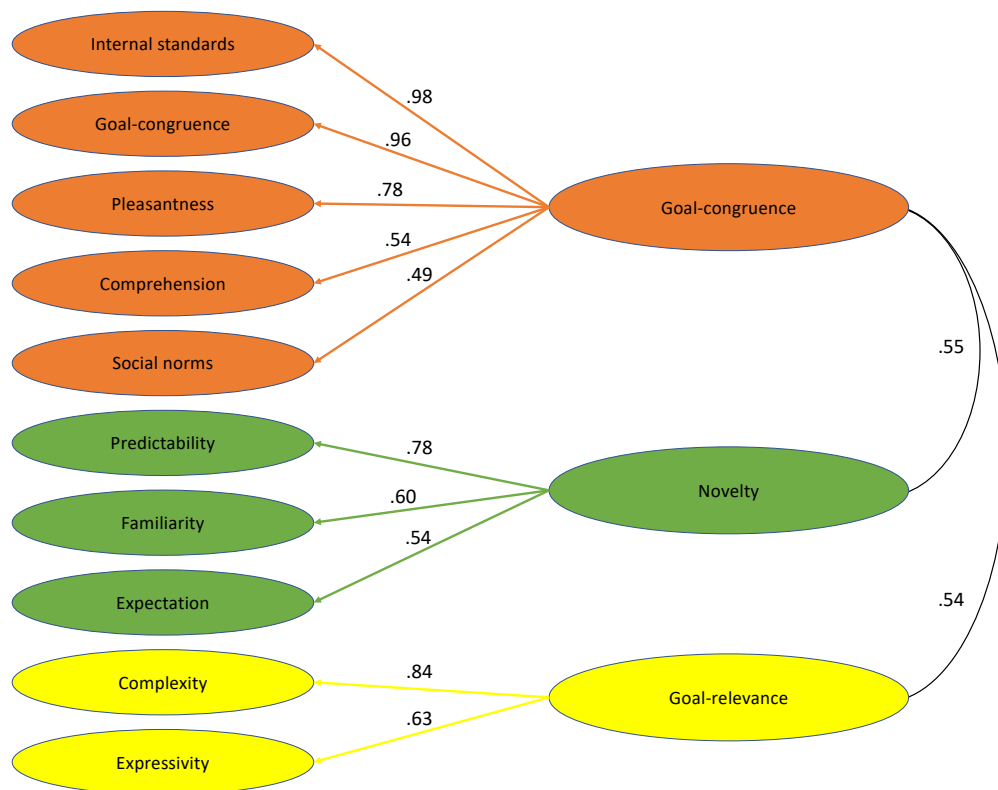


Figure 3.3: Factor analysis with component loadings and factor correlation coefficients

factors. A separate LMM was run for each latent factor ('Goal-congruence', 'Novelty', 'Goal-relevance') with six fixed effects (Variability [HIGH SD AROUSAL, HIGH SD VALENCE, LOW SD AROUSAL, LOW SD VALENCE], Genre [CLASSICAL, ELECTRIC, JAZZ, POP/ROCK, WORLD], Gender [MALE, FEMALE], Age, Genre preference [ROCK/HEAVY, POP/ELECTRO, CLASSICAL/WORLD, OTHER], and Musical self-image [NON-MUSICIAN; MUSIC-LOVING NON-MUSICIAN; AMATEUR MUSICIAN; SERIOUS AMATEUR MUSICIAN; SEMI-PROFESSIONAL MUSICIAN; PROFESSIONAL MUSICIAN]) and two random effects (Participant and Track). I remind the reader here that 'Variability' is associated with the perceived ratings of valence and arousal provided by the DEAM dataset and was used to select experimental stimuli for this experiment. It is qualitatively different to the felt ratings of valence and arousal collected in this experiment.

The first latent factor ('Goal-congruence') showed one fixed effect with significant differences, Variability [LOW SD AROUSAL ($t(52.0)=2.19$, $p=.033$)]. The second latent factor ('Novelty') showed no significant predictors for mediating variables. The third latent factor ('Goal-relevance') showed three fixed effects with significant differences; the JAZZ Genre ($t(52.0)=3.17$, $p=.003$), the WORLD Genre ($t(52.0)=2.60$, $p=.012$) and Musical self image [Non-musician ($t(41.0)=-2.13$, $p=.039$)]. The full tables for each LMM can be viewed in the Supplemental Material B.0.6.

The second set of LMMs explored the contribution of latent appraisal factors in predicting ratings of valence, arousal, and interest. Separate linear models were run for each dependent variable (arousal, valence, and interest) with nine fixed effects (Goal-congruence, Novelty, Goal-relevance, Variability [HIGH SD AROUSAL, HIGH SD VALENCE, LOW SD AROUSAL, LOW SD VALENCE], Genre [CLASSICAL, ELECTRIC, JAZZ, POP/ROCK, WORLD], Gender [MALE, FEMALE], Age, Genre preference [ROCK/HEAVY, POP/ELECTRO, CLASSICAL/WORLD, OTHER], and Musical self-image [NON-MUSICIAN;

Table 3.2: Linear mixed model for arousal ratings predicted by latent appraisal factors

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.118	0.607	92.619	6.779	0.000
Goal relevance	0.262	0.042	949.485	6.217	0.000
GenderMale	-0.340	0.147	42.223	-2.312	0.026
GenreElect.	1.438	0.463	51.476	3.106	0.003
GenreJazz	1.443	0.464	51.827	3.112	0.003
GenrePop	1.757	0.463	51.636	3.793	0.000
GenreWorld	1.408	0.464	51.814	3.037	0.004
VariabilityLoSd_A	-0.896	0.414	51.661	-2.161	0.035
Goal congruence:Novelty	0.043	0.018	958.552	2.386	0.017

^a Table reports only significant results. The full table can be viewed in the supplemental material

MUSIC-LOVING NON-MUSICIAN; AMATEUR MUSICIAN; SERIOUS AMATEUR MUSICIAN; SEMI-PROFESSIONAL MUSICIAN; PROFESSIONAL MUSICIAN]), three interaction effects (Goal-congruence*Novelty, Goal-congruence*Goal-relevance, and Novelty*Goal-relevance), and two random effects (Participant and Track).

Arousal showed significant effect for the latent appraisal factor Goal-relevance, as well as Gender [Female], Genre [Electric, Jazz, Pop, World], Variability [Low SD Arousal]. One interaction effect emerged between the latent appraisal factors Goal-congruence and Goal-relevance. Only significant effects are presented here in Table 3.2. The full table of results for all LMMs can be seen in the Supplemental Material B.0.7.

Valence showed significant effects for all latent appraisal factors Goal-congruence, Novelty, and Goal-relevance, as well as Genre [Jazz, Pop, World]. Significant effects are presented in Table 3.3.

Interest also showed significant effects for all latent appraisal factors Goal-congruence, Novelty, and Goal-relevance, as well as Genre [Jazz, Pop, World], and Age. Significant effects are presented in Table 3.4.

Table 3.3: Linear mixed model for valence ratings predicted by latent appraisal factors

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.389	0.366	75.822	11.983	0.000
Goal congruence	0.310	0.040	859.427	7.748	0.000
Novelty	0.187	0.034	726.044	5.562	0.000
Goal relevance	0.185	0.037	874.782	5.038	0.000
GenreJazz	0.730	0.217	52.109	3.372	0.001
GenrePop	0.688	0.216	51.506	3.186	0.002
GenreWorld	0.589	0.217	52.092	2.718	0.009

^a Table reports only significant results. The full table can be viewed in the supplemental material

Table 3.4: Linear mixed model for interest ratings predicted by latent appraisal factors

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.495	0.390	54.576	11.534	0.000
Goal congruence	0.430	0.037	957.934	11.626	0.000
Novelty	-0.108	0.032	918.735	-3.420	0.001
Goal relevance	0.435	0.034	947.297	12.806	0.000
Age	-0.014	0.005	41.718	-2.762	0.009
GenrePop	0.571	0.151	52.313	3.772	0.000
GenreWorld	0.430	0.152	53.245	2.829	0.007

^a Table reports only significant results. The full table can be viewed in the supplemental material

To compare each model's the effect size the goodness-of-fit (R^2) was compared across models. A reduced nested model was built for each dependent variable (arousal, valence, and interest). This nested model included only fixed effects that showed significant differences for at least one of the dependent variables (Goal-congruence, Novelty, Goal-relevance, Gender [MALE, FEMALE], Genre [CLASSICAL, ELECTRIC, JAZZ, POP/ROCK, WORLD], Variability [HIGH SD AROUSAL, HIGH SD VALENCE, LOW SD AROUSAL, LOW SD VALENCE], and Age) and two random effects (Participant and Track). The arousal model produces a weak but not un-substantial fit with the data ($R^2_{LMM(m)}=.21$) nonetheless the largest proportion of the model was explained by the random variables ($R^2_{LMM(c)}=.62$). The valence model performed well for psychological models ($R^2_{LMM(m)}=.41$), random effect improving the model by 11% ($R^2_{LMM(c)}=.52$). The interest model produced a very strong fit with the data ($R^2_{LMM(m)}=.59$, $R^2_{LMM(c)}=.64$).

Finally, each latent appraisal factor was plotted showing the contribution of each sub-appraisal category in the latent factor. Goal-congruence was a significant predictor of valence and interest ratings (Figure 3.4) . Novelty was a significant predictor of valence and interest ratings (Figure 3.6). Goal-relevance was a significant predictor of valence, interest, and arousal ratings (Figure 3.5). Each plot additionally shows the contribution of each sub-category appraisal within a factor plotted for individual genres because genre was a contributing factor in all LMMs.

3.4 Discussion

The discussion first centres on the exploratory nature of the experimental design. It takes the test battery of appraisal terms developed for the experiment and focuses upon the validity of the appraisal terms for measuring their representative appraisal dimension, the overarching structure of musical appraisal in comparison to previous work, and the effects of individual differences upon appraisal. Next it will look at the ability of appraisal factors to predict induced ratings of core-affect

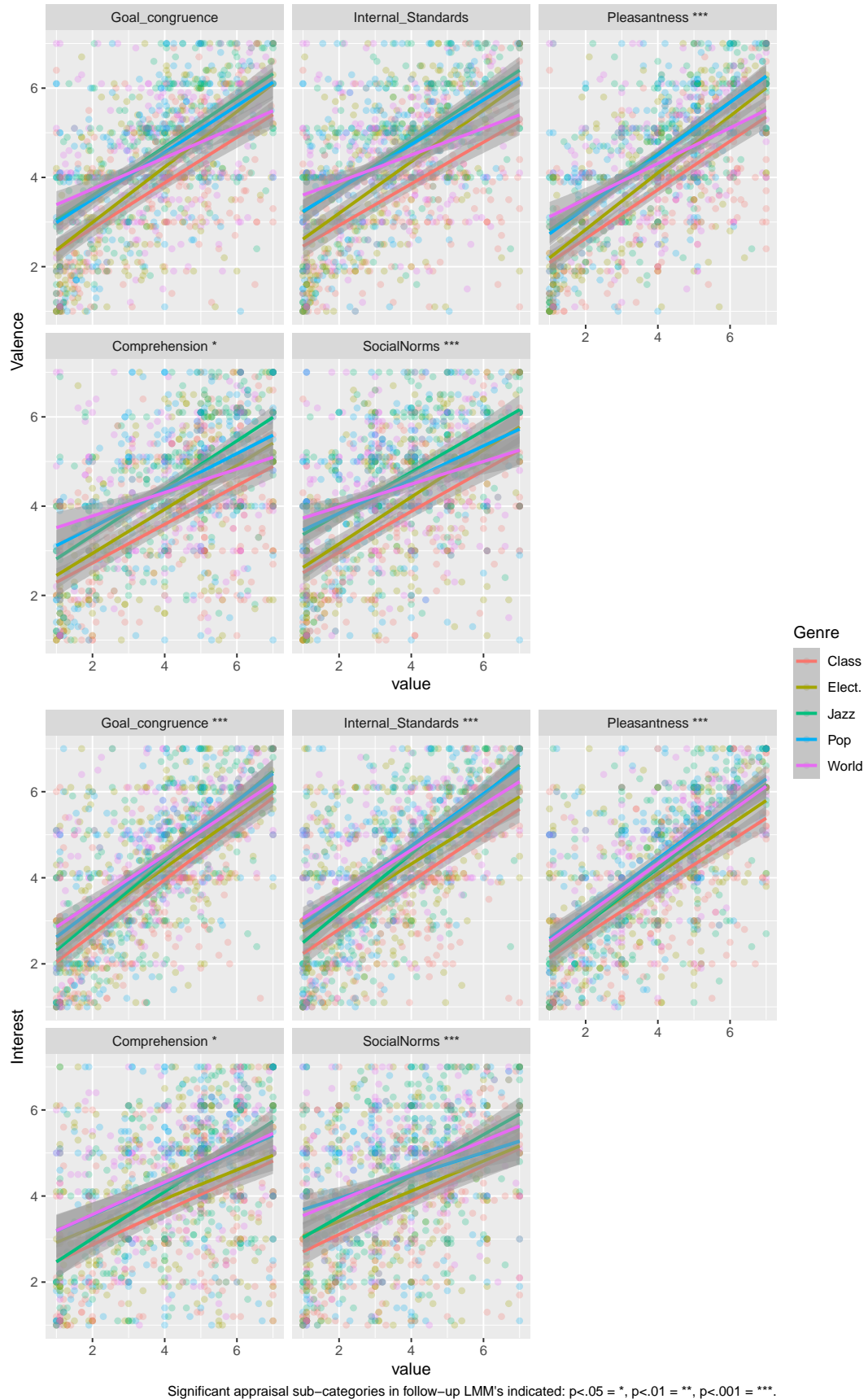


Figure 3.4: Ratings of valence and interest for individual appraisal sub-categories in the latent Goal-congruence factor grouped by genre

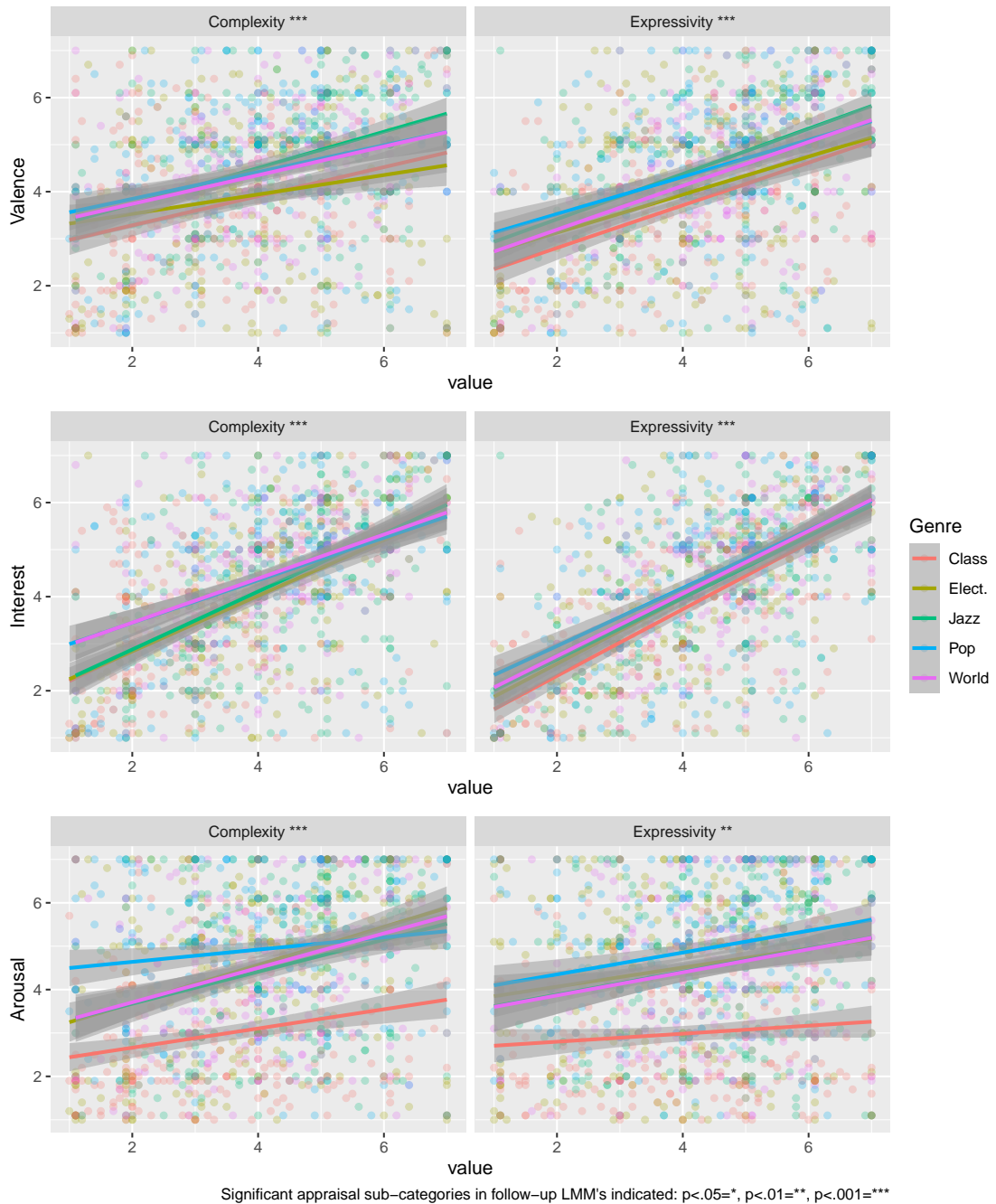


Figure 3.5: Ratings of valence, interest, and arousal for individual appraisal sub-categories in the latent Goal-relevance factor grouped by genre

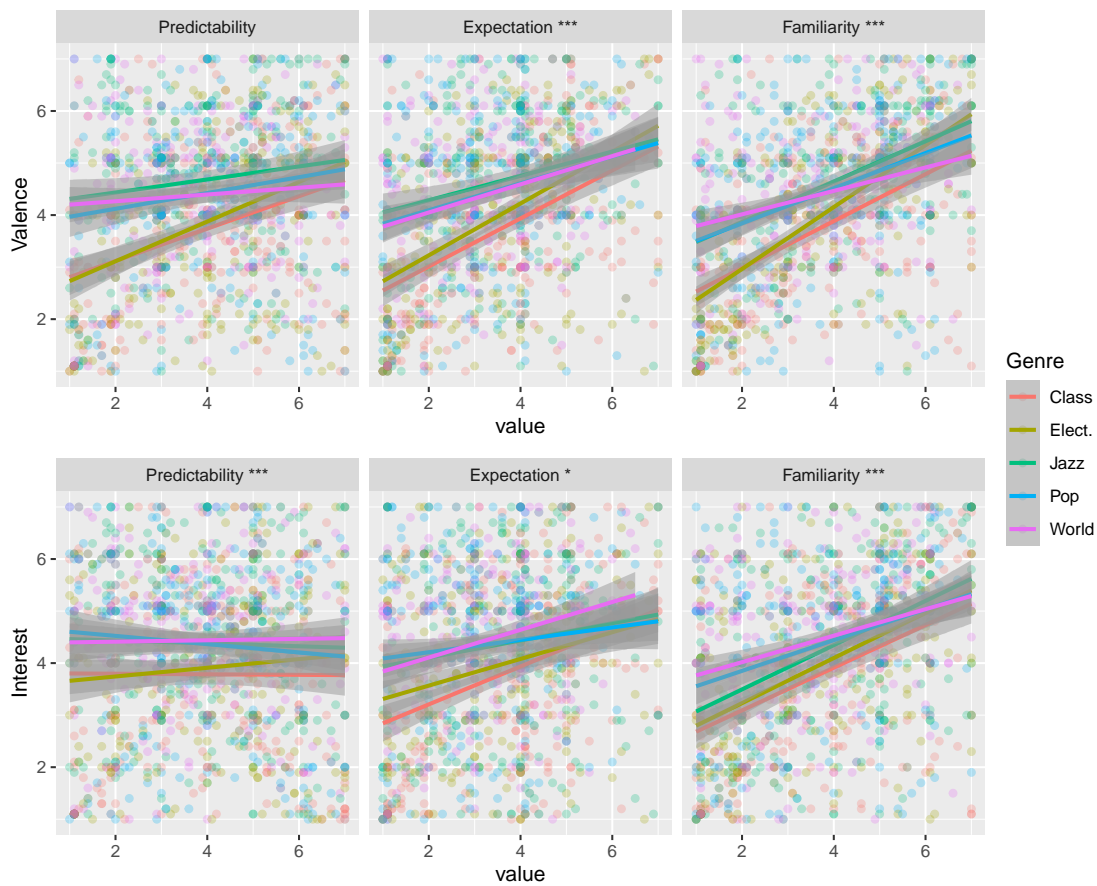


Figure 3.6: Ratings of valence and interest for individual appraisal sub-categories in the latent Novelty factor grouped by genre

with regards to valence and arousal individually, followed by appraisal factors as predictors of interest. Interest is also discussed in regards to Silvia's hypotheses before taking a wider view of interest as a place holder for the relevance of a stimulus to an individual. Finally, some limitations and future directions are discussed in relation to adopting a goal-directed approach to the study of musical appraisal.

As many of the wider appraisal groups, the newly named latent factors, individual appraisal dimensions, and the terms used in this experimental design to represent appraisals share similar names (see 3.1), I distinguish between them in the discussion as follows. Appraisal groups and latent factors are referred to with capitals in single quotation marks. Individual appraisal dimensions are referred to in lower case in single quotation marks. The terms used in the experiment to represent appraisal dimensions are referred to in double quotation marks.

3.4.1 Appraisal dimensions in music

Here I discuss the validity and latent structure of appraisal dimensions and the role of individual differences in appraisal.

3.4.1.1 The validity of appraisal dimensions for music

Of the hypothesised 14 appraisal dimensions 12 showed good internal consistency across participants. Some of the appraisal terms used were representative of the same appraisal dimension (sub-category, 3.1). The terms "outcome" and "satisfaction" were both representative of the appraisal dimension 'goal-congruence'; "beauty" and "personal taste" were both representative of the appraisal dimension 'internal standards'. In these cases neither term was judged to be more robust than the other. Instead, a further reduction in the number of appraisals was applied by assessing the correlation between appraisal dimensions. Strong correlations ($>.80$) in appraisal terms that were representative of the same appraisal dimensions (appraisal sub-category) were averaged to form a composite measure. This

left a total of 10 appraisal terms, representative of all appraisal sub-categories and the four larger appraisal groups.

What is interesting about in the correlation between appraisal terms is that in some cases where multiple terms were used to represent a single appraisal dimension (e.g., “predictability”, “familiarity”, and “complexity” were all used as indicators of the ‘novelty’ appraisal dimension) there were not substantial enough correlations between terms to justify forming a composite measure. This suggests that some appraisal dimensions are in themselves multifaceted constructs, at least in their construction as linguistically accessible cognitive structures.

It is also interesting that certain appraisal terms are considered by the theories that suggested them to be representative of the wider latent appraisal group, instead of a single dimensional appraisal sub-groups (e.g., “satisfaction”⁶ was hypothesised to be representative of the wider group of appraisals that form the ‘Implications and Consequences’ group; and “beauty”⁷ was hypothesised to be representative of wider ‘Norm-compatibility’ group). These results suggest that there are meaningful distinctions between individual appraisal dimensions. Furthermore, theories that have considered appraisal groups as wider constructs could benefit from a more nuanced view of how appraisal terms may contribute to musical appraisal and further cognitive processing.

Finally, I note that several appraisal terms were representative of appraisal dimensions that are seen to be less accessible to conscious experience and are measured implicitly. For example, “expressivity” and “effect”⁸ are representative of the ‘goal-relevance’ appraisal dimension which is an appraisal hypothesised to be less accessible to conscious experience (Scherer, Dan, and Flykt 2006). Similarly, “satisfaction” was hypothesised to be an implicit measure of ‘goal-congruence’, another less consciously accessible appraisal dimension. With regard to these terms, the results suggest that the appraisal dimension can be measured successfully in

⁶an appraisal term that became part of the ‘goal-congruence’ composite

⁷an appraisal term that became part of the ‘internal-standards’ composite

⁸The appraisal term “effect” was removed from subsequent analyses for low internal reliability

a musical context through the use of implicit measures, allowing conclusions to be formed that can at least be seen as indicative of the underlying mechanisms. Acknowledging that certain terms were hypothesised to be implicit measures of appraisal dimensions may explain why some terms did not produce substantial internal reliability measures (e.g., in the case “effect”, a term that was dropped from subsequent analyses).

In sum, what can be concluded thus far is that several appraisal terms, representative of a wide spectrum of appraisal dimensions and all wider appraisal groups, form a valid set of measures for the cognitive assessment of music. This vastly expands previous conceptions about which cognitive mechanisms are substantive features in the cognitive appraisal of music. Moreover, it allows for a baseline of comparison upon which further terms, additional appraisal dimensions, and context specific adaptations can be built.

3.4.1.2 The structure of musical appraisals

To assess the structure of musical appraisal dimensions, initially a parallel analysis was run to determine the number of components/factors captured by the terms. The principal component analysis (PCA) suggested a two component solution. PCA seeks to identify the cumulative variance that the observed appraisal dimensions explain, i.e., the variance in the data explained by the appraisal terms is best described in two dimensions. This fits well with the structure of the stimuli used in this experiment (musical stimuli that varied across two dimensions; valence and arousal) and suggests that ratings of appraisal dimensions do vary across core-affect.

The exploratory factor analysis alternatively seeks to identify the number of underlying or latent factors that are captured within the appraisal dimensions, i.e., the degree of correlation between appraisal dimensions that suggests a common or indicative grouping of the measures. Factor analysis supports a three-factor solution of appraisal dimensions; that is three wider appraisal groups. Individual

components loaded cleanly on to each factor which suggests a reasonably robust analysis.

This three-factor solution differs from the initial theoretical framework proposed (Table 3.1). A four-factor model is common to many appraisal theories ('Relevance', 'Implications', 'Coping Potential', and 'Norm-compatibility'; Ellsworth and Scherer (2003)). This analysis is more inline with other models of appraisal that describe the fourth set of appraisal dimensions ('Norm-compatibility') as another form of goals (C. A. Smith and Lazarus 1991). That is to suggest something that is inline with our social and/or individual norms can be seen as something that is appraised as goal-congruent. There is of course the possibility that the distinction between goal-congruence (in the 'Implications/Consequences' appraisal group) and 'Normative Significance' is not captured in this set of stimuli (the stimuli did not vary significantly in these dimension from those in goal-congruence). Similarly, the experimental participants (British nationals) may not capture meaningful distinctions between what people see as social/individually normative as opposed to goal-congruent with out an alternative comparison group. More explicit experimental designs would be needed to assess if these additional appraisal dimensions are meaningful in music, for instance, including more stimuli from different cultural traditions and participants from other cultures.

In further contrast to the four-factor model the appraisal dimensions were based on (Table 3.1). Individual appraisal dimension do not load on to the latent factors in a comparable way to existing theories. Indeed, the latent factors contain components from multiple wider appraisal groups. Nonetheless, some interpretation can be made in relation to how these components may represent key components in musical appraisal. The first factor 'Goal-congruence' shows appraisal dimensions loading from all four of the wider appraisal groups. The two variables with the strongest factor loadings are the two composite scales ('internal standards', .98; and 'goal-congruence', .96). Here I follow Smith and Lazarus (1991) and take appraisals from the 'Norm-compatibility' group, representative of higher cognitive

goals, to be subsumed under ‘goal-congruence’ generally. Subsequently the factor was named ‘Goal-congruence’. The second factor ‘Novelty’ comprises three terms representing two different appraisal dimensions (‘novelty’ dimensions and ‘expectations’ dimensions). These dimensions are from two different wider appraisal groups (‘Relevance’ and ‘Implications/Consequences’). The two strongest factor loadings (“predictability”, .78; and “familiarity”, .60) come from the ‘novelty’ appraisal dimensions, therefore, the factor was named the ‘Novelty’ factor.

The third factor ‘Goal-relevance’ comprises two appraisal terms (“complexity”, .84; and “expressivity”, .63) both representing appraisal dimensions from the wider appraisal group ‘Relevance’. In the table of appraisal terms presented in this experiment (Table 3.1) “complexity”, as the strongest loading variable in the factor, is represented as relating to the ‘novelty’ appraisal dimension. This choice to have the term “complexity” representative of the ‘novelty’ dimensions was informed by Silvia’s (2005a, 2005b, 2006) work on aesthetic appraisal. However, the other terms representative of the ‘novelty’ appraisal dimensions in this experiment appear more closely related to the second latent factor (‘Novelty’; comprising of “predictability”, “familiarity”, and “expectation”). The terms that load on to the second factor are more in line with utilitarian construction of appraisal theory and hold a greater degree of consensus across theoretical applications of appraisal theories for music. It is worth noting that Silvia used an experimental manipulation of more and less complex visual images as representative of complexity; his design did not use the term “complexity” as was done here. The term “complexity”, however, shows a substantial amount of disagreement across different theoretical interpretations of appraisal theories. Cespedes-Guevara (2021), for example, alternatively to Silvia (Silvia 2005b, 2005a) places the term “complexity” as relating to the appraisal grouping ‘Norm-compatibility’ (see Appendix B.0.1). Robinson (2005), however, in her philosophical account of aesthetic appraisal interprets the term “complexity” as referring to the emotional complexity of what is being expressed by music; something closer to the implicit measure of goal-relevance presented in this adaption of appraisal terms. Given the lack of consensus on

the term “complexity” and the lack of compatibility the term shows with other variables associated with the ‘novelty’ appraisal dimensions, the second highest loading component was selected to guide the interpretation of the factor (“expressivity”, relating to the appraisal dimension ‘goal-relevance’). Subsequently, and in line with Robinson’s (2005) interpretation, the factor was named ‘Goal-relevance’.

3.4.1.3 Individual differences in appraisal factors

To explore the three-factor appraisal structure presented above, the latent appraisal factors were analysed using LMMs to assess the influence of individual differences on each. Results show that while some significant effects emerged for ‘Goal-relevance’ and ‘Goal-congruence’ (Genre, Musical Self-image, and Variability) there are no consistent effects across factors. One point of interest in the findings is that the ‘Novelty’ factor showed no significant differences for individual variables, suggesting that this appraisal factor is more robust to the effects of individual differences than the other appraisal factors identified by this analysis, at least in the context of a within culture participant pool. It remains quite plausible that this would not be the case at a cross-cultural level. I remind the reader that the collection of musical stimuli included world music tracks but a balanced cross-cultural design would be more robust.

3.4.2 Appraisal and core-affect

The relationship between appraisal and core-affect (valence and arousal) is a key component of many utilitarian (Clore and Ortony 2013; Russell 2003, 2009) and musical theories (Céspedes-Guevara 2021; Lennie and Eerola 2022), as discussed in the introduction to this experiment. Individual LMMs assessed the contribution of latent appraisal factors for valence and arousal individually. Plots and follow-up LMMs show the contribution of individual appraisals within a factor to the dimensions of core-affect individually (see Figures 3.4 - 3.5 and the full table of results in the Appendix B.0.8).

The arousal model showed the latent factor ‘Goal-relevance’ to be the strongest predictor. The relationship between ‘Goal-relevance’ and arousal is regularly hypothesised in the utilitarian research (Kuppens, Champagne, and Tuerlinckx 2012) and recently in relation to music too (Lennie and Eerola 2022). The results from this exploratory experiment supporting this goal-relevance hypothesis. What remains unclear with music is the causal direction of this interaction. Kuppens et al. (2012) found evidence for a one-way relationship between arousal ratings and goal-relevance appraisals. In Kuppens et al.’s case, the causal arrow leads from increased arousal to higher levels of ‘goal-relevance’; as Kuppens et al. argue, arousal as an attention orientating system leads to a heightened sense of ‘goal-relevance’. The results here show ‘goal-relevance’ is predictive of ratings of arousal in music, supporting hypotheses for the causal interaction between ‘goal-relevance’ and arousal. However, with the lack of data for ratings over time, the direction of this causal interaction is not possible to identify. The most likely interpretation, as argued by Lennie and Eerola (2022), is that this relationship is bi-directional and in different contexts the direction of this causal relationship can change - an emotional-episode is a dynamic process (Scherer 2009b). What is clear from these results is that a relationship between ‘Goal-relevance’ and arousal is evident in music too.

Genre also plays a significant role in predicting arousal. The ‘Goal-relevance’ factor may be the most substantial individual component, however, the cumulative variance explained by all genres together accounts for the largest part of the model. Such distinctions between genres can be seen even within the ‘Goal-relevance’ appraisal dimensions (Figure 3.5). Classical music for example, appears to produce substantially lower arousal ratings than other genres, although the trend is positively related to arousal across all genres. Similarly, the relationship between the ‘complexity’ appraisal and arousal appears to differ by genre, some genres showing substantially steeper trends than others (e.g., World and Electronic vs. Pop and Classical). This suggests there is a substantial amount of variance in arousal that is inherently within the music itself. This is in agreement with previous con-

clusions that arousal is easier to predict from acoustic cues (Céspedes-Guevara and Eerola 2018). This conclusion is further verified by assessing the model’s goodness-of-fit with the data. The arousal model’s fixed factors contribution was modest at best, though not inconsequential. The largest amount of the variance was explained by the random factors (between participant variance and individual tracks). This again implies that arousal ratings can be accounted for reasonably successfully by features of the stimulus.

The results for arousal best explained by the factors within the music, yet, the inclusion of appraisal can certainly improve the model. Appraisal in the context of the ‘Goal-relevance’ factor, associated more typically with implicit and less consciously accessible appraisals, contribute meaningfully to the model. These results provide the first support for the predictions of several appraisal theories of music: that *cognitive appraisals influence core-affect in a musical context*. One further novel insight beyond this, and in line explicitly with the predictions of the CODA model (Lennie and Eerola 2022) over competing models, is the addition that goal-directed appraisals contribute to variations in arousal. This challenges previous convictions that music lacks goal-relevance (Juslin and Västfjäll 2008; Juslin 2013) and that ‘Novelty’ appraisals are the only appraisal associated directly with musical core-affect (Céspedes-Guevara 2021). This research adds that ‘novelty’ appraisals are better characterised by their interaction with ‘Goal-congruence’ appraisals and suggests that previous conclusions about the role of ‘Novelty’ appraisal should be expanded to include appraisals associated with ‘Goal-congruence’, again inline with the predictions of the CODA model (Lennie and Eerola 2022). These conclusions not only add novel insights to appraisal theory but substantially challenge previous philosophical assumptions that musical emotions are devoid of goals.

The valence model showed substantial and significant effects for all three latent factors. The most prominent being ‘Goal-congruence’, though all latent factors contributed substantially. This provides direct support for the interaction be-

tween appraisal and ratings of valence. It expands on aspects of previous models (Scherer and Coutinho 2013) and notes that the relationship between appraisal and core-affect in music is not limited to lower appraisals (Céspedes-Guevara 2021), nor is it devoid of goals (Juslin and Västfjäll 2008; Juslin 2013). Quite the opposite, goal-directed mechanisms are shown to be highly important predictors. In conjunction with the correlation analysis and plots, these results provide direct support for the predictions of the CODA model, showing that appraisal dimensions are inherently valenced concepts and contribute to the construction of a macro-valence rating; what would be considered the subjective experience of valence in the core-affect model (Russell 2003). These findings are notable with regards to several previous limitations. Not only do they suggest that appraisal forms a key component in predicting valence, a task that has been notoriously difficult to achieve previously (Céspedes-Guevara and Eerola 2018), they allow for a more nuanced understanding of multiple musical phenomena, such as the ‘guilty pleasure’ phenomena or mixed emotions both as limitations to one dimensional valence in core-affect.

These conclusions are further supported by assessing the valence model’s goodness-of-fit to the data. The model performs remarkably well for a psychological model and substantially out-performs the arousal model. This further suggests that valence is a more cognitively driven component, as previously suggested by others (Céspedes-Guevara and Eerola 2018). Moreover, that appraisal provides a robust method of study for such components, in line with the CODA model (Lennie and Eerola 2022).

Genre, similar to arousal, played a significant role in predicting valence. Some differences in the role of genre between appraisal factors are notable. The ‘Goal-relevance’ factor appears substantially robust across genres suggesting reasonable homogeneity to the appraisal dimensions across genres. For the ‘Novelty’ and ‘Goal-congruence’ factors, some genres (Pop, Jazz, and World) show greater differences in the relationship between appraisal and valence; for example, World

music shows less steepness in the effects of appraisal on valence, even though the trend is still characterised by a positive slope. This suggests that some degree of difference between valence rating in different genres is captured by appraisal dimensions. Pop and Jazz alternatively show intrinsically higher intercepts than other genres. One possible explanation can be found in previous findings that have suggested emotion, particularly valence, ‘operates differently’ depending on the genre (Eerola 2011). Similarly, such effect may be accounted for by mechanisms such as ‘mere exposure’ (Huron 2006), tentatively supported by the significant findings for “familiarity” in these results, though no explicit manipulation of this was made. In conclusion, while genre is a significant factor in the model, the effects of genre are marginal in comparison to appraisal. These results overwhelmingly support the idea that appraisal is a much stronger predictor of valence and that these appraisal dimensions are substantially robust across genres, with small deviations for non-Western music.

3.4.3 Appraisal and interest

Silvia (2005b) predicts that a balance between complexity and “ability to understand” (‘coping potential’) leads to greater ratings of interest. “Complexity” was defined by Silvia as relating to the novelty appraisal-dimension; Silvia’s decision was based on theoretical discourse. This experiment alternatively, through dimensional reduction methods, finds that complexity relates more to goal-relevance (see the discussion on the validity of appraisal dimensions above). Nonetheless, conclusions about Silvia’s work can still be drawn from the data both in relation to the role of the ‘novelty’ and in relation to the role of “complexity” (subsumed under the ‘Goal-relevance’ factor in this paper); both of which significantly contribute to the model of interest. “complexity” in the ‘Goal-relevance’ factor was a significant independent predictor in follow-up LMMs, as was “comprehension” relevant to the ‘coping potential’ appraisal in Silvia’s hypothesis (Appendix B.0.8). This suggests, in line with Silvia’s conclusions that ‘novelty’ and ‘coping potential’ are important appraisals in predicting what participants find interesting. Partici-

pants ratings of “complexity” were also an important predictor of interest, though grouped differently in this experiment with regards to its theoretical underpinning in appraisal theory. This suggests that how ‘goal-relevant’ a stimulus is to an individual also plays an important role in predicting interest along with several other appraisal dimensions. These additional appraisal dimensions are associated with the ‘goal-relevance’ and ‘goal-congruence’ of a stimulus.

The two goal-directed factors ‘Goal-relevance’ and ‘Goal-congruence’ were by far the strongest predictors of interest. The ‘Novelty’ factor was by comparison not such a strong predictor. The ‘Goal-relevance’ and ‘Goal-congruence’ factors contain the appraisal dimensions Silvia holds as necessary for an occurrence of interest to emerge but add that the emphasis of these factors and the other contributing appraisal dimension suggests a goal-directed interpretation hold substantially more value in a musical context. Moreover, beyond Silvia’s fairly narrow description of interest as a discrete aesthetic emotion and taking a wider view of interest as symptomatic of ascribing *relevance* to an aesthetic object, is a process that warrants further attention and cognitive resources (Lennie and Eerola 2022). One can see that goal-directed appraisals appear highly important in determining the relevance of a musical stimuli to an individual. The prevalence of goal-directed terms as predictors of interest further validates the wider view of interest as related to the relevance of an aesthetic stimulus.

Lastly, I note the strong correlation between interest and valence, though the two concepts are not identical. It is certainly true that people can have *interest* in things appraised as having an unpleasant ‘affective quality’ (Russell 2003), for example, “morbid curiosity” (Scrivner 2021) but this is not to say that their subjective experience (core-affect) is unpleasant. Similarly, while interest may indicate further cognition and attention, it does not necessarily imply that a valenced perspective has been adopted; i.e., it is yet to be ascribed meaning. It is quite possible that interest leads to mixed (bi-valenced) feelings or may remain fairly neutral until further cognitive processing has occurred. This may certainly

be true in an experimental design such as this where short musical excerpts are used and could be developed by a methodology that adopted ratings over time. Alternatively, it may be true that there is less distinction between interest and valence in music. Induced musical emotions are often described as being more typically positive or having a positive pull (Eerola 2017). Further investigation into the relationship between interest and valence in music is certainly warranted and appraisal may play a role in distinguishing these concepts in music. The most striking differences in appraisals between valence and interest emerge in the ‘Novelty’ factor (see 3.6) and while not such a strong predictor of interest specifically, it may be important in distinguishing valence from interest.

Altogether, while these findings are supportive of Silvia’s initial hypotheses, they suggest there is considerably more nuance to the role of appraisal in understanding what makes a stimulus interesting to an individual. I argue that adopting a goal-directed interpretation of interest allows for a more complete and flexible model of contextual and individual factors.

3.4.4 Limitations and future directions

Some limitations with the experiment are noted in relation to future directions for research.

1. The stimulus were chosen to represent a large and less stereotyped range of the affective space, but were not representative of manipulations for all the possible appraisal dimensions, as this experiment sought to explore multiple appraisal’s relationship with core-affect in the context of music. A stimuli set that varies across all appraisal dimensions would be incredibly large, time consuming for participants, and likely require a validation task as no such data set currently exists. Future experiments would benefit from such implicit manipulations of appraisal dimensions in experimental stimuli (e.g., musical stimuli that vary in complexity or goal-relevance). Yet, achieving such a mammoth task is likely to be built on incremental experiments,

testing single appraisal dimensions where stimuli can vary or collecting participants who may vary in a single appraisal dimensions (e.g., goal-relevance, how important music is to an individual; or complexity, how musically able participants are).

2. The theoretical discourse that underpins this experiment is rooted in the description of an emotional episode but it is harder to justify, in this exploratory design, that all ratings are representative of an emotional-episode induced by music. It is quite possible that participants are responding to a hypothetical emotional response to the music, given a different situation (e.g., not filling in an online survey) or when a participant is more in the mood to listen to jazz or classical music (i.e., preferences for music are not fixed over a lifetime or a day). Moreover, the musical excerpts were short (45 seconds), while some research has suggested that this is an adequate time for an emotional-episode to occur (Eerola and Vuoskoski 2013) this is itself not a sufficient criteria for an emotional-episode to occur (i.e., if 45 second of music is heard an emotional-episode will follow). These results, nonetheless, do show a clear relationship between two different components of an emotional-episode, whether a full-blown emotional episode was experienced or not, and provides ample support for the conclusion that appraisal do form a meaningful component in the emotional experience of music.
3. The experiment was limited by the number of participants in the sample in relation to the robustness of its conclusions about the validity of individual appraisal dimensions and the structure of appraisal dimensions through exploratory factor analysis. Such a large number of variables would require an approximate minimum of 10 participants per-variable for a robust factor analysis to be run. This is before considering splitting the data to include an additional confirmatory analysis; another valid extension of the current findings.
4. Future studies would benefit from empirical analysis of the types of appraisal

that can be described in music, the types of context that these often relate to, and the terms people most commonly use to describe these variables. The terms used here represent what is theoretically justifiable, but extending this through qualitative approaches would compliment and extend these findings; providing a more robust grounding for appraisal in music and improving the internal validity of (or offer alternatives to) the dimensions proposed.

5. Combining several of these listed future directions, the explicit development of a specific appraisal tool for music would be of huge benefit to the field.

3.5 Conclusions

The exploratory experiment in this paper developed and tested the validity of several appraisal mechanisms in the context of an emotional episode induced by music. In the first test battery of appraisal, all terms used were representative of several appraisal dimensions hypothesised for music. The experiment demonstrated these appraisal terms' effectiveness in predicting individual ratings of valence, arousal, and interest against an ecologically valid collection of more and less stereotyped music stimuli from across the affective space (core-affect). The above results provide the first proof of concept for the value of the wider appraisal framework in a musical context.

A total of ten appraisal terms were validated, representative of all eight hypothesised appraisal dimensions. These ten appraisal terms, through an exploratory factor analysis, were grouped into three latent variables, 'Goal-relevance', 'Goal-congruence', and 'Novelty'. These three latent factors were shown to be good predictors of core-affect (most substantially rating of valence) and interest. This exemplifies the explanatory strength of incorporating appraisal variables into musically-induced emotional episodes. Moreover, these factors address previous limitations within the literature, such as providing a way to assess individual and contextual differences, and resolving problems in predicting valence from the

stimulus alone. Several future studies as more direct tests of the CODA model's hypotheses (Lennie and Eerola 2022) have been suggested. Yet, while multiple future directions and applications of appraisal are possible these results most notably provide novel support for a goal-directed approach as fundamental to understanding what makes a (musical) stimulus *relevant* and *meaningful* to an individual. This challenges decades of dogma that aesthetic emotions, including musical emotions, are devoid of goals. They are not! And there is a fascinating future for those willing to acknowledge the value of goal-directed mechanisms.

Chapter 4

The role of goal-directed mechanisms in emotional episodes induced by music

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Preface

This chapter naturally follows from the findings of my exploratory analysis which identifies goal-directed mechanisms as central to the meaning making process. This study represents a methodologically refined test of goal-directed mechanisms, where causal process and direction of effects can be assessed. It consists of two experiments. First, and required for a methodologically rigorous test, it developed and tested a specific set of stimuli that represent manipulations of goal-directed mechanisms. Second, it takes the newly identified stimuli set to directly test the relationship between goal-directed mechanisms with core-affect and emotional intensity. The relationship between goal-directed mechanisms and core-affect is

directly related to the hypotheses of the CODA model in Chapter 2 and the findings of my exploratory analysis. The relationship with intensity is also identified in the CODA model as being of specific importance to assessing the contribution and validity of the model as a whole (Moors 2009), discussed in Chapter 1.

Abstract

This study aims to test the contribution of goal-directed cognitive evaluation on emotional episodes induced by music. Specifically, it will explore the role of two goal-directed mechanisms (goal-relevance and goal-congruence) in different musical contexts (musical functions). This study is formed of two experiments. First, it gathers a collection of highly familiar musical functions (goal-relevance) for UK participants ($N = 39$) and musical stimuli that can be experienced as well-suited or poorly-suited to a specific musical function (goal-congruence). In a second experiment, with different participants ($N = 117$), this paper uses a vignette methodology to explore the effect of goal-directed evaluations on induced core-affect (valence and arousal) and intensity of an emotional episode. Finally, it collects highly goal-congruent (self-selected) music for different musical functions again measuring its impact on induced core-affect and intensity. Results are explored using linear mixed model analysis and discussed in the context of recent models of musical induced emotion. Results suggest that goal-relevance implies an optimum arousal state to be achieved by the music. Music that can achieve optimum arousal (goal-congruent music) leads to more positive valence. Optimum goal-congruence induces more intense emotional experiences. In conclusion, this paper suggests strong support for the role of goal-directed mechanisms in emotional episodes induced by music and moves the study of musical emotions closer to the wider affective sciences.

4.1 Introduction

Emotional responses to music have become an increasingly popular area of study over the past 40 years, though its origins in the psychological literature are most readily ascribed to Meyer (1956). Several theoretic models have subsequently been put forward describing emotional responses to music. These models span neurological (Flaig and Large 2014; Koelsch et al. 2015), philosophical (J. Robinson 2005; Kivy 1981), and cognitive (Konečni 2008b; Scherer and Coutinho 2013; Juslin 2019; Céspedes-Guevara 2021; Lennie and Eerola 2022) models. Still, the mechanisms that underlie these emotional responses remain a matter of contention (Céspedes-Guevara and Eerola 2018; Warrenburg 2020b) and we are likely still some time from a comprehensive model. Nonetheless, several of these models have proposed that goals in varying forms and with varying degrees of importance should be included in music emotion models (J. Robinson 2005; Scherer and Coutinho 2013; Céspedes-Guevara 2021; Lennie and Eerola 2022; Koelsch et al. 2015). Some models go further and hypothesise a direct relationship between goal-directed mechanisms and other components of emotional episodes - e.g., core-affect (Thompson, Quinto, et al. 2011; Lennie and Eerola 2022); as hypothesised in utilitarian emotional episodes (Frijda 2007a; Moors and Fischer 2019). However, to date, goal-directed mechanisms and their impact on the components of an emotional-episode remain untested, with one exception (Gómez-Cañón, Lennie, et al. 2022). This experiment describes the first direct test of goal-directed mechanisms in emotional episodes induced by music. Specifically, it tests the effect of goal-directed mechanisms on the emotional component of core-affect and intensity.

4.1.1 A goal-directed approach

Goal-directed processes have developed to become a central feature of the affective and cognitive sciences (Sloman 1996; Balleine and Dickinson 1998; Frijda 2007a; Eder and Hommel 2013; Schiller et al. 2022). Even contemporary perspectives

on aesthetic emotions have now begun to include goals as a central feature in their theoretical discourse (Menninghaus et al. 2019). Moors (2017) describes goal-directed processes as cognitive processes that relate directly to an organism's needs, wishes, desires, values, or beliefs (p. 4). This cognitive evaluation is an ongoing and dynamic process, constantly re-informed by new information. As such, the relevance of a stimulus or an event may be described as multiple competing goals. For instance, an ape may be foraging for food but a warning call of a predator from the troop will orientate attention towards reaching safety in the tree tops. Similarly, a new student may be attempting to study but the opportunity to spend time with new friends may distract from this task. These two examples illustrate two very different types of goals. Subsequently, it is useful to describe goals at different functional levels. Low-level goals can be considered biologically driven or innate such as a sudden loud sound that may startle (Simons 1996). This type of goal can be described as protective and may lead to attentional orientation towards the sounds source or towards a specific objective/behaviour – as in the ape example. Similarly, goals can be considered at a higher functional level and can be considered learnt. Such goals may incorporate personal values, social identity, or even knowledge of a stimulus's physiological effects.

There are several cognitive mechanisms that can have an impact upon an individual's goals. At a cognitive level, these mechanisms and how they relate to one's goals are most readily described in the literature on appraisal (C. A. Smith and Lazarus 1991; Frijda 2007a; Scherer 2009b; Clore and Ortony 2013; Ellsworth 2013) – 'a process that detects and assesses the significance of the environment for well-being' (Moors et al. 2013, 120). Many of these cognitive mechanisms have been theoretically applied to the context of musical emotional episodes (Scherer and Coutinho 2013; Lennie and Eerola 2022). For instance, the degree of 'control' an individual has in a situation for achieving their goals may impact their emotional experience of music. When driving along in the car and a song you do not like appears on the radio you have the ability to change the station or turn it off. Alternatively, you may be a passenger being driven somewhere by

your parents and have no control over their ‘terrible’ choice in music. The lack of control the individual has in the latter of these two examples may lead to a more negative emotional experience. Some appraisal mechanisms have even been tested empirically in music, for example, familiarity (Lahdelma and Eerola 2020; Ali and Peynircioğlu 2010). However, empirical testing of appraisal mechanisms remain rare in the music cognition literature. Goal-directed mechanisms themselves, that is mechanisms that explicitly evaluate ‘how well’ a stimulus or a situation impacts the achievement of one’s goals, or the utility of one’s possible actions in achieving a goal, remain untested, save one example (Cespedes-Guevara and Dibben 2022). In many cases they remain actively excluded as unnecessary for music-induced emotion (Juslin and Västfjäll 2008) or are included as a ‘strawman’ representation (Juslin et al. 2008, 2016).

For the purposes of this experiment it is important to distinguish between two key goal-directed mechanisms. First, the degree of ‘goal-relevance’, sometimes referred to as motivational-relevance. This evaluation is an assessment of how important a specific goal is in a situation because different individuals can have several competing goals in different situations and, as noted above, the importance of different goals is constantly re-evaluated. The second goal-directed mechanism ‘goal-congruence’, is sometimes called motivational-congruence or motive consistency. This evaluation refers to how well a stimulus relates to the achievement of one’s goals. For example, music to help you sleep may be slow and quiet to lower physiological arousal levels, non-complex and therefore not too cognitively engaging, or just appropriate for drowning-out other auditory stimuli like traffic. The type of music can be different depending on the goal. Music to drown out traffic noise may not need to be slow and quiet though the end result (to get to sleep) is the same. It is the goal that changes what is appropriate in different examples. Similarly, the priority of different goals can change. A party may afford you several goals (to catch-up with old friends, to dance, to celebrate a close friend’s birthday/achievements, to meet new people, or other reasons people go to parties that this socially reclusive academic doesn’t necessarily understand ...). You may

be catching up with old friends (a socially orientated non-musical goal) but when an old favourite song begins to play (a stimulus evaluated as goal-congruent) this may prioritise an alternate goal – to dance (a common musical goal).

4.1.1.1 Goal-directed mechanisms and core-affect

Evidence from the wider affective literature suggests an interaction between core-affect and goal-directed mechanisms exists, as acknowledged by many emotion models (Russell 2003, 2009; Barrett 2017), including music emotion models (Eerola 2017; Lennie and Eerola 2022). Cognitive evaluations of the relevance of a stimulus to one’s goals are often described as the principal cognitive factor in determining the affective quality of an emotional episode (Ellsworth and Scherer 2003). Therefore, it seems self-evident that such a mechanism should be common in music-induced emotional episodes too - if emotional episodes in music are based on the same cognitive mechanisms as all other emotional episodes as argued by several authors (Scherer and Coutinho 2013; Lennie and Eerola 2022).

Empirical work in the wider affective science can help guide hypotheses when applied to music. This paper will focus on the hypotheses that can be made for the goal-directed mechanisms; ‘goal-relevance’ and ‘goal-congruence’. However, further hypotheses relating to other cognitive mechanisms associated with these goal-directed mechanisms can also be drawn from the literature and applied to music (Scherer and Coutinho 2013; Lennie and Eerola 2022).

Goal-congruence is the mechanism that evaluates how well a stimulus “fits” a particular goal. Previous research using affective pictures (Scherer, Dan, and Flykt 2006), experience sampling (Kuppens, Champagne, and Tuerlinckx 2012), and vocal acoustic cues (Nordström et al. 2017) all converge to show a relationship between goal-congruence and valence. The studies by Scherer et al. (2006) and Kuppens et al. (2012) both directly tested the ability of appraisal to predict core-affect ratings leading to more robust casual conclusions about the influence of goal-congruence on valence. Nordstrom et al. (2017) alternatively used a dis-

crete emotion methodology. Nonetheless, the relationship between goal-congruent and non-congruent appraisals with positive and negative emotions was present. Moreover, this trend was observed in both Australian and Indian participants, tentatively suggesting a cross-cultural basis for this mechanism.

A musical example that can be viewed as supportive of the role of music as goal-congruent can be found in Mehr et al. (2019). A large ethnographic corpus of vocal songs from around the world showed that songs can be differentiated by their intended behaviours (e.g., love songs, lullabies, etc.) and that these musical categories show different acoustic properties. This suggests that music is written for purpose (it has a goal). A logical continuation of this narrative suggests music could therefore be inappropriate for a goal, at least as far as its acoustic affordances do not fulfill that goal. For instance, there are very few individuals that would scream a song to get a baby to sleep.

Goal-relevance is an important mechanism in relation to the above described goal-congruence. Without a ‘goal’ a stimulus cannot be evaluated as fulfilling this goal or not. However, individuals may have different goals in different situations. Moreover, the degree of importance these goals have to different individuals may again differ, even in the same situation. Some authors have equated goal-relevance specifically to the intensity of an emotional experience - the more important the goal(s), the more intense the emotional episode (Frijda 2007a). Similar ideas have been applied to musical emotional episodes (Lennie and Eerola 2022).

To understand the variety of goals that can exist and the role they play, it is important to understand the many contextual influences that shape emotion. Research on goal-relevance has typically centred around one of the three areas of focus: stimulus context (the surrounding attributes of the stimulus), individual context (the internal affective state of an observer), and cultural context (Barrett, Mesquita, and Gendron 2011). Goals are most readily applied to an individual context, as proposed by many theories (psychological construction, Russell 2003, 2009; Barrett 2006, 2017; appraisal, Ellsworth and Scherer 2003; Ellsworth 2013;

Scherer 2009b; Clore and Ortony 2000; and social construction, Mesquita, Boiger, and De Leersnyder 2016). Though one could also refer to the perceived goals of another agent in the situation. For instance in a musical context, the perceived goals of the composer or performer. This lies beyond the aims of this study but illustrates the importance of goals in understanding context. Much work can be seen as supportive of the hypothesis that context can change individual's emotional responses as context is assumed to inherently contain goals (Barrett and Kensinger 2010). The role of context has been explored in facial expressions (Barrett, Mesquita, and Gendron 2011; Wieser and Brosch 2012) and vocalisations (Keltner et al. 2016). The explicit effects of an individual's goals, values, or norms remains to be better understood as a contextual feature. Nonetheless, some key studies can illustrate some of the ways goals can influence emotional episodes. In an experimental design using social goals (cooperative vs. competition) Tamir and Ford (2012) showed that participants would actively choose emotion regulation strategies that would induce more negative affect (anger), if they believed that it was beneficial to the task (competition), and more positive affect when given a the goal of cooperation. Of anecdotal interest to this study, music was used by Tamir and Ford as the emotion regulation tool suggesting emotion regulation is a common goal people use music for. However this design highlights how music could be used to achieve an external goal as opposed to how an individual's goals may change the emotional experience of music.

One music specific example of the effect of musical goals on induced and perceived emotions can be seen in the work by Céspedes-Guevara and Dibben (2022). They tested the effect of different program notes (two different affective descriptions related to the composer and a neutral technical description) on participants' affective responses to music. They found significant differences in induced and perceived responses for two of the three experimental tracks. This provides clear evidence that contextual information plays a key role in emotional episodes; i.e. knowledge of the composer's situation. One could even argue that program notes can be interpreted as a goal-directed variable; i.e., to understand the inten-

tion of the composer. The role of another person's perceived goals has frequently been noted in literature on cognitive evaluations, typically referred to as 'agency' (Ellsworth and Scherer 2003).

Here I suggest that if goal-relevance is important to musical emotional episodes it is necessary and sufficient initially to show that different goals can change the experience of the same stimuli. The degree and direction of change is however determined by the individual's goal-congruence evaluation of the stimuli, along with many other cognitive evaluations such as the degree of control an individual has to change the situation in the presence of a non-congruent stimuli as in the car example above.

These examples illustrate the way goal-directed mechanisms can influence core-affect. This paper acknowledges that the interaction between goal-directed mechanisms and core-affect is *bidirectional*. That is, pre-existing core-affect can also influence future cognitive evaluations (Kuppens, Champagne, and Tuerlinckx 2012). Moreover, cognitive evaluations are more typically described in combinations (Ellsworth and Scherer 2003). However, the number and complexity of the research questions and *a priori* assumptions grows exponentially. To keep things straightforward this paper assesses two key goal-directed mechanisms individually and leaves several future directions for researchers to take.

4.1.1.2 Testing goal-directed mechanisms

There are of course many different approaches to testing goal-directed mechanisms from its neurological underpinning (M. Corbetta and Shulman 2002; Brosch and Sander 2013), to correlations with action tendencies and physiological responses (Scherer and Moors 2019). However, this paper is concerned with the cognitive applications of goal-directed mechanisms and to test such mechanisms adopts methodologies commonly applied to appraisal theories.

Many methodologies such as, subjective self-report (e.g., emotion terms, action tendencies), implicit manipulations, electroencephalography (EEG), facial elec-

tromyography (EMG), semantic analyses, psychophysiological measures, overt behaviour measures (e.g., vocal analyses), and advanced statistical and computational modelling, have been applied to the study of appraisal theory - see Scherer and colleagues (Scherer, Schorr, and Johnstone 2001; Scherer and Moors 2019; Scherer 2019) for reviews. One of the most commonly used and appropriate for the current study is ‘vignette’ methods. These are most concisely described as recall or scenario methodologies. Vignette methods have been critiqued in emotion research (M. D. Robinson and Clore 2001) with commentators suggesting that participants are more likely to report beliefs about emotions, appraisals, or their interaction than concurrent experience (Parkinson 1997). Robinson and Clore (2001) directly tested appraisal reports of hypothetical and real scenarios. They found that across 18 appraisals participants agreed almost identically on appraisal reports between real and hypothetical scenarios (medium correlation; $r = .94$). Participants did however tend to overestimate the intensity of emotional experiences in the hypothetical condition. Vignettes therefore, provide a robust starting point for research into musical cognitive evaluations or more specifically goal-directed mechanisms.

4.1.2 Musical goals as musical functions

This paper has described a goal-directed mechanism, cited the evidence for its effects on core-affect, and suggests an appropriate methodological test of such mechanisms. But what constitutes a musical goal?

There are many possible ways to define musical goals. One-interpretation, offered by Juslin (2019), is that of lower-level survival goals such as a sudden loud sound. Yet, as Juslin notes, this type of goal does not occur particularly regularly with music. With regard to higher-level goals, again many interpretations are available. For instance, goals can be seen as learnt action-perception loops (Reybrouck 2012; Schaefer 2015) or musical affordances (Schiavio, Schyff, Cespedes-Guevara, et al. 2017). One approach that has been suggested is to consider the functions music

has in everyday life (Lennie and Eerola 2022). Musical functions have a large history of empirical research (Roe 1985; DeNora 1999; North, Hargreaves, and O’Neill 2000; Laukka 2007; Juslin et al. 2008; Boer 2009; Greasley and Lamont 2011; Londsdales and North 2011; Boer et al. 2012; T. Schäfer et al. 2013; Saarikallio, Maksimainen, and Randall 2018; Saarikallio et al. 2020). This offers a reasonably inclusive starting point for the study of musical goals and their effect on musical affect. The functional uses of music described here most readily relate to the goals of the music listener, though one could equally consider the goals of the performer or the composer.

The empirical literature on musical functions shows several different approaches, including different theoretical, methodological, and participant samples, that have been taken to its study. The reader can find comprehensive reviews in Schäfer et al. (2013) and Maloney (2019). Overall this leads to a heterogeneous picture of musical functions - a good starting point for the first direct test of musical goals. Some studies (T. Schäfer et al. 2013; Saarikallio, Maksimainen, and Randall 2018; Boer et al. 2012) have gone further in their analyses to show how these functions can be grouped into their underlying dimensions. Each study used different analysis techniques including principal component analysis, exploratory factor analysis, and multidimensional scaling. Nonetheless, markedly similar underlying functional dimensions appear in all these studies such as underlying functional dimensions relating to the self, social, and arousal/mood-regulation. Each of these dimensions produced a high internal reliability (T. Schäfer et al. 2013, $\alpha > .92$). The self dimension can be described as including more cognitive functions, such as contemplation, self-identity, personal-values. The social dimension can be described as including functions such as, social bonding and cultural uses. The arousal/mood-regulation dimension can be described as including functions such as diversion, be related to the physical sensations of music and be used to regulate one’s physiological arousal.

There are also some subtle differences that emerge between these studies. The

most prominent of these differences is the degree of importance placed on social/socio-cultural functions. Schafer (2013) concludes that the role of social functions in music may be overstated in comparison to other dimensions. Boer et al. (2012) and Saarikallio et al. (2018) alternatively have shown that the social functions of music are more representative of collectivist, over individualist, Western, cultures. Therefore, the low rating of importance Schafer et al. (2013) gives to the social relatedness dimension may be a cultural artifact produced by the study's German sample (an individualist culture, Hofstede 2001) or possibly a methodological artifact of the studies design (i.e., key studies on cross-cultural music functions may have been overlooked due to a prominence of Western-centric studies).

Finally, it is worth noting that while the approach to identifying the underlying dimensions of musical functions has been key in producing a clearer picture of the research landscape, in reality, it is unlikely that a single function is fulfilled by music in any one specific context. For instance, Maloney (2019) presents a thematic analysis of musical functions and posits a 'meta-domain'. This 'meta-domain' represents typical overlaps between functions subsumed under different dimensions (e.g., relaxation and stress relief are described as having cognitive, physiological, and emotional functions). Similarly, Greasley and Lamont (2011) present the multiple goals hypothesis from their empirical study suggesting that music typically supports 3+ functions for the average listener. This idea fits well with a goal-directed theory of music (Lennie and Eerola 2022), where the on-going interaction between an individual and a (musical) stimulus can be viewed as multiple goals and the fulfillment of multiple goals can be viewed in an additive fashion. That is, the fulfillment of multiple goals can drive greater cognitive engagement and resources. As such, establishing the relevance of two key goal-directed mechanisms (goal-relevance and goal-congruence) and their relationship with musical affect provides a novel and theoretically justifiable approach to the understanding of individual and contextual differences in musically-induced emotional episodes.

4.1.3 Aims

This study aims to test the validity of two goal-directed mechanisms in emotional episodes induced by music. First goal-relevance, which can be described in this experiment as the functional context in which the music is heard. Second goal-congruence, this is related to how well the music “fits” (is congruent with) the functional context (the goal). This study uses a vignette methodology with a participant-led selection of experimental stimuli: musical functions (goals) and musical stimuli (goal-congruent / non-congruent). Specifically, this experiment seeks to assess the effect of these goal-directed mechanisms on the core-affect component of an emotional episode induced by music. This will provide the first evidence of goal-directed mechanisms at a cognitive level in music.

Following these research aims and the literature review this study draws three hypotheses.

H1: Different goals (musical functions) will change the induced emotional experience (core-affect) of the same musical stimuli.

H2: The degree of goal-congruence music has for a particular function (goal) will change the induced emotional experience (core-affect).

The research from utilitarian emotional responses Kuppens, Champagne, and Tuerlinckx (2012) in relation to H2 would predict this most prominently in the valence dimension (congruent = more positive / non-congruent = more negative). I leave such hypotheses open in a musical context. One can think of examples where non-congruent musical stimuli (e.g., music that goes against or subverts the narrative of a film) can be humorous. Moreover, examples where congruent music is inherently designed to heighten a negative affect (e.g., Horror films)

H3: Highly goal-congruent music will lead to greater changes in core-affect and show increased emotional intensity.

4.2 Method

This experiment was constructed in two parts. The first experiment sought to collect appropriate musical functions and musical stimuli that can be representative of musical goals and congruent/non-congruent musical stimuli, respectively. The second experiment, using a different set of participants, then measured induced emotions (core-affect and intensity) for the selected musical stimuli in different functional contexts.

4.2.1 Experiment 1: Identifying experimental stimuli

4.2.1.1 Stimuli

Experiment 1 sought to identify functional uses of music that were highly familiar to UK participants and therefore likely to be goal-relevant to the majority of UK participants. The initial list of functions was developed using Schäfer et al. (2013), one of the most comprehensive list of musical functions published to date. Furthermore, it sought to identify a diverse collection of musical excerpts that could be described as congruent (music that fits a functional context well), non-congruent (does not fit the function well) and bi-modal (divides opinion). Rentfrow, Goldberg, and Levitin's (2011) five-factor model of music preferences was used as it is representative of musical stimuli that vary in acoustic features, emotional reactions, and genres, collected from a diverse participant pool in age, gender, and socio-economic backgrounds.

4.2.1.1.1 Functional contexts To identify appropriate functional uses of music this study used Schäfer et al.'s (2013) comprehensive review of musical functions. Schäfer et al. compiled a list of 129 non-redundant functions quantitatively rated by 834 participants and grouped by principal component analysis into three dimensions (self, social, arousal) each with a high internal reliability ($\alpha > .92$). This study sought to identify a short list of highly representative musical functions spanning the three underlying dimensions. Fifteen functions were identified from

Schäfer et al.'s list (five functions for each of the three underlying dimensions). These were selected using three criteria. First, calculated across all dimensions, items must have a greater than mean factor loading ($>.52$) suggesting it is better representative of the dimension. Second, calculated for each dimension individually, items must have a greater than mean participant rating suggesting the item is an important function for individuals. And third, calculated for each dimension individually, they must have a standard deviation smaller than the third quartile suggesting greater agreement across participants. This produced a list of 24 functions that was thinned to 15 functions by the author selecting the most varied collection within each underlying dimension. The final list of selected functions with mean, standard deviation, and factor loading from Schäfer et al. (2013) can be found in the Appendix (C.0.5).

Results were analysed using R. From the 15 functions the highest means and smallest standard deviations were used to select functions that can be viewed as goal-relevant to UK participants. Three functions were selected to represent the arousal/mood regulation dimension. Three functions were selected to represent the self dimension. Mean ratings for the social dimension were generally lower than those for the self and arousal dimensions, as to be expected for Western participants (Saarikallio et al. 2020). However, one function with the highest mean was selected to be representative of the dimension. This led to a total of seven different musical functions representing the three underlying dimensions - *Arousal*: Enhance my mood, Take my mind off things, and Helps me relax. *Self*: Comforts me when I'm sad, Gives me the energy I need for the day, Lets me forget the world around me. *Social*: Talk about with my friends

4.2.1.1.2 Musical stimuli The aim of Experiment 1 was to establish a diverse range of musical stimuli to be rated by participants in different functional contexts. Rentfrow, Goldberg, and Levitin's (2011) five-factor model of musical preference (mellow, sophisticated, urban, intense, campestrial) provides such a collection differing in social, emotional, and auditory characteristics. Moreover,

tracks can be described as broadly unfamiliar to participants (p. 11) controlling for familiarity effects. Twenty-five tracks were selected (five tracks for each of the five factors). Tracks were selected using the highest factor loading (Rentfrow, Goldberg, and Zilca 2011, Table 1, 2 & 3) and the widest collection of genres subsumed under each factor (Rentfrow, Goldberg, and Zilca 2011, Table 4).

Some factors produced highly American-centric music selections. For example, the ‘Campestral’ factor included new country, modern country, country, and bluegrass. These were less likely to be relevant to an English sample. To counter this equivalent UK genres (e.g., indie singer-songwriter, UK folk) were gathered by the author that represented the musical and emotional correlations of the category (Rentfrow, Goldberg, and Zilca 2011, Table 4). For example, the ‘Campestral’ factor is described as including relaxing, romantic, or sad emotional-orientated attributes and negatively correlated with musical attributes such as distorted, electric, fast, instrumental, and loud. All the selected pieces were chosen from less mainstream artists in keeping with the study design by Rentfrow et al. (2011) and minimising the effects of familiarity. One American country song with the highest factor loading (.80) was kept so the genre was not removed completely. Fifteen second excerpts from each piece were selected by the author as representative of the piece both acoustically and emotionally, following (Rentfrow, Goldberg, and Zilca 2011). The full list of selected tracks and time markers can be found in the Appendix (C.0.5).

Experiment 1 collected participants ratings of congruence (‘fit’) for each musical stimuli in each functional context (see Experiment 1: Participants & procedure). Results were analysed in R. First, for each of the seven selected functions the most and least congruent were selected using density plots. One track (Intense 3) was removed due to consistently negative results across all functions. A paired-MANOVA was conducted between type of function and music stimuli. This showed significant differences between mean ratings for types of function $p < .001$, music stimuli $p < .001$, as well as a significant interaction between type of

function and music stimuli $p < .001$. This was followed by pairwise comparisons for both type of function and musical stimuli. In tandem with the density plots this facilitated the choice of musical stimuli - i.e., musical selections for functions were not too similar across functions.

To keep the widest selection of music possible, two tracks that divided opinion (how well a track fits a function) were also to be selected for each function. These tracks were selected by assessing their degree of bimodality. Bimodal distribution was assessed using convergent results across bimodal coefficients and dip tests that can be seen as supportive of a bimodal interpretation (Pfister et al. 2013). Bimodal coefficients were assessed using the package ‘mousetrap’ (Wulff et al. 2021) and dip tests were run using ‘diptest’ (Maechler 2015). Two tracks for each function with the highest convergence across these two tests were selected as bimodal tracks. This generated four tracks for each function; one congruent, one non-congruent, and two bimodal tracks. Note that several tracks appear in multiple functions (see Appendix C.0.5 for table of tracks by function). In total there were 25 tracks across 15 functions. See Figure 4.1 for density plots of each selected track by function.

4.2.1.2 Participants & procedure

43 participants were collected through Prolific.ac.uk using the criteria ‘UK resident since birth’. Sample size was calculated using G*power estimating a small to medium effect size. Participants took a median of 30 minutes to complete the study and were paid £8.97/hr. Four participants were removed from the analysis for completing the study in under 19 minutes, leaving a total of 39 participants (Female: $N=22$ and one ‘prefer not to say’; Age range 22-86, $M=49.8$, $SD=18.2$)

1. Participants were first asked to provide some basic demographics (age & gender identity) and genre preferences were collected using the STOMP-R (Rentfrow and Gosling 2003).
2. After a short instructions slide and volume check, participants were asked

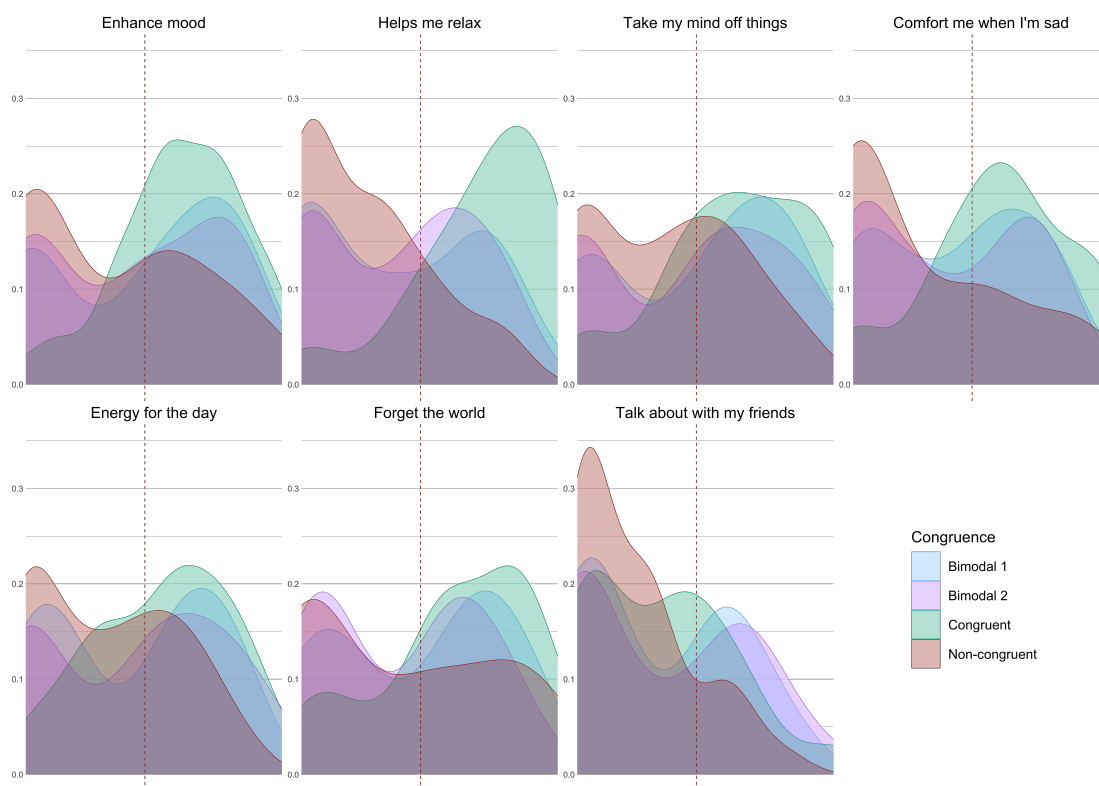


Figure 4.1: Density plots for selected tracks in each selected function with mean congruence rating for all selected tracks within a function

to provide perceived valence (1:Negative - 7:Positive) and arousal (Likert; 1:Sleepy - 7: Awake) ratings for each of the 25 musical stimuli. Perceived ratings were collected as a validation check against ‘felt’ ratings in the second experiment of this chapter. Perceived was described as ‘This is the emotion expressed by the music. This is **NOT** the emotion aroused in yourself. E.g., The music sounds sad, as if the sadness was somehow within the music.’ Participants were asked to use the same volume level throughout.

3. Participants were then asked to rate each musical function by how familiar it was to them ‘I listen to music because ... [insert function]’ using a Likert scale (1: not familiar at all - 7:extremely familiar).
4. Finally, participants were asked to rate how well each musical stimuli ‘fit’ each of the 15 functional uses of music on a Likert scale (1:terribly - 7:perfectly).

4.2.2 Experiment 2: The effect of goal-directed mechanisms on emotional episodes induced by music

The selected functional uses and musical stimuli (Figure 4.1) from experiment 1 were next used to assess the effect of goal-directed mechanisms on musically-induced affect (core-affect and intensity) in experiment 2.

4.2.2.1 Participants and procedure

117 participants (Female: $N=36$, Trans female: $N=1$, Trans male: $N=2$, and prefer not to say: $N=1$; Age ranges from 19-75, M age=40.4, $SD=12.9$) were collected through Prolific using the criteria ‘UK national since birth’ and did not participate in Experiment 1. Participant numbers were again calculated using G*power estimating a small to medium effect size. Participants took an average of 22 minutes to complete the study and were paid £8.80/hour for their work. Several participants ($N = 24$) took substantially longer than anticipated to complete the survey. Upon inquiry this was due to substantial time considering their

self-selected tracks (see Procedure below). Participants were thanked for their diligence and paid extra (calculated by the amount of additional time taken, ranging from £0.70 to £7.80 with mean extra payment of £2.20).

1. The main study first asked participants to provide some basic demographics (age and gender identity) and genre preferences were collected using the STOMP-R (Rentfrow and Gosling 2003).
2. After a short instructions slide and volume check participants were randomly presented a functional context ‘Imagine a scenario where you are using music to [insert function]’ and one of the four possible musical stimuli (congruent, non-congruent, bimodal x 2). The music would not play automatically to allow participants time to think of an appropriate scenario. Participants were then asked to rate their felt experience of the music in this context ‘This is NOT the emotion expressed by the music. This is your feelings generated by the music.’. Participants rated Arousal (Likert; 1:Sleepy - 7: Awake), Valence (1:Negative - 7:Positive), Intensity (1:No Emotion - 7:Very strong emotion), and Liking (1:Not at all - 7:Very much). Participants received all four possible tracks (congruent, non-congruent, bi-modal x2) for each of the seven musical functions. This led to a total of 28 examples to rate for each participant.
3. Lastly, participants were asked to provide a Youtube link or a description (artist & track name) for each of the seven musical functions ‘music that would best perform this function for you’. Participants were then asked to rate their felt experience of the selected track in the functional context for Arousal (Likert; 1:Sleepy - 7: Awake), Valence (1:Negative - 7:Positive), Intensity (1:No Emotion - 7:Very strong Emotion).

4.3 Results

All data was analysed using R Studio. Genre preferences from the STOMP-R were calculated in accordance with Rentfrow et al. (2011). In specific cases noted during the results, due to the unmanageable length of some tables, only significant results are reported in the paper. The full analyses can be viewed in the Appendix referenced next to the relevant tables. Datasets and analysis scripts can be accessed at (https://github.com/lenni3/Goal-directed_Data).

4.3.0.1 The impact of goal-relevance

To address the impact of goal-relevance on emotional episodes induced by music (H1), valence, arousal, and intensity ratings for the same track were compared across different functional contexts. First, the data was subset to include only those tracks that appeared in multiple functions, since not all of the 15 tracks did. A total of 10 tracks appeared in at least two different functional contexts. Linear mixed models (LMM's) were used to assess each dependent variable separately (arousal, valence, intensity) with ten fixed effects (function [ENHANCE MOOD, TAKE MIND OFF THINGS, HELPS ME RELAX, COMFORT ME WHEN I'M SAD, ENERGY FOR THE DAY, FORGET THE WORLD, TALK ABOUT WITH MY FRIENDS], congruence [CONGRUENT, NON-CONGRUENT, BIMODAL 1, BIMODAL 2], liking, mellow genre preferences, unpretentious genre preferences, sophisticated genre preferences, intense genre preferences, contemporary genre preferences, age, and gender), two interactions effects (function:track[x10], and liking:track[x10]), and one random effect (participant). The model was run using Nelder-Mead optimisation.

For arousal and intensity several main effects and several interaction effects were observed between function and track. However, planned comparisons of pairwise estimated marginal means (EMM) did not show any significant differences for function by track. I point the reader to the Appendix (C.0.1) for the full table of results. For valence, main effects for 'enhance mood' and 'take mind off things'

functions, ‘bimodal 2’, liking, age, ‘male’ and ‘trans female’ genders emerged. Several interactions between functions and track, as well as liking and track also emerged (Table 4.1); the full table can be viewed in the Appendix (C.0.1). Planned comparisons of EMMs were calculated using the emmeans package (Lenth 2022) pairwise for track by function. The EMM model was simplified to include only main effects that allow the model to fit well with no interaction terms included, as recommended in the package documentation vignettes for studies where not all factor combinations are possible (package 2022) - i.e., not all tracks appeared in all functions. The EMM model included main effects of function and track as the planned comparison. Liking was additionally included as one of the strongest components of the model, and a random effect for participant. Here I present only the significant comparisons relevant to this factorial design (Figure 4.2). Four out of the ten tracks showed significant differences across six of the seven different musical functions. The track Sophisticated 4 showed significant differences between ‘Comfort me when I’m sad’ and ‘Helps me relax’ ($t(2426.1)=-5.41, p<.001$). Sophisticated 5 showed significant differences between ‘Comfort me when I’m sad’ and ‘Enhance my Mood’ ($t(2426.1)=-4.68, p<.001$); ‘Comfort me when I’m sad’ and ‘Forget the World’ ($t(2426.2)=-3.91, p=.002$); and ‘Comfort me when I’m sad’ and ‘Takes my mind off things’ ($t(2426.1)=-4.21, p<.001$). Intense 1 showed significant differences between ‘Comfort me when I’m sad’ and ‘Energy for the day’ ($t(2426.8)=-7.27, p<.001$). Mellow 3 showed significant differences between ‘Comfort me when I’m sad’ and ‘Takes my mind off things’ ($t(2426.1)=-4.21, p=.001$). The full list of EMMs can be viewed in the Appendix (C.0.2). Finally, the goodness-of-fit for the valence model was assessed using the MuMin package (Bartoń 2022). To reduce overfitting the model was re-run including only factors that reached significance. The main effects produced a strong fit with the data ($R^2_{(m)} = .62$) and random variables improving the fit by approximately 5% ($R^2_{(c)} = .67$).

These results are consistent with H1 showing that goal-relevance influences core-affect in the valence dimension. That is four tracks showed significant differences

Table 4.1: Linear mixed model for valence ratings of tracks in different functional contexts reporting only significant results

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	1.605	0.400	540.967	4.016	0.000
FunctionEnhance Mood	-0.717	0.328	2454.539	-2.190	0.029
CongruenceBimodal 2	0.413	0.192	2434.322	2.149	0.032
Liking	0.588	0.037	2453.779	15.933	0.000
Age	0.009	0.003	100.248	3.092	0.003
GenderMale	0.170	0.080	99.787	2.124	0.036
GenderTrans female	1.241	0.380	100.234	3.262	0.002
TracknameIntense 1:FunctionComfort Me When Im Sad	-0.756	0.353	2457.631	-2.139	0.032
TracknameSophisticated 4:FunctionComfort Me When Im Sad	-0.759	0.229	2431.052	-3.313	0.001
TracknameUrban 2:FunctionEnergy For The Day	-0.798	0.379	2422.889	-2.108	0.035
TracknameMellow 2:FunctionEnhance Mood	0.730	0.328	2425.258	2.229	0.026
TracknameSophisticated 5:FunctionEnhance Mood	1.079	0.328	2454.534	3.293	0.001
TracknameUrban 1:FunctionForget The World	-1.051	0.460	2423.939	-2.285	0.022
TracknameMellow 3:FunctionTakes My Mind Off Things	1.070	0.334	2416.559	3.205	0.001
TracknameIntense 1:Liking	0.105	0.047	2425.809	2.223	0.026
TracknameUrban 1:Liking	0.124	0.051	2433.223	2.432	0.015
TracknameUrban 4:Liking	0.154	0.049	2435.804	3.164	0.002

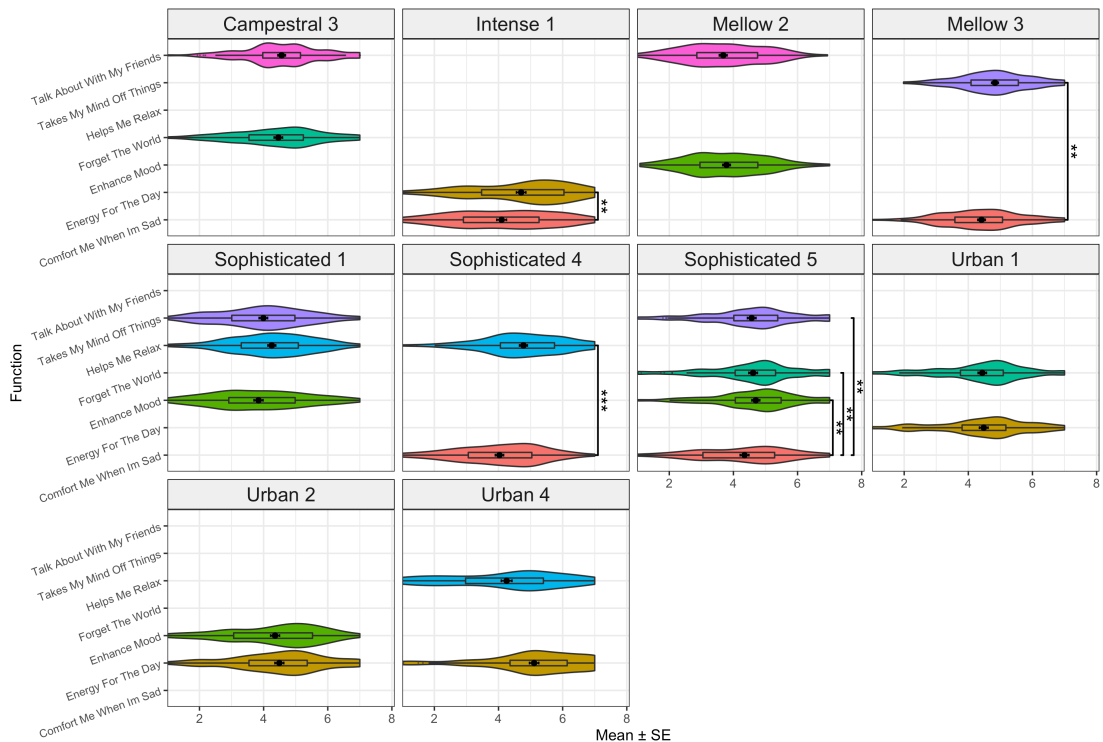


Figure 4.2: Violin plot for ratings of valence for individual tracks in different functional contexts with significant pairwise comparisons. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

in core-affect across six different functional contexts.

4.3.0.2 The impact of goal-congruence

The second hypothesis (H2) concerned the impact of congruent and non-congruent musical stimuli for different functions. The data was subset to include only tracks that had been identified as congruent or non-congruent with a particular function. LMMs were used to assess the impact on arousal, valence, and intensity separately with nine fixed effects (congruence [CONGRUENT, NON-CONGRUENT], liking, mellow genre preferences, unpretentious genre preferences, sophisticated genre preferences, intense genre preferences, contemporary genre preferences, age, and gender), two interaction effects (CONGRUENCE:FUNCTION, and LIKING:TRACK), and one random effect (PARTICIPANT).

Most relevant to H2 are the interaction effects between congruence and function. For valence and intensity, no main effect for congruence was observed. Some main effects did reach significance in both models. Most notably across both models liking appears to play the most significant role (valence: $\beta = .52$, $t = 7.68$, $p < .001$; intensity: $\beta = .52$, $t = 7.68$, $p < .001$). This result for liking largely explains other significant results in the model. That is, more prominent significant interactions between congruence and function match tracks where interactions between liking and track are also observed. The full tables can be viewed in the Appendix (C.0.3). For arousal, main effect for congruence, liking, sophisticated genre preferences, age, and gender [Trans female] were observed. Several of the most prominent significant results were observed in interactions between congruence and function. One interaction between liking and track [sophisticated 5] was also observed. The significant result for gender is likely to have emerged due to the small number of participants representative of this category. Plotting the results for arousal (Figure 4.3) does not show any consistent effects for congruence on ratings of arousal and the results are more likely explained by the tracks themselves. A follow up LMM as above but including track as a main effect suggests this is the case; five out of eight tracks showed highly significant results for predicting arousal

Table 4.2: Linear mixed model of arousal ratings comparing tracks rated as congruent and non-congruent reporting only significant results

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	1.643	0.417	275.260	3.938	0.000
TracknameCampestral 5	1.939	0.370	1433.541	5.237	0.000
TracknameIntense 1	1.681	0.380	1427.968	4.422	0.000
TracknameIntense 2	3.167	0.340	1444.584	9.323	0.000
TracknameUrban 3	1.542	0.365	1439.103	4.223	0.000
TracknameUrban 4	2.939	0.333	1443.689	8.827	0.000
Liking	0.200	0.057	1458.149	3.483	0.001
GP_Sophisticated	0.164	0.058	105.183	2.848	0.005
Age	0.017	0.004	100.408	4.518	0.000
GenderTrans female	1.349	0.480	100.394	2.813	0.006
TracknameSophisticated 5:Liking	0.148	0.065	1463.443	2.270	0.023

ratings. Moreover, the inclusion of Track as a variable moves congruence to a non-significant value (Table 4.2); full table in Appendix (C.0.3). The goodness-of-fit for the arousal model including trackname was assessed using the MuMin package (Bartoń 2022). Again to reduce overfitting the model only included factors that reached significance ($R^2_{(m)} = .60$; $R^2_{(c)} = .67$).

These results do not support H2. The observed effects for arousal (Figure 4.3) instead appear more closely related to features of the track (Table 4.2).

4.3.0.3 The impact of highly goal-congruent music

To investigate the third hypothesis (H3), the impact of highly goal-congruent music on an emotional episode induced by music (arousal, valence, intensity), a comparison between self-selected tracks and experimenter-selected tracks (Experiment 1) was made. LMMs were used to assess the impact on arousal, valence, and intensity separately with nine fixed effects (selection [SELF, EXPERIMENTER], function [ENHANCE MOOD, TAKE MIND OFF THINGS, HELPS ME RELAX, COMFORT ME WHEN I'M SAD, ENERGY FOR THE DAY, FORGET THE WORLD, TALK ABOUT WITH MY FRIENDS], mellow genre preferences, unpretentious genre preferences, sophisticated genre preferences, intense genre pref-

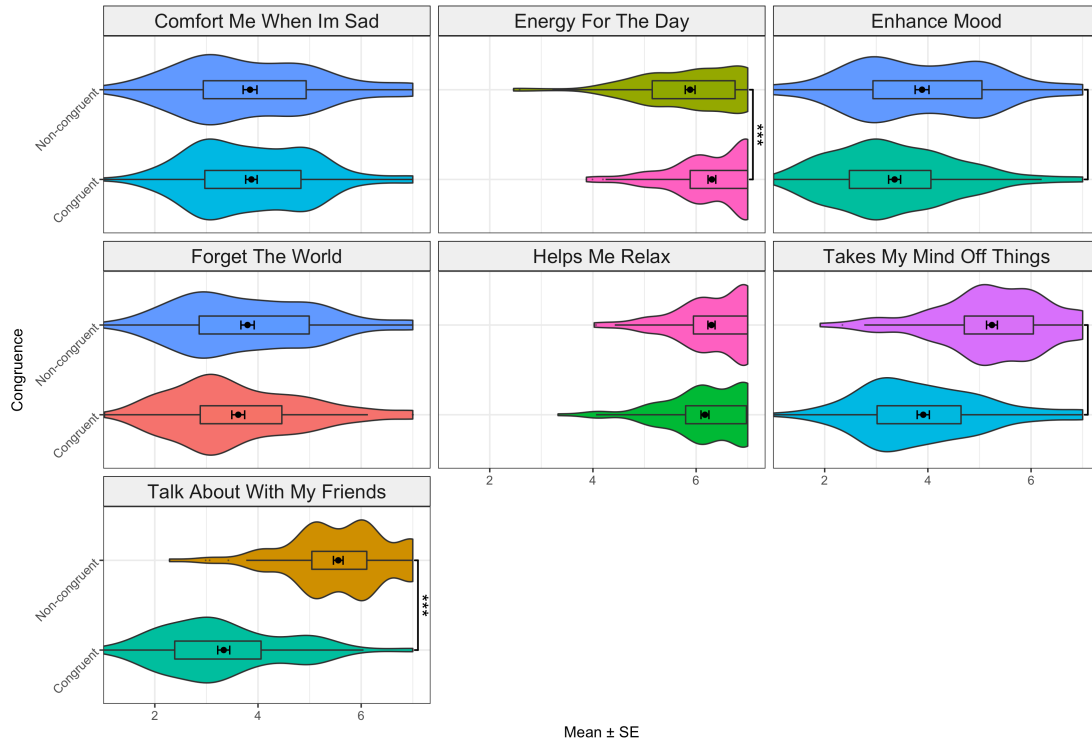


Figure 4.3: Violin plot of arousal ratings for congruent and non-congruent tracks in different functions. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

erences, contemporary genre preferences, age, and gender), one interaction effect (SELECTION:FUNCTION), and one random effect (PARTICIPANT).

For arousal, several main effects and interactions were observed (Table 3). The beta and t-values suggest that some functions themselves (e.g., energy for the day) play an important role in predicting arousal, while other functions show stronger effects in the interaction with self-selected music (e.g., enhance mood). Planned pairwise comparisons of exact means were run with self-selected music as a reference category. Nearly all comparisons between self-selected and experimenter-selected tracks were significant (Figure 4.4); for the full list of pairwise comparisons see Appendix (C.0.4). The goodness-of-fit for the model was then assessed. To reduce overfitting the model was re-run including only factors that reached significance. The main effects produced a fit with the data of $R^2_{(m)} = .21$ and random variables improving the fit by approximately 8% ($R^2_{(c)} = .29$).

For valence, several main and interaction effects were observed (Table 4.4). The

Table 4.3: Linear mixed model for arousal ratings between experimenter and self-selected tracks

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	2.604	0.339	106.873	7.673	0.000
SelectionSelf	0.593	0.146	3727.001	4.067	0.000
FunctionEnergy For The Day	1.589	0.092	3727.001	17.228	0.000
FunctionEnhance Mood	-0.161	0.092	3727.001	-1.741	0.082
FunctionForget The World	-0.189	0.092	3727.001	-2.051	0.040
FunctionHelps Me Relax	0.493	0.092	3727.001	5.349	0.000
FunctionTakes My Mind Off Things	-0.068	0.092	3727.001	-0.737	0.461
FunctionTalk About With My Friends	0.211	0.092	3727.001	2.283	0.022
GP_Mellow	-0.035	0.057	99.998	-0.613	0.542
GP_Unpretentious	-0.009	0.049	99.998	-0.192	0.848
GP_Sophisticated	0.208	0.059	99.998	3.505	0.001
GP_Intense	-0.003	0.038	99.998	-0.081	0.935
GP_Contemporary	0.085	0.052	99.998	1.623	0.108
Age	0.014	0.004	99.998	3.641	0.000
GenderMale	-0.045	0.105	99.998	-0.426	0.671
GenderTrans female	0.981	0.500	99.998	1.961	0.053
GenderTrans male	-0.406	0.357	99.998	-1.137	0.258
SelectionSelf:FunctionEnergy For The Day	0.107	0.206	3727.001	0.516	0.606
SelectionSelf:FunctionEnhance Mood	1.522	0.206	3727.001	7.379	0.000
SelectionSelf:FunctionForget The World	0.702	0.206	3727.001	3.405	0.001
SelectionSelf:FunctionHelps Me Relax	-1.218	0.206	3727.001	-5.908	0.000
SelectionSelf:FunctionTakes My Mind Off Things	0.628	0.206	3727.001	3.045	0.002
SelectionSelf:FunctionTalk About With My Friends	0.802	0.206	3727.001	3.887	0.000

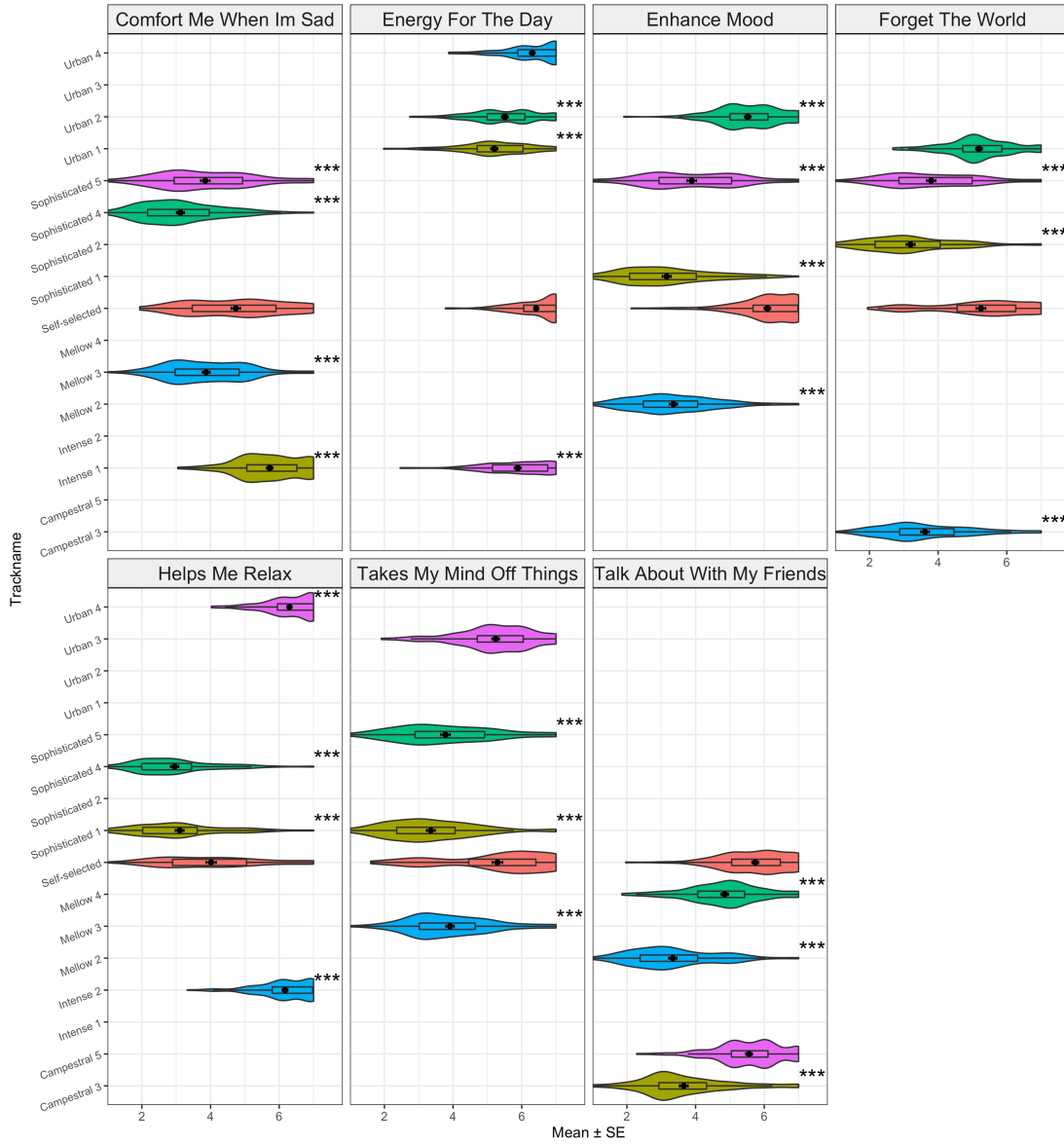


Figure 4.4: Violin plot of arousal ratings comparing experimenter-selected to self-selected tracks (red-orange) as a reference category in different functions. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

largest effects emerging for self-selected music, contemporary genre preferences, and the interaction between function and self-selected music. All planned pairwise comparisons between self-selected and experimenter-selected tracks were significant and plots show that in all cases valence increases in a positive direction (Figure 4.5); the full list of pairwise comparisons in the Appendix (C.0.4). To assess the goodness-of-fit the model was reduced to include only significant factors, reducing overfitting. Main effects and random effects behaved almost identically to arousal ($R^2_{(m)} = .21$ and $R^2_{(c)} = .29$). For intensity, again several main effects emerged (Table 4.5). In line with the results for arousal and valence, self-selected music, some functions, contemporary genre preferences, and several interactions between self-selected music and function make a significant contribution to the model. Planned comparisons of exact means were run with self-selected music as a reference category. All comparisons between self-selected and experimenter-selected tracks were significant and, like with valence, plots show a positive trend for intensity in self-selected music (Figure 4.6; the full list of pairwise comparisons see Appendix (C.0.4). To assess the goodness-of-fit the model was reduced to include only significant factors, reducing overfitting ($R^2_{(m)} = .24$ and $R^2_{(c)} = .42$).

4.4 Discussion

The results to Experiment 1 are briefly discussed. Although Experiment 1 was designed to identify appropriate stimuli for Experiment 2, there is a novel contribution to be gained from acknowledging that individual stimuli can vary in their appropriateness for different contexts. The results for Experiment 2 are then discussed in relation to the hypotheses individually before discussing the results as a whole. This more global discussion culminates in a strong argument for the role of goal-directed processes in emotional episodes induced by music. Moreover, it presents these findings as supportive of the classic theory of Meyer (1956) whose work has defined the subsequent years of study into musical emotions and is sup-

Table 4.4: Linear mixed model for valence ratings between experimenter and self-selected tracks

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	2.488	0.327	106.416	7.615	0.000
SelectionSelf	0.968	0.136	3726.999	7.128	0.000
FunctionEnergy For The Day	0.471	0.086	3726.999	5.487	0.000
FunctionEnhance Mood	-0.051	0.086	3726.999	-0.591	0.554
FunctionForget The World	0.313	0.086	3726.999	3.643	0.000
FunctionHelps Me Relax	0.092	0.086	3726.999	1.068	0.285
FunctionTakes My Mind Off Things	0.103	0.086	3726.999	1.201	0.230
FunctionTalk About With My Friends	0.007	0.086	3726.999	0.077	0.939
GP_Mellow	-0.008	0.055	100.003	-0.147	0.884
GP_Unpretentious	0.075	0.047	100.003	1.582	0.117
GP_Sophisticated	0.109	0.057	100.003	1.904	0.060
GP_Intense	0.048	0.037	100.003	1.298	0.197
GP_Contemporary	0.127	0.050	100.003	2.524	0.013
Age	0.006	0.004	100.003	1.580	0.117
GenderMale	0.049	0.101	100.003	0.480	0.632
GenderTrans female	0.514	0.482	100.003	1.065	0.289
GenderTrans male	-0.108	0.344	100.003	-0.314	0.754
SelectionSelf:FunctionEnergy For The Day	0.691	0.192	3726.999	3.600	0.000
SelectionSelf:FunctionEnhance Mood	1.345	0.192	3726.999	7.005	0.000
SelectionSelf:FunctionForget The World	0.272	0.192	3726.999	1.417	0.157
SelectionSelf:FunctionHelps Me Relax	0.419	0.192	3726.999	2.180	0.029
SelectionSelf:FunctionTakes My Mind Off Things	0.655	0.192	3726.999	3.409	0.001
SelectionSelf:FunctionTalk About With My Friends	0.873	0.192	3726.999	4.544	0.000

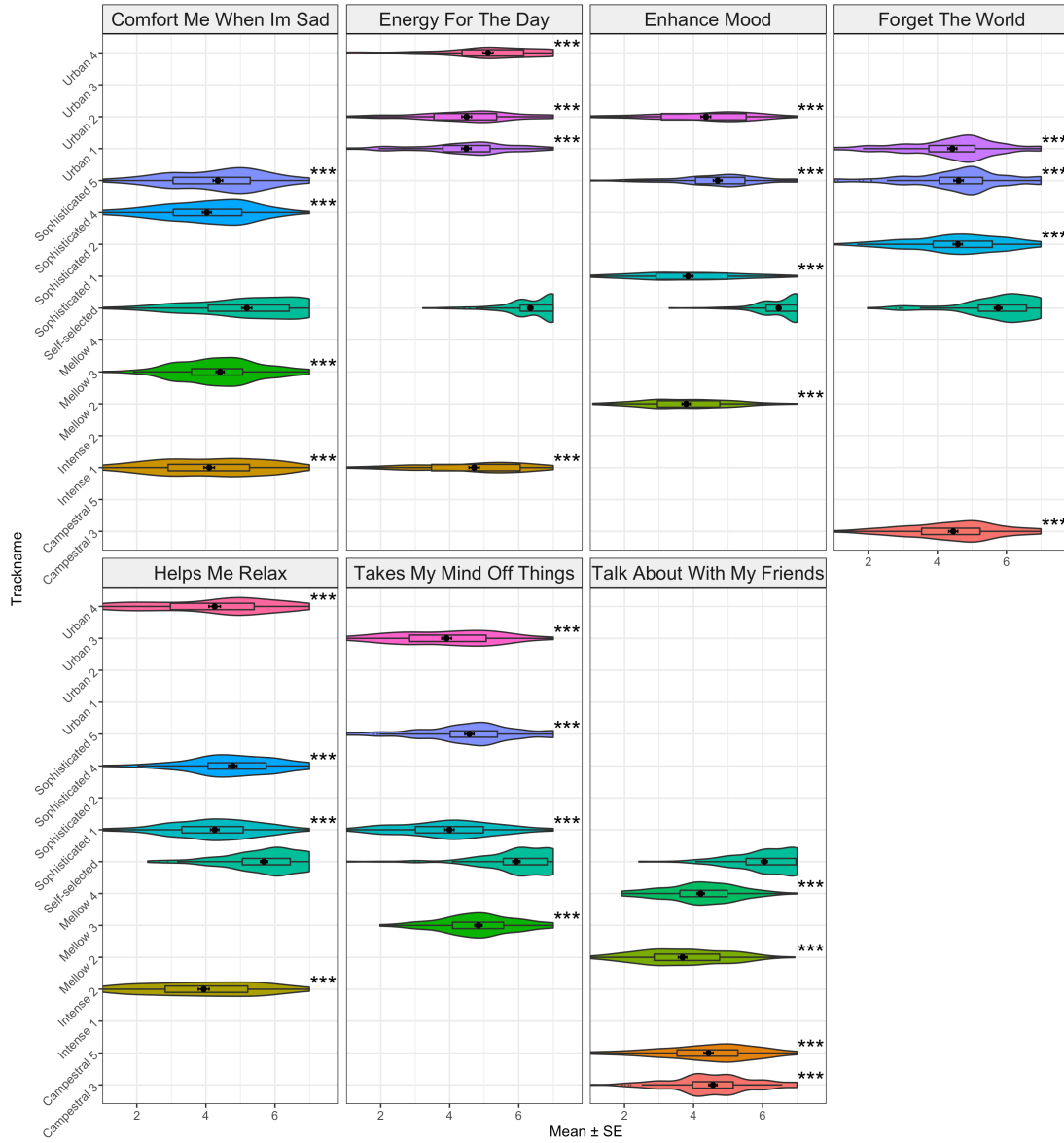


Figure 4.5: Violin plot of valence ratings comparing experimenter-selected to self-selected tracks (light green) as a reference category in different functions. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

Table 4.5: Linear mixed model for intensity ratings of experimenter and self-selected tracks

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	1.882	0.491	102.595	3.834	0.000
SelectionSelf	2.009	0.132	3727.000	15.267	0.000
FunctionEnergy For The Day	0.302	0.083	3727.000	3.633	0.000
FunctionEnhance Mood	-0.095	0.083	3727.000	-1.145	0.252
FunctionForget The World	0.012	0.083	3727.000	0.146	0.884
FunctionHelps Me Relax	0.246	0.083	3727.000	2.960	0.003
FunctionTakes My Mind Off Things	-0.121	0.083	3727.000	-1.451	0.147
FunctionTalk About With My Friends	-0.099	0.083	3727.000	-1.195	0.232
GP_Mellow	-0.017	0.084	100.001	-0.207	0.837
GP_Unpretentious	0.111	0.072	100.001	1.541	0.127
GP_Sophisticated	0.104	0.087	100.001	1.204	0.231
GP_Intense	0.065	0.056	100.001	1.167	0.246
GP_Contemporary	0.168	0.076	100.001	2.206	0.030
Age	0.011	0.006	100.001	1.908	0.059
GenderMale	-0.024	0.154	100.001	-0.159	0.874
GenderTrans female	0.762	0.731	100.001	1.043	0.300
GenderTrans male	-0.447	0.522	100.001	-0.856	0.394
SelectionSelf:FunctionEnergy For The Day	-0.321	0.186	3727.000	-1.723	0.085
SelectionSelf:FunctionEnhance Mood	0.066	0.186	3727.000	0.357	0.721
SelectionSelf:FunctionForget The World	-0.037	0.186	3727.000	-0.198	0.843
SelectionSelf:FunctionHelps Me Relax	-0.489	0.186	3727.000	-2.626	0.009
SelectionSelf:FunctionTakes My Mind Off Things	-0.185	0.186	3727.000	-0.992	0.321
SelectionSelf:FunctionTalk About With My Friends	-0.042	0.186	3727.000	-0.226	0.821

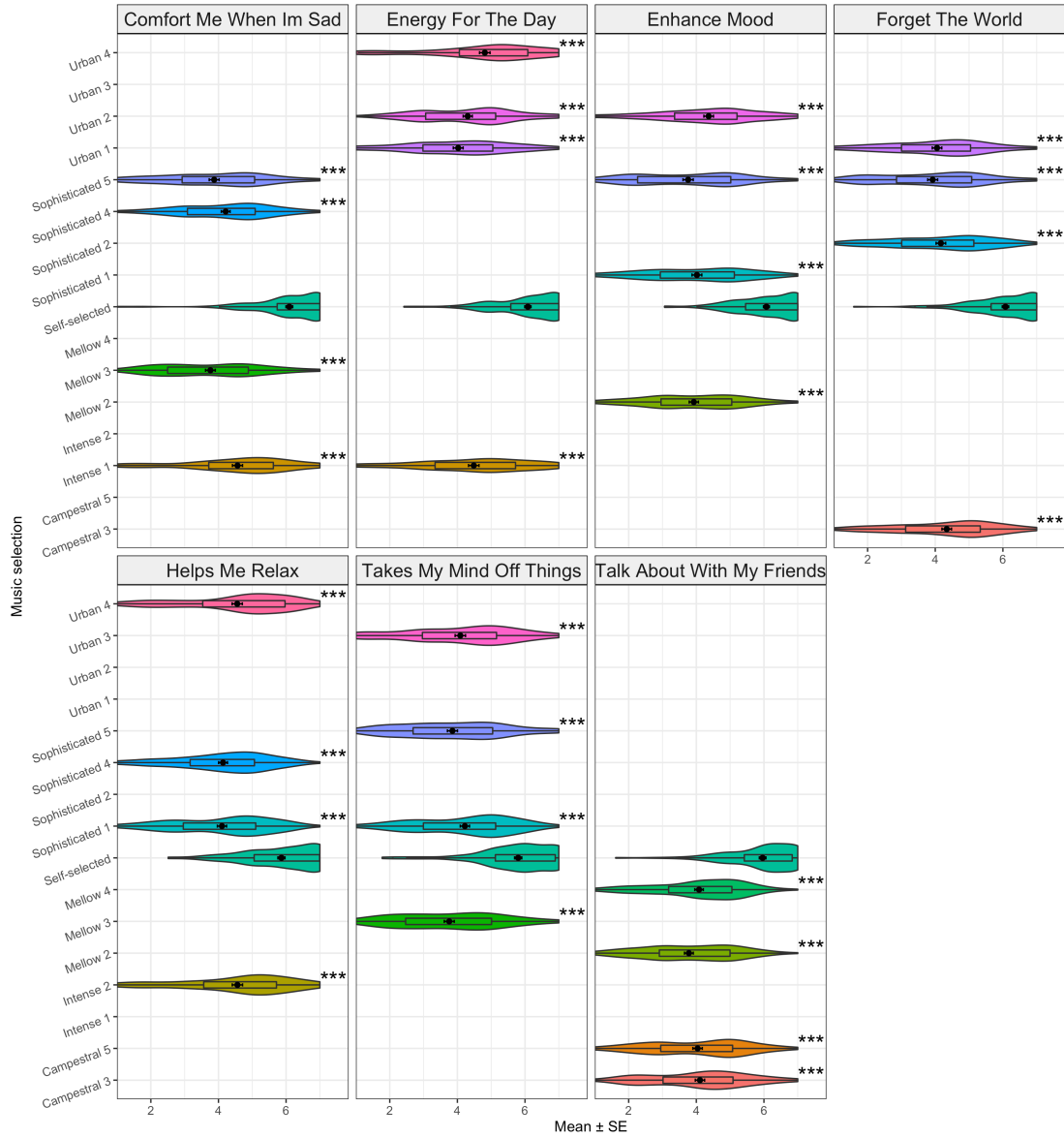


Figure 4.6: Violin plot of intensity ratings comparing experimenter-selected to self-selected tracks (light green) as a reference category in different functions. * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

portive of more recent music emotion models (Céspedes-Guevara 2021; Lennie and Eerola 2022) that explore the underlying mechanisms that drive these processes.

4.4.1 The contextual variability of stimuli

The results of Experiment 1 have shown that it is possible to identify musical stimuli that are more or less contextually appropriate for specific purposes. Although not the aim of this paper as a whole, this finding represents a novel contribution in itself and poses a challenge for future research to better acknowledge the role of context in both experimental design and stimuli selection.

Experiment 1's findings suggest that musical stimuli should not be approached as single entities appropriate for one function, nor should they be viewed as specific triggers for particular mechanisms (e.g., brainstem reflexes, Juslin and Västfjäll 2008). Music does not represent stimuli that trigger pre-defined causal paths. Instead, the context (and the individual) define stimulus relevance and meaning in a particular situation for a particular individual (Scherer and Zentner 2001). This raises interesting questions about the appropriateness of stimuli in different experimental contexts and has substantial implications for experimental designs. Warrenburg's review (2020a) of experimental stimuli states the music psychology field typically relies on nine discrete emotion terms under which stimuli are grouped and that 42% of studies selected stimuli because they had been used/validated in previous studies (p. 250). Yet, in this paper I have shown that musical stimuli are contextually sensitive. As such, identifying stimuli as singular discrete emotion terms does not necessarily make them comparable across studies and may be leading to type I and II errors. In conclusion, it suffices to say that better understanding the role of context will undoubtedly be illuminating for the field.

4.4.2 The role of goal-relevance

The results show that the type of function can change the induced valence of music. This suggests that the reasons (goals) people engage with music in differ-

ent contexts can change how positive or negative the experience of an emotional episode induced by music is. This was shown for the same piece of music experienced with different goals. This effect was observed in four of ten tracks (Mellow 3, Sophisticated 4, Sophisticated 5, and Intense 1). These tracks span different genre preferences (Rentfrow, Goldberg, and Zilca 2011), though genre preferences themselves did not play a significant role. This suggests the effects may be robust across genres. The role of liking, however, should not be underestimated in relation to valence ratings. Liking made a substantial contribution to the valence model. Liking has been equated with approach/avoidance action tendencies (Swaminathan and Schellenberg 2015) and it is closely tied to familiarity (Zajonc 1980). Significant interaction effects between liking and specific tracks (Urban 1, Urban 4, and Intense 1) suggests that individual differences in valence can also be mediated by liking regardless of function, at least for specific tracks. Interactions between liking and track suggests that urban and intense tracks were the most influenced by liking. This influence of liking may also explain the significant effect of age. Liking for urban and intense tracks is more commonly associated with younger listeners. Previous studies (Bonneville-Roussy et al. 2017) have noted such trends in age differences showing a decrease in preference for intense and urban music with age. However, genre preferences are not the only cognitive influence on liking (Brattico 2015). This experiment adds that the function of the music (the goal of the listener) is also an important cognitive predictor of valence. I suggest, inline with much research (Hunter and Schellenberg 2010), that liking either viewed specifically as an action tendency or viewed as a more basic affective response, is associated with goal-directed listening: simply ‘people listen to music because of the way it makes them feel’ (Hunter and Schellenberg 2010, 150).

An interesting observation in the role of function for predicting valence is the recurrent comparison against the goal to ‘comfort me when I’m sad’. This leads to the suggestion that certain functions have a stronger ability to mediate valence ratings. ‘Comfort me when I’m sad’ is described as relating to the dimension of ‘self’ related functions (over social or arousal/mood regulation functions). How-

ever, as suggested by Greasley and Lamont (2011; see also Maloney 2019) music can fulfil multiple goals. It is quite possible that the function ‘Comfort me when I’m sad’ also fulfills goals related to ‘arousal/mood regulation’. To comfort when sad suggests a move from low and negative core-affect back towards a more neutral or positive point. Similarly, as a social function it may be related to loneliness and concepts of music as a ‘social surrogate’ (K. Schäfer and Eerola 2020). This experiment had not evaluated goals as differentiated by suggesting a pre-existing core-affect, as in the case of ‘comfort me when I’m sad’. Nor had it considered goals as implying a direction of change in core-affect as in ‘energy for the day’ (a positive move in arousal) or ‘enhance my mood’ (a positive move in valence and possibly arousal too). The functions in this experiment were selected to be highly representative of typical goals for UK participants and therefore control for differences in familiarity with the type of function. Yet, many functions here could be considered as related to ‘arousal/mood regulation’ goals, even if they are also related to social or self functions. They may therefore differ in the degree and direction of change in core-affect. Moreover, the degree of goal-relevance an individual places on a particular goal for a certain function may be substantially different. One individual may place a greater weighting on the ‘arousal/mood regulation’ goals they can gain from music, while others may be more concerned with the cognitive benefits, even if both these functions are being fulfilled. This poses an interesting future direction for researchers.

This discussion exemplifies how there may be many interdependencies within the results deserving of further investigation. What is clear from these results, is that regardless of further possible mediated factors, the functional role that music serves should be considered an important factor in predicting valence in musically-induced emotional episodes.

4.4.3 The role of goal-congruence

The experimenter-selected tracks, identified as congruent and non-congruent for a particular function, did not show any significant effects for valence or intensity. Arousal similarly showed no effect for congruence after the inclusion of track as a predictor. These results instead suggests that, valence and intensity are more closely related to liking while arousal ratings are better explained by the tracks themselves. This finding for arousal supports well acknowledged trends in the literature. A meta analysis (Céspedes-Guevara and Eerola 2018) of acoustic cues in music and speech suggest arousal is better predicted by acoustic features of the music. Valence however, did not show such strong predictive effects from acoustic cues in the meta-analysis. Such findings add additional support for the interpretation that individual tracks are stronger predictors of arousal ratings.

The role of liking in predicting arousal ratings is more difficult to explain. One possibility is that the relationship between valence and arousal is not orthogonal. Instead a V-shaped relationship between the two dimensions exists (Kuppens et al. 2017). This suggests that as valence increases in a positive or negative direction, arousal automatically increases too. In relation to the results presented here in the goal-relevance analysis, as valence moves further from a neutral centre point (with greater liking/disliking) arousal will automatically increase. Such hypotheses have been adapted to the music emotion literature (Lennie and Eerola 2022) and empirical support for the link between goal-congruent stimuli and arousal ratings has been found. In the only other direct empirical test of goal-directed mechanisms in music Gómez-Coñón et al. (2022) found that music supportive of right-leaning political ideologies showed higher arousal ratings for right leaning Colombian participants. Yet, to test the idea of a V-shaped relationship between valence and arousal in music rigorously would require a carefully controlled set of experimental stimuli that vary incrementally across the valence spectrum. What is clear from the results is that ratings of arousal are more closely related to features of the tracks. The possibility these effects may be further mediated by

positive or negative valence remains open.

As stated above, the results for goal-congruence did not support the hypothesis. It is of course quite possible that experimenter-selected tracks did not represent congruent and non-congruent music for these functions within a new pool of participants. Simply, substantial individual differences between the participant pools in what makes music *right* for a function may explain the lack of significant findings for congruent and non-congruent music. Overall, this is to suggest that what makes music *right* for a function is more than just the music itself - it requires cognitive evaluation (Meyer 1956). The results for highly goal-congruent music support such a conclusion.

4.4.4 Optimal goal-congruence

Highly goal-congruent music, being self-selected and presumably liked music for a specific function, shows a clear trend in valence and intensity ratings. Highly goal-congruent music leads to increased valence and emotional intensity. Valence however, shows more significant interaction effects between self-selected music and the type of function to be stronger predictors. This suggests the ability to choose the *right* song is inherently linked to the goals individuals wish to achieve. Intensity ratings alternatively show self-selected music to be a much stronger predictor, over interactions between self-selected music for a particular function. By taking the reasonable assumption that self-selected congruent music is also liked, the results for intensity replicate previous findings; that liking is a positive predictor of intensity (Cespedes-Guevara and Dibben 2022). Therefore, while the role of self-selected music in valence and intensity produces similar effects the model suggests important differences in the causality of these effects. Contemporary genre preferences, most closely aligned with ‘urban’ tracks (Rentfrow, Goldberg, and Zilca 2011), showed a significant effect in both valence and intensity. This suggests that certain genre preferences may play a more important role when considering self-selected music.

Arousal similarly shows a significant effect for self-selected music. However, the strongest predictor of arousal was the function ‘energy for the day’. Many other individual functions were significant predictors of arousal too (e.g., ‘helps me relax’). Furthermore, arousal does not show a consistently positive direction of change (Figure 4.4), as observed in valence and intensity (Figure 4.5 & 4.6). Significant effects for sophisticated genre preferences and age also emerged for arousal ratings in self-selected music (compared to experimenter selected). This supports the trend in other analyses run here which suggest age and sophisticated genre preferences are more closely linked than other genre preferences in this population.

The results for self-selected music all together can be summarised in three broad trends. The strongest predictors of arousal are the individual functions. The strongest predictors for valence are interactions between self-selected music and type of function although self-selected music also contributes as a strong predictor. Intensity is best predicted by self-selected music (the ability to choose the music).

4.4.5 Core-affect and intensity in a goal-directed context

The picture painted by the results for highly goal-congruent music are supported by the other analyses conducted in this study. That is, the effect the type of function has on valence (Table 4.1 and Figure 4.2; discussed in ‘The role of goal-relevance’) and the importance of individual tracks in predicting arousal ratings (Table 4.2, Table 4.3, Figure 4.3, and Figure 4.4; discussed in ‘The role of goal-congruence’). Both these effects are mirrored and amplified in the trends of the linear mixed models presented for highly goal-congruent (self-selected) music.

The overview of this evidence makes a strong case for the role of goal-directed mechanisms in musically-induced emotional episodes, and specifically, suggesting there is a meaningful interaction between goal-directed mechanisms and core-affect. In the context of the wider literature this interaction can be summarised in three key conclusions. There is an optimum arousal state implied by a functional context - an individual’s goals. Music that can induce the desired optimum

arousal leads to a more positive emotional experience and therefore valence is best explained by the right music for the right function. Being able to choose the music, and presumably pre-existing knowledge about its appropriateness for achieving a desired core-affect state, makes the experience more intense.

This goal-directed conclusion supports recent hypotheses applied to musical emotional episodes (Lennie and Eerola 2022; Céspedes-Guevara 2021; Thompson, Quinto, et al. 2011) and it ties in well with the seminal work of Meyer (1956) and his expectation-arousal theory: music may stimulate physiological arousal however, it requires cognitive appraisal to be distinguished as positive or negative. These results add that this cognitive appraisal is informed by how well the music can induce a goal-directed optimum arousal. The effects of highly goal-congruent music on the intensity of an emotional episode similarly support Meyer’s hypothesis for anticipated arousal. That is, knowing the effects of the music and anticipating the changes in arousal leads to more intense experiences. Moreover, these findings support more recent hypotheses about the role of goal-directed learning (i.e., individuals learn through experience what different stimuli afford them in relation to their goals). These conclusions draw the music emotion literature closer to the wider affective literature (Russell 2003; Barrett 2017; Ellsworth and Scherer 2003; Clore and Ortony 2000; Moors, Boddez, and De Houwer 2017; Mesquita, Boiger, and De Leersnyder 2016) while also providing a valuable insight into the ill-understood role of goal-directed mechanisms more broadly.

There are some nuances to be acknowledged too. Some functions appear to place a greater emphasis on achieving optimum arousal than others (e.g., ‘energy for the day’, ‘helps me relax’). Therefore, given that the acoustic features of music are more closely tied to ratings of arousal, the acoustic features of music may play a more important role in being goal-congruent for certain functions than others. In other cases, where arousal/mood regulation goals are less prominent, it may be other features of the music (e.g., lyrics) that play a key role in cognitive evaluations of music. Which features of music in different contexts are important

in an evaluation of goal-congruence remains an open question; one that may vary considerably by individual. Nonetheless, it is the right music for the right functions that leads to more positive emotional experiences, while being able to choose the music leads to more intense emotional experiences. Of course, it is quite possible the music is chosen because it induces strong emotional responses and the causal direction of this effect on emotional intensity cannot be extrapolated from this experiment. These results regarding previous non-musical findings agree with Kuppens et al. (2012). They found that while goal-relevance (the functional context in this design) did not influence felt arousal, pre-existing arousal (as core affect) did influence evaluations of goal-relevance. Put simply in relation to these findings, a desired arousal level and the role that music can play in achieving this goal is an important feature of what makes music relevant and meaningful in specific contexts.

4.4.5.1 Limitations and future directions

Some limitations to the study should be noted. The study did not measure how much participants liked, or how often they used music for a particular function. It is quite possible that there are several individual differences of note here in spite of the fact the functions were chosen to be highly representative of common UK functions of music (T. Schäfer 2016). Moreover, the results can only be generalised to a UK population.

One key observation in different goals afforded by music is that specific goals may imply a pre-existing core-affect state or a direction of change in core-affect. This was not controlled for in the selection of functions but poses an interesting direction for future research to consider. For instance, future research might explore a balanced representation of functions that relate to different quadrants of the affective space or similarly a systematic selection of functions that represent directions of change across the affective space. Similarly, I note that several of the functions address affective outcomes (e.g., Enhance Mood). Such terms may well have biased the results for both experimenter and self-selected music. These

points together highlight the many challenges that come with operationalising the predictions of the CODA model (Lennie and Eerola 2022) in to measurable variables.

Highly goal-congruent music was represented as a self-selected (and liked) stimuli for a specific functional purpose. It is of course quite possible that self-selected music may be more influenced in real scenarios by factors like genre preferences even if the music itself may be less congruent or even incongruent with the functional context. Alternatively, assuming that self-selected music in this experiment is representative of highly-congruent and liked music; participants were asked to select music that ‘fit’ the function best. This merging of cognitive evaluations (highly-congruent and liked) does not allow for the effects of each of these variables to be separated in the analysis. The discussion here takes the results of other analyses, where liking can be assessed as a separate variable, as supportive of the interpretation made for self-selected music. Nonetheless, how these cognitive evaluations interact and the individual contribution of each cannot be assessed in this design and leaves the question open for future studies. One such approach could be to look at the interaction between goal-directed appraisals and action tendencies; liking as representative of approach-avoidance tendencies (Hunter and Schellenberg 2010). Utilitarian hypotheses for the link between appraisals and action tendencies can be found in Scherer and Moors (2019).

Finally, these results are collected through self-report. There are notable limitations with self-report paradigms (Zentner and Eerola 2010) and future experiments should seek to verify these findings through more objective measures such as physiological and neurological responses. Still, these results can be seen as indicative of the cognitive mechanisms investigated in this experiment.

4.5 Conclusions

Using a participant-led selection of the functional uses of music and appropriate musical stimuli for each function, Experiment 1 provides novel evidence that musical stimuli can be more or less well-suited to a particular function. Experiment 2 provides the first direct evidence for the role of goal-directed mechanisms and their influence on core-affect in emotional episodes induced by music. It has shown how two goal-directed mechanisms (goal-relevance and goal-congruence) influence induced core-affect. Specifically, it suggests that goal-relevance implies a desired state of core-affect to be achieved through music; most prominently but not explicitly in the arousal dimension. A cognitive evaluation of music's ability to achieve this desired change (goal-congruence) leads to changes in how positive or negative an induced emotional episode is. Finally, being able to choose the music that achieves an individual's goals leads to more intense emotional experiences. Collectively these conclusions are in line with the goal-directed hypotheses proposed by (Lennie and Eerola 2022). More broadly, the results emphasise the importance of the individual and the role of context (Scherer and Zentner 2001) in understanding what makes music meaningful to an individual and how music is used to influence our emotional states.

Chapter 5

Appraisals in the wild: Goal-directed mechanisms in a socio-cultural context and its applications to MER

Juan Sebastián Gómez-Cañón, Thomas Magnus Lennie, Tuomas Eerola, Pablo Aragón, Estefanía Cano, Perfecto Herrera, Emilia Gómez, (2023). *Polarization through Colombian not-so-popular music and algorithms: appraisal guided musically induced emotions*. [Manuscript submitted for publication]. Music Technology Group, Universitat Pompeu Fabra.

Preface

This final study of the thesis again builds upon the previous findings for goal-directed mechanisms and seeks to expand on them by extending these findings into more ethologically valid real-world settings. Moreover, it seeks to advance the role of goal-directed mechanisms and the CODA model as a useful contribution to the field of music information retrieval; allowing for a theoretically grounded

approach to the study of individual and contextual differences. These two components together not only allow for further testing of goal-directed mechanisms as a useful addition to other fields but also show how acknowledging such mechanisms can advance understanding of real-world effects of music: in this case as the algorithmic manipulation of goal-directed mechanisms to induce negative affect. The results while different to previous findings in this thesis, are described as supportive of the role of goal-directed mechanisms. The discussion notes the complexity and limitations of addressing such specific mechanisms in the variable context of the real-world. The conclusions highlight the benefits for researchers that attempt cross-disciplinary research such as this.

Abstract

This work presents a study of how Music Emotion Recognition (MER) systems could be biased with respect to annotations of musically-induced emotions in a political context. Specifically, we analyse traditional Colombian music containing politically charged “left-wing” guerrilla Fuerzas Armadas Revolucionarias de Colombia (FARC) and (2) corridos from sympathizers of the “right-wing” paramilitaries Autodefensas Unidas de Colombia (AUC). We train personalised machine learning models to predict induced emotions for participants with diverse political views – we aim at identifying the songs that may induce negative emotions for a particular user, such as anger and fear. By acknowledging the context of the user (their political leaning), we show that user’s emotion judgments could be interpreted as problematising data – subjective emotional judgments could in turn be used to influence the user in a human-centred machine learning environment. In short, highly desired “emotion regulation” applications could potentially deviate to “emotion manipulation” – the recent discredit of emotion recognition technologies might transcend ethical issues of diversity and inclusion.

5.1 Introduction

Emotion is acknowledged as one of the core reasons people engage with music (Juslin, Barradas, and Eerola 2015). Yet, the mechanisms that underpin the emotional effects of music are still a matter of debate (Céspedes-Guevara and Eerola 2018; Warrenburg 2020c). We are likely still some time from a comprehensive model of musical emotions. Nonetheless, progress has been made by Lennie and Eerola (2022) to situate emotional responses to music within contemporary developments in the affective and cognitive sciences – the CODA Model: Constructivistly-Organised Dimensional-Appraisal. Lennie and Eerola (2022) hypothesise that affective responses to music, like many utilitarian affective responses (Frijda 2007a; Moors 2017), are driven by goal-directed mechanisms.

The CODA model (Lennie and Eerola 2022) hypothesises that an individual’s goals and the relevance of a stimulus to those goals in a specific situation will influence the development of an emotional episode induced by music. This relationship between goal-directed mechanisms and music is predicted to be bi-directional. That is, a musical stimuli seen as relevant to one’s goals may amplify the degree of relevance that an individual places on a particular goal. Similarly, a stimuli that is in conflict with an individual’s goals may amplify negative reactions through an inability to achieve or align with one’s goals. For example, a song that discredits Apple devices could be used with different purposes as it could yield different reactions (and possibly different induced emotions) – depending on the *fit* of a stimulus with an individual’s goals. The value of musical goals has been acknowledged in previous literature (Sloboda and Juslin 2010) and has been included in several theoretical models (Scherer and Coutinho 2013; Céspedes-Guevara 2021). Some models explicitly hypothesise the link between goal-directed mechanisms and core-affect¹ (Thompson, Quinto, et al. 2011; Lennie and Eerola 2022). Yet, little empirical work has followed, possibly due to a historical narrative that aesthetic emotions, including musical emotions, have little influence

¹Core affects are arousal and valence. Arousal refers to energy or activation and valence relates to pleasantness or positiveness of an emotion.

on life goals (Kant 1790). An idea recently described as irreconcilable with current biological understanding (Huron 2016, 242). This goal-directed and context dependent understanding of musical emotions allows for substantial individual variation in emotional responses to music. Subsequently, it provides a valuable theoretical grounding for exploring individual differences in Music Emotion Recognition (MER) and guiding the focus of future data collection for personalisation models.

From the computational perspective, MER attempts to predict the emotion perceived by or induced in a particular listener (Yang and Chen 2011). To design predictive models it is necessary to obtain a “ground truth” – a term that refers to the “real” or “true” information that the machine learning algorithm attempts to predict (Schuller 2013). A main limitation to MER is to attempt to create this “ground truth” due to the subjectivity of the task. However, a growing effort has been made to produce enriched datasets of emotion judgments with more listening data to better represent the properties and context of the listener (Barthet, Fazekas, and Sandler 2013; Schedl, Flexer, and Urbano 2013; Gómez-Cañón, Cano, Eerola, et al. 2021): demographics, cultural and individual differences, preference, familiarity, functional uses of music, physiological signals, and language. In this context, personalised models which incorporate this information could more easily predict the particular emotion judgments from a particular listener (Yang et al. 2007; Su and Fung 2012; Y.-A. Chen et al. 2014; Gómez-Cañón, Cano, Yang, et al. 2021). However, only recently has research started to study the impact of “toying with emotions combined with personalisation” in a decision-making process due to increasing concerns regarding dark patterns and manipulative personalisation in digital commercial practices (European Commission et al. 2022) – MER systems could potentially be harmful when inducing particular emotions to a listener.

One way in which this could occur is through the manipulation of goal-directed mechanisms, where several aspects of musical engagement may be negatively affected by the misuse of such systems. For example, music recommendations that

reflect patriotic out-of-group identity or ideologies may lead to stronger nationalistic views and/or more negatively orientated associations towards such out-groups. Similarly, such recommendations could easily misrepresent a persons' ideological stance or social identity, if such recommendations were to appear in publicly accessible playlists. Moreover, personalisation strategies, which should target societal well-being as a requirement to produce trustworthy artificial intelligence², are frequently imposing unbalanced and unfair digital asymmetries onto more vulnerable societies in forms of “colonial value and power paradigms” that researchers should strive to acknowledge (Mohamed, Png, and Isaac 2020; Adams 2021; Birhane and Guest 2021). From the field of music technology, Huang, Sturm, and Holzapfel (2021) have pointed out how ethical concepts such as “human rights”, “well-being” and “potential misuse” – that are typically used in Western societies – need to be carefully examined in other cultural contexts.

5.1.1 Aims

This study is an extension from the work presented by Gómez-Cañón, Herrera, et al. (2021) and Lennie and Eerola (2022) – the aim of this study is to attempt to understand if an MER algorithm can effectively be biased to classify music which can induce “negative” emotions to a listener through the manipulation of goal-directed mechanism. In essence, we wish to empirically show the validity of goal-directed mechanisms in musically induced emotions and how this directly relates to real-world applications of music listening. We use the word “negative” carefully, since the subjectivity of the task complicates defining if an emotion is negative or not. However, a personalised MER algorithm can produce music recommendations grounded on the listeners' judgments (already standard in streaming platforms), which in turn could prove beneficial or harmful to this listener when inducing particular emotions.

This study diverges from previous research which aims at using music for beneficial

²<https://op.europa.eu/s/pInE>

purposes: to enhance memory, relieve boredom, improve concentration, promote prosociality, or aid learning (Xiao Hu, Chen, and Wang 2021; Agres et al. 2021; Cespedes-Guevara and Dibben 2021). The reason is that, despite the common consensus regarding beneficial uses of music, it has also aided to create generalised misconceptions – for example, the Mozart effect (A. A. K. Mehr Samuel A. AND Schachner 2013), binaural beats (Orozco Perez, Dumas, and Lehmann 2020), or 432 Hz tuning (Rosenberg 2021). Only recently has research started to theorize and analyse music-induced harm (Ziv 2016; Silverman, Gooding, and Yinger 2020) – a topic that should be more widely studied by academia. Online social networks, streaming platforms, and personalised ad companies are already making use of emotional responses to maximise users’ engagement (O’Neil 2016; Noble 2018; Zuboff 2019; Véliz 2020). Facebook has been involved in several cases in this regard. A massive experiment showed empirical evidence of emotional contagion through the exposure of users to posts from Facebook friends expressing specific emotions (Kramer, Guillory, and Hancock 2014). The episode with Cambridge Analytica demonstrated the potential of digital technologies to persuade users, polarise opinions, and affect decision-making processes by promoting/manipulating emotional stimuli (H. Davies 2015). In fact, these emotional stimuli can lead to harmful consequences on the integrity of individuals, as observed in the amplification of hate speech on Facebook towards Rohingya refugees in Myanmar (Fink 2018). This form of persuasion, where individuals appear immune to any evidence contrary to their own views, has colloquially been referred to as the “filter bubble” (Pariser 2011) or “echo chamber” effect (Sunstein 2002; Garrett 2009), but most notably refers to the greater presentation of information amenable to an individual’s existing view points. The homophily principle argues that “similarity breeds connection” (Mcpherson, Smith-Lovin, and Cook 2001) – personal networks tend to be heterogeneous regarding demographic, behavioural, and individual properties. Homophily is often associated with other forms of individual biases, such as confirmation bias (people tend to favour information confirming their values) and cognitive dissonance (people experience psychological stress when participating

in actions against their beliefs). Thus, several studies have taken advantage of the availability of social media data to characterise the formation of polarization phenomena online (Adamic and Glance 2005; Conover et al. 2011; Del Vicario et al. 2016; Garimella et al. 2021). We refer the reader to Tucker et al. (2018) for a thorough literature review on this topic. While homophily is a common tendency of individuals, recent work is critically examining whether polarization online is boosted by platform design. Unlike the polarising dynamics of social networks that employ personalisation algorithms that influence user exposure and navigation, the design of other platforms such as Wikipedia has shown the value of generating common spaces among users (Shi et al. 2019; Neff et al. 2013). Hence, the impact of algorithms in polarization have been questioned in order to produce systems that “depolarise by design” (Garimella et al. 2017; Stray 2021; Fabbri et al. 2022).

Most of the aforementioned studies have been carried out using very direct stimuli and interactions between users of social media (e.g., online political conversations on Twitter). To further understand this phenomenon with other forms of stimuli, we present an experiment which addresses polarization in a two-fold approach by using:

1. music – and specifically lyrics – as an emotional stimuli to users,
2. personalisation algorithms that attempt to predict the emotion induced by the music to the listener.

The Colombian presidential elections offered a unique opportunity to access a time where listeners would show strong political opinions (goal-relevance) and strong emotional responses. The contextualization of the Colombian political landscape escapes the scope of this paper, thus we refer the reader to Chomsky (2004; Zamosc 1986; Berquist 1978; Stokes 2005; Arocha R. et al. 1988; Fals Borda et al. 2001; Mahoney 2020) for deeper analysis regarding the history of violence in Colombia. In a broad context, the “biblical holocaust” of Colombian violence – portrayed by the writer Gabriel García Márquez – has resulted in more than 420,000 vio-

lent deaths over the last 70 years, more than 11 million Colombians leaving the country or being internally displaced, and one of the most unequal distribution of income in the continent (Mahoney 2020). Diverse sources of inequality (i.e., agrarian capitalism, socio-economic exclusion, decolonization processes, the war on drugs, illegal economies, and exploitation of natural resources) are the cause of the formation of illegal armies fuelled by political ideologies (Grajales 2021): “left-wing” Fuerzas Armadas Revolucionarias de Colombia (FARC) and “right-wing” Autodefensas Unidas de Colombia (AUC), amongst several other illegal groups. As an oversimplification of Colombia’s historical process (and reflecting the generalised trend in the world), polarization has arisen over whether and how to pursue peace in the country, producing negative relationships between political discourses and everyday life (Feldmann 2019).

Music has been used as political propaganda reflecting this polarization of strong left/right political stances in Colombia. The “left-wing” guerrilla group FARC is associated with *vallenatos*³ and social songs that support their political ideology. Similarly, the *corridos prohibidos* – ballads often associated with the 20th century Mexican revolution and later with the narcotics trade (Villalobos and Ramírez-Pimienta 2004; Barbosa Caro and Suavita 2019) – have been used by several sympathizers of the “right-wing” paramilitaries AUC. While neither of the types of music is popular by Colombian chart standards, their political allegiance is clear within the lyrical content and the political stances they support are well understood by the population – we have previously referred to this music as Colombian not-so-popular music (Gómez-Cañón, Herrera, et al. 2021).

Through the interdisciplinary link between affective cognition and MER described here, we formulate the following research questions:

- Do an individuals’ political values (goals) influence emotional episodes induced by music in terms of core-affect?
- Can a MER algorithm for induced emotions be biased towards a particular

³A Colombian folk tradition that translates as “born in the valley”.

opinion with respect to music with polarising lyrics?

5.2 Related work

Next we explore the literature that led to the development of these research questions and explore some of the key terms used in the paper. We finish this section by offering some explicit hypotheses drawn from this literature that provide support for these wider research questions.

5.2.1 A goal-directed approach

A goal-directed mechanism can be described as cognitive processes that relates to an organisms needs, wishes, desires, values or beliefs, grouped together broadly as goals. Goals can be described at different functional levels. For example, lower-level goals included basic survival functions like food or sex, while higher-level goals include higher cognitive functioning such as personal values or social identity, sometimes described as “norm-compatibility”. A goal-directed mechanism is more typically described as a competition between multiple competing goals (Moors 2017).

Goal-directed processes have become a central part of the wider research in the affective and cognitive sciences (Sloman 1996; Balleine and Dickinson 1998; Frijda 2007a; Eder and Hommel 2013; Schiller et al. 2022). The BRECVEM model – one of the most well cited music emotion models (Juslin and Västfjäll 2008; Juslin 2013) – however, does not consider goal-directed processes meaningful to music and has been explicitly criticized for this (Moors and Kuppens 2008; Scherer and Zentner 2008; Scherer and Coutinho 2013; Céspedes-Guevara 2021; Lennie and Eerola 2022). Later variations of this model (Juslin 2013, 2019) acknowledge that goals are present but distinguishes them as separate from other underlying mechanisms and describes them as occurring “rarely” (Juslin 2013, 239). In contrast, Lennie and Eerola (2022) have proposed a new model that seeks to re-centre

goal-directed processes into the mechanisms that underpin emotional responses to music. Uniquely, they use a goal-directed mechanisms to draw together to competing emotion models: Constructionist (Russell 1980, 2003; Barrett 2006, 2017) and Dimensional-Appraisal (Ellsworth and Scherer 2003; Scherer 2009a, 2009b; Moors et al. 2013), reflecting recent developments in the affective sciences (Schiller et al. 2022).

Some goal-directed theories have made explicit predictions about how different goals may be prioritized over others in different context (Moors, Boddez, and De Houwer 2017) and drive further attention and cognitive resources towards this goal. Put simply, certain contexts may lead to the prioritisation of certain goals over others. For instance, during political elections people may give greater priority to evaluating their political position or may invest greater cognitive resources towards defending or strengthening their existing political position; be it intentionally or unintentionally – the “echo chamber” phenomenon (Garrett 2009). Explicit predictions about how stimuli interact with an organism’s goals leading to changes in other components of emotion have been made (Kreibig, Gendolla, and Scherer 2012; Moors et al. 2013). Evidence for this has come from studies showing that multiple appraisal dimensions, including goal-relevance and goal-congruence (how well a stimulus supports or inhibits a goal), can bi-directional interact and modify core-affect (Kuppens, Champagne, and Tuerlinckx 2012). This interaction is often closely related to how congruent or incongruent a stimulus is for an organism to achieve its goals. More recently, studies testing the causal nature of these mechanisms over time have shown that goal-relevant stimuli lead to greater changes in core-affect compared to irrelevant ones, most prominently in experienced pleasantness (Asutay and Västfjäll 2021).

Goal-directed processes have long been associated with personal and social values (Frijda et al. 1986; Frijda 2007a; C. A. Smith and Lazarus 1991; Scherer 1982, 2009a; Ellsworth and Scherer 2003). The evidence further suggest that stimuli that are congruent or incongruent with an individual’s personal identity or social

values can also influence the development of an emotional episode (Scherer and Moors 2019 i.e., influencing other components of emotion).

5.2.2 Social & personal identities

Music preferences are a commonly cited feature in the formation of social identities (Tarrant, North, and Hargreaves 2002; Shepherd and Sigg 2015) and personal values (Steele and Brown 1995; Saarikallio 2019). In this sense, music is viewed as a resource in the development of these components rather than something that directly influences them. Evidence for music as a mediating influence in the development of these components has emerged. Tarrant (2002) has shown that preferences for a particular music may lead to attributing similar personality traits to individuals that are associated with the social group as a whole. Under the umbrella of social and personal identities, research has provided firm grounding for the correlation of music preferences with personality traits, value systems, cognitive abilities, perceptions of gender (Zweigenhaft 2008; Dunn, Ruyter, and Bouwhuis 2012; Delsing et al. 2008; Ter Bogt et al. 2010) and critically political ideologies (Rentfrow and Gosling 2003; Rentfrow, Goldberg, and Zilca 2011; Carney et al. 2008), see Rentfrow (2012) for a general review. Studying a sample of American participants, Carney et al. (2008, Study 3) found that conservative viewpoints correlated with more conventional music choices and owning fewer variety of CD's. Liberals alternatively, showed greater preference for world, folk, classical, contemporary rock, and golden oldies. Unsurprisingly, this result similarly correlates with the personality dimension "openness to experience". A somewhat cautious interpretation of Carney et al. (2008) is warranted here due to the large number of statistical tests conducted. This has possibly led to several chance findings. In a similar vein, Rentfrow, Goldberg, and Zilca (2011) found that "aesthetic and complex" entertainment types, and in Rentfrow and Gosling (2003) "reflective and complex" and "energetic and rhythmic" music, correlated with a liberal self-identity. This finding was negatively correlated with social dominance orientation (Rentfrow and Gosling 2003). Alternatively, and in agreement with Carney

et al. (2008), Rentfrow and Gosling (2003) found self-identified right-leaning participants preferred “upbeat and conventional” music. Importantly, Rentfrow and Gosling (2003) notes that future research should explore the link between music preferences with values and goals (p. 1251).

Other findings (Heisbourg and Feitosa 2021) have linked music to marginal influences on the perception of some personality traits in political representatives in a positive direction. However, it remains to be shown if music can negatively influence perceptions of certain personality traits. The Heisbourg and Feitosa study made no assessment of participants’ preference for the presented music, its lyrical content, or their general music preferences. Furthermore, the study’s focus on influencing a participant’s perception of another persons personality is not directly related to the participants’ personal political stance or their emotional response to the stimuli. This makes it difficult to relate the already marginal effects directly to the music literature. For example, does music that is incongruent with an individual’s personal values or social identity, such as political ideologies, induce negative emotions (i.e., fear, anger, disbelief, sadness)?

Given the wealth of literature associating music preferences with personal identity and social values, including political orientation (Rentfrow, Goldberg, and Zilca 2011; Carney et al. 2008), it is feasible that music can be used as a stimulus that can be appraised as either congruent or incongruent with an individual’s goals in a political context. Moreover, that goal’s more broadly, as hypothesised by Lennie and Eerola (2022), can be viewed as an important feature of emotional cognition; a feature that can be used to inform computational tasks such as MER. Yet, no musical study of this kind has been attempted to the authors’ knowledge.

5.2.3 Music emotion recognition

Music emotion recognition (MER) is a computational task that evaluates emotionally relevant features from music and correlates them with certain emotions, be it *perceived* or *induced* in a listener. Interestingly, while we may *perceive* that cer-

tain music expresses a “happy” emotion, since it is upbeat and in major tonality for a Western context, it does not necessarily makes us *feel* “happy” (Gabrielsson 2006). This is an important distinction to understand the complexity of producing a “ground truth” for MER systems since low quality annotations have a direct impact on the overall performance of the algorithms (Yang and Chen 2011; Xiao Hu and Yang 2017). MER uses features that are typically low-level acoustic representations of sound (e.g., tempo or pitch), high-level semantic descriptions (e.g., genre), information extracted from lyrics, and data about the listeners’ properties or context (e.g., collecting physiological data from listeners). Machine learning algorithms are then used to correlate these features with an emotion “ground truth” (Laurier and Herrera 2009; Laurier 2011; Yang and Chen 2011) – emotion judgments are typically collected through subjective listening tests in which listeners annotate excerpts of music.

Panda, Malheiro, and Paiva (2020) recently reviewed several emotionally-relevant acoustic features. For example, melody relates to fundamental frequency f_0 or pitch salience; rhythm relates to note onsets or note durations; dynamics relate to sound level or note intensity; timbre relates to spectral centroid or mel-frequency cepstral coefficients. Towards a more multi-modal approach, da Silva Mahleiro (2016) combined acoustic features and data extracted from lyrics to predict the emotions in music – his studies reveal up to 9 percentage point improvement of F-scores by using a multi-modal classification approach. Textual features may be extracted from lyrics through natural language processing methods that leverage machine learning approaches to analyse sentiment from text (Manning and Schütze 1999; Jurafsky and Martin 2009; Feldman 2013; Medhat, Hassan, and Korashy 2014; L. Zhang, Wang, and Liu 2018). Recently, Agrawal, Shanker, and Alluri (2021) used novel deep neural networks to predict emotions in lyrics. The use of this contextual information can enhance the performance of a multi-faceted MER system.

Given the subjectivity of the annotation task in producing a “ground truth”, (Yang

et al. 2007) proposed that the response variability of each individual listener could be better modeled by introducing personalised models – a personalised model is trained exclusively from the annotations of an individual listener. Sarasúa, Laurier, and Herrera (2012) and Su and Fung (2012) leveraged active learning to improve MER performance and produce personalised models, respectively – active learning is based on selecting specific training instances such that algorithms perform better with less training. Gómez-Cañón, Cano, Yang, et al. (2021) proposed consensus entropy to improve active learning by leveraging the collective judgments from music – the main assumption is that the data instances, which a collective of annotators disagrees upon, reflect individual boundaries that could be informative for personalisation. The TROMPA-MER dataset was created with a human-centric approach for data collection and annotation (Gómez-Cañón, Gutiérrez-Páez, et al. 2022): listeners annotated each music excerpt with single free-text emotion words (in native language), distinct forced-choice emotion categories, preference, and familiarity. In short, MER has started to incorporate more personal and contextual data as a way to improve the performance of the system – this type of data becomes central to the future of MER and potential applications that will follow in the future.

From the perspective of ethics in artificial intelligence, personal data (personal interests, preferences, psychological profile, mood) and the growth of machine learning systems (involving personalisation practices) have been typically used for persuasion purposes – steering, coercing or manipulating users into making decision that may or may not be in their best interest (European Commission et al. 2022). As recently discussed during the United Nations Security Council on Technology and Conflict, “digital technologies have raised major human rights concerns”, including artificial intelligence systems that may be discriminatory (United Nations 2022). Therefore, there is a need to evaluate the role of data as a resource typically exploited for economic expansion (Mohamed, Png, and Isaac 2020) – artificial intelligence may conceal asymmetrical power relations that are difficult to assess by developers. Decision systems with direct impact on

users are generally linked to the notion of algorithmic oppression (Noble 2018) – linking criminal datasets to discriminatory police practices (O’Neil 2016), using facial recognition systems that fail to recognize black faces (Buolamwini and Gebru 2018), and threatening privacy and enforcing racist pseudo-sciences by using facial emotion recognition systems (Stark 2016; Crawford 2021). Conversely, the apparently innocuous task of MER has only recently shown the advantages of gathering data such as listening habits or physiological signals (Xiao Hu, Li, and Ng 2018; Gómez-Cañón, Cano, Eerola, et al. 2021) – the potential ethical issues of MER will appear as sensitive emotional data is processed by personalisation systems that increasingly improve with the users’ engagement. Thus, and to the extent of our knowledge, MER systems have not been evaluated to this degree in the past.

Drawing from this literature we present three specific hypotheses that can be used to support our overarching research aims. Hypotheses H1 and H2 relate directly to research question R1 and H3 relates to research question R2.

5.2.4 Hypotheses

- Participants with different political viewpoints (goal-relevance) will show different induced arousal annotations.
- Politically sensitive music stimuli that agree/disagree with participants’ political stance (goal-congruence) will show different induced valence annotations.
- Personalised algorithms will be effectively biased towards specific categories depending on the political stance of listeners – namely, personalised algorithms reflect the listeners’ political views.

5.3 Methodology

5.3.1 Experimental setup

The experiment was held in an online platform developed using React and a Flask backend. It was developed in English (for design purposes) and translated to Spanish (for the participants)⁴. The experiment was first piloted with 5 Colombian nationals. Participants were collected through social media outlets (Twitter and Instagram) targeting Colombian nationals over the course of 2 months (June-July) in the run up to the 2022 presidential elections and after the first round of elections. We also invited researchers from the following Colombian universities: Universidad Central, Universidad de Antioquia, Universidad de los Andes, and Universidad Nacional. Participants were incentivized through a prize draw for one of four €100 vouchers. The experiment took an average of 30-40 minutes to complete. We summarise our experimental procedure as follows:

1. Participants agreed to the consent form validated by the ethics committee from the Universitat Pompeu Fabra (in conformity with GDPR and Colombian data protection laws) – stating that they are Colombians and are between 18 and 65 years old.
2. Participants provided general demographic variables: age, gender, native language, and musical self-identification.
3. A short attention check followed: three sounds in randomly assigned order were played and each participant should select the one with lowest sound level. If the participant was not able to complete this step, they were informed that their device did not have the audio fidelity to continue with the experiment.
4. Participants received an explanation on how to complete the annotations: a comparison between perceived and induced emotions in music and a description of the annotation interface (see section on annotation gathering).

⁴<https://trompa-mtg.upf.edu/colombian-not-popular/>

5. Participants carried on to annotate the music: (a) each participant was randomly assigned a different personalisation strategy: a model trained with acoustic features (*ACO*), a model trained with features from the lyrics (*LYR*), a multi-modal model that takes into account both lyrics and acoustic features (*MIX*), and a pseudo-random baseline that presented music to perform an annotation consistency check (*RAND*); (b) initially, all participants annotated the same 6 tracks for the first iteration (2 FARC-songs; 2 AUC-songs; 2 songs without lyrics which were randomly selected) to train personalised models (see section on personalisation); (c) based on the output of the first annotations, the personalised model was retrained and queried a new batch of 6 tracks to be annotated by the participant; and (d) the personalised model was then refined using the remaining tracks presented in 4 iterations of 6 tracks each (i.e., each participant annotated 30 tracks in total).
6. Finally, participants completed three questionnaires on the political opinion – Right-Wing Authoritarianism scale (RWA), the Social Dominance Orientation scale (SDO), and a Colombian specific political questionnaire made the purposes of this study.

5.3.2 Scales

Musical self-identification was measured by the Ollen Musical Sophistication Index (OMSI). This single item scale provides estimates of the psychometric measures used to determine membership of the category “musician” (Ollen 2006). The OMSI musician rank item is concerned with the individual’s self-assessed level of musical identity as opposed to an item relating to musical expertise (J. D. Zhang and Schubert 2019).

The *right-wing authoritarianism* (RWA) scale, originally developed by Altemeyer (1998), measures social attributes, such as the degree to which people defer to established authorities, show aggression toward out-groups when authorities sanc-

tion that aggression, and support traditional values endorsed by authorities (Saunders and Ngo 2017), racism and sexism (Zakrisson 2005). We used the short 15-item version of the RWA (Zakrisson 2005) which uses less extreme and more modern language, and makes less reference to specific groups (e.g., women).

Social dominance orientation (SDO) refers to the extent to which a person desires that one's in-group dominate and be superior to out-groups. SDO is considered to measure social and political attitude orientation toward inter-group relations, reflecting whether one generally prefers such relations to be equal, versus hierarchical, that is, ordered along a superior-inferior dimension (Pratto et al. 1994). We used the updated SDO7 (Ho et al. 2015) which is significantly shorter (8 items) and uses more modern references compared to original iterations. Both the RWA and the SDO scales are said to capture two different dimensions of political opinions (Asbrock, Sibley, and Duckitt 2010). This two-dimensional interpretation offers a substantial amount more nuance to our interpretation of Colombian voters. Scales can be seen as capturing different aspects of political values, goals, and motivations. Nonetheless, the scales should show a reasonable degree of correlation in capturing left/right political view points. Both scales were measured on a 5-point Likert-like scale (original scales used a 1–9 rating). However, for ease of use with mobile phones we shortened the scale for compatibility. Importantly, all political scales were measured on the same scale to allow for equivalence. Higher ratings on both the SDO and the RWA suggests a stronger right-wing political ideology.

The *Colombian specific political questionnaire* was developed during the piloting section of the experiment through participant suggestions for extensions of either the RWA or SDO scales. Although both scales have been used in cross-cultural contexts (Duckitt et al. 2010), including other collectivist cultures in South America (Cantal et al. 2015), neither has been validated in a Colombian setting to our knowledge. Specifically, candidates' proposals addressed the Colombian political climate: political nuances are idiosyncratic to the electoral timeframe. We con-

cluded that such a measure would be highly beneficial in assessing Colombian political dimensions and to counter limitations in the RWA and SDO. We chose 9 items to represent several key components of the current elections in Colombia – three proposals by each candidate that identified the political “centre”, “right”, and “left” were rated by each participant, also on a 5-point scale (see full scales in the complementary website⁵).

An additional measure of the Big-Five personality traits was initially considered given the link between personality traits and political ideology. However, to limit the time commitment required by participants in the experiment this was not included.

5.3.3 Music selection

We refer the reader to studies by Quishpe (2020), Barbosa Caro and Suavita (2019), and Katz-Rosene (2017) with respect to historical, functional, and lyrical analysis of the two types of music used: (1) FARC-songs (mainly in the style of *vallenato* and *canción social*) and (2) AUC-songs (in the style of *corridos*). These musical styles make part of traditional Colombian (and Latin-american) music, yet they have distinctive sonorities, structures, and instrumentation. It must be noted that music with politically motivated lyrics from both types have incorporated other similar styles of music as well (e.g., hip-hop and rock), but this study only considers this reduced range of styles. Additionally, FARC-songs have been typically created by active members from the guerrilla as a mechanism of identity confirmation and propaganda (Quishpe 2020), while AUC-songs have been typically been produced by sympathizers of the paramilitaries as promotion to their deeds and in open criticism to the FARC and left-wing politicians (Barbosa Caro and Suavita 2019). Crucially, the functionality of the music and the target listener can be seen as different.

We remark that humans frequently listen to music *without* feeling any emotion at

⁵<https://trompa-mtg.upf.edu/colombian-not-popular/visualization/>

all (Kivy 1990; Juslin 2019), but music *might* trigger mechanisms such as episodic memories for particular individuals (Juslin 2013; Eerola 2017). However, the potential induction of emotions from the music in this study is based mainly to the semantic content of the lyrics – inducing different emotions to listeners with different political views. In Gómez-Cañón, Herrera, et al. (2021), we exclusively evaluated acoustic features from the music – in this study we extended the analysis to features in the lyrics as analysed in natural language processing and topic modelling (see the personalisation section for the description of computational models). Nonetheless, the acoustic features are useful to provide a content-based contrast among the different styles of music: (1) FARC-songs typically use less instruments and might include only voice and guitar, and (2) AUC-songs are more heavily orchestrated with faster tempo. Namely, the machine learning models should be able to differentiate between the types of music – the interesting element is to attempt to understand which users will provide problematising labels (i.e., music that induces subjectively negative emotions) that can bias the algorithm towards a particular class.

We used 50 music excerpts with lyrics from each music type (30 seconds long) and extracted 260 emotionally relevant acoustic features (mean and standard deviation of 65 low-level music descriptors and their first order derivatives) from segments of 1 second (Aljanaki, Yang, and Soleymani 2017), with 50% overlap, and standardize across features – using the IS13 ComParE feature set (Weninger et al. 2013) and OpenSMILE toolbox (Eyben et al. 2013). We processed the tracks using Audiosourcere DeMIX software to extract versions without lyrics – we obtained a total set of 150 excerpts (50 FARC-songs, 50 AUC-songs, 25 FARC-songs without lyrics, and 25 AUC-songs without lyrics). Each excerpt was normalized for loudness following the ITU-R BS.1770-4 recommendation using the pyloudnorm package⁶.

⁶<https://github.com/csteinmetz1/pyloudnorm>

5.3.4 Annotation gathering

We use a discretised model of emotion based on Russell’s circumplex model (Russell 1980) and recent work on MER (Panda, Rui, and Paiva 2018; Gómez-Cañón, Cano, Eerola, et al. 2021), which conceptualizes emotions in to two-dimensional core affect (arousal and valence) and four distinct categories/quadrants of emotion: Q_1 (positive valence and arousal), Q_2 (positive arousal and negative valence), Q_3 (negative valence and arousal), Q_4 (negative arousal and positive valence). Figure 5.1 shows the annotation interface: Q_1 refers to emotions such as happy and excited, alert; Q_2 refers to emotions as tension and anger; Q_3 refers to emotions as sadness and boredom; Q_4 refers to emotions as calmness, serenity. To refer to arousal, we used the words activation/deactivation (*activación/desactivación*). To refer to valence, we used pleasant/unpleasant (*positivo/negativo*). Annotations of arousal and valence were made on continuous sliders ranging from 1–100. We use continuous scale values to analyse annotations but use the discretised classes to train our machine learning models. We also collected each participant’s preference and familiarity for the musical excerpts through check boxes “*I know this song*” and “*I like this song*” (see Figure 5.1).

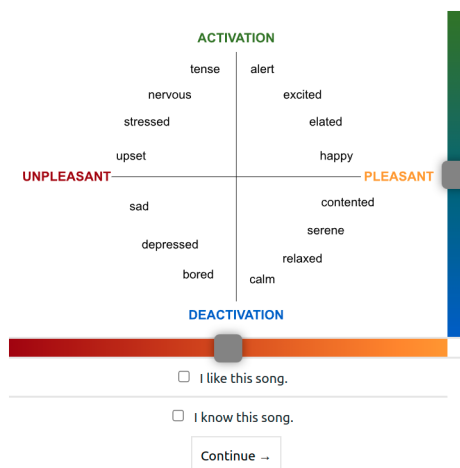


Figure 5.1: Annotation interface for the experiment.

Table 5.1: Classical and short text topic modelling (TM) approaches tested to produce lyrics models. Bold indicates the best algorithm and ** indicates the amount of topics selected (100 songs with lyrics \times 25 topics)

TM approach	Algorithm	5 topics	10 topics	15 topics	20 topics	25 topics	30 topics	35 topics
Classical TM	NMF	0.556	0.588	0.464	0.551	0.628	0.625	0.551
	SVD	0.711	0.687	0.714	0.709	0.723**	0.675	0.777
	LDA	0.527	0.428	0.497	0.518	0.469	0.641	0.516
	GS-DMM	0.622	0.642	0.650	0.595	0.610	0.587	0.556
Short text TM	NQTM	0.597	0.557	0.549	0.526	0.491	0.528	0.557
	Biterm	0.431	0.569	0.379	0.544	0.515	0.453	0.524

5.3.5 Personalisation

We use the “machine consensus” MER personalisation strategy presented by Gómez-Cañón, Cano, Yang, et al. (2021): consensus entropy for active learning. This strategy uses a committee of classifiers to analyse their output agreement and queries each user for instances with the highest uncertainty. Each participant receives a committee of classifiers: 5 independent extreme gradient boosting models (T. Chen and Guestrin 2016) and 5 logistic regression models optimised with stochastic gradient descent (Bottou 2010). Each one of these models had previously been pre-trained on separate cross-validation splits of the DEAM dataset, the benchmark dataset for MER (Aljanaki, Yang, and Soleymani 2017). In order to select uncertain data to be labelled, classifiers predict the output probabilities for the pool of excerpts. We then perform the consensus entropy strategy by analysing the disagreement across classifiers. For example, full disagreement from a committee of four classifiers results when each one predicts a different class/quadrant with 100% probability. This yields average probabilities per quadrant $p_{avg} = \{Q_1 : 0.25, Q_2 : 0.25, Q_3 : 0.25, Q_4 : 0.25\}$ and high inter-class entropy/uncertainty of 1.386. Following Gómez-Cañón, Gutiérrez-Páez, et al. (2022), we balanced the instances with respect to the quadrants for each

epoch: (1) prior to the calculation of entropy, we split the probabilities p_{avg} into four matrices corresponding to the instances with higher probability of belonging to each quadrant, (2) we calculate entropy independently for each matrix (four quadrant probabilities \times 150 instances), and (3) we select instances with highest entropy from each matrix. Thus, we alleviated the issue of imbalanced classes for each retraining iteration, since the instances selected for query are more likely to belong to each of the quadrants. In the case that the probabilities do not favour a particular quadrant (i.e., models are biased towards particular classes), we simply select the instances with highest entropy from the initial matrix. Excerpts with highest uncertainty are then queried to each participant to be annotated. Initially, we pseudo-randomly draw 2 excerpts from each type of music (6 excerpts for the first annotation iteration), retrain our classifiers with the annotations provided by each user, identify the excerpts to be annotated for the next iteration, and present the new batch of music to be annotated. Given the low amount of available music, we perform only five iterations for a total of 30 annotations per user – past research has shown that only 20-30 annotations are needed in order to reach personalisation (Su and Fung 2012; Y.-A. Chen et al. 2017). Please refer to Gómez-Cañón, Cano, Yang, et al. (2021) and Gómez-Cañón, Gutiérrez-Páez, et al. (2022) for additional information of the consensus entropy methodology.

In order to extract information from lyrics, we used a standard topic modelling approach (Manning and Schütze 1999) – an unsupervised method that detects word patterns within different texts and attempts to cluster documents (i.e., lyrics) into a particular amount of topics. The classical bag-of-words approach was implemented by: (1) calculating the frequency of words from each lyric (i.e., term frequency-inverse document frequency); (2) testing different algorithms to obtain a numeric representation of the likelihood of each lyric to belong to topic t ; (3) using the extracted text features as input to a logistic regression classifier that is subsequently trained with the annotations of each participant. However, short texts face the challenge of being ambiguous and noisy for topic modelling (Al-balawi, Yeap, and Benyoucef 2020) – we use the text of the lyrics from the 30

seconds selection exclusively. Following Valero, Baranes, and Epure (2022), we tested different classical and short text topic modelling methods, and evaluated binary classification (FARC-songs or AUC-songs). Thus, in (2) we tested non-negative matrix factorisation (NMF), singular value decomposition (SVD), latent dirichlet allocation (LDA), collapsed Gibbs sampling for dirichlet multinomial mixture (GSDMM) from Yin and Wang (2014), negative sampling and quantisation topic model (NQTM) from Wu et al. (2020), and biterm topic model from Yan et al. (2013). We performed 5-fold cross-validation and report F1-scores in Table 5.1. As there is no “ground truth” about the optimal number of topics in topic modelling tasks, Chang et al. (2009) suggested focusing on assessments that rely on real-world task performance. Therefore, we ran different tests with different number of topics for each method, and selected the algorithm that offered not only the best topic coherence but also the best classification performance – singular value decomposition and 25 topics. Finally, we obtained a feature matrix that represents the data from the lyrics and that we use as input to a logistic regression classifier: 100 songs with lyrics \times 25 topics calculated using SVD.

In summary, we produce four types of models: *ACO* models use acoustic features, *LYR* models use features extracted using topic modelling on the lyrics, *MIX* models with use both acoustic and lyrics features, and *RAND* models that pseudo-randomly present music to the participants (i.e., no entropy is calculated).

5.4 Results

Table 5.2: Inter-rater reliability and consistency statistics. We report Krippendorff’s α_k and Cronbach’s α_c . Qstands for quadrants, A for arousal. V for valence.

		All users			Left (n=15)			Center (n=22)			Right (n=12)			Rand (n=13)		
		Q	A	V	Q	A	V	Q	A	V	Q	A	V	Q	A	V
All	α_k	0.035	0.025	0.051	-0.047	-0.088	-0.067	0.045	0.018	0.131	0.028	0.058	-0.013	0.058	-0.036	0.181
	α_c	0.921	0.917	0.937	0.863	0.884	0.947	0.872	0.852	0.894	0.853	0.823	0.819	0.885	0.867	0.938
Lyr.	α_k	0.028	0.025	0.019	-0.033	-0.098	-0.054	0.045	0.040	0.072	0.031	0.032	-0.006	0.053	-0.032	0.158
	α_c	0.876	0.865	0.915	0.700	0.800	0.920	0.803	0.820	0.852	0.785	0.779	0.836	0.800	0.769	0.920
No Lyr.	α_k	0.052	0.027	0.122	-0.082	-0.082	-0.093	0.047	-0.033	0.260	0.024	0.133	-0.031	0.069	-0.037	0.230
	α_c	0.868	0.808	0.849	0.767	0.705	0.893	0.730	0.510	0.757	0.735	0.310	0.223	0.774	0.731	0.771

A total of 194 participants started the experiment. 52 participants completed the whole study. 3 participants were removed from the completed entries since the server failed to collect their annotations, leaving a total of 49 participants for the analysis. We gathered participants from different age groups ($\mu = 35.6, \sigma = 12.75$): 19 participants were 18-30 years old, 23 participants were 30-50 years old, and 7 participants were 50-65 years old. We had unbalanced participation with respect to gender: 19 female, 29 male, and 1 non-binary. With respect to musical self-identification, most of our participants were non-musicians⁷. 15 participants received the *MIX* model, 13 received the *RAND* model, 11 received the *LYR* model, and 10 received the *ACO* model.

5.4.1 Political scale assessment

We obtained five political scores s from our three political questionnaires: RWA (s_{RWA}), SDO (s_{SDO}), PlanLeft (s_{left}), PlanCentre (s_{center}), and PlanRight (s_{right}). Agreement to statements from the Colombian specific political questionnaire corresponded to agreeing with the political discourse from a given candidate (i.e., s_{left} , s_{center} , and s_{right}). First, the five political ideology scales were correlated to assess their effectiveness at capturing political leaning. All five scales correlated as predicted showing that the RWA and the SDO scores

⁷27 non-musicians, 6 amateur musicians, 5 serious amateur musicians, 5 professional musicians, 3 semi-professional musicians, and 3 music loving musicians

capture left/right leaning ideas in the Colombian population, presented the our Colombian specific political questionnaire (see Figure 5.2).

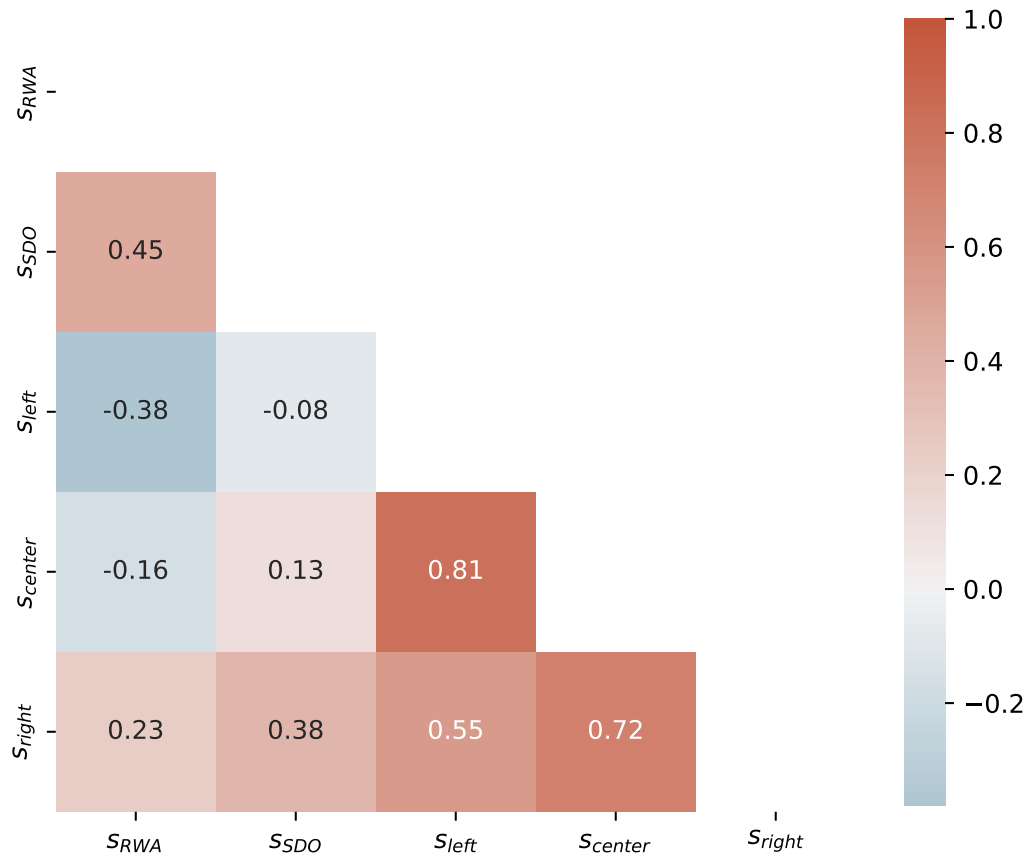


Figure 5.2: Correlation matrix for political scales in the experiment.

Next, we segmented the participants into three groups: “right-leaning”, “left-leaning”, and “centre” orientation. In order to produce these groups: (1) we grouped participants using the 33% quantile from the RWA and the SDO scores – namely, $s < 0.33$ are “left”, $0.33 \leq s \leq 0.66$ are “centre”, and $s > 0.66$ are “right”; (2) we group participants from the Colombian specific questionnaire depending on the highest score obtained – for example, we assign “left” if $s_{left} > s_{right}$ and $s_{left} > s_{center}$, and (3) we obtain the final group by taking the mode from the

three resulting classes – for example, if RWA results in “right”, SDO results in “centre”, and the Colombian specific questionnaire results in “right”, we assign the participant to the group “right”. Using this score, our participants were grouped as follows: 22 participants are “centre”, 15 participants are “left-leaning”, and 12 participants are “right-leaning”.

5.4.2 Annotation analysis

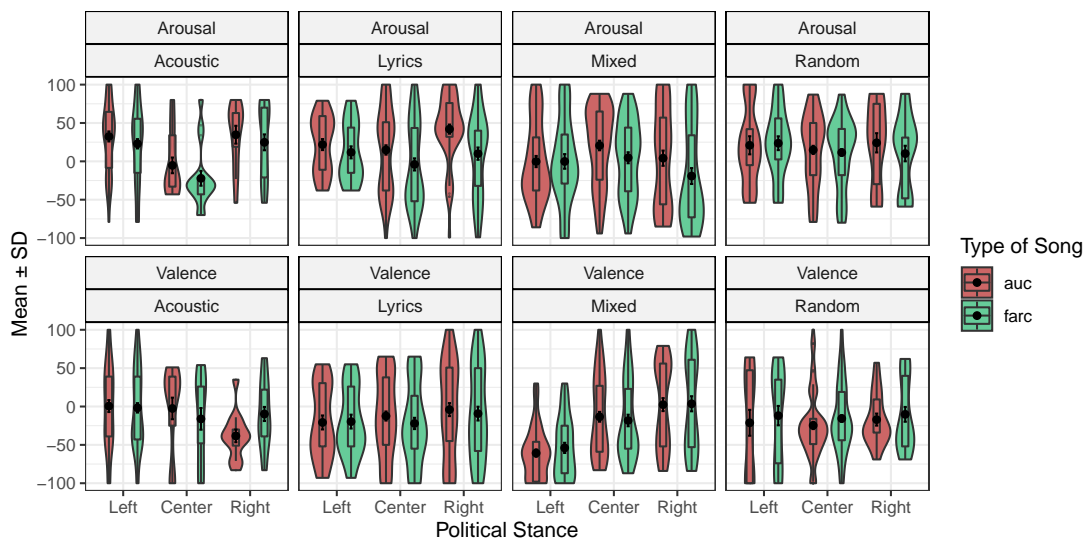


Figure 5.3: Annotation analysis of music with lyrics showing the comparisons with respect to model type, annotation (continuous arousal and valence), and political stance.

As we have argued previously in Gómez-Cañón, Cano, Eerola, et al. (2021), inter-rater agreement must be routinely analysed and reported in studies that involve MER. In Table 5.2, we summarise inter-rater reliability statistics calculated from the discretised categories used for the MER algorithms: nominal Krippendorff’s coefficient α_k and Cronbach’s consistency coefficient α_c . To calculate the statistics, we keep only the songs that have been annotated by at least two participants (140 songs from 150 songs) – this reveals that given the initial seed of 6 songs, the response and model variability allowed the participants to annotate most of the data. As mentioned previously, the *RAND* model would produce pseudo-random presentations of songs to be annotated – using the same random seed resulted in

13 participants that annotated the same 30 songs (9 AUC-songs, 12 FARC-songs, and 9 songs without lyrics). Moreover, all participants annotated the same initial 6 songs. We discuss inter-rater reliability and consistency statistics as follows: (1) agreement as measured by α_k is notably low in general – we argue that the sparsity of the annotations leads to increasing the probability of agreement due to chance and lowering the agreement coefficient (i.e., each participant annotated 30 from a pool of 150 songs); (2) annotations of valence are more consistent than annotations of quadrants and arousal for most groups (see α_c) – this is a surprising finding, since typically valence is the most subjective quality and exhibits least consistency; (3) annotations of music without lyrics show a low consistency for “right-leaning” participants – it is likely that the music without lyrics is interpreted with more freedom (e.g., vallenatos and corridos are music normally used for parties); (4) as expected, the response variability of induced emotions from music is evident – using personalised models to capture response variability is a reasonable approach to create MER models (Yang et al. 2007; Gómez-Cañón, Gutiérrez-Páez, et al. 2022).

Table 5.3: Annotation analysis of music with lyrics showing the comparison with respect to model type, annotation continuous arousal and valence, and political stance.

Political leaning	Model type	Top 10			Top 20		
		AUC (%)	FARC (%)	No Lyr. (%)	AUC (%)	FARC (%)	No Lyr. (%)
Center	Acoustic	35.0	65.0	0.0	40.0	60.0	0.0
	Lyrics	42.0	50.0	8.0	48.0	42.0	10.0
	Mix	53.3	35.0	11.7	45.0	40.8	14.2
	Random	34.4	53.3	12.2	38.3	48.9	12.8
Left	Acoustic	43.3	51.7	5.0	43.3	46.7	10.0
	Lyrics	65.0	35.0	0.0	55.0	45.0	0.0
	Mix	50.0	30.0	20.0	50.0	29.0	21.0
	Random	35.0	35.0	30.0	35.0	27.5	37.5
Right	Acoustic	50.0	40.0	10.0	42.5	45.0	12.5
	Lyrics	45.0	22.5	32.5	38.8	28.8	32.5
	Mix	25.0	40.0	35.0	25.0	38.8	36.3
	Random	30.0	45.0	25.0	22.5	40.0	37.5

Linear Mixed Model (LMM) analysis was carried out separately for continuous rating of arousal and valence with five fixed factors (model *RAND*, *LYR*, *MIX*,

ACO, type of music *FARC-songs/AUC-songs*, political orientation of the participant *Left/Centre/Right*, and gender), and two random factors (participant and track). Comparisons between music with and without lyrics were dropped as the hypotheses were based around music with lyrics. For valence, main effects for the *MIX* model ($\beta = -31.4$, $t=-2.25$, $p=.030$) and gender ($\beta = 23.7$, $t=2.36$, $p=.023$) emerged. We refer the reader to Figure 5.3 for a visualization of the annotations of music with lyrics. Planned contrasts in valence annotations showed no significant differences in AUC and FARC music. For arousal, main effect for gender ($\beta = -15.0$, $t=-2.03$, $p=.049$) and an interaction between type of music and political orientation *Right* ($\beta = -17.3$, $t=-2.62$, $p=.009$) emerged. Post hoc comparisons of this main effect show that arousal annotations were significantly higher for AUC songs compared with FARC songs for right-leaning ($t(1352.9)=3.88$, $p\leq .001$) and centre-leaning participants ($t(1078.0)=2.75$, $p=.006$) regardless of the model. Further planned comparisons for arousal annotations suggests these effects were more pronounced in right-leaning participants annotations obtained under *MIX* ($\beta=26.8$, $t(1380.4)$, $p=.0001$) and *LYR* models ($\beta=24.1$, $t(1377.9)$, $p=.007$). For centre-leaning participants, more pronounced annotations were only noted in the *LYR* model ($\beta=19.9$, $t(1381)$, $p=.012$). No differences emerged for left-leaning participants across or between models.

5.4.3 Algorithmic evaluation

In order to evaluate the personalised models, it must be noted that there was *no testing data* – all the annotated data was used to train the models and there is no “ground truth” to compare the predictions from the models. However, we propose an evaluation strategy to account for the possible bias that results from “misusing” the personalised models. Given that there is a significant difference in the way that participants from different groups annotated the music, it is likely that models are inherently biased towards certain categories (Nigam et al. 2000; Schölkopf, Platt, and Hofmann 2007) – moreover, the only evaluation possible is probabilistic given the choice of the algorithms for machine learning.

Thus, each personalised model was used to test on the remaining data from each participant, following our previous work on Gómez-Cañón, Herrera, et al. (2021) – the resulting matrix has 120 songs \times 4 quadrants. We sorted the matrix with respect to the highest probabilities of belonging to a particular class and select the top 10 and 20 predictions that: belong to a particular quadrant (i.e., Q_1 , Q_2 , Q_3 , and Q_4), belong category of arousal (i.e., positive and negative), and belong to a category of valence (i.e., positive and negative). Table 5.3 summarises the findings that we deem ethically problematic – the type of music that some personalised models appear to classify with high probability of negative valence is revealing the political stance from the participants. In general, we conclude that results are not as discernible as the ones reported in Gómez-Cañón, Herrera, et al. (2021): (1) in the case of “left-leaning” participants, the *LYR*, *MIX*, and *RAND* models predict that AUC-music (i.e., “right-wing”) has a higher probability of inducing negative valence than FARC-music; (2) in the case of “right-leaning” participants, we find that only the *MIX* and *RAND* models predict that FARC music (i.e., “left-wing”) has a higher probability of inducing negative valence than AUC-music; (3) we find no trends as to the type of models that might capture the political stance (i.e., only the *MIX* models do so consistently for the left- and right-leaning groups) – it is likely that the classification strategy might be too coarse to capture the response diversity of each participant and subtle political differences; (5) despite that the political stance from the participants was not necessarily captured by all the models, we find that the models are accurately capturing that *both* types of music might induce emotions with negative valence – this was expected since the political content of the lyrics was strong and specific memories with a negative connotation might have been triggered through music listening; (6) we find that certain participants resulted with models that are the most problematic, we offer a summary of predictions in the complementary website for clarity on the behaviour of each participant’s model.

5.5 Discussion

We discuss our findings regarding our proposed hypotheses in the context of the wider research questions as follows:

- Participants with different political viewpoints (goal-relevance) will show different induced arousal annotations.
- Politically sensitive music stimuli that agree/disagree with participants political stance (goal-congruence) will show different induced valence annotations.
- Personalised algorithms will be effectively biased towards specific categories depending on the political stance of listeners – namely, personalised algorithms might reflect the listeners’ political views.

These results did not support our initial hypothesis H1. That is, differences in political values (goal-relevance) did not show significant differences in arousal annotations. However, in relation to our broader research question (R1) the observed effects support an alternative goal-directed interpretation. A significant interaction between political values and type of music was observed. Planned contrasts indicate that arousal annotations by right and centre-leaning participants were significantly higher for AUC (right-orientated) music than FARC music across MER models. Coefficients suggest this effect was largest in right-leaning participants and suggest that goal-congruence (how well the stimuli aligns with the participant’s political values) influences induced arousal annotations. The direction of change cannot be interpreted from these results. Goal-congruence may amplify induced arousal annotations. Alternatively, non-congruent music may suppress induced arousal annotations; both may be true. The inclusion of a control group (e.g., a-political Colombians or non-Colombian nationals) would be required to establish a baseline and subsequently the direction of these effects. Nonetheless, both of these interpretations provide direct support for a goal-directed interpretations and go beyond a purely stimulus-driven interpretations.

Further planned comparisons between models allow us to acknowledge that the main effect on arousal was most present in *LYR* and *MIX* models for right-leaning participants, but only the *LYR* model for centre-leaning participants. These difference between models support our assumption that lyrics (at least in combination with acoustic features) play an important role in how a piece of music is appraised and subsequently, through goal-directed processes, annotated in terms of arousal. With regard to our second hypothesis H2, that goal-congruent / incongruent stimuli (AUC and FARC music) would influence annotations of valence, our results did not support our hypothesis. No main effects or planned contrasts revealed significant differences between AUC and FARC music. Again, however, the results do support our main research question (R1) and a goal-directed interpretation. An overall effect for valence was observed in the *MIX* model. This shows lower valence annotations for both AUC and FARC tracks in left-leaning participants. This suggests that political values (goal-relevance) influence annotations of valence, at least in the context of the *MIX* model's presentation of "negative" stimuli. This trend in the *MIX* model can be observed from left to right-leaning participants (see Figure 5.3), also supportive of a goal-directed interpretation. However, these results are not as clear as they are in arousal annotations and some interaction between the type of algorithm and goal-relevance must be acknowledged.

In our introduction and discussion on hypotheses H1 and H2 we suggest lyrics are an important factor in producing these differences in core affect – lyrics more readily orientating awareness of a stimulus as related to an individual's social identity or personal values (i.e., goals)⁸. One could suggest the effects of lyrics are purely acoustic, for instance, lyrics may be sung at a faster tempo. However, only the alternative goal-directed interpretation could account for differences between AUC and FARC music by some groups but not others. Though the role of lyrics is not fully understood the results support a goal-directed interpretation over a

⁸We acknowledge that some degree of associative processing of the music as related to social-identity was also evident, as the effects to a lesser extent were also seen in right-leaning participants annotations of non-lyrical music too.

purely stimulus-driven one. Acoustic features have been robustly linked to arousal annotations (Céspedes-Guevara and Eerola 2018), but accounting for individual differences in these ratings has proved difficult experimentally (Beveridge and Knox 2018). We do not wish to underestimate the contribution acoustic cues make to induced emotional episodes. Moreover, we acknowledge that the interaction between acoustic cues and goal-directed mechanism is a fascinating future direction for research. Yet, the degree of contribution goal-directed mechanism make to musical emotional episodes is as yet unknown.

We have shown that while both H1 and H2 are not supported by the data, the evidence is supportive of our main research question (R1) - goal-directed mechanisms do influence core-affect in a musical context. Our hypotheses were drawn from previous utilitarian emotion research. As described in the introduction, goal-directed mechanisms have been broadly neglected in music-emotion research. To our knowledge, this finding provides the first empirical evidence that goal-directed mechanism underpin emotional episodes induced by music. However, the evidence suggests that goal-directed processes may behave differently in a musical context. The keen reader will have noted that the evidence for each hypothesis H1 and H2 is in fact reversed. We predicted that goal-relevance would influence annotations of arousal and that goal-congruence would influence annotations of valence. The results we collected suggests the opposite interpretation. Goal-relevance in fact appears to relate to valence, while the goal-congruence of the stimuli relates more closely to arousal. This leaves an open question for future research to address and poses a possible challenge to existing utilitarian emotion models.

In relation to our third hypothesis H3, we find conflicting results to our preliminary findings in Gómez-Cañón, Herrera, et al. (2021). In the previous study, we found that personalised models from left and right-leaning participants would reflect that incongruent music would show high probability of belonging to high arousal and negative valence – polarising lyrics spark different opinions, which in turn result in different annotations and diverse predictions according to the algorithms. To

build upon our previous study, in this experiment we added several more levels of complexity: we used music without lyrics in the same styles, we included the *LYR*, *MIX*, and *RAND* models, and we allowed our participants to annotate the music using continuous arousal and valence sliders. To a certain extent, the machine learning algorithms are able to capture the political stance of some participants – namely, the model from a “left-leaning” participant would show high probability that AUC-music (“right-wing”) would induce negative valence. However, the political views of the personalised algorithms were not necessarily reflected in each one of the models. In general, the broad assumption behind this experiment was that a strong political stances should be reflected accordingly with arousal and valence annotations – however, it is likely that participants from different or less extreme political views (e.g., centre-left / centre-right) would find both types of music produce emotions with negative valence similarly. We do not find strong support that the models have effectively captured the political stance from all of the participants – 10 out of 27 personalised models would show high probability that music belonging to an incongruent political stance would induce emotions with negative valence.⁹ We find it particularly interesting that all models were able to capture that music belonging to both music styles (which are strong emotional stimuli) would induce negative valence. Table 5.3 shows that most of the models for all groups of participants would predict that music with lyrics would induce negative valence, as opposed to music without lyrics. Thus, we argue that the algorithms have effectively captured that music with negative valence belongs primarily to both AUC- and FARC-music through the personalisation strategy.

Beyond the initial hypotheses we set out, we have also provided tentative evidence for the utility of the right-wing authoritarian (RWA) scale and the social dominance orientation (SDO) scale in a Colombian population. This is tentative because the sample size is too small to draw conclusions about the population generally. Yet, they behave and correlate as expected with one another and with our Colombian specific political questionnaire. The interpretations of the SDO

⁹See complementary website for additional information on personalised models.

and the RWA is highly important to our interpretation of the data. A critical look at these scales may shed some light on why the effects were explicitly seen in “right-leaning” participants. In relation to H1 and H2 and the valence and arousal annotations, many of the observed effects were noted specifically in “right-leaning” participants. However, the distribution of participants in the SDO and the RWA both produce a left-skew suggesting greater “left-leaning” ideologies (supported by the results of the presidential elections). This may mean that some effects in the “left-leaning” participants are somewhat muted by the “centre” grouping.

5.5.1 Limitations and future directions

We note several limitations in the design of the experiment and some future directions for researchers in music cognition and MER to take.

- Dropout rate: The number of participants who started the experiment but did not complete it was substantially higher than is typical for online experiments (Hoerger 2010). This may have been due to the length of the experiment as Hoerger suggests. It may also have been due to the nature of the experiment. That is, attempting to allow algorithms to identify music that can induce a negative effect in a participant. If the algorithms were even somewhat successful in this task, it is quite possible that people did not find the experiment enjoyable and left. More data could have been drawn from the numerous partial responses if participants had completed the political scales. However, if the political scales had been placed earlier in the experiment design, it may have cued in participants to the main manipulation in the experiment and skew results.
- Type of machine learning models: the type of algorithms that were used for the personalisation approach have been established as classical approaches to classification and are efficient models. However, the logistic regression classifier (used in the *ACO*, *LYR*, and *MIX* models) assumes linearity between the acoustic or lyrics features and the annotations from participants

– it is likely too coarse to model the subtle non-linearity that relate features to an annotation. Our previous work in Gómez-Cañón, Cano, Yang, et al. (2021) shows that faster personalisation could be achieved by the use of convolutional neural network architectures – given the computational requirements of deep learning model estimations, our web servers were not capable of supporting online training.

- Political labels: The measures for political leaning produced more a predominant left skew in both the RWA and SDO. This in itself did not drastically affect the analysis; three almost perfectly even groups were still derived from our grouping through percentiles. With regards to the interpretation of the results however, it is fair to acknowledge that “right-leaning” participants may be better described as “centre-right” to “right” political ideologies. Similarly, “left-leaning” participants cause similar problems as it is difficult to find a clear distinction between “left” and “centre-left” ideologies. We point the reader towards strong correlations between the centre, left, and right in our Colombian specific political scale (see Figure 5.2).
- Musical extremes: It is of course true that these music genres represent quite extreme political ideologies within the Colombian community. We in contrast, have used them as representative of right/left political distinctions. It is quite possible that they are more representative of far-right/left political ideologies.

5.6 Conclusions

In relation to the research questions posed in our study:

- Do an individuals’ political values (goals) influence emotional episodes induced by music in terms of core-affect?
- Can a MER algorithm for induced emotions be biased towards a particular opinion with respect to music with polarising lyrics?

This study supports the overall aims of the study, showing that an individual's political-identity makes a meaningful contribution to their induced emotional experience of music, at least rated in terms of core-affect. It provides the first empirical evidence for a goal-directed mechanism in musically-induced emotions; these effects observed beyond a wholly acoustic interpretation. Yet, how this goal-directed interpretation relates explicitly to music and the extent to which goal-directed mechanisms can influence emotional episodes induced by music remains an open question. Moreover, emotions induced by music can be manipulated in real world scenarios by algorithmic models to bias individuals towards negative emotional states. We highlight the importance of acknowledging and understanding how MER algorithms with increasing personal data could be used, both in positive and negative scenarios. Research into music that promotes well-being and beneficial uses has yielded important findings and is likely to grow in the following years (Xiao Hu, Chen, and Wang 2021; Agres et al. 2021), we stress that research in music-induced harm has only started to be explored (Saarikallio, Gold, and McFerran 2015; Sharman and Dingle 2015; Silverman, Gooding, and Yinger 2020; Surana et al. 2020). It is critical that the field of music technology acknowledges and builds upon the field of music cognition – there is a necessity to ground technological applications on reliable psychological research, since each algorithm will be used to develop specific use cases. Moreover, there is a need to acknowledge that technology poses asymmetrical power relationships onto vulnerable populations (Mohamed, Png, and Isaac 2020; Adams 2021) – while the episode from Cambridge Analytica is a well-known situation in Western societies, it is less-known that they influenced elections in more than 30 countries and 100 election campaigns (including Colombian elections).

We conclude by suggesting that MER and music cognition can work productively and informatively together. As music and emotion research seeks to identify the mechanisms that underpin the effects of music and MER seeks to understand and benefit from emotion annotations in real-world applications of music uses. To the researchers in music technology (and mainly the Music Emotion Recogni-

tion task), we respectfully suggest: before engaging with implementing the latest machine learning algorithm, assembling enormous datasets, or getting state-of-the-art accuracy, we believe that the most relevant question that should be addressed is *what for?* Particularly toward the aim of personalisation in MER, we encourage acknowledgement of goal-directed theories as a template for identifying key variables of interest – see Lennie and Eerola (2022) for suggestions about considering goals in a musical context. To researchers focused on music cognition, we respectfully suggest: before engaging in the collection of emotion annotations, and often trying to predict these solely from acoustic features (i.e., *Which emotion?*), to consider instead – *What is this music for? What purpose does it serve this individual in this context? What makes this music meaningful to an individual?* There is an exciting and productive future for those engaging in such interdisciplinary research.

Chapter 6

Discussion

This thesis was developed around three core aims intended to contribute new knowledge to the field of music and emotion.

The first aim was to examine existing theories of music and emotion through the lens of the wider affective sciences. This was addressed in Chapters 1 and 2 where a skeptical approach was adopted to grouping and critiquing contemporary developments in the affective sciences as well as popular music-specific models. The second aim of this thesis was to develop a new model of musical emotions. This model, dubbed Constructivistly-Organised Dimensional-Appraisal (CODA), is described in section 2.5. Based on the critique offered by the first aim, the CODA model unifies multiple competing models from several decades of research, highlighting ‘*what’s missing?*’ and naturally raising specific hypotheses which could explain current gaps in the literature (presented in section 2.5.3). The third aim of my thesis, was to test the predictions of the CODA model, and those current gaps in the literature, most prominently understanding individual and contextual differences. Testing the CODA model’s output included an initial proof of concept, a direct lab-based experiment, and finally application to a utilitarian and ecologically robust design. This was presented in Chapters 3, 4, and 5.

In this final chapter I evaluate my thesis with regard to the three aims outlined

above. I first collate a summary of the theoretical and empirical contributions of this thesis. Second, I evaluate the contribution of the proposed CODA model as a culmination of the first two aims. Third, I evaluate the empirical support for key predictions of the CODA model. Some limitations of the thesis are acknowledged along with potential future empirical and theoretical directions before a final argument is made for this thesis' wide-scoping contribution to knowledge in the field of music and emotion.

6.1 A summary of contributions

The work described in this thesis has made several meaningful contributions to the field of music emotion science. A brief summary of each of these, their academic value, and their contribution to knowledge, can be found below.

- *In the rise of affectivism*: This thesis proposed a new model of musically induced emotions - the CODA model. The CODA model brings the field of music and emotion literature closer to the wider affective sciences by aligning the components of musical affect with that of utilitarian affect and that of general cognition; in line with the new era of affectivism (Dukes et al. 2021). At the heart of the CODA model are the newly hypothesised goal-directed mechanisms that draw together multiple competing models into a single more versatile model. It offers a more unified and integrated understanding of the components of (musical) emotion, and is compatible with contemporary psychological and neurological perspectives such as 4E cognition (Newen, De Bruin, and Gallagher 2018).
- *Beyond the reductionist*: This thesis moves beyond circular conversations about which emotion a piece of music produces. It provides an alternative to previous and highly cited theories that seek to associate specific mechanisms with individual discrete emotions (Juslin and Västfjäll 2008; Juslin et al. 2016; Juslin 2019). The CODA model and its skeptical rationale provide a

selection of highly dynamic mechanisms that are well adapted to explaining individual and contextual variability in the generation of meaning-making; mechanisms that offer testable hypotheses.

- *The law of parsimony and efficiency:* The CODA model offers a more parsimonious interpretation of musically induced emotional episodes than models that seek music-specific mechanisms. That is, the CODA model does not seek to invent an ever increasing number of mechanisms to account for the infinite diversity of emotional responses to music - e.g., BRCVEM (Juslin and Västfjäll 2008), BRECVEMA (Juslin et al. 2016), ICINAS-BRECVEMA (Juslin 2019). Instead the CODA model seeks to build from the most agreeable interpretations of emotional components offered by the wider affective sciences. Subsequently this allows the future focus of empirical work to operate in a more efficient manner, while an ever increasing number of mechanisms requires greater resources and time.
- *The role of appraisal:* This thesis provides the first direct test of multiple appraisal mechanisms in the context of music. Appraisals form a component of many theories of musically induced emotional episodes but these mechanisms have remained to a large extent unidentified. This thesis brought about a first test battery of appraisal mechanisms in the context of music. Moreover, those theories that have previously proposed specific appraisal mechanisms (Scherer and Coutinho 2013; Céspedes-Guevara 2021) remain untested. This thesis directly examines and provides evidence for the role of multiple appraisal mechanisms in music showing how these mechanisms relate to other components of an emotional episode.
- *The novelty and validity of goal-directed mechanisms:* This thesis provides the first direct evidence to support the role of goal-directed mechanisms in the context of music induced emotional episodes, and adds validity to the hypotheses of several models (Scherer and Zentner 2001; Scherer and Coutinho 2013; Céspedes-Guevara 2021). The findings discussed in the

above chapters also expand the current role of appraisal in existing models to place goal-directed mechanism as a central feature of music, over just mediating mechanisms.

- *Relevance and applicability:* The CODA model has shown its value to the wider field of music in several aspects of this thesis. Specifically, within this thesis I have shown the empirical and theoretical value to disciplines such as MER in Chapter 5, and to aesthetic emotions in Appendix D and Chapter 3. In addition, the CODA model has also added to the understanding of cross-cultural differences (Appendix D). The work of these collaborations shows the usefulness of the CODA model to its related musical sub-disciplines and ultimately its ability to hone future understanding rather than add further accretions.

6.2 Evaluation of the CODA Model

To evaluate the CODA model, one can use Moors' (2009) critical evaluation of models that seek to explain emotion causation (presented in 1.2). With respect to emotion causation, my thesis addresses the 'algorithmic' and the 'functional' levels of analysis. The CODA model also provides evidence for the neurological underpinning ('implementation' level) of its proposed mechanisms (Brosch and Sander 2013; Brosch et al. 2013; Kafkas and Montaldi 2014) but this is not the causal level of explanation it focuses upon. Within the algorithmic and the functional levels of analysis, the CODA model can be said to address all three questions Moors (2009) defines as crucial to a theory of emotion causation: elicitation, intensity, differentiation.

1. *Elicitation* refers to assessing which stimuli lead to an emotional episode and which do not, including why this can vary by individual and situation even for the same stimulus.

The CODA model addresses the elicitation problem (the first of Moors' questions)

through goal-directed mechanisms. More specifically, as seen from a theoretical perspective in Chapter 2) and with some preliminary empirical evidence in Chapter 3, the CODA model suggest that as a goal-relevance threshold is crossed the subjective experience of a stimuli moves from less to more emotional processing. This approach more neatly aligns with the era of affectivism: all cognition is affective (Dukes et al. 2021). Moreover, the CODA model allows for substantial individual and situational variation in when a stimuli might lead to an emotional episode. For example, the CODA model can explain why the same stimuli can elicit an emotional response for some individuals but not others (Chapter 4). Further empirical work is required to answer the elicitation question fully. A good experimental start would be recording subjective reports of ‘feeling’ an emotional episode is occurring would be a reasonable starting point, corroborated by identifying synchronisation through multiple components (e.g., physiological responses).

2. *Intensity* refers to assessing the strength of an emotional episode.

The CODA model addresses differences in emotional intensity again through goal-directed mechanisms. The CODA model suggests that should the initial threshold for goal-relevance be crossed, the degree of congruence a stimuli has with a particular goal will relate directly to the intensity of an emotional episode. Evidence for this was also presented in Chapter 4. The definition of an emotional episode (presented in Chapters 1 and 2) also allows the intensity of an episode to vary over time. This process is explained by the on-going cognitive evaluation of goal-relevance and goal-congruence driving further cognitive processes. As greater synchrony between the components of an emotional episode emerge, further goals afforded by the stimuli or the situation can materialise, subsequently generating the opportunity for multiple forms of goal-congruence to develop. Chapter 4 (experiment 2) shows clear links between goal-directed mechanisms and subjective feelings of intensity. Further work would seek to substantiate these findings through replication and cross-validation through other emotion components (e.g, physiological responses).

3. *Differentiation* refers to the quality of an emotional episode. In the wider sense meaning distinctions in valence, in a more restrictive sense discrete terms.

Goal-directed mechanisms are also able to answer Moors' (2009) question of differentiation as the CODA model places goal-directed appraisals as inherently valenced dimensions. Each dimension, as a micro-valence, informs the construction of a macro-valence and refers to the quality of an emotional episode. The empirical evidence (described in Chapters 3, 4, and 5) supports that goal-directed mechanisms lead to the differentiation of the affective space, organised as core-affect, and this micro-valenced interpretation (Chapter 3). Thus, the CODA model allows not only for substantial individual and contextual variation in responses even to the same stimuli but also for the acknowledgement of mixed emotional responses.

In this evaluation of the CODA model, I acknowledge that an emotional episode is a complex multi-componential and dynamic event. The CODA model has explicitly addressed the lack of goal-directed mechanisms in music and can account for emotional episodes induced by music through such mechanisms. However, goal-directed mechanisms will not be the only mechanisms that can account for such elicitation, intensity, or differentiation in emotional responses to music, for instance, 'mere-exposure' (Zajonc 1980; Huron 2006). I do, nevertheless, wish to suggest that goal-directed mechanisms are a substantially more common driver of emotional episodes induced by music than has been previously acknowledged, if not the most common given the situated nature of our everyday experience with music.

6.2.1 In comparison with other models

While the bulk of the critique of music emotion models is addressed in the initial review (Chapter 2), this critique comprises the closest (Scherer and Coutinho 2013) and furthest models (Juslin and Västfjäll 2008; Juslin 2013, 2019) to my theory. There are some other models that share similarities with the CODA model

and as such deserve some mention. In this section I hope to address alternative models that could be seen as similar to the model proposed by this thesis and in so doing dispel any misconceptions that may have arisen with regard to the CODA model.

A neurodynamic model was put forward by Flaig and Large (2014). They suggest that acoustic features of the music (rhythm and metre; pitch and tonality) activate the nervous system through musical expectancy at different time-scales that create spatiotemporal patterns of activity. These neural patterns of activity directly influence core-affect. This theory directly overlaps with the CODA model which is built upon core-affect. The distinction between the CODA model and Flaig and Large's (2014) model can be seen in Moors' (2009) review of processes in emotion causation (section 1.2). Flaig and Large's (2014) model addresses the 'implementation' level, while the CODA model focuses upon the 'algorithmic' and 'functional' levels of analysis. These models can therefore be seen as complementary, concerning different levels of analysis of core-affect. The CODA model does not address the neural basis of appraisal in a causal fashion but does note the brain basis of several appraisal dimensions. Both theories similarly seek to address the 'elicitation' and 'differentiation' questions of emotion causation (Moors 2009, section 1.2). I note, however, that the CODA model additionally seeks to address the emotional 'intensity' problem, not addressed in Flaig and Large's (2014) model. Similarly, I note that the CODA model is additionally able to explain individual and contextual differences in musically induced emotional episodes.

In the commentary on Juslin and Västfjäll's (2008) model, Thompson and Coltheart (2008) put forward a variation of a dual-process model. In this interpretation Thompson and Coltheart (2008) describe the mechanisms put forward by Juslin and Västfjäll (2008) simply as relating to two systems: 'signal detection mechanisms' (e.g., brain stem, evaluative conditioning) and 'amplification mechanisms' (e.g., visual imagery, episodic memory). This grouping of mechanisms can be seen as equivalent to a classical dual-process model. They describe the first

‘signal detection’ as ‘unmediated sources of emotion’ (p. 597), whereas ‘amplifiers’ act as mediators in conjunction with signal detection mechanisms if the cognitive resources are available, ‘most music listening accompanies activities such as driving, reading, and socializing, with little opportunity for imagery and episodic memory’ (p. 598). The CODA model can be critically and meaningfully distinguished from this more classical interpretation (Thompson and Coltheart 2008). The classical dual-process model states that the stimulus driven mechanisms take priority most of the time and explicitly when the additional cognitive resources needed for higher cognitive processing are not available (i.e., most of the time). I alternatively follow Moors et al. (2017; 2019) in the development of her skeptical parallel-competitive dual-process model (described and critiqued in Appendix A.0.1). In these models (Moors, Boddez, and De Houwer 2017; Moors and Fischer 2019; Lennie and Eerola 2022) the default mechanism is the ‘goal-directed’ one, not the stimulus driven mechanism, allowing for less reductive interpretations.

Céspedes-Guevara’s (2021) recent development of a constructionist account of musical emotions, based more specifically on the work of Barrett’s (2006, 2017) ‘Conceptual Act’ model, is another closely aligned model to the one proposed in this thesis. Céspedes-Guevara’s (2021) model is described in full and critiqued through a skeptical lens in the Appendix (A.0.2). A few brief comments can be made here though. A constructionist account of musically induced emotions is a valuable one. As discussed in section 2.2.2, it comprises several skeptical ideas I acknowledged as crucial to the development of theories of musical affect. Barrett’s theory however, does not represent a ‘true’ skeptical theory as its focus is still towards categorisation (Moors 2017). The CODA model alternatively seeks to address the interaction between multiple dynamic components as opposed to labeling an emotional episode. Barrett’s (2006, 2017) model also does not actively introduce a mechanism that can account for the interaction between the ‘Conceptual Act’ and core-affect. To counter this problem Céspedes-Guevara (2021) in his musical adaption introduces a small collection of appraisal mechanisms to account

for this interaction¹. However, these appraisal mechanisms are explicitly distinguished between those related to core-affect and those related to the conceptual act. Céspedes-Guevara defends this distinction by describing the appraisal mechanisms as representative of equivalent mechanisms at different neural time-scales. Several limitations to this are noted from a skeptical perspective in A.0.2. The key distinction between the goal-directed CODA model and Céspedes-Guevara's (2021) constructionist account can be subsumed under the acknowledgement that the CODA model proposes all appraisal can be both rule-based and associative², and subsequently linked to multiple types of information processing. As such, all appraisals can influence other components of an emotional-episode, be it core-affect or subjective feeling. This is in contrast to the suggestion that specific appraisals should be viewed as related to core-affect and others should be explicitly viewed as relating to the component of subjective feeling (Céspedes-Guevara 2021).

As I have explained in Chapter 1 constructionist theories are a very popular utilitarian approach (Barrett, Lewis, and Haviland-Jones 2016) to emotion and one that has been adapted to music (Eerola 2017; Céspedes-Guevara 2021) to address many of the challenges that precede this thesis. I acknowledge this endeavor as crucial to the development of the CODA model; the CODA model developed within a constructionist organisation of emotional episodes. However, a common criticism of the constructionist approach is that it does not specify the mechanisms that lead to changes in core-affect (Deonna and Scherer 2010). As I have noted above and in section A.0.2, there is only a conscious labeling of core-affect and this does not constitute a mechanism in itself. The incorporation of appraisal mechanisms goes some way to solving the missing mechanism problem, as attempts to adapt the constructionist framework for music note (Eerola 2017; Céspedes-Guevara 2021). The CODA model adds that it is of critical importance that goals are central to these mechanisms and form a principal component of the dynamic

¹'goal-relevance' notably as one of them, though not as the central component as described in the CODA model (Lennie and Eerola 2022)

²described in dimensional-appraisal

system that forms an emotional episode.

There are of course many models of musical affect and one cannot hope to address them all. However, I have drawn explicit distinctions between several models that could be seen as similar to the CODA model and in doing so highlight the unique theoretical contribution of this work.

In a final comment on alternative models, it seems unlikely that those who seek an entirely reductive and stimulus driven explanation of musical emotional episodes will ever be satisfied by my claims. There will never be substantial enough evidence generated to dispel the idea that greater resolution in their particular field of study will lead to conclusive findings that discrete emotions have distinct physiological or neurological pathways that are triggered by particular musical cues. However, I hope that I have convinced more objective readers that a more critical and informative direction of study lies in acknowledging an individual's goals as central to the meaning-making process. I hope those who read this will find the ideas pertinent, useful, and mentally stimulating, and acknowledge the benefit of incorporating goal-directed mechanisms into their own areas of study.

6.3 Evaluation of the empirical findings

The CODA model presents an ambitious number of mechanisms and research questions to be explored, far more than achievable in a single PhD thesis. Nonetheless, one of the core premises this thesis was written for, and the CODA model was designed to address, was to place models of musically induced emotional episodes closer to the guiding principles of the wider affective sciences. This was achieved most readily by the incorporation of goal-directed mechanisms as central to emotional episodes, something that both the wider affective sciences (Ellsworth 1994), and music specific emotion models (Juslin 2019) have declined to acknowledge in a meaningful way. Therefore, the empirical aspect of this thesis was developed around assessing the contribution of goal-directed mechanisms first and foremost.

From exploratory, through well-controlled lab-based empiricism, to real-world applications, this thesis produces a strong argument for the CODA model and why goal-directed mechanisms make up a meaningful component of musical emotional episodes. Below, I will discuss each experiment individually before addressing their cumulative contribution.

6.3.1 Study 1: Exploring appraisal dimensions

This study had two key aims. The first aim of this study was to assess the validity and structure of several hypothesised appraisal dimensions in a musical context. Nearly all of these mechanisms have remained empirically untested in a musical context until now. Those few, like familiarity (e.g., Ali and Peynircioğlu 2010; Lahdelma and Eerola 2020; Cespedes-Guevara and Dibben 2022) or expectation (e.g., Huron 2006; Lerdahl and Krumhansl 2007), that have been tested more typically represent isolated mechanisms that are considered mediators of other effects (e.g., Lahdelma and Eerola 2020). To test this first aim, several terms representative of these appraisal dimensions, were taken from the existing appraisal and aesthetic literature to develop a test battery for several appraisal dimensions. The validity of these dimensions was then assessed in a musical context using confidence intervals and Cronbach alphas, while the underlying structure of these appraisal dimensions was assessed using exploratory factor analysis. The second aim of this experiment was to explore the contribution of appraisal dimensions in musical meaning-making (as core-affect and aesthetic ‘interest’). To address this aim, linear mixed models were used to assess the ability of appraisal factors to differentiate a collection of 60, more and less stereotyped, musical stimuli from across the affective space (core-affect). The findings of this experiment identified ten experimentally robust appraisal dimensions. These appraisal dimensions were grouped into three latent variables (Novelty, Goal-relevance, and Goal-congruence) that could be successfully used as predictors of valence, arousal, and interest.

In the first experiment, I focused upon the validity of the hypothesised appraisal dimensions in a musical context and the terms used as representative measures of these dimensions. I explored how the structure of appraisal dimensions in a musical context relates to the wider appraisal literature and I addressed the justification for naming the latent appraisal factors. The relationship between latent appraisal factors and individual appraisal dimensions with core-affect and interest is a promising predictor in the meaning making process. In sum, the benefits of adopting an appraisal framework for addressing explanations of individual differences in felt experience and in differentiating what makes a musical stimulus interesting to an individual are highly evident. Identified by exploratory factor analysis, goal-directed mechanisms were central to this predictive power, most notably in relation to valence and interest.

The findings from this exploratory analysis have several implications for the wider literature. These include: goal-directed mechanisms specifically being acknowledged as a meaningful component in a musically induced emotional episode; acknowledging appraisal's predictive relationship with the affective quality of an emotional episode, most explicitly in the valence dimensions of core-affect; appraisal's ability to predict the relevance of a musical stimuli as aesthetically interesting (Menninghaus et al. 2019); and the opportunity to address individual differences within the components of core-affect and interest. I will discuss the implications of each individually.

First and foremost the results of my first experiment provide evidence for several music emotion models that have incorporated appraisal (Huron 2006; Scherer and Zentner 2001; Scherer and Coutinho 2013; Koelsch et al. 2015; Eerola 2017; Céspedes-Guevara 2021). Many of these models have not been explicit about which appraisals should be included³ as relevant to music. The results of my experiment offer a specific set of appraisal dimensions that relate to musical affect. For those models that have proposed explicit appraisal dimensions for music,

³The exceptions being (Céspedes-Guevara 2021; Scherer and Coutinho 2013)

the results of my thesis in many cases calls for an expansion in the number of appraisal dimensions included. The results also suggest that some appraisal dimensions identified here and included in other models may also require further clarification. Notably, at a conscious level of description (i.e., self-report) appraisal dimensions should be seen as multifaceted constructs themselves. For instance, terms most suited to capturing rhythmic novelty, tonal novelty, lyrical novelty, and situational novelty may be different, and may contribute differently to further cognitive processing. Other areas of music have had similar problems in identifying the most appropriate term to capture the phenomena they wish to describe, for instance, consonance and dissonance (Lahdelma and Eerola 2020). These problems have led to confusion in the literature about what is truly being described. Because of this, I have suggested (Chapter 3) that careful consideration should be taken to identify what is being appraised and how it is measured in any future experiments. The results of my first experiment, however, do provide an important baseline from which other appraisal dimensions or terms can be compared. Similarly, the appraisals identified in this experiment can be used as a baseline for implicit manipulations and indirect measures (e.g., physiological).

Second, individual differences are commonly acknowledged as a current limitation in the music emotion literature (Warrenburg 2020b). Core-affect is one example of a commonly studied component in music and emotion studies that has shown individual differences (e.g., MER, Gómez-Cañón, Cano, Eerola, et al. 2021; self-report, Céspedes-Guevara and Eerola 2018). Specifically, valence has been difficult to model successfully, typically explained as a more cognitive component (Céspedes-Guevara and Eerola 2018). My findings imply a positive step in identifying the cognitive components that relate to valence and mark a substantial contribution to many approaches that have predominantly been stimulus driven (Juslin and Laukka 2003). This implies tentative evidence for the prediction of mirco-valences (Shuman, Sander, and Scherer 2013; Lennie and Eerola 2022).

Third, my findings have implications for the study of aesthetic experiences in mu-

sic, too. Indeed, I offer the first musical evidence for the role of goals in aesthetic experiences (Menninghaus et al. 2019) and a new, more nuanced understanding of key aesthetic features (i.e., interest). This is explored in more detail later in this discussion through a summary of a published chapter that identifies developments of the CODA model in the context of aesthetics (section 6.5).

Finally, in support of the CODA model, my results identify the central importance of goal-directed mechanisms in the musical meaning making process. Alternative models, to a greater or lesser degree, negate the role of goals to mediating mechanisms. Goal-directed mechanisms offer new means of identifying individual and contextual differences in a more methodologically rigorous way. This is a requirement that has been noted several times in the music emotion literature (Scherer and Zentner 2001; Eerola 2017; Warrenburg 2020b; Céspedes-Guevara 2021; Lennie and Eerola 2022). For instance, it is identified in research concerning individual differences as micro-valences (Shuman, Sander, and Scherer 2013), the identification of individual differences in the type of goal desired from music, predispositions for and prioritisation of different goals (Moors 2020) or even cultural differences in musical goals where individual or contextual differences, such as the situational factors that may constrain or afford new goals in different situations. Simply, the identification of several goal-directed appraisal mechanisms as valid components in musical meaning making allows for musically induced emotional episodes to be studied in the situated context that they occur.

6.3.2 Study 2: The role of goal-directed mechanisms

This study comprised of two experiments reported in Chapter 4. The aim of these experiments was to directly test the role of goal-directed mechanisms in music. The first experiment in study 2, tested the degree to which musical stimuli could be evaluated as congruent or non-congruent with a selection of highly typical musical functions. The second experiment directly tested the effect of non-congruent, congruent, and highly-congruent music for different functions on

induced core-affect and intensity. Together, the results of these experiments show, in line with the predictions, that musical stimuli can be more or less appropriate for specific musical functions, and that goal-directed mechanisms have a direct effect on induced core-affect. More specifically, the type of goal implies a desired change in core-affect, while music's ability to achieve the desired core-affect (goal-congruence) leads to more positive experiences. Finally, highly-congruent music leads to more intense emotional episodes.

These findings have implications for existing collections of stimuli (Eerola 2011; Eerola and Vuoskoski 2011; Warrenburg 2020a; see also Gómez-Cañón, Cano, Eerola, et al. 2021 for a review of MER data sets) and experimental designs. There is a tendency to assume that musical stimuli, pre-validated into discrete emotion categories or valence and arousal quadrants, will be representative of a mean annotated affective quality regardless of the context. The experiment here suggests that the affective quality of musical stimuli is highly changeable depending on the situational context. Moreover, while some stimuli can be assessed as more or less appropriate for a particular functional context, many also appear to be highly individually sensitive in their appropriateness for different contexts. Certain tracks were clearly congruent or non-congruent in some functions but highly individually variant for other functions showing strong bimodal distributions. What is clear is that researchers must give careful consideration to stimuli selection; how appropriate they are for a particular context, and how individually variable stimuli may be in different situations. Similarly, the assumption that stimuli represent predefined affective states should not be an *a priori* assumption.

The findings for highly-congruent music and intensity also have implications for studies that consider individual differences in induced emotional episodes. In this experimental context, highly-congruent implies familiarity and the ability to choose the music, obviously, but knowledge of the effects of a particular piece (expectations) are also important. An individual's awareness of such effects is key to the implications of Study two's findings. For instance, when considering the

intensity of musical chills (Blood and Zatorre 2001), brain regions associated with reward have been identified (Koelsch 2005). Knowledge of the effects of music implies that this is part of a learning process, it implies that this is changeable and that people can associate a musical stimuli with new goals over time. Highly-congruent music may therefore afford the fulfillment of multiple goals which leads to a more intense experience. Many other components may also be important in understanding what is afforded to an individual by a musical stimuli and future research must begin to acknowledge such individual factors. What is clear from this experiment, and has implications for all experiments using music as a stimuli, is that an individual's evaluation of how appropriate the stimuli is for a particular context has a direct effect upon the induced emotional episode.

Finally, and in continuation from the implications of Study 1, direct evidence for goal-directed mechanisms in musically induced emotional episode has two key implications for research. One is that these findings challenge numerous *a priori* assumptions in the music specific literature and the wider affective literature. Inspired by Kant (1790), much of the literature has made this assumption (e.g., Juslin and Västfjäll 2008; Ellsworth 1994). Yet, these findings suggest a cautious interpretation of literature that has made this assumption. The second is direct evidence for the ability of goal-directed mechanisms to address contextual and individual differences in musically induced emotional episodes. Some researchers have made positive steps in trying to address individual and contextual factors through methodologies such as ESM. Randall and Rickard (2017) have noted individual factors such as prior mood as important, while others (Greb, Schlotz, and Steffens 2018) have noted that situation appears to be the strongest determinant of emotional states. Acknowledging the role of goal-directed mechanisms can supplement such music-based studies in their theoretical and empirical discourse by offering a new approach to assessing an individual in a situation - a situated affective state. Examples of goal-directed mechanisms in ESM studies have been shown (Kuppens, Champagne, and Tuerlinckx 2012), and given the support this thesis provides for goal-directed mechanisms in music, such studies in a musical

context appears to be an obvious and highly achievable continuation.

6.3.3 Study 3: Appraisals in the wild

The aim of the third study was to test the role of goal-directed mechanisms in a real-world environment and to show the applicability of the CODA model to studying individual differences in the related field of music emotion recognition. The results to this third study (Chapter 5) showed that goals, represented in the study as political affiliations of people in Colombia, can change the induced emotional episode of an individual, at least in terms of core-affect. By using algorithmic models, the experiment was also able to demonstrate that the manipulation of goal-directed mechanisms can bias individuals towards negative states.

As argued throughout this thesis, the CODA model offers a valuable guide for the study of how individual and contextual variables influence emotion episodes due to its goal-directed focus. Thus, the CODA model offers a valuable template that can guide the search for new variables from a theoretically robust starting point. Indeed, as this third study has shown, the CODA model would be particularly beneficial for the field of MER (which is explicitly focused on stimulus driven components, Gómez-Cañón, Cano, Eerola, et al. 2021), as well as, more generally, for examining real-life listening applications.

The results of Study 3 were observed beyond the acoustic effects of the music; polarisation occurred only in lyrical and mixed algorithms models but not acoustic or random, as predicted. With regard to real-world applications, the results suggest goal-directed mechanisms are not only observable in real-world scenarios but also are as implicitly malleable within specific contexts. The effects were observed even given the methodological limitations (discussed below). These limitations may have led to the more mediated findings for goal-directed mechanisms than in other studies. Nevertheless, such observations are undoubtedly of importance in a world of increasingly accessible personal data, especially considering growing evidence for music induced harm (Saarikallio, Gold, and McFerran 2015;

Silverman, Gooding, and Yinger 2020). Goal-directed mechanisms and the CODA model offer an active question to researchers in MER - *why this music for this individual?*

In a similar vein, this study has implications for cross-cultural research. It also shows that goal-directed appraisals are robust across cultures. It suggests, in line with many of the predictions of the CODA model, that goal-directed appraisal can be informative in addressing cross-cultural differences in affective responses to music. The implications for this are discussed in more detail later in this chapter (section 6.5).

The causal effects of goal-directed mechanisms on core-affect, however, are not as clear as in the lab-based studies. In line with previous findings, the hypotheses predicted relationships between specific goal-directed mechanisms and core-affect (valence and arousal) work independently. The results of this experiment are substantially more mediated than in other experiments reported in this thesis. Acknowledging the limitations of the experiment may help explain this. First, that the algorithm was designed to amplify negative affect. As a result, participant's motivation to engage with the task (reporting their felt experience) may have diminished. Second, the stimuli represent quite extreme right / left political ideologies, perhaps less congruent to your average centre right/left political voter. Third, and related to the second limitation, is that such extreme political views (represented in the stimuli choices) are inherently negative to many listeners because they do not agree with listener's goals. Finally, and possibly most importantly for a goal-directed interpretation, we did not control for the degree of political engagement individuals have. Those who are more politically engaged (goal-relevance) are likely to have stronger affective responses to such stimuli than those who are less politically engaged. This implies that to observe the effects of goal-directed mechanisms on other components of an emotional episode in real-world contexts requires very careful experimental designs with multiple measures.

It is important to note that the findings of study 3 were also influenced by the

mixed algorithmic model (acoustic and lyrics) as well as the lyric specific algorithm. This has implications for the development of all models that incorporate appraisal. Thus, I suggest that more consideration of how goal-directed mechanisms interact with an acoustic environment may be a rewarding future direction. Affective meaning-making in music is a process that involves the music, the context, and the individual as has been well acknowledged (Scherer and Zentner 2001). This thesis makes strong claims for the role of goal-directed process in better understanding individual and contextual features but one of the most valuable implications of this study is that empirical studies need to address all these components together. I point again to ESM as a meaningful starting point in this endeavor. A development of the CODA model that begins to incorporate these developments is discussed later (section 6.5).

Altogether, this study suggests that while goal-directed mechanisms appear to be robust in real-world applications and cross-culturally, the nuances of assessing the effects of goal-directed mechanisms upon other components of emotions are substantially more complicated and likely require careful participant and stimuli selection. Nevertheless, it is studies such as this that will allow for better clarity of musically induced emotional episodes.

6.4 Limitations and future recommendations

The research methods described throughout this thesis follow a natural development from exploratory analyses, through lab-based experiments, finally to real-world applications. Much of the methodological design has been informed by appraisal theory; as the incorporation of goal-directed appraisals is one of the most prominent aspects of the CODA model. The individual limitations of each methodological design have been discussed in their respective chapters. There are some more general limitations that can be noted in regard to the thesis as a whole that I will now explore in the context of future recommendations and continued research.

6.4.1 Methodology and samples

All the studies reported through this thesis are based on self-report and have been collected through online data collection platforms, most typically Prolific. There are notable limitations to the use of self-report methods (Paulhus, Vazire, et al. 2007), some shared with many different methodologies (e.g., anchoring, primacy effects, or time constraints), others specific to self-report. Those most applicable to the study of emotion and the results presented here can include: retrospective reflection leading to distorted or mis-remembered emotions (Hadinejad et al. 2019), inaccurate perceptions of emotional intensity (M. D. Robinson and Clore 2001), inability to fully describe the emotional content (Hadinejad et al. 2019), including the precision or complexity of their emotional responses (Lindquist and Barrett 2008). In addition to these limitation, one can also note that the sheer prevalence of the self-report methodology in appraisal (Scherer and Moors 2019) and music emotion (Eerola and Vuoskoski 2013) literature also demands greater variation in methodological choices to advance understanding and to allow for corroboration between findings.

The choice to focus upon online and self-report methods across the studies was informed by different limitations for data collection in each instance, including access to cross-cultural participants (e.g., Study 5), the collection of new stimuli annotations that could not be achieved through indirect methods (e.g., degree of congruence with activities; Study 4), and COVID-19 restrictions that led to online design which limits collection of additional measures (e.g., physiological or neurological measures). The self-report measures should nonetheless be indicative of the underlying mechanism or effect, while coordinating results between different methods is a natural development for future studies (see 6.4.2 below).

The online focus did allow for a more diverse collection of UK participants in terms of age, education, and musical ability, than a typical collection of undergraduate students. Moreover, the collection of Colombian participants provided evidence for the cross-cultural validity of goal-directed mechanisms. Yet, the participant

samples can predominantly be described as a WEIRD population (Henrich, Heine, and Norenzayan 2010) limiting the extrapolation of these findings. A continued focus to collect data from a wider participant pool is a required step for validating the utility of goal-directed mechanisms and the continued development of the CODA model.

Finally, a quick note on sample size should be addressed in relation to Study 1 (Chapter 3). Such a large collection of variables being tested would benefit from a larger participant pool. Future studies did find evidence for the goal-directed mechanisms identified by the exploratory study. The prevalence of these mechanisms though may not be equivalent in a larger sample, or different cultural samples. Needless to say, a confirmatory design is a warranted continuation as is a greater cross-cultural focus for the structure of musical appraisal; particularly as I have argued appraisal's main contribution to understanding musically induced emotional episodes is in individual and contextual differences.

6.4.2 Implicit manipulation and indirect measures

As noted above, additional methodologies to corroborate findings across methods would be an effective next step for future researchers. Several specific hypotheses have been made by the CODA model about the relationship between goal-directed appraisals with physiological (Kreibig, Gendolla, and Scherer 2012), neurological (Nieuwenhuis, De Geus, and Aston-Jones 2011), action tendency (Brosch et al. 2013), and expression (Aue, Flykt, and Scherer 2007; Aue and Scherer 2008, 2011; Laukka and Elfenbein 2012; D. Corbetta, Guan, and Williams 2012; Gentsch, Grandjean, and Scherer 2015; Nordström et al. 2017) components. New studies that take such research as guidelines for studying musical goals can open up new fields of study linking goal-directed appraisals to other components of a musically induced emotional episode. A key benefit of the CODA model is that it provides a greater focus upon the synchronisation of emotion components through an emotional episode, thereby moving beyond single discrete labels as the 'to be described

phenomena'. Similarly, adopting methodologies such as priming tasks can be an informative way to address the effects of goal-directed mechanisms through more implicit manipulations. Moors and De Houwer (2001), along with their evaluation of implicit measures (De Houwer and Moors 2007; De Houwer et al. 2009) are excellent examples of such manipulations which, when taken in tandem with the findings of Study 2 (Chapter 4), allow one to adapt such tasks to fit typical musical goals. For instance, this could involve demonstrating that the priming of different goals and/or implicit manipulations of congruent/non-congruent music can change individual responses to a stimulus through either self-report or through other indirect biological or expression based data. Indeed, the methodological possibilities remain extremely broad, while the underpinning idea remains eloquently simple. This poses a diverse and compelling future direction for research.

6.4.3 Dynamic states and longitudinal studies

None of the studies in this thesis took a longitudinal approach, yet, one key prediction of the CODA model is that goal-directed mechanisms operate and contribute to further components of emotion in a dynamic way. This construction of goal-directed mechanisms is implied by the definition of an emotional episode adopted by this thesis - one that does not seek to categorise by single discrete terms. Unfortunately, evidence that goal-directed mechanisms contribute to musically induced emotional episode in a dynamic way cannot be inferred from the experimental designs explored in this thesis. To achieve this, methodologies that allow for the collection of data over time are required.

Such studies could include physiological, neurological, or expression-based measures, which are inherently dynamic by nature, as well as continuous core-affect ratings. This type of design as extensions of the experiments presented here (e.g., vignette methods) or as more ecologically robust ESM studies, would be highly beneficial for extending the existing findings for the role of goal-directed mechanisms. Unfortunately, it is more common practice to take dynamic measures and

reduce them to fixed mean ratings for comparison to discrete terms (Eerola and Vuoskoski 2013). Moving beyond lab-based study designs, which are not necessarily the most conducive to the study of felt emotion, and to address hypotheses for the bi-directional interaction between goal-directed mechanisms and other emotion components, diary studies and ESM would be well suited. This way, it will be possible to assess the relationship between everyday (musical) goals, preexisting core-affect, action tendencies, and subsequent changes in core-affect. This is something that has become increasingly achievable through new technologies.

As alluded to above, many of the studies where longitudinal analysis may be useful are often instead reduced to single data points. This is not because the analyses do not exist. Such analyses have been developed for longitudinal studies such as ESM and diary studies (Asparouhov, Hamaker, and Muthén 2018), and developmental studies (Shamshoian et al. 2022). Obviously, I do not wish simply to state that adopting new analyses (e.g., time-series) would be beneficial for assessing responses to a stimuli that inherently changes over time. Instead, I wish to note that predictions made in this thesis identify not only the dynamic nature of a musical emotional episode but also state that the relevance of a component or mechanism (at any given moment in an emotional episode) can change. To address these questions in a meaningful way undoubtedly requires novel analyses. Specifically, I point to Bayesian analysis as a method that can represent changes in the weighting of components or particular mechanisms to assess how these can lead to changes in an emotional episode. For example, to expand on the above suggested ESM study, one can see how incorporating a weighted analysis of multiple goals in unison with prior existing knowledge can be a more nuanced predictor of the multitude of possible emotional responses (i.e., it allows for different individuals to have different priorities at different times across different contexts). While the Bayesian method is by no means the only way to approach such problems, I do wish to note its consistency with existing approaches to modelling cognitive process (Hohwy 2020) and for example in music (Koelsch, Vuust, and Friston 2019). I therefore offer this as a logical and consistent direction to begin such

investigations.

6.4.4 Stimuli

Much previous research has been constructed around highly exaggerated and stereotyped examples (Warrenburg 2020a; Eerola and Vuoskoski 2013; Céspedes-Guevara and Eerola 2018). This is perhaps not surprising, when considering other areas in the affective sciences (e.g., facial and vocal expressions) one can see how the use of exaggerated examples came from a necessity for experimental designs but has led to some over zealous claims about the nature of emotion (Nelson and Russell 2013); as discussed in section 2.2.1. To counter such problems, more diverse stimulus selection is certainly one of the most important steps (Eerola and Vuoskoski 2013). As such, the stimuli selection for all the experiments reported in this thesis attempted to move away from over exaggerated emotionally stereotyped musical stimuli in favour of stimuli more appropriate for evaluating the emotion space beyond a few discrete terms and the wider meaning-making process. Stimuli selection came from large data sets (Aljanaki, Yang, and Soleymani 2017; Rentfrow, Goldberg, and Zilca 2011; Gómez-Cañón, Cano, Eerola, et al. 2021) containing multiple genres, appropriate for the intended audience and differing in terms of acoustic qualities, emotionality (more and less stereotyped), and contextual appropriateness (e.g., politically motivated music). The use of these large data sets of music which are more representative of ‘everyday listening’ may not always be appropriate. They are often designed with specific objectives, for example musical preferences (Rentfrow, Goldberg, and Zilca 2011) or feature extraction (Aljanaki, Yang, and Soleymani 2017), and do not therefore necessarily capture the context-sensitive nature of an emotional episode (Gómez-Cañón, Cano, Eerola, et al. 2021). That is they do not acknowledge the changeability of stimuli across contexts.

In Study 1 (Chapter 3), the DEAM data set (Aljanaki, Yang, and Soleymani 2017) was analysed to identify stimuli with higher standard deviations as rep-

representative of less stereotyped examples. In Study 2 (Experiment 1, Chapter 4), two further approaches were adopted to address this limitation. First, an existing data set (Rentfrow, Goldberg, and Zilca 2011) was re-annotated by a new participant pool for a new purpose (goal-congruence). This new annotation showed that some tracks were more variable than others and suggests that collating new data sets with more contextual annotations can fall foul of the same limitations previous data sets have (Nelson and Russell 2013), if not well thought through. Second, the novel approach of using participant-selected, in addition to researcher-selected stimuli, was adopted, taking inspiration from Rickard (2004; in Eerola and Vuoskoski 2013) (Study 2, Experiment 2). Self-selected music similarly has limitations in the degree of control experimenters have over other mediating mechanisms such as episodic memory or learned associations. Nonetheless, a greater focus upon self-selected music in conjunction with new analysis tools and context-sensitive applications (Gómez-Cañón, Cano, Eerola, et al. 2021), and/or in comparison with well-controlled research-selected stimuli (Study 2; Chapter 4) is a positive future direction for researchers. It is one that begins to build more personalised and context-sensitive data sets as standard.

6.4.5 What is a goal

The greatest strength of this research is also its greatest weakness. I have introduced, theoretically justified, and empirically validated goal-directed mechanisms for musically induced emotional episodes. In doing so, I have provided a very broad definition of appraisal as cognitive mechanisms that relate to an individual's needs, wishes, desires, and goals. In this definition, goal-directed appraisals can be fast and automatic or slow and reflective as well as associative and rule-based. What remains unclear then is what is not a goal-directed appraisal? Such discussions between the wider and more narrow definitions of a 'cognitive' process are evident in the broader emotion literature, too (e.g., see Lazarus (1981) vs Zajonc (1980); discussed in Chapter 1) and are likely to continue into the future. What is crucial to my definition of goal-directed mechanisms and what it offers the music

emotion field is a theoretical approach that centralises an individual's purposes and the situational context within the meaning making process and moves away from previous approaches that prioritise the features of the music Juslin (2019). There is, and needs to be, acknowledgement of alternative mechanisms, such as, 'mere exposure' (Zajonc 1980; Huron 2006) where the 'cognitive' component is not central to meaning making process. These mechanisms are most commonly the mediating mechanisms in the meaning making process as I have argued in Lennie and Eerola (2022).

A clear direction for future studies is to look more closely at the many goals and contexts people have when engaging with music, and music's ability to fulfill these goals. One possibility for refining the many types of goals, is to follow research into motivation theory. Maslow (1948) suggested a hierarchy of different motivations that people can have and while the hierarchy he suggested has not held up against empirical research (people tend to differ in which priorities are most important) several components appear relatively robust. Noting contextual differences in how and when people prioritise different goals fits well with the hypotheses present in this thesis for multiple competing goals.

I have listed several limitations that can be applied broadly to the theory and methods used in the thesis as a whole. These can be summarised as looking for convergence across methodologies, greater ecological validity in both stimuli and real-world applicability, and finally replicability. However, given the promising findings that have been presented, such limitations point not to problems but promising future directions in research. Future directions that can ask better questions, in more robust ways, to better understand the causal processes that govern individual musical meaning making in different contexts.

6.5 On-going developemnt of the CODA model: aesthetic affordances and cross-cultural con- texts

Finally, I note here some existing theoretical developments in the CODA model, specifically goal-directed mechanisms, for addressing cross-cultural differences in aesthetic emotions (Timmers, Bannister, and Lennie in press). Aesthetic emotions are a prominent point of study in the music emotion/psychology field. In a collaborative chapter with Renee Timmers and Scott Bannister the relevance of the CODA model to the understanding of aesthetic emotions and peak experience is discussed. The full published chapter can be seen in the Appendix D.1.

The chapter first defines aesthetic emotions as distinct from utilitarian emotions through the act of adopting an aesthetic mode of engagement (e.g., focused listening, Brattico and Pearce 2013). Next are described the typical self-report (e.g., AESTHEMOS, Schindler et al. 2017) and biological (e.g., chills, tears) measures used to capture peak aesthetic responses. The text goes on to explore the role of acoustic features that are typically associated with aesthetic experiences. Acoustic features are described as dynamic changes in probabilities of tonal and temporal structures that lead to changes in the tension-relaxation appraisal dimension. This dimension, along with other appraisal-dimensions, forms a micro-valenced contribution that has been linked to increased physiological and pleasure responses (Solberg and Dibben 2019). The role of acoustic features in aesthetic responses is noted as being captured by ‘two forms of prediction’: predictable events in uncertain contexts, and vice versa, unpredictable occurrence in a familiar context (Cheung et al. 2019). Solberg and Dibben (2019) provide one example of the first form of prediction. The infamous ‘drop’ common to electronic dance music is a highly predictable rhythm in the uncertain context of when it will reoccur. Such ideas build a more dynamic interpretation of the static inverted-U of ‘complexity’ (Berlyne 1970).

Next, drawing from the CODA model, the chapter situates this description of musical structure into individual and context dependent interpretation of aesthetic emotions in music as ‘musical affordances’. Music may afford dancing, spiritual reflection, shared grief, or cathartic relief in different contexts. Much research has linked the complex relationship of aesthetic emotions in music to such individually driven value systems of what music affords. For example, Eerola et al.’s (2018) review of sad music points towards the reasons and meaning of music as shaping the aesthetic experience. Ultimately, we suggest that what music is appreciated for is being tightly linked to the values it affords different listeners in different contexts.

The last section of the chapter places this musical construction of aesthetic affordances into a cross-cultural context, first by reviewing the existing cross-cultural literature. It notes the most typical approaches as focusing upon individual and static musical features over dynamic and probabilistic ones, identifying basic over aesthetic emotions, and with very little physiological data to support aesthetic interpretations such as chills or tears. Nonetheless, two key points of evidence emerge as tentative support for the interpretations of musical affordances we developed as cross-culturally robust: tonal and rhythmic novelty (Laukka et al. 2013), and familiarity Egermann et al. (2015). Finally, aesthetic emotions are framed by the cultural prevalence and cultural values associated with them. Examples such as Saarikallio et al.’s (2020) comparison between Indian and Finnish participants and Schäfer et al.’s (2012) comparison between German and Indian participants are used to suggest that certain musical functions that accentuate ‘intrapersonal and contemplative values’ may emerge more commonly in different cultures and influence the regularity with which an aesthetic mode of listening is afforded to a listener.

Ultimately, this chapter concludes that to understand aesthetic experiences with music, researchers must adopt a position that allows the interaction between music, listeners, and context to be central. I have argued in this thesis that goal-directed

mechanisms and the CODA model offer an appropriate framework to address such interactions. In the case of this published chapter (Timmers, Bannister, and Lennie in press), moving away from an explicitly stimulus-driven interpretation of aesthetic emotions and peak experience towards more contextually relevant ideas, i.e., what affords ‘meaningful encounters with music’ is crucial for different listeners in different contexts.

This small addition to the discussion, though not central to the thesis, shows the impact of my work in supporting new and interesting directions in the music emotion field.

6.6 Conclusions

In this final discussion chapter I bring together the analyses and results from this thesis, summarising the key contributions this thesis has made to the field of music and emotion science. Here, I offer a critical evaluation of the model I formulated (the CODA model) in the context of emotion theory’s aims. I highlight how CODA can be distinguished from previously published models due to its goal-directed focus. This distinction of the CODA model has important implications for researchers, which I also discuss above. As you have already seen, this thesis outlines four experiments, all of which together support the conclusions of the CODA model that goal-directed mechanisms are a central feature of the causal process in emotional episodes. I have provided brief summaries of the results for each experiment together with a reflection on what those results suggest in relation of the CODA model and the wider literature. Limitations of the methods adopted across this thesis are considered and several recommendations for future studies have been made. Finally, I note how theoretical developments of the CODA model, as goal-directed mechanisms, are already being applied to address limitation in musical aesthetic emotions and cross-cultural research.

The benefit of adopting the goal-directed approach outlined in this thesis, with

a clear rationale from theoretical development to empirical support, provides a strong challenge to previous theoretical dogma regarding goal-directed mechanisms in music (Juslin and Västfjäll 2008). My goal-directed approach draws together several competing models of emotional episodes induced by music into a single framework (Lennie and Eerola 2022). It aligns the music and emotion field with more contemporary stances in the wider affective sciences (Russell 2009; Scherer 2009a; Moors and Fischer 2019), aesthetic emotions (Menninghaus et al. 2019), and cognition (Dukes et al. 2021). The results of this thesis advance current limitations in the literature and pose novel questions to researchers. These questions address not what emotion music is labelled as but what emotion music affords a listener, in a context. Simply because it acknowledges that music, and the way we interact with it, is essentially *goal-directed*.

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Appendix A

The CODA model: Additional material

A.0.1 Parallel-competitive dual-process model

A third skeptical theory (Moors, Boddez, and De Houwer 2017; Moors and Fischer 2019) argues for the incorporation of dual-process models from cognitive and behavioural sciences into the emotion sciences, under the skeptical premise that the same mechanisms should be used to explain emotional episodes. This model is grounded in appraisal. However, like Russell (2003, 2012), it takes behaviour (emotional and non-emotional) as the “to be explained phenomena” through sub-components of “learning, motivation, action, and decision making” (Moors 2017).

Dual-process theories typically propose two types of processes: stimulus-driven and goal-directed mechanisms. A goal-directed mechanism evaluates the functionality of multiple actions and initialises the action tendency with the greatest functionality in a given context. For example, an action tendency that may then become overt behaviour. Several cycles of multiple goals can run simultaneously to map changes in behaviour over time, as in cyclic cybernetic models of cognitive control (Inzlicht, Bartholow, and Hirsh 2015). Typically, dual-process theories adopt an ‘interventionist’ approach to the goal-directed mechanism, in which

stimulus-driven processes are the default due to their simplicity and automatic nature. Goal-directed mechanism is more complex and less automatic but can intervene under certain conditions. The stimulus-driven mechanism has the risk of producing less optimal behaviour, while the goal-driven mechanism can correct for this to produce more optimal behaviour when the time and resources are available.

Moors et al. (2017) suggest an alternative “parallel-competitive” model in which they challenge the automatic / non-automatic distinction. They reason that the goal-directed mechanism can also be automatic¹. They argue this through three core propositions. First, goal-directed operations can extend from simple (fewer possible action or outcome predictions) to complex (several action and outcome predictions). Second, goals can compensate for a lack in ideal operating conditions (e.g., time or attention). Third, the goal-directed mechanism can recruit associative as well as rule-based operations. Empirical evidence for all three of these positions has emerged (Moors, Boddez, and De Houwer 2017). The implication of this is that stimulus and goal-driven mechanisms will predominantly operate in parallel where the goal-directed mechanism should operate as the default cause of behaviour because the system will prioritise the process that leads to the most optimal predicted outcome. Moors et al. (2017) note how D-A theory is consistent with dual-process theories and attitude formation theories citing Smith and De Coster (2000) and Sloman (1996) respectively. This model expands upon the typical appraisal processes though by placing within the goal-directed process an appraisal of ‘utility’. This allows the most effective action (the action tendency with the best perceived outcome) to take priority over others, something that is not present in existing D-A theories. It makes no prediction about component interactions but acknowledges that both suggested skeptical options are possible.

In the broader concept of behavioural dual-process theories this model allows

¹They also acknowledge that under “poor operating conditions” the simplicity of the stimulus-driven mechanism can give it priority. However, this does not imply goal-directed mechanisms can not operate in these situations (Moors, Boddez, and De Houwer 2017).

emotions to become a more central part of the broader decision making process, with the difference between colder and hotter cognitive processes being marked by the degree of goal-relevance a person places on a stimulus. Similar ideas have also been considered by others who incorporate animal as well as human behaviour (Eder and Hommel 2013).

A.0.2 Constructionist model of musical emotions

Céspedes-Guevara's (2021) constructionist model of musical emotions proposes several mechanisms that reflect the influence upon arousal and valence (core-affect) independently. This is in conjunction with associative and appraisal mechanisms that influence the 'conceptual-act' (Barrett 2006); the dynamic and fast integration of top-down knowledge with the sensory and affective information that defines core-affect. These two systems (core-affect & the conceptual-act) can be seen as separable by the aspects that inform them; (i) core-affect influenced by the acoustic cues within the music and (ii) the conceptual-act informed by the personal and social significance of an event.

Core-affect mechanisms influenced by acoustic cues inform arousal and valence separately – 'attunement' (p. 76). The concept of attunement is built around embodied cognition of music (internal mimicry of action), interaction with the affordances (Clarke 2005) and states of action readiness (Frijda 2009), and the dynamic neural resonance of musical sound (Flaig and Large 2014). For arousal, four mechanisms are presented. This is multiple mechanisms (*neural resonance*, *bodily tuning*, *motor simulation*, and *prediction success*) viewed as equivalent phenomena at different neural timescales. The appraisal *prediction success* represents how successful the neural pattern predictions are at a cognitive level.

Valence is constructed around four mechanisms. Predominantly, intrinsic pleasantness (Scherer and Coutinho 2013), and mediated by additional mechanisms of *mere exposure* (Huron 2006), *evaluative conditioning* (Juslin 2013), and *enculturation*. Céspedes notes that changes in valence are harder to predict from acoustic

cues than arousal. Furthermore, valence emerges from the interaction between *intrinsic pleasantness* and the conceptual-act (*aesthetic preferences, goals, significance of events* etc.) possibly overriding such effects of ‘primitive appraisals’ (p. 83). However, little is mentioned as to how this interaction occurs.

The conceptual-act comprises two groups of mechanisms representing top-down information (*associative* and *rule-based appraisal* mechanisms), together allowing the categorisation of core-affect into a discrete musical emotion. These associative mechanisms include *visual imagery, episodic memories, semantic referents*, and *visual / verbal narratives*. More research into these mechanisms is required but Céspedes-Guevara suggests only episodic memory leads to induced emotion independently (2021). For other associative mechanisms it is necessary to invoke appraisal to provide situational relevance.

Three rule-based appraisal mechanisms are hypothesised by Céspedes-Guevara (*goal-relevance, control, and aesthetic judgment*) integrated from Scherer (2009b) and Clore and Ortony (2000). *Goal-relevance* is described in relation to the situation, like most theories of musical emotions (Scherer and Coutinho 2013; Juslin 2019), where the emotion is not directly related to active music listening but to the task it facilitates or impedes. However, he also notes that goals can be fulfilled by listening to music (e.g., mood-regulation). This is seen as a conscious ‘meta’ decision where the abstraction of imagining how to achieve a goal is implied. *Control* is related to one’s ability to stop or change the music, again related to situational evaluations. Both appraisals offer contextual assessment value. Yet, little discussion is given to broader conceptions of appraisal (e.g., J. Robinson 2005; Silvia 2005a).

The third appraisal is *aesthetic judgment*, consisting of an appraisal of the musician (e.g., their skill level or creativity) and the music itself (e.g., its beauty, complexity, and challenge). It is suggested that aesthetic appraisals would differ culturally and that it could influence other capacities such as empathy. This *aesthetic judgment* mechanism is equivalent to the *norm-compatibility* appraisal

(internal and cultural art norms, Scherer and Coutinho 2013), with the additional appraisal of *agency* (music or performer). However, a list of aesthetic judgments can quickly form an ever-expanding list of evaluations (Egermann and Reuben 2020) yet nearly all appraisal theories contend there should be a reasonably small number of appraisals. Notably, Céspedes-Guevara's concept of *aesthetic judgment* remains separate from the other appraisal mechanisms he proposes, both in being a meta-appraisal and leading to discrete aesthetic emotions. Moreover, no predictions about how perceptions of 'beauty' or 'challenge' may influence or interact with core-affect through a *conceptual-act* are offered. Aesthetic appraisal is not explicitly placed in a superior position to other mechanisms, as noted in BRECVEMA (2019), but does infer a special status as a conscious (meta) evaluation.

The final element of the model is 'attentional deployment'. This is divided into three levels: shallow, cognitively engaged but emotionally detached, and deep. This attentional process shapes the emotional experience of music and can be modified by choice. The first level (shallow) is situationally focused, has little personal significance, and is less likely to lead to an emotional reaction. In the second (un-emotional cognition) music is the active point of attentional focus but is not personally relevant. At the third (deep) level active meaning construction occurs through significant personal associative mechanisms and/or relevance to current goals. The music does not have to be actively attended to in the attentively deep level (but can be) and forms a meaningful part of a situation. All of these model elements lead to a complex process where musical cues induce changes in core-affect and are sculpted through the associative and/or rule-based appraisals to form discrete emotions under the right attentional attitude.

A.0.2.1 Constructionist model under a skeptical lens

Céspedes-Guevara's work has been instrumental in defining a constructionist model of musical emotions. Yet, there is still room for improvement and expansion based on our review of skeptical theories of emotion. His model incorporates

some skeptical ideas (e.g., a move away from discrete emotions as purely stimulus driven) but still focuses upon the act of categorising. Céspedes-Guevara incorporates some appraisal mechanisms in his model as described above; several more than Barrett (2006) who contends ‘appraisals are not literal cognitive mechanisms’ (p. 40). He additionally notes the overlap between different mechanisms and appraisal mechanisms (Scherer and Coutinho 2013) often defining them as equivalent at different neural timescales. Such an approach, which we endorse, allows the reader to link existing research on musical mechanisms with appraisal. Nonetheless, we seek to improve on this model with skeptical perspectives directed at ‘folk’ categories (**categorisation**), the construction and interaction of **components** and the narrow representation of **appraisal**.

A.0.2.1.1 Categorisation Skeptical theories do not view emotion categories as meaningful scientific sets from which to group underlying cognitive mechanisms. Instead, they seek to remove the ever-expanding number of mediating mechanisms and focus upon the components of the emotion process to generate hypotheses shifting the focus to consciousness and behaviour. Céspedes-Guevara’s continued focus on categorisation, despite being more diverse and granulated than basic emotions, defends distinctions between concepts like utilitarian and aesthetic emotions thus the need to invoke additional mechanisms such as aesthetic judgments. Emotions like *interest* and *surprise* are not considered utilitarian emotions in this construction because they are not clearly valenced. However, the literature on aesthetic emotions (Tan 2000) marks them as highly important. This highlights the problem research has in undertaking the study of aesthetic emotions and further exemplifies why much research chooses to separate aesthetic experience from the rest of emotion research.

In acknowledging the skeptical aim to recenter research upon the components of an emotional episode, rather than the organisation of emotional space, the skeptical perspective offers a clear advantage in this respect. Research into aesthetic and utilitarian emotions can be neatly placed within the same mechanisms as general

cognition. Goal-directed accounts may form a more valid scientific set in which to distinguish such concepts; that is embodied and enactive goal-directed affordances discussed in our CODA model.

A.0.2.1.2 Components Skeptical theories further contend that the components of an emotional episode are more logically represented in multidimensional space. Within Céspedes-Guevara's model we can see such conceptions in core-affect, but not associative and appraisal mechanisms, which tend to be described in binary ways (the music produces a memory or it does not; the music is or is not goal-relevant). Adopting more nuanced dimensional accounts allows greater flexibility in the emotion process and additionally allows for more dynamic non-linear modelling, something Céspedes-Guevara himself notes as important.

The interaction between components is a point of contention in skeptical theories. Céspedes-Guevara makes little comment on component interactions apart from to note the complexity of multiple elements. The interaction between the conceptual-act and core-affect does not describe an actual interaction, just the process of labelling core-affect in relation to current situation. One exception to this is the valence dimension, where the conceptual-act mechanisms are noted as having a significant role in determining valence, in many cases overriding the initial mechanisms associated with the dimension (intrinsic pleasantness etc.). However, how this occurs, in what circumstances, or why certain appraisals should be superior to others is not described. We discuss below the situational and individual factors influencing stronger or weaker component interactions. Whether these component interactions form consistent patterns between events remains to be seen.

A.0.2.1.3 Appraisals Skeptical theories all note the importance of appraisal, something we argue is missing from much of the music emotion literature. Céspedes-Guevara admirably has sought to rectify this and incorporated some rule-based appraisal mechanisms. However, exploration of the appraisal literature

suggests not only can more be gleaned but it can lead to testable hypotheses applicable to several current music-emotion debates (discussed in our CODA model). Here, we offer a critique of current adaptations of appraisal.

First, it is not clear whether the *novelty* appraisal, a dimensional appraisal related to arousal, should be considered explicitly a novelty dimension or a novelty-familiarity continuum. The mediating mechanisms Céspedes-Guevara links to valence are more closely tied to familiarity (enculturation / mere-exposure), so we assume these should be separate dimensions (see CODA model: novelty). We contend these appraisals should not be so explicitly divided between valence and arousal. A clear example comes from evidence of too much or too little novelty producing negative affect (Silvia 2006). Similarly, for the *intrinsic pleasantness* appraisal associated with valence, there is evidence that extremely positive or negative ratings automatically increase arousal forming a V-shaped relationship (Kuppens et al. 2017). Together this suggests a more nuanced interaction between these dimensions and between appraisal and core-affect.

Second, we note the distinction between appraisals in core-affect and the conceptual-act. We find it strange that some appraisals (novelty & intrinsic pleasantness) should be reserved explicitly for acoustic cues in core-affect, while others (goal-relevance & control) for purely situational and personal aspects. We exclude *aesthetic judgment* from this distinction because it is representative of both though placed in conceptual mechanisms. Novelty and intrinsic pleasantness could very easily be applied to a situation as much research has shown (Scherer and Moors 2019). Moreover, though less intuitively, we note that goal-relevance and control can equally be applied to acoustic features. Such examples come from Schiavio et al. (2017, goals) and Silvia (2005b, 2005a; 2006, control) and vocal acoustic cues (Nordström et al. 2017, goal-conduciveness, urgency, power, and norm-compatibility) discussed below. We simply note here that skeptical theories would argue such distinctions are not needed and appraisals are part of a dynamic interaction between individual and environment (sonic or situational).

Third, skeptical theories note that dimensional-appraisals can occur in both a rule-based and associative way². Moreover, both processes are linked with multiple types of information processing. Céspedes-Guevara describes the appraisal mechanisms associated with the conceptual-act as explicitly rule-based, retaining the historic association between rule-based processing with conceptual and verbal-like information. Skeptical theories reject such dichotomies (Moors 2017). Appraisals (including goals) can be seen as automatic, can be stimulus-driven in an embodied and enactive perceptual nature, and linked to multiple types of information (conceptual, propositional, perceptual, and sensory). Through this acknowledgment we remove constraints upon which types of processes appraisal can operate in. Such dichotomies between types of processes are closely tied to how familiar a stimulus is and form graded distinctions between ongoing rule-based and associative processing. For example, an unfamiliar tonal system is likely to be processed in a rule-based fashion, while a familiar rhythmic component may be processed associatively. We explore the distinctions between rule-based and associative process as graded distinctions further with examples in our CODA model.

Fourth, we identify the central role of *goals* in skeptical theories. Céspedes-Guevara acknowledges the many goals of musical engagement but refrains from allowing it a central role in core-affect or the acoustic environment. We note important evidence for links between arousal and *goal-relevance*, and *goal-conduciveness* with valence (Kuppens, Champagne, and Tuerlinckx 2012; Moors and De Houwer 2001). Furthermore, we highlight that embodied and enactive goal-directed accounts of meaning construction can be acoustically relevant. The diverse and well documented reasons people have for engaging with music (Saarikallio 2011; Randall and Rickard 2017; T. Schäfer et al. 2013) can be constructed around the affordances of the acoustic environment (discussion and examples in CODA model). When such constructions are acknowledged, other mechanisms Céspedes-

²Rule-based processes refer to the active processing of an appraisal or multiple appraisal outputs. *Associative* process refer to the learned association between a stimulus and appraisal outputs. Rule-based processes offer greater flexibility to the process while associative processes are more rigid.

Guevara suggests as important mediators, such as *evaluative conditioning* (Juslin 2013) in valence, may not be needed. As evidenced by Kolsseck, Yu, and Dickenson (2011) evaluative conditioning effects only occur under particular conditions, while a goal-directed interpretation remains more flexible (Moors, Boddez, and De Houwer 2017; Moors 2017). This removes the need for additional mediating mechanisms.

Finally, we note the contribution of appraisal to the overall system. We have cited the neurological evidence for more appraisals than are currently acknowledged (Brosch and Sander 2013; Kafkas and Montaldi 2014) and state that appraisals have been well acknowledged in cognitive and behavioural (animal & human) models (Eder and Hommel 2013). Simply, by building on the skeptical notion that the same mechanisms should underpin both cognitive and emotional process (Dukes et al. 2021), we state that a greater incorporation of appraisal into music-emotion models is a prerequisite for advancement in the field.

Appendix B

Study 1: Additional Material

B.0.1 Comparison between appraisal terms used in different applications of appraisal theory

Table B.1: Review of terms used in different applications of appraisal theories

		Appraisal Theory				
		(Scherer, 2013)	(Scherer, Dan, Flykt, 2006)	(Silvia, 2005a, b; 2006)	(Scherer & Coutinho, 2013)	(Cespedes, 2016)
Appraisal Group	Sub-category	Appraisal scale				
Relevance	Novelty	Familiarity	Familiarity	Complex	Predictability Familiarity Suddenness	Emotionality Tension Predictability
	Intrinsic Pleasantness	Pleasantness	Pleasantness	N/A	Pleasantness	Goodness / Badness (related to exposure and implicit learning)
	Goal-relevance	< Untouched / Touched by >	< Had (no / strong) effect on me >	N/A	<Expressivity> (as representative of liking)	Can music produce the desired emotional effect? Is the music aiding any other goal?
Implications / Consequences	Causal attribution	Chance / Human Agency (self or other) Intentionality	Chance / Human Agency	N/A	N/A	N/A
	Consequences / Outcome probability	Predictability of further consequences of the event	(No / Further) consequences of the pictured scene	N/A	Will music produce the desired outcome	Will music facilitate the achievement of (the task / desired emotional state)?
	Expectations	(Expected / Did not expect) this to happen	(Expected / Did not expect) to see images like this	N/A	How different was the piece from your expectations	N/A
	Goal-congruence	Positivity of consequences for person (self / other)	< (Decreases / Increases) well-being >	N/A	Conducive to your goals	Did the music facilitate this outcome

Table B.2: Table 8.1 Continued...

Implications / Consequences	Urgency	Requires immediate response	N/A	N/A	N/A	N/A
Coping Potential	Control	Individual control over consequences	* (Low / High) coping potential to deal with the image.	* Comprehensible * Coherent * Easy-to-understand	Can you stop the music	Can you choose the music
	Power	Power over event consequences			Can you change the listening situation	N/A
	Adjustment	Ability to live with event consequences			How much can you change the listening situation	N/A
Norm-compatibility	Internal-standards	Incongruence with personal ideals and standards	* < Acceptable / Unjust, Immoral >	N/A	Does the music match your musical / social identity	* Beautiful * Complex * Challenging * How creative and skilled are the musicians
	External-standards	Violation of laws or socially accepted norms		N/A	Aesthetic beauty Is the music of good taste	

Note:

^aNot all theories acknowledge all appraisal sub-categories. These are marked by an N/A.

^bOther theories use a single scale measure they see as representative of all sub-categories for an appraisal group these are marked *.

^cSome appraisals are considered less accessible to consciousness than others. Some theories instead use implicit measures as representative of the appraisal.

These are marked by <>

B.0.2 Selected tracks from the DEAM data set for Experiment 1

Table B.3: Selected high and low sd track from DEAM data set for study

1

DEAM...track.number	Genre	Core.affect	sd
138	Classical	Valence	High
159	Classical	Valence	High
246	Classical	Valence	High
456	Electronic	Valence	High
423	Electronic	Valence	High
454	Electronic	Valence	High
707	Jazz	Valence	High
676	Jazz	Valence	High
634	Jazz	Valence	High
35	World	Valence	High
1638	World	Valence	High
1611	World	Valence	High
952	Pop	Valence	High
797	Pop	Valence	High
781	Pop	Valence	High
158	Classical	Valence	Low
171	Classical	Valence	Low
198	Classical	Valence	Low
425	Electronic	Valence	Low
459	Electronic	Valence	Low
482	Electronic	Valence	Low
1757	Jazz	Valence	Low
1792	Jazz	Valence	Low
657	Jazz	Valence	Low
1615	World	Valence	Low
1683	World	Valence	Low
1606	World	Valence	Low
851	Pop	Valence	Low
902	Pop	Valence	Low
938	Pop	Valence	Low

Table B.3: Selected high and low sd track from DEAM data set for study

1 (*continued*)

DEAM...track.number	Genre	Core.affect	sd
207	Classical	Arousal	High
150	Classical	Arousal	High
172	Classical	Arousal	High
387	Electronic	Arousal	High
422	Electronic	Arousal	High
423	Electronic	Arousal	High
631	Jazz	Arousal	High
676	Jazz	Arousal	High
696	Jazz	Arousal	High
1684	World	Arousal	High
1673	World	Arousal	High
1675	World	Arousal	High
776	Pop	Arousal	High
858	Pop	Arousal	High
781	Pop	Arousal	High
1118	Classical	Arousal	Low
1150	Classical	Arousal	Low
1132	Classical	Arousal	Low
390	Electronic	Arousal	Low
427	Electronic	Arousal	Low
1332	Electronic	Arousal	Low
722	Jazz	Arousal	Low
1775	Jazz	Arousal	Low
649	Jazz	Arousal	Low
1654	World	Arousal	Low
1693	World	Arousal	Low
1632	World	Arousal	Low
756	Pop	Arousal	Low
767	Pop	Arousal	Low
804	Pop	Arousal	Low

B.0.3 Valence and arousal rating for selected tracks in DEAM data set

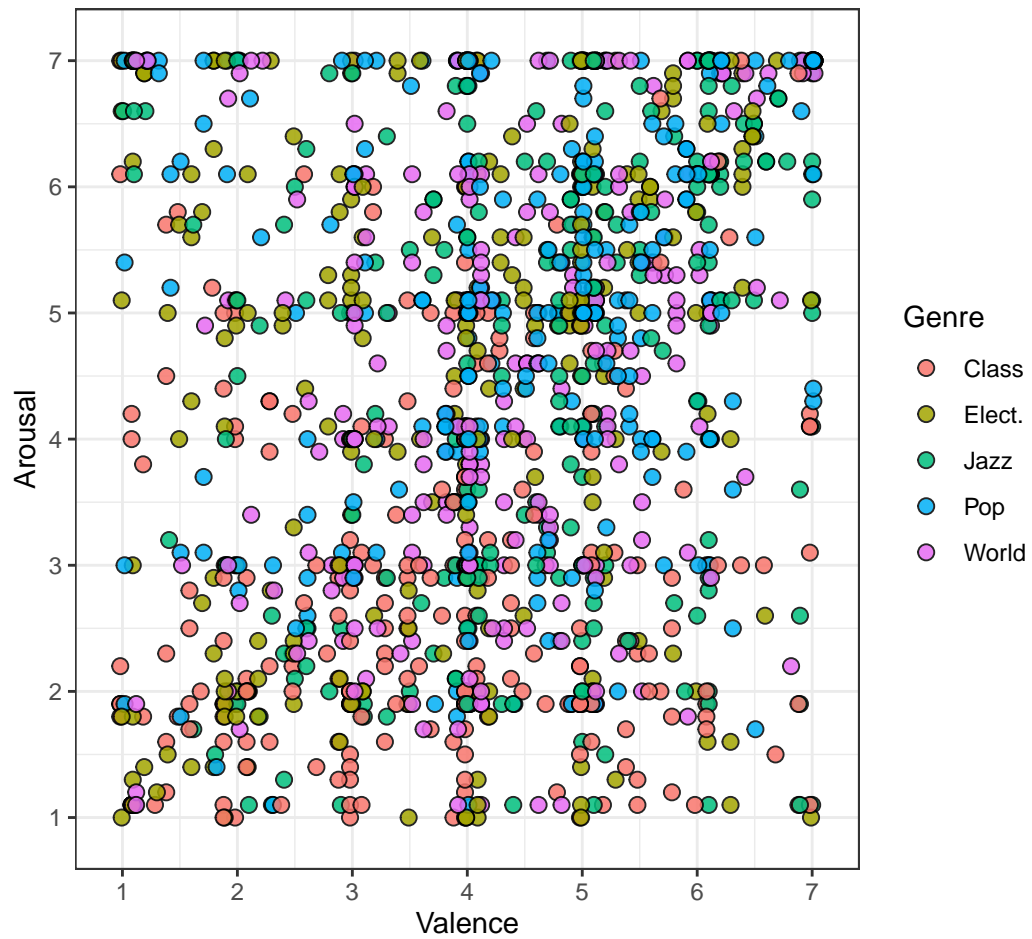
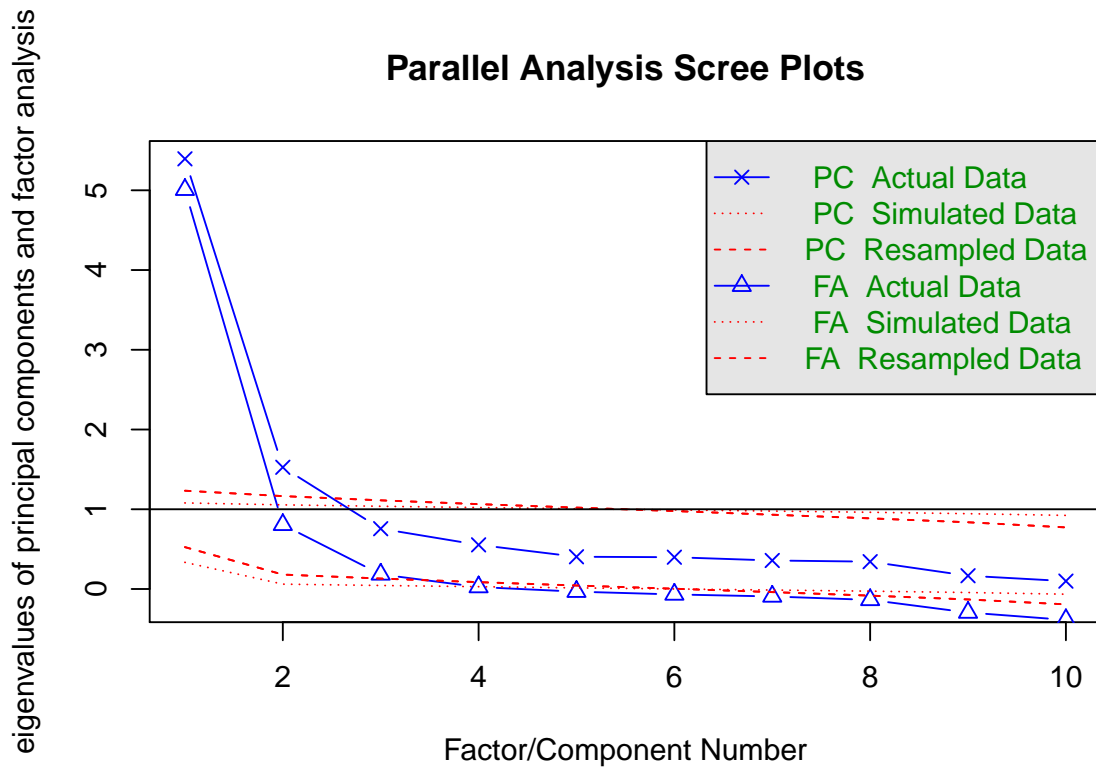


Figure B.1: Mean valence and arousal rating for selected tracks from DEAM data set for Study 1

B.0.4 Parallel analysis for experiment 1



B.0.5 Exploratory factor analysis

	PA1	PA3	PA2
Internal_Standards	0.9776101	-0.0457095	-0.0270843
Goal_congruence	0.9571385	-0.0436784	0.0357015
Pleasantness	0.7811119	0.1077825	0.0866645
Comprehension	0.5383979	0.3559365	-0.0057234
SocialNorms	0.4905038	0.3733337	0.0190381
Predictability	-0.1198802	0.7784378	-0.0898834
Familiarity	0.1820440	0.6048153	0.1821497
Expectation	0.1806248	0.5428005	0.0282370
Complexity	-0.0955535	-0.0219592	0.8392279
Expressivity	0.2614558	0.0225413	0.6280607

B.0.6 Linear mixed models for predicting latent appraisal factors from individual differences

Table B.4: Individual differences as predictors of Goal-congruence latent appraisal factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	0.074	0.291	55.923	0.255	0.800
VariabilityHiSd_V	-0.166	0.116	52.000	-1.434	0.158
VariabilityLoSd_A	0.253	0.116	52.000	2.189	0.033
VariabilityLoSd_V	0.221	0.116	52.000	1.912	0.061
GenreElect.	-0.151	0.129	52.000	-1.170	0.247
GenreJazz	0.052	0.129	52.000	0.406	0.687
GenrePop	-0.081	0.129	52.000	-0.624	0.535
GenreWorld	0.001	0.129	52.000	0.009	0.993
GenderMale	-0.041	0.089	41.000	-0.459	0.649
Age	-0.004	0.004	41.000	-1.049	0.301
Genre.PreferenceOther	0.016	0.237	41.000	0.066	0.947
Genre.PreferencePop/Electro	0.081	0.234	41.000	0.347	0.730
Genre.PreferenceRock/Heavy	-0.001	0.233	41.000	-0.003	0.998
Musical.Self.ImageMusic-loving nonmusician	0.010	0.096	41.000	0.106	0.916
Musical.Self.ImageNonmusician	-0.289	0.149	41.000	-1.936	0.060
Musical.Self.ImageProfessional musician	-0.006	0.290	41.000	-0.021	0.983
Musical.Self.ImageSerious amateur musician	0.112	0.147	41.000	0.761	0.451

Table B.5: Individual differences as predictors of the latent Novelty appraisal factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	-0.166	0.278	55.229	-0.596	0.553
VariabilityHiSd_V	-0.129	0.108	52.000	-1.187	0.240
VariabilityLoSd_A	0.198	0.108	52.000	1.825	0.074
VariabilityLoSd_V	0.151	0.108	52.000	1.392	0.170
GenreElect.	-0.097	0.121	52.000	-0.802	0.426
GenreJazz	0.008	0.121	52.000	0.069	0.946
GenrePop	-0.083	0.121	52.000	-0.683	0.498
GenreWorld	-0.097	0.121	52.000	-0.802	0.426
GenderMale	-0.045	0.086	41.000	-0.524	0.603
Age	0.003	0.004	41.000	0.817	0.419
Genre.PreferenceOther	0.120	0.228	41.000	0.526	0.601
Genre.PreferencePop/Electro	0.114	0.225	41.000	0.509	0.613
Genre.PreferenceRock/Heavy	0.053	0.224	41.000	0.235	0.815
Musical.Self.ImageMusic-loving nonmusician	-0.055	0.092	41.000	-0.592	0.557
Musical.Self.ImageNonmusician	-0.210	0.144	41.000	-1.460	0.152
Musical.Self.ImageProfessional musician	-0.162	0.279	41.000	-0.583	0.563
Musical.Self.ImageSerious amateur musician	0.130	0.141	41.000	0.925	0.361

Table B.6: Individual differences as predictors of the latent Goal-relevance appraisal factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	-0.150	0.248	48.904	-0.604	0.549
VariabilityHiSd_V	-0.129	0.075	52.000	-1.711	0.093
VariabilityLoSd_A	0.047	0.075	52.000	0.623	0.536
VariabilityLoSd_V	0.060	0.075	52.000	0.799	0.428
GenreElect.	0.030	0.084	52.000	0.358	0.722
GenreJazz	0.266	0.084	52.000	3.171	0.003
GenrePop	0.138	0.084	52.000	1.639	0.107
GenreWorld	0.218	0.084	52.000	2.595	0.012
GenderMale	-0.041	0.079	41.000	-0.521	0.605
Age	-0.001	0.003	41.000	-0.392	0.697
Genre.PreferenceOther	0.030	0.210	41.000	0.141	0.889
Genre.PreferencePop/Electro	0.143	0.207	41.000	0.689	0.495
Genre.PreferenceRock/Heavy	0.080	0.207	41.000	0.388	0.700
Musical.Self.ImageMusic-loving nonmusician	0.029	0.085	41.000	0.339	0.736
Musical.Self.ImageNonmusician	-0.283	0.133	41.000	-2.131	0.039
Musical.Self.ImageProfessional musician	-0.270	0.257	41.000	-1.048	0.301
Musical.Self.ImageSerious amateur musician	0.097	0.130	41.000	0.742	0.463

B.0.7 Linear mixed models for latent appraisal factors predicting arousal, valence, and interest

Table B.7: Linear mixed models for latent appraisal factors as predictors of arousal

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.118	0.607	92.619	6.779	0.000
X1	-0.051	0.046	943.911	-1.103	0.271
X2	0.019	0.039	879.066	0.496	0.620
X3	0.262	0.042	949.485	6.217	0.000
GenderMale	-0.340	0.147	42.223	-2.312	0.026
Age	0.002	0.006	42.783	0.264	0.793
GenreElect.	1.438	0.463	51.476	3.106	0.003
GenreJazz	1.443	0.464	51.827	3.112	0.003
GenrePop	1.757	0.463	51.636	3.793	0.000
GenreWorld	1.408	0.464	51.814	3.037	0.004
Genre.PreferenceOther	-0.583	0.389	41.328	-1.500	0.141
Genre.PreferencePop/Electro	-0.211	0.384	41.754	-0.550	0.585
Genre.PreferenceRock/Heavy	-0.463	0.384	41.752	-1.207	0.234
Musical.Self.ImageMusic-loving nonmusician	-0.117	0.157	40.873	-0.745	0.461
Musical.Self.ImageNonmusician	-0.016	0.247	42.205	-0.067	0.947
Musical.Self.ImageProfessional musician	-0.062	0.477	41.751	-0.130	0.897
Musical.Self.ImageSerious amateur musician	-0.027	0.240	40.593	-0.113	0.911
VariabilityHiSd_V	-0.598	0.414	51.491	-1.444	0.155
VariabilityLoSd_A	-0.896	0.414	51.661	-2.161	0.035
VariabilityLoSd_V	-0.813	0.414	51.571	-1.963	0.055
X1:X2	0.043	0.018	958.552	2.386	0.017
X1:X3	0.014	0.018	941.775	0.804	0.421
X2:X3	-0.035	0.022	952.527	-1.589	0.112

^a X1 = Goal-congruence ; X2 = Novelty; X3 = Goal-relevance

Table B.8: Linear mixed models for latent appraisal factors as predictors of valence

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.389	0.366	75.822	11.983	0.000
X1	0.310	0.040	859.427	7.748	0.000
X2	0.187	0.034	726.044	5.562	0.000
X3	0.185	0.037	874.782	5.038	0.000
GenderMale	-0.076	0.102	41.138	-0.738	0.465
Age	-0.003	0.004	42.210	-0.779	0.441
GenreElect.	0.319	0.215	50.942	1.480	0.145
GenreJazz	0.730	0.217	52.109	3.372	0.001
GenrePop	0.688	0.216	51.506	3.186	0.002
GenreWorld	0.589	0.217	52.092	2.718	0.009
Genre.PreferenceOther	-0.126	0.270	40.053	-0.467	0.643
Genre.PreferencePop/Electro	-0.240	0.268	40.701	-0.898	0.375
Genre.PreferenceRock/Heavy	-0.312	0.267	40.698	-1.167	0.250
Musical.Self.ImageMusic-loving nonmusician	0.100	0.109	39.314	0.922	0.362
Musical.Self.ImageNonmusician	0.216	0.172	40.944	1.257	0.216
Musical.Self.ImageProfessional musician	-0.142	0.332	40.555	-0.428	0.671
Musical.Self.ImageSerious amateur musician	0.076	0.166	38.930	0.457	0.650
VariabilityHiSd_V	-0.305	0.193	50.943	-1.585	0.119
VariabilityLoSd_A	-0.242	0.193	51.499	-1.251	0.216
VariabilityLoSd_V	-0.357	0.193	51.198	-1.853	0.070
X1:X2	-0.028	0.016	931.338	-1.734	0.083
X1:X3	-0.012	0.016	880.782	-0.771	0.441
X2:X3	0.005	0.020	925.409	0.265	0.791

^a X1 = Goal-congruence ; X2 = Novelty; X3 = Goal-relevance

Table B.9: Linear mixed models for latent appraisal factors as predictors of interest

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	4.495	0.390	54.576	11.534	0.000
X1	0.430	0.037	957.934	11.626	0.000
X2	-0.108	0.032	918.735	-3.420	0.001
X3	0.435	0.034	947.297	12.806	0.000
GenderMale	-0.165	0.121	40.812	-1.366	0.179
Age	-0.014	0.005	41.718	-2.762	0.009
GenreElect.	0.264	0.151	51.334	1.753	0.086
GenreJazz	0.224	0.152	53.262	1.469	0.148
GenrePop	0.571	0.151	52.313	3.772	0.000
GenreWorld	0.430	0.152	53.245	2.829	0.007
Genre.PreferenceOther	0.109	0.320	40.435	0.341	0.735
Genre.PreferencePop/Electro	0.050	0.316	40.844	0.157	0.876
Genre.PreferenceRock/Heavy	0.192	0.316	40.833	0.606	0.548
Musical.Self.ImageMusic-loving nonmusician	-0.060	0.129	39.867	-0.470	0.641
Musical.Self.ImageNonmusician	0.171	0.203	41.081	0.844	0.404
Musical.Self.ImageProfessional musician	-0.280	0.392	40.663	-0.715	0.479
Musical.Self.ImageSerious amateur musician	0.012	0.197	39.743	0.059	0.953
VariabilityHiSd_V	0.024	0.135	51.351	0.175	0.862
VariabilityLoSd_A	-0.142	0.135	52.245	-1.052	0.298
VariabilityLoSd_V	-0.206	0.135	51.706	-1.529	0.132
X1:X2	-0.009	0.015	985.640	-0.586	0.558
X1:X3	-0.008	0.015	974.815	-0.538	0.591
X2:X3	0.014	0.018	987.786	0.769	0.442

^a X1 = Goal-congruence ; X2 = Novelty; X3 = Goal-relevance

B.0.8 Follow-up linear mixed models for individual appraisal dimensions within each latent factor separately for Valence, Arousal, and Interest

B.0.8.1 Follow-up linear mixed models for individual appraisal dimensions in the latent Goal-congruence factor for Valence and Interest separately

Table B.10: Follow-up linear mixed model for valence predicted by individual appraisal dimensions in the latent Goal-congruence factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	1.460	0.217	168.990	6.717	0.000
Satisfaction	-0.015	0.042	1264.823	-0.354	0.723
Beauty	-0.010	0.039	1245.041	-0.267	0.789
PersonalTaste	-0.044	0.036	1234.598	-1.212	0.226
Outcome	0.078	0.041	1250.570	1.915	0.056
Pleasantness	0.412	0.036	1289.289	11.352	0.000
Comprehension	0.064	0.027	849.331	2.354	0.019
SocialNorms	0.100	0.027	904.837	3.686	0.000
GenderMale	-0.045	0.081	67.024	-0.557	0.579
Age	-0.001	0.003	66.463	-0.378	0.707
GenreElect.	0.351	0.202	54.670	1.743	0.087
GenreJazz	0.812	0.201	53.943	4.041	0.000
GenrePop	0.757	0.202	54.600	3.758	0.000
GenreWorld	0.576	0.201	53.976	2.867	0.006

Table B.11: Follow-up linear mixed model for interest predicted by individual appraisal dimensions in the latent Goal-congruence factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	1.934	0.243	156.744	7.960	0.000
Satisfaction	0.222	0.044	1269.960	5.072	0.000
Beauty	-0.034	0.041	1305.553	-0.837	0.403
PersonalTaste	0.195	0.038	1282.234	5.190	0.000
Outcome	0.095	0.042	1271.311	2.264	0.024
Pleasantness	0.299	0.037	1289.242	7.982	0.000
Comprehension	-0.047	0.029	1183.376	-1.621	0.105
SocialNorms	-0.113	0.029	1213.560	-3.910	0.000
GenderMale	-0.096	0.114	63.155	-0.839	0.405
Age	-0.013	0.005	62.855	-2.666	0.010
GenreElect.	0.306	0.177	53.337	1.728	0.090
GenreJazz	0.462	0.176	52.415	2.620	0.011
GenrePop	0.627	0.177	53.268	3.539	0.001
GenreWorld	0.558	0.176	52.448	3.163	0.003

B.0.8.2 Follow-up linear mixed models for individual appraisal dimensions in the latent Novelty factor for Valence and Interest separately

Table B.12: Follow-up linear mixed model for valence predicted by individual appraisal dimensions in the latent Novelty factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	2.694	0.255	147.068	10.559	0.000
Predictability	-0.016	0.025	1272.982	-0.644	0.519
Expectation	0.125	0.027	1229.802	4.543	0.000
Familiarity	0.283	0.026	1015.971	10.988	0.000
GenderMale	-0.111	0.093	64.912	-1.186	0.240
Age	-0.010	0.004	63.167	-2.500	0.015
GenreElect.	0.225	0.254	52.637	0.886	0.380
GenreJazz	0.811	0.254	52.752	3.193	0.002
GenrePop	0.712	0.254	52.685	2.801	0.007
GenreWorld	0.691	0.254	52.713	2.718	0.009

Table B.13: Follow-up linear mixed model for interest predicted by individual appraisal dimensions in the latent Novelty factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	3.984	0.284	136.234	14.046	0.000
Predictability	-0.253	0.027	1304.218	-9.252	0.000
Expectation	0.064	0.031	1309.793	2.081	0.038
Familiarity	0.398	0.029	1245.207	13.666	0.000
GenderMale	-0.157	0.143	62.907	-1.098	0.276
Age	-0.024	0.006	62.106	-3.987	0.000
GenreElect.	0.210	0.184	52.645	1.138	0.260
GenreJazz	0.417	0.184	52.903	2.260	0.028
GenrePop	0.582	0.184	52.757	3.160	0.003
GenreWorld	0.645	0.184	52.804	3.496	0.001

B.0.8.3 Follow-up linear mixed models for individual appraisal dimensions in the latent Goal-relevance factor for Valence, Interest, and Arousal separately

Table B.14: Follow-up linear mixed model for valence predicted by individual appraisal dimensions in the latent Goal-relevance factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	2.472	0.275	130.280	8.987	0.000
Complexity	0.098	0.028	1221.653	3.490	0.000
Expressivity	0.292	0.029	1204.642	10.223	0.000
GenderMale	-0.021	0.090	63.716	-0.231	0.818
Age	-0.007	0.004	63.652	-1.902	0.062
GenreElect.	0.177	0.297	54.529	0.596	0.554
GenreJazz	0.677	0.297	54.981	2.276	0.027
GenrePop	0.571	0.297	54.556	1.923	0.060
GenreWorld	0.435	0.297	54.638	1.465	0.149

Table B.15: Follow-up linear mixed model for interest predicted by individual appraisal dimensions in the latent Goal-relevance factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	1.581	0.221	169.808	7.157	0.000
Complexity	0.279	0.027	1293.809	10.270	0.000
Expressivity	0.471	0.028	1282.212	17.087	0.000
GenderMale	-0.105	0.102	62.889	-1.037	0.304
Age	-0.019	0.004	63.107	-4.372	0.000
GenreElect.	0.111	0.160	54.612	0.697	0.489
GenreJazz	0.073	0.161	56.012	0.455	0.651
GenrePop	0.324	0.160	54.683	2.028	0.047
GenreWorld	0.250	0.160	54.936	1.563	0.124

Table B.16: Follow-up linear mixed model for arousal predicted by individual appraisal dimensions in the latent Goal-relevance factor

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	2.225	0.399	95.062	5.582	0.000
Complexity	0.172	0.029	1254.453	5.961	0.000
Expressivity	0.086	0.029	1248.296	2.909	0.004
GenderMale	-0.267	0.109	64.129	-2.446	0.017
Age	-0.003	0.005	64.070	-0.542	0.590
GenreElect.	1.459	0.484	54.928	3.013	0.004
GenreJazz	1.379	0.485	55.118	2.844	0.006
GenrePop	1.824	0.484	54.941	3.766	0.000
GenreWorld	1.381	0.484	54.977	2.851	0.006

Appendix C

Study 2: Additional Material

C.0.1 A: Full individual linear mixed models for arousal, valence, and intensity ratings of tracks in different functional contexts - the impact of goal-relevance

C.0.1.1 A1: Arousal

Table C.1: Linear mixed model for arousal ratings of tracks in different functional contexts

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	-2.124	0.486	424.816	-4.368	0.000
FunctionEnergy For The Day	6.864	0.541	2437.401	12.680	0.000
FunctionEnhance Mood	5.544	0.377	2442.636	14.720	0.000
FunctionForget The World	3.804	0.572	2433.265	6.651	0.000
FunctionHelps Me Relax	3.250	0.228	2430.030	14.242	0.000
FunctionTakes My Mind Off Things	3.404	0.317	2426.011	10.752	0.000
FunctionTalk About With My Friends	3.516	0.422	2441.271	8.336	0.000
CongruenceBimodal 2	-0.096	0.221	2425.060	-0.437	0.662
CongruenceConductive	-0.329	0.274	2414.737	-1.202	0.229
CongruenceUnconductive	3.372	0.365	2441.068	9.228	0.000
Liking	0.238	0.042	2441.777	5.608	0.000
GP_Mellow	-0.077	0.057	100.211	-1.355	0.178
GP_Unpretentious	-0.047	0.049	101.257	-0.959	0.340
GP_Sophisticated	0.181	0.059	103.424	3.041	0.003
GP_Intense	-0.037	0.038	101.686	-0.964	0.337
GP_Contemporary	0.078	0.052	100.842	1.504	0.136
Age	0.019	0.004	100.450	4.809	0.000
GenderMale	0.051	0.105	100.092	0.491	0.624
GenderTrans female	1.144	0.498	100.439	2.296	0.024
GenderTrans male	-0.342	0.355	99.969	-0.962	0.338
TracknameIntense 1:FunctionComfort Me When Im Sad	5.559	0.406	2445.403	13.691	0.000
TracknameMellow 3:FunctionComfort Me When Im Sad	4.138	0.495	2423.730	8.358	0.000
TracknameSophisticated 4:FunctionComfort Me When Im Sad	3.465	0.263	2422.456	13.173	0.000
TracknameIntense 1:FunctionEnergy For The Day	-4.578	0.568	2426.116	-8.065	0.000
TracknameUrban 1:FunctionEnergy For The Day	-1.840	0.384	2412.844	-4.794	0.000
TracknameUrban 2:FunctionEnergy For The Day	-1.335	0.435	2415.659	-3.070	0.002
TracknameMellow 2:FunctionEnhance Mood	-2.011	0.376	2417.602	-5.344	0.000
TracknameSophisticated 1:FunctionEnhance Mood	-2.300	0.264	2421.583	-8.701	0.000
TracknameSophisticated 5:FunctionEnhance Mood	-5.521	0.377	2442.632	-14.658	0.000
TracknameSophisticated 5:FunctionForget The World	-3.876	0.572	2433.284	-6.778	0.000
TracknameUrban 1:FunctionForget The World	1.323	0.528	2416.487	2.505	0.012
TracknameSophisticated 1:FunctionHelps Me Relax	-0.118	0.301	2416.340	-0.394	0.694
TracknameMellow 3:FunctionTakes My Mind Off Things	0.737	0.383	2410.558	1.923	0.055

Table C.1: Linear mixed model for arousal ratings of tracks in different functional contexts (*continued*)

	Estimate	Std. Error	df	t-value	p-value
TracknameIntense 1:Liking	0.027	0.054	2418.003	0.492	0.623
TracknameMellow 2:Liking	0.064	0.058	2420.005	1.092	0.275
TracknameMellow 3:Liking	0.005	0.061	2429.833	0.088	0.930
TracknameSophisticated 1:Liking	-0.023	0.054	2438.030	-0.430	0.667
TracknameSophisticated 4:Liking	-0.080	0.062	2434.706	-1.294	0.196
TracknameSophisticated 5:Liking	0.095	0.050	2441.968	1.894	0.058
TracknameUrban 1:Liking	0.030	0.059	2424.098	0.517	0.605
TracknameUrban 2:Liking	0.014	0.056	2432.283	0.252	0.801
TracknameUrban 4:Liking	-0.076	0.056	2426.197	-1.362	0.173

C.0.1.2 A2: Valence

Table C.2: Linear mixed model for valence ratings of tracks in different functional contexts

	Estimate	Std. Error	df	*t*-value	\textit{p}
(Intercept)	1.605	0.400	540.967	4.016	0.000
FunctionEnergy For The Day	0.184	0.471	2448.723	0.391	0.696
FunctionEnhance Mood	-0.717	0.328	2454.539	-2.190	0.029
FunctionForget The World	0.172	0.498	2443.988	0.346	0.729
FunctionHelps Me Relax	-0.222	0.199	2440.185	-1.116	0.264
FunctionTakes My Mind Off Things	-0.473	0.276	2435.304	-1.715	0.086
FunctionTalk About With My Friends	-0.066	0.367	2453.110	-0.180	0.857
CongruenceBimodal 2	0.413	0.192	2434.322	2.149	0.032
CongruenceConductive	-0.356	0.238	2421.776	-1.491	0.136
CongruenceUnconductive	-0.334	0.318	2452.921	-1.050	0.294
Liking	0.588	0.037	2453.779	15.933	0.000
GP_Mellow	-0.031	0.044	99.942	-0.715	0.476
GP_Unpretentious	0.004	0.038	101.289	0.099	0.922
GP_Sophisticated	-0.032	0.046	104.041	-0.708	0.480
GP_Intense	-0.025	0.029	101.842	-0.854	0.395
GP_Contemporary	0.044	0.040	100.754	1.114	0.268
Age	0.009	0.003	100.248	3.092	0.003
GenderMale	0.170	0.080	99.787	2.124	0.036
GenderTrans female	1.241	0.380	100.234	3.262	0.002
GenderTrans male	0.002	0.271	99.629	0.007	0.994
TracknameIntense 1:FunctionComfort Me When Im Sad	-0.756	0.353	2457.631	-2.139	0.032
TracknameMellow 3:FunctionComfort Me When Im Sad	0.306	0.431	2432.663	0.709	0.478
TracknameSophisticated 4:FunctionComfort Me When Im Sad	-0.759	0.229	2431.052	-3.313	0.001
TracknameIntense 1:FunctionEnergy For The Day	-0.173	0.494	2435.555	-0.351	0.726
TracknameUrban 1:FunctionEnergy For The Day	-0.628	0.334	2419.426	-1.879	0.060
TracknameUrban 2:FunctionEnergy For The Day	-0.798	0.379	2422.889	-2.108	0.035
TracknameMellow 2:FunctionEnhance Mood	0.730	0.328	2425.258	2.229	0.026
TracknameSophisticated 1:FunctionEnhance Mood	0.177	0.230	2429.959	0.770	0.441
TracknameSophisticated 5:FunctionEnhance Mood	1.079	0.328	2454.534	3.293	0.001
TracknameSophisticated 5:FunctionForget The World	0.084	0.498	2444.009	0.168	0.867
TracknameUrban 1:FunctionForget The World	-1.051	0.460	2423.939	-2.285	0.022
TracknameSophisticated 1:FunctionHelps Me Relax	-0.047	0.262	2423.669	-0.178	0.858
TracknameMellow 3:FunctionTakes My Mind Off Things	1.070	0.334	2416.559	3.205	0.001
TracknameIntense 1:Liking	0.105	0.047	2425.809	2.223	0.026
TracknameMellow 2:Liking	0.010	0.051	2428.316	0.203	0.839
TracknameMellow 3:Liking	0.020	0.053	2440.069	0.376	0.707
TracknameSophisticated 1:Liking	0.018	0.047	2449.567	0.380	0.704
TracknameSophisticated 4:Liking	-0.029	0.054	2445.751	-0.534	0.594
TracknameSophisticated 5:Liking	0.048	0.044	2454.112	1.109	0.267

Table C.2: Linear mixed model for valence ratings of tracks in different functional contexts (*continued*)

	Estimate	Std. Error	df	*t*-value	\textit{p}
TracknameUrban 1:Liking	0.124	0.051	2433.223	2.432	0.015
TracknameUrban 2:Liking	0.085	0.049	2442.961	1.740	0.082
TracknameUrban 4:Liking	0.154	0.049	2435.804	3.164	0.002

C.0.1.3 A3: Intensity

Table C.3: Linear mixed model for intensity ratings of tracks in different functional contexts

	Estimate	Std. Error	df	*t*-value	\textit{p}
(Intercept)	-0.452	0.589	307.269	-0.767	0.444
FunctionEnergy For The Day	2.020	0.596	2423.649	3.389	0.001
FunctionEnhance Mood	2.377	0.415	2427.849	5.731	0.000
FunctionForget The World	0.721	0.629	2420.417	1.145	0.252
FunctionHelps Me Relax	1.433	0.251	2417.950	5.705	0.000
FunctionTakes My Mind Off Things	1.244	0.348	2414.980	3.570	0.000
FunctionTalk About With My Friends	0.780	0.464	2426.691	1.680	0.093
CongruenceBimodal 2	-0.360	0.243	2414.163	-1.483	0.138
CongruenceConducive	0.286	0.301	2406.511	0.949	0.343
CongruenceUnconducive	0.866	0.402	2426.502	2.152	0.032
Liking	0.538	0.047	2427.019	11.505	0.000
GP_Mellow	-0.023	0.076	99.735	-0.306	0.760
GP_Unpretentious	0.072	0.065	100.458	1.103	0.273
GP_Sophisticated	-0.042	0.079	101.977	-0.534	0.594
GP_Intense	0.008	0.050	100.754	0.169	0.866
GP_Contemporary	0.144	0.069	100.171	2.094	0.039
Age	0.014	0.005	99.901	2.740	0.007
GenderMale	0.055	0.139	99.653	0.399	0.691
GenderTrans female	1.049	0.660	99.893	1.589	0.115
GenderTrans male	-0.179	0.471	99.568	-0.380	0.705
TracknameIntense 1:FunctionComfort Me When Im Sad	1.732	0.447	2430.043	3.873	0.000
TracknameMellow 3:FunctionComfort Me When Im Sad	0.034	0.545	2413.206	0.062	0.951
TracknameSophisticated 4:FunctionComfort Me When Im Sad	1.685	0.289	2412.303	5.823	0.000
TracknameIntense 1:FunctionEnergy For The Day	-1.347	0.625	2414.978	-2.157	0.031
TracknameUrban 1:FunctionEnergy For The Day	-0.456	0.422	2405.135	-1.079	0.280
TracknameUrban 2:FunctionEnergy For The Day	0.288	0.478	2407.200	0.602	0.547
TracknameMellow 2:FunctionEnhance Mood	-1.481	0.414	2408.636	-3.579	0.000
TracknameSophisticated 1:FunctionEnhance Mood	-1.271	0.291	2411.676	-4.369	0.000
TracknameSophisticated 5:FunctionEnhance Mood	-2.502	0.415	2427.846	-6.033	0.000
TracknameSophisticated 5:FunctionForget The World	-0.684	0.629	2420.431	-1.087	0.277
TracknameUrban 1:FunctionForget The World	1.236	0.581	2407.787	2.127	0.033
TracknameSophisticated 1:FunctionHelps Me Relax	-0.357	0.331	2407.735	-1.080	0.280
TracknameMellow 3:FunctionTakes My Mind Off Things	-1.343	0.422	2403.491	-3.184	0.001
TracknameIntense 1:Liking	-0.066	0.060	2408.896	-1.102	0.270
TracknameMellow 2:Liking	-0.020	0.064	2410.334	-0.310	0.756
TracknameMellow 3:Liking	0.089	0.067	2417.723	1.325	0.185
TracknameSophisticated 1:Liking	-0.026	0.059	2424.052	-0.431	0.666
TracknameSophisticated 4:Liking	-0.069	0.068	2421.466	-1.014	0.310
TracknameSophisticated 5:Liking	-0.035	0.055	2427.081	-0.632	0.527

Table C.3: Linear mixed model for intensity ratings of tracks in different functional contexts (*continued*)

	Estimate	Std. Error	df	*t*-value	\textit{p}
TracknameUrban 1:Liking	-0.155	0.064	2413.406	-2.406	0.016
TracknameUrban 2:Liking	-0.170	0.062	2419.583	-2.736	0.006
TracknameUrban 4:Liking	-0.166	0.061	2414.940	-2.694	0.007

C.0.2 B: Estimated marginal means for planned comparison of valence pairwise function by track

Table C.4: Estimated marginal means for ratings of valence pairwise by function for different tracks

contrast	Trackname	estimate	SE	df	t.ratio	p.value
Comfort Me When Im Sad - Energy For The Day	Campestral 3	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Campestral 3	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Campestral 3	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Campestral 3	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Campestral 3	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Campestral 3	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Campestral 3	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Campestral 3	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Campestral 3	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Campestral 3	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Campestral 3	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Campestral 3	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Campestral 3	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Campestral 3	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Campestral 3	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Campestral 3	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Campestral 3	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Campestral 3	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Campestral 3	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Campestral 3	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Campestral 3	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Intense 1	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Intense 1	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Intense 1	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Intense 1	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Intense 1	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Intense 1	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Intense 1	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Intense 1	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Intense 1	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Intense 1	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Intense 1	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Intense 1	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Intense 1	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Intense 1	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Intense 1	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Intense 1	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Intense 1	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Intense 1	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Intense 1	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Intense 1	0.0470242	0.1089143	2426.004	0.4317542	0.9995082

Table C.4: Estimated marginal means for ratings of valence pairwise by function for different tracks (*continued*)

contrast	Trackname	estimate	SE	df	t.ratio	p.value
Takes My Mind Off Things - Talk About With My Friends	Intense 1	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Mellow 2	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Mellow 2	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Mellow 2	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Mellow 2	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Mellow 2	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Mellow 2	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Mellow 2	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Mellow 2	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Mellow 2	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Mellow 2	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Mellow 2	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Mellow 2	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Mellow 2	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Mellow 2	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Mellow 2	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Mellow 2	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Mellow 2	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Mellow 2	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Mellow 2	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Mellow 2	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Mellow 2	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Mellow 3	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Mellow 3	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Mellow 3	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Mellow 3	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Mellow 3	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Mellow 3	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Mellow 3	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Mellow 3	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Mellow 3	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Mellow 3	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Mellow 3	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Mellow 3	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Mellow 3	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Mellow 3	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Mellow 3	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Mellow 3	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Mellow 3	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Mellow 3	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Mellow 3	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Mellow 3	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Mellow 3	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Sophisticated 1	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Sophisticated 1	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628

Table C.4: Estimated marginal means for ratings of valence pairwise by function for different tracks (*continued*)

contrast	Trackname	estimate	SE	df	t.ratio	p.value
Comfort Me When Im Sad - Forget The World	Sophisticated 1	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Sophisticated 1	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Sophisticated 1	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Sophisticated 1	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Sophisticated 1	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Sophisticated 1	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Sophisticated 1	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Sophisticated 1	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Sophisticated 1	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Sophisticated 1	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Sophisticated 1	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Sophisticated 1	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Sophisticated 1	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Sophisticated 1	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Sophisticated 1	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Sophisticated 1	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Sophisticated 1	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Sophisticated 1	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Sophisticated 1	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Sophisticated 4	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Sophisticated 4	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Sophisticated 4	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Sophisticated 4	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Sophisticated 4	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Sophisticated 4	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Sophisticated 4	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Sophisticated 4	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Sophisticated 4	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Sophisticated 4	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Sophisticated 4	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Sophisticated 4	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Sophisticated 4	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Sophisticated 4	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Sophisticated 4	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Sophisticated 4	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Sophisticated 4	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Sophisticated 4	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Sophisticated 4	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Sophisticated 4	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Sophisticated 4	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Sophisticated 5	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Sophisticated 5	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Sophisticated 5	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Sophisticated 5	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Sophisticated 5	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381

Table C.4: Estimated marginal means for ratings of valence pairwise by function for different tracks (*continued*)

contrast	Trackname	estimate	SE	df	t.ratio	p.value
Comfort Me When Im Sad - Talk About With My Friends	Sophisticated 5	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Sophisticated 5	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Sophisticated 5	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Sophisticated 5	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Sophisticated 5	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Sophisticated 5	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Sophisticated 5	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Sophisticated 5	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Sophisticated 5	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Sophisticated 5	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Sophisticated 5	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Sophisticated 5	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Sophisticated 5	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Sophisticated 5	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Sophisticated 5	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Sophisticated 5	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Urban 1	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Urban 1	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Urban 1	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Urban 1	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Urban 1	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Urban 1	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Urban 1	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Urban 1	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Urban 1	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Urban 1	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Urban 1	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Urban 1	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Urban 1	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Urban 1	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Urban 1	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Urban 1	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Urban 1	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Urban 1	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Urban 1	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Urban 1	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Urban 1	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Urban 2	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Urban 2	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Urban 2	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Urban 2	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Urban 2	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Urban 2	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Urban 2	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Urban 2	0.2051207	0.0769173	2426.158	2.6667683	0.1072317

Table C.4: Estimated marginal means for ratings of valence pairwise by function for different tracks (*continued*)

contrast	Trackname	estimate	SE	df	t.ratio	p.value
Energy For The Day - Helps Me Relax	Urban 2	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Urban 2	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Urban 2	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Urban 2	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Urban 2	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Urban 2	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Urban 2	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Urban 2	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Urban 2	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Urban 2	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Urban 2	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Urban 2	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Urban 2	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963
Comfort Me When Im Sad - Energy For The Day	Urban 4	-0.5198081	0.0715457	2426.832	-7.2653969	0.0000000
Comfort Me When Im Sad - Enhance Mood	Urban 4	-0.3371454	0.0720833	2426.103	-4.6771641	0.0000628
Comfort Me When Im Sad - Forget The World	Urban 4	-0.3146874	0.0805759	2426.192	-3.9054804	0.0018651
Comfort Me When Im Sad - Helps Me Relax	Urban 4	-0.3945810	0.0729536	2426.124	-5.4086563	0.0000015
Comfort Me When Im Sad - Takes My Mind Off Things	Urban 4	-0.2852925	0.0678446	2426.116	-4.2050876	0.0005381
Comfort Me When Im Sad - Talk About With My Friends	Urban 4	-0.3475568	0.1035073	2426.051	-3.3578011	0.0140238
Energy For The Day - Enhance Mood	Urban 4	0.1826627	0.0711097	2426.360	2.5687471	0.1360915
Energy For The Day - Forget The World	Urban 4	0.2051207	0.0769173	2426.158	2.6667683	0.1072317
Energy For The Day - Helps Me Relax	Urban 4	0.1252272	0.0753985	2426.284	1.6608707	0.6423744
Energy For The Day - Takes My Mind Off Things	Urban 4	0.2345156	0.0809219	2426.279	2.8980497	0.0580721
Energy For The Day - Talk About With My Friends	Urban 4	0.1722514	0.1017778	2426.179	1.6924262	0.6212315
Enhance Mood - Forget The World	Urban 4	0.0224580	0.0753660	2426.030	0.2979856	0.9999434
Enhance Mood - Helps Me Relax	Urban 4	-0.0574356	0.0768974	2426.005	-0.7469122	0.9895623
Enhance Mood - Takes My Mind Off Things	Urban 4	0.0518529	0.0710666	2426.004	0.7296374	0.9907848
Enhance Mood - Talk About With My Friends	Urban 4	-0.0104113	0.0878095	2426.004	-0.1185675	0.9999998
Forget The World - Helps Me Relax	Urban 4	-0.0798936	0.0898348	2426.015	-0.8893391	0.9742284
Forget The World - Takes My Mind Off Things	Urban 4	0.0293949	0.0831877	2426.025	0.3533563	0.9998463
Forget The World - Talk About With My Friends	Urban 4	-0.0328693	0.0878124	2426.024	-0.3743131	0.9997849
Helps Me Relax - Takes My Mind Off Things	Urban 4	0.1092884	0.0786308	2426.005	1.3898939	0.8074531
Helps Me Relax - Talk About With My Friends	Urban 4	0.0470242	0.1089143	2426.004	0.4317542	0.9995082
Takes My Mind Off Things - Talk About With My Friends	Urban 4	-0.0622642	0.1041912	2426.004	-0.5975957	0.9968963

C.0.3 C: Full individual linear mixed models for arousal, valence, and intensity ratings comparing experimenter-selected tracks rated as congruent and non-congruent.

C.0.3.1 C1: Arousal

Table C.5: Linear mixed model of arousal ratings comparing tracks rated as congruent and non-congruent including individual track as a fixed predictor

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	1.643	0.417	275.260	3.938	0.000
CongruenceUnconductive	0.079	0.127	1411.366	0.623	0.533
TracknameCampestral 5	1.939	0.370	1433.541	5.237	0.000
TracknameIntense 1	1.681	0.380	1427.968	4.422	0.000
TracknameIntense 2	3.167	0.340	1444.584	9.323	0.000
TracknameMellow 2	-0.366	0.323	1440.406	-1.134	0.257
TracknameMellow 3	0.191	0.343	1450.623	0.558	0.577
TracknameSophisticated 5	-0.419	0.345	1448.110	-1.217	0.224
TracknameUrban 3	1.542	0.365	1439.103	4.223	0.000
TracknameUrban 4	2.939	0.333	1443.689	8.827	0.000
Liking	0.200	0.057	1458.149	3.483	0.001
GP_Mellow	-0.067	0.055	100.346	-1.212	0.228
GP_Unpretentious	-0.011	0.048	103.461	-0.236	0.814
GP_Sophisticated	0.164	0.058	105.183	2.848	0.005
GP_Intense	-0.048	0.037	103.232	-1.293	0.199
GP_Contemporary	0.069	0.050	100.496	1.372	0.173
Age	0.017	0.004	100.408	4.518	0.000
GenderMale	-0.042	0.101	100.086	-0.412	0.681
GenderTrans female	1.349	0.480	100.394	2.813	0.006
GenderTrans male	-0.579	0.342	99.822	-1.694	0.093
CongruenceConductive:FunctionEnhance Mood	0.019	0.125	1408.196	0.148	0.882
CongruenceUnconductive:FunctionEnhance Mood	0.024	0.125	1408.172	0.189	0.850
CongruenceUnconductive:FunctionForget The World	-0.073	0.125	1408.174	-0.580	0.562
CongruenceConductive:FunctionTakes My Mind Off Things	0.005	0.125	1408.673	0.044	0.965
TracknameCampestral 5:Liking	0.028	0.077	1440.288	0.365	0.715
TracknameIntense 1:Liking	0.120	0.074	1432.754	1.633	0.103
TracknameIntense 2:Liking	-0.119	0.074	1448.212	-1.610	0.108
TracknameMellow 2:Liking	0.075	0.069	1446.360	1.080	0.281
TracknameMellow 3:Liking	0.035	0.072	1457.182	0.493	0.622
TracknameSophisticated 5:Liking	0.148	0.065	1463.443	2.270	0.023
TracknameUrban 3:Liking	0.052	0.076	1447.467	0.692	0.489
TracknameUrban 4:Liking	-0.050	0.067	1449.000	-0.745	0.456

C.0.3.2 C2: Valence

Table C.6: LMM comparing valence ratings for congruent and non-congruent tracks

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	1.481	0.297	206.601	4.989	0.000
CongruenceUnconductive	-0.249	0.227	1458.390	-1.095	0.274
Liking	0.613	0.051	1471.932	11.941	0.000
GP_Mellow	-0.010	0.042	99.950	-0.241	0.810
GP_Unpretentious	0.026	0.037	104.073	0.725	0.470
GP_Sophisticated	-0.054	0.044	106.342	-1.213	0.228
GP_Intense	-0.015	0.028	103.815	-0.531	0.596
GP_Contemporary	0.037	0.038	100.144	0.975	0.332
Age	0.009	0.003	100.022	3.308	0.001
GenderMale	0.107	0.077	99.591	1.387	0.168
GenderTrans female	0.804	0.368	100.007	2.188	0.031
GenderTrans male	-0.073	0.262	99.240	-0.280	0.780
CongruenceConductive:FunctionEnergy For The Day	-0.065	0.249	1478.433	-0.261	0.794
CongruenceUnconductive:FunctionEnergy For The Day	0.054	0.255	1461.033	0.213	0.832
CongruenceConductive:FunctionEnhance Mood	-0.236	0.238	1461.117	-0.994	0.320
CongruenceUnconductive:FunctionEnhance Mood	0.361	0.112	1407.715	3.213	0.001
CongruenceConductive:FunctionForget The World	-0.243	0.307	1463.172	-0.790	0.429
CongruenceUnconductive:FunctionForget The World	0.256	0.112	1407.718	2.275	0.023
CongruenceConductive:FunctionHelps Me Relax	-0.436	0.255	1472.917	-1.713	0.087
CongruenceUnconductive:FunctionHelps Me Relax	-0.208	0.211	1485.247	-0.988	0.324
CongruenceConductive:FunctionTakes My Mind Off Things	0.292	0.113	1408.387	2.588	0.010
CongruenceUnconductive:FunctionTakes My Mind Off Things	-0.274	0.231	1467.507	-1.187	0.236
CongruenceConductive:FunctionTalk About With My Friends	-0.316	0.237	1461.065	-1.334	0.182
CongruenceUnconductive:FunctionTalk About With My Friends	0.338	0.240	1469.861	1.408	0.159
Liking:TracknameCampestral 5	0.056	0.069	1450.598	0.807	0.420
Liking:TracknameIntense 1	0.064	0.066	1440.768	0.965	0.335
Liking:TracknameIntense 2	0.061	0.066	1460.409	0.920	0.358
Liking:TracknameMellow 2	-0.029	0.062	1458.203	-0.463	0.643
Liking:TracknameMellow 3	-0.004	0.064	1471.087	-0.055	0.956
Liking:TracknameSophisticated 5	0.017	0.058	1478.235	0.286	0.775
Liking:TracknameUrban 3	0.084	0.068	1459.486	1.238	0.216
Liking:TracknameUrban 4	0.118	0.060	1461.467	1.954	0.051

C.0.3.3 C3: Intensity

Table C.7: LMM comparing intensity ratings for congruent and non-congruent tracks

	Estimate	Std. Error	df	t-value	p-value
(Intercept)	-0.160	0.538	142.801	-0.298	0.766
CongruenceUnconductive	0.560	0.296	1431.360	1.891	0.059
Liking	0.516	0.067	1439.231	7.681	0.000
GP_Mellow	0.051	0.085	100.078	0.608	0.545
GP_Unpretentious	0.077	0.073	101.945	1.055	0.294
GP_Sophisticated	-0.024	0.088	102.981	-0.274	0.785
GP_Intense	-0.022	0.056	101.784	-0.390	0.697
GP_Contemporary	0.092	0.077	100.170	1.196	0.235
Age	0.013	0.006	100.121	2.278	0.025
GenderMale	0.061	0.155	99.930	0.392	0.696
GenderTrans female	0.955	0.737	100.110	1.296	0.198
GenderTrans male	-0.362	0.526	99.771	-0.689	0.492
CongruenceConductive:FunctionEnergy For The Day	1.981	0.326	1443.010	6.076	0.000
CongruenceUnconductive:FunctionEnergy For The Day	0.391	0.333	1433.278	1.177	0.240
CongruenceConductive:FunctionEnhance Mood	0.880	0.310	1432.926	2.834	0.005
CongruenceUnconductive:FunctionEnhance Mood	-0.125	0.146	1407.977	-0.859	0.390
CongruenceConductive:FunctionForget The World	0.837	0.402	1434.056	2.085	0.037
CongruenceUnconductive:FunctionForget The World	0.036	0.146	1407.978	0.250	0.803
CongruenceConductive:FunctionHelps Me Relax	2.597	0.333	1439.767	7.794	0.000
CongruenceUnconductive:FunctionHelps Me Relax	1.422	0.276	1447.606	5.142	0.000
CongruenceConductive:FunctionTakes My Mind Off Things	-0.135	0.146	1408.277	-0.921	0.357
CongruenceUnconductive:FunctionTakes My Mind Off Things	0.984	0.302	1436.683	3.252	0.001
CongruenceConductive:FunctionTalk About With My Friends	0.765	0.309	1432.901	2.473	0.014
CongruenceUnconductive:FunctionTalk About With My Friends	0.848	0.314	1437.976	2.699	0.007
Liking:TracknameCampestral 5	-0.101	0.090	1427.243	-1.127	0.260
Liking:TracknameIntense 1	0.027	0.086	1422.628	0.316	0.752
Liking:TracknameIntense 2	-0.288	0.086	1432.372	-3.337	0.001
Liking:TracknameMellow 2	0.011	0.081	1431.122	0.132	0.895
Liking:TracknameMellow 3	0.123	0.084	1438.376	1.464	0.144
Liking:TracknameSophisticated 5	-0.005	0.076	1442.711	-0.064	0.949
Liking:TracknameUrban 3	-0.126	0.088	1431.891	-1.421	0.155
Liking:TracknameUrban 4	-0.132	0.079	1432.825	-1.673	0.094

C.0.4 D: Pairwise comparisons of exact means for arousal, valence, and intensity with self-selected music as a reference group against experimenter-selected tracks.

C.0.4.1 D1: Arousal

Table C.8: Pairwise comparisons of exact means for ratings of arousal between experimenter-selected and self-selected tracks with self-selected music as a reference group

Function	group1	group2	statistic	df	p.adj	p.adj.signif
Comfort Me When Im Sad	Self-selected	Intense 1	-6.207	193.132	0.000	****
Comfort Me When Im Sad	Self-selected	Mellow 3	4.993	214.053	0.000	****
Comfort Me When Im Sad	Self-selected	Sophisticated 4	9.309	214.507	0.000	****
Comfort Me When Im Sad	Self-selected	Sophisticated 5	4.729	219.948	0.000	****
Energy For The Day	Self-selected	Intense 1	4.615	196.811	0.000	****
Energy For The Day	Self-selected	Urban 1	10.212	192.314	0.000	****
Energy For The Day	Self-selected	Urban 2	7.996	199.207	0.000	****
Energy For The Day	Self-selected	Urban 4	1.136	216.856	0.257	ns
Enhance Mood	Self-selected	Mellow 2	18.724	205.540	0.000	****
Enhance Mood	Self-selected	Sophisticated 1	19.174	198.465	0.000	****
Enhance Mood	Self-selected	Sophisticated 5	13.713	190.656	0.000	****
Enhance Mood	Self-selected	Urban 2	4.540	219.933	0.000	****
Forget The World	Self-selected	Campestral 3	8.926	218.894	0.000	****
Forget The World	Self-selected	Sophisticated 2	11.261	218.632	0.000	****
Forget The World	Self-selected	Sophisticated 5	7.812	219.695	0.000	****
Forget The World	Self-selected	Urban 1	0.343	194.658	0.732	ns
Helps Me Relax	Self-selected	Intense 2	-13.233	168.099	0.000	****
Helps Me Relax	Self-selected	Sophisticated 1	4.829	215.337	0.000	****
Helps Me Relax	Self-selected	Sophisticated 4	5.775	209.808	0.000	****
Helps Me Relax	Self-selected	Urban 4	-14.300	158.783	0.000	****
Takes My Mind Off Things	Self-selected	Mellow 3	7.359	210.823	0.000	****
Takes My Mind Off Things	Self-selected	Sophisticated 1	10.144	214.336	0.000	****
Takes My Mind Off Things	Self-selected	Sophisticated 5	7.577	219.088	0.000	****
Takes My Mind Off Things	Self-selected	Urban 3	0.279	199.737	0.780	ns
Talk About With My Friends	Self-selected	Campestral 3	13.373	207.110	0.000	****
Talk About With My Friends	Self-selected	Campestral 5	1.372	219.898	0.171	ns
Talk About With My Friends	Self-selected	Mellow 2	15.957	211.798	0.000	****
Talk About With My Friends	Self-selected	Mellow 4	6.268	217.856	0.000	****

C.0.4.2 D2: Valence

Table C.9: Pairwise comparisons of exact means for ratings of valence between experimenter-selected and self-selected tracks with self-selected music as a reference group

Function	group1	group2	statistic	df	p.adj	p.adj.signif
Comfort Me When Im Sad	Self-selected	Intense 1	5.208	219.424	0	****
Comfort Me When Im Sad	Self-selected	Mellow 3	4.187	210.210	0	****
Comfort Me When Im Sad	Self-selected	Sophisticated 4	5.980	217.403	0	****
Comfort Me When Im Sad	Self-selected	Sophisticated 5	4.229	219.347	0	****
Energy For The Day	Self-selected	Intense 1	9.877	164.327	0	****
Energy For The Day	Self-selected	Urban 1	12.042	173.088	0	****
Energy For The Day	Self-selected	Urban 2	11.712	170.097	0	****
Energy For The Day	Self-selected	Urban 4	7.521	165.852	0	****
Enhance Mood	Self-selected	Mellow 2	19.874	171.779	0	****
Enhance Mood	Self-selected	Sophisticated 1	16.971	155.756	0	****
Enhance Mood	Self-selected	Sophisticated 5	12.723	167.911	0	****
Enhance Mood	Self-selected	Urban 2	13.777	156.818	0	****
Forget The World	Self-selected	Campestral 3	7.691	212.431	0	****
Forget The World	Self-selected	Sophisticated 2	6.955	213.334	0	****
Forget The World	Self-selected	Sophisticated 5	6.690	210.774	0	****
Forget The World	Self-selected	Urban 1	7.877	213.085	0	****
Helps Me Relax	Self-selected	Intense 2	9.339	190.465	0	****
Helps Me Relax	Self-selected	Sophisticated 1	8.944	213.832	0	****
Helps Me Relax	Self-selected	Sophisticated 4	5.688	214.040	0	****
Helps Me Relax	Self-selected	Urban 4	7.336	183.939	0	****
Takes My Mind Off Things	Self-selected	Mellow 3	7.445	220.000	0	****
Takes My Mind Off Things	Self-selected	Sophisticated 1	11.539	209.181	0	****
Takes My Mind Off Things	Self-selected	Sophisticated 5	8.050	208.307	0	****
Takes My Mind Off Things	Self-selected	Urban 3	11.427	201.494	0	****
Talk About With My Friends	Self-selected	Campestral 3	10.105	205.160	0	****
Talk About With My Friends	Self-selected	Campestral 5	10.085	191.875	0	****
Talk About With My Friends	Self-selected	Mellow 2	15.759	201.891	0	****
Talk About With My Friends	Self-selected	Mellow 4	13.544	215.326	0	****

C.0.4.3 D3: Intensity

Table C.10: Pairwise comparisons of exact means for ratings of intensity between experimenter-selected and self-selected tracks with self-selected music as a reference group

Function	group1	group2	statistic	df	p.adj	p.adj.signif
Comfort Me When Im Sad	Self-selected	Intense 1	8.575	192.869	0	****
Comfort Me When Im Sad	Self-selected	Mellow 3	13.381	196.740	0	****
Comfort Me When Im Sad	Self-selected	Sophisticated 4	11.485	206.420	0	****
Comfort Me When Im Sad	Self-selected	Sophisticated 5	12.503	193.739	0	****
Energy For The Day	Self-selected	Intense 1	8.905	179.942	0	****
Energy For The Day	Self-selected	Urban 1	11.952	186.157	0	****
Energy For The Day	Self-selected	Urban 2	10.902	194.849	0	****
Energy For The Day	Self-selected	Urban 4	7.036	178.834	0	****
Enhance Mood	Self-selected	Mellow 2	13.281	186.963	0	****
Enhance Mood	Self-selected	Sophisticated 1	12.133	179.891	0	****
Enhance Mood	Self-selected	Sophisticated 5	13.312	176.139	0	****
Enhance Mood	Self-selected	Urban 2	10.263	182.551	0	****
Forget The World	Self-selected	Campestral 3	10.217	192.187	0	****
Forget The World	Self-selected	Sophisticated 2	11.227	192.048	0	****
Forget The World	Self-selected	Sophisticated 5	12.328	187.997	0	****
Forget The World	Self-selected	Urban 1	11.953	192.792	0	****
Helps Me Relax	Self-selected	Intense 2	7.040	195.409	0	****
Helps Me Relax	Self-selected	Sophisticated 1	10.218	206.636	0	****
Helps Me Relax	Self-selected	Sophisticated 4	10.296	210.273	0	****
Helps Me Relax	Self-selected	Urban 4	7.105	196.317	0	****
Takes My Mind Off Things	Self-selected	Mellow 3	11.206	199.825	0	****
Takes My Mind Off Things	Self-selected	Sophisticated 1	9.098	207.264	0	****
Takes My Mind Off Things	Self-selected	Sophisticated 5	10.643	199.197	0	****
Takes My Mind Off Things	Self-selected	Urban 3	9.152	195.516	0	****
Talk About With My Friends	Self-selected	Campestral 3	11.028	197.962	0	****
Talk About With My Friends	Self-selected	Campestral 5	11.346	196.582	0	****
Talk About With My Friends	Self-selected	Mellow 2	13.424	203.259	0	****
Talk About With My Friends	Self-selected	Mellow 4	11.841	206.710	0	****

C.0.5 E: Selected musical stimuli for the validation study

Table C.11: Selected musical stimuli from Rentfrow et al., 2011 for experiment 1

Dimension	Coding	Dataset	Artist	Piece	Genre	link	Component.loading	Time.marker	X
Mellow	M1	Rentfrow et al., 2011	Skylark	Wildflower	R&B / Soul	https://www.youtube.com/watch?v=9MJ8fVWLI1	0.68	0:09 - 0:24	
Mellow	M2	Rentfrow et al., 2012	Karla Bonoff	Just Walk away	Soft Rock	https://www.youtube.com/watch?v=JF7fW4-NRnU	0.65	1:43 or 2:40	
Mellow	M3	Rentfrow et al., 2013	Earl Klugh	Laughter in the Rain	Quite Storm	https://www.youtube.com/watch?v=WJHKzaAMWU	0.58	0:33 - 0:48	
Mellow	M4	Rentfrow et al., 2014	Taryn Murphy	Love Along the Way	Soft Rock	https://www.youtube.com/watch?v=dUR6F7AXDak	0.55	2:04 - 2:19	
Mellow	M5	Rentfrow et al., 2015	Bruce Smith	Children of Spring	Adult contemporary	https://www.youtube.com/watch?v=REyLp1uvwWY	0.50	0:45 - 1:00	
Sophisticated	S1	Rentfrow et al., 2016	Philip Glass	Symphony No. 3	Avant-garde classical	https://www.youtube.com/watch?v=5WsBCF_u-nU	0.83	2:08 - 2:23	
Sophisticated	S2	Rentfrow et al., 2017	Louise Farrenc	Piano Quintet No. 1 in A Minor	Classical	https://www.youtube.com/watch?v=8ntPqtclpAw	0.79	9:29 - 9:44	
Sophisticated	S3		Horse Guards Parade	God Save the Queen	Marching Band	https://www.youtube.com/watch?v=NQL0sBQHGzc	NA	0:33 - 0:48	Replaced American marching band for English relevance
Sophisticated	S4	Rentfrow et al., 2019	William Boyce	Symphony No.1 in B Flat Major	Classical	https://www.youtube.com/watch?v=kgMqMct1G64	0.78	3:13 - 3:28	
Sophisticated	S5	Rentfrow et al., 2020	Oscar Peterson	The Way You Look Tonight	Traditional jazz	https://www.youtube.com/watch?v=ks0V1B1Xq_E	0.74	1:02 - 1:17	
Urban	U1	Rentfrow et al., 2021	D-Nice	My Name is D-Nice / Call Me D-Nice	Rap	https://www.youtube.com/watch?v=bbWnRyPzce4	0.76	1:08 - 1:23	
Urban	U2	Rentfrow et al., 2022	Ludacris	Intro	Rap	https://www.youtube.com/watch?v=2HjIFeT5c	0.72	0:18 - 0:33	
Urban	U3		Knucks	Hide & Seek	UK Rap	https://www.youtube.com/watch?v=AZ688CN2uG8	NA	2:15 - 2:30	Replaced US for UK rap relevance
Urban	U4		Digital Base Project (Stonebringers Remix 2019)	Sunshine	Euro Dance	https://www.youtube.com/watch?v=VGJT2HLOOOo	NA	1:56 - 2:11	Replace with contemporary euro dance / house / club
Urban	U5		Biecp	Glue	Electronica	https://www.youtube.com/watch?v=A7ZxRs45tTg	NA	2:10 - 2:26	Replaced with contemporary UK electronica
Intense	I1	Rentfrow et al., 2026	Squint	Michigan	Punk	https://www.youtube.com/watch?v=brXgnouangg	0.83	1:03 - 1:18	
Intense	I2	Rentfrow et al., 2027	The Tomatoes	Johnny Fly	Classic Rock	https://www.youtube.com/watch?v=uAPvwQf8dVY	0.80	0:53 - 1:08	
Intense	I3		GAYLE	abcdefu	Pop rock	https://www.youtube.com/watch?v=NaFd8uchLuo	0.77	1:09 - 1:24	Added for comtempoary (over classic) pop rock
Intense	I4	Rentfrow et al., 2029	Social Distortion	Cold Feelings	Punk	https://www.youtube.com/watch?v=NMfblPsv2yIU	0.78	2:15 - 2:30	
Intense	I5	Rentfrow et al., 2030	Five Finger Death Punch	White Knuckles	Heavy Metal	https://www.youtube.com/watch?v=Oluizn_zhYg	0.77	2:25 - 2:40	
Compestral	C1	Rentfrow et al., 2031	The O'Kanes	Oh Darlin'	Country rock	https://www.youtube.com/watch?v=TR9AG_R6eO0	0.80	0:10 - 0:25	
Compestral	C2		Amarula Café Club	Low	Indie / Afro-Pop	https://www.youtube.com/watch?v=NdpYn9pSNkU	NA	2:03 - 2:18	Added for UK equivalent to country (indie)
Compestral	C3		Plasi	Vienna	Indie	https://www.youtube.com/watch?v=6Ua4srXC9IM	NA	1:55 - 2:10	Added for UK equivalent to modern country (indie)
Compestral	C4		The Longest Johns	Hard Times Come Again No More	UK Folk	https://www.youtube.com/watch?v=WHjxQOLgN3U	NA	4:15 - 4:30	Added for UK equivalent to bluegrass (folk)
Compestral	C5		Bellowhead	Roll the Woodpile Down	UK Ska / Folk	https://www.youtube.com/watch?v=5Fddr0CTf8Q	NA	0:40 - 0:55	Added for UK equivalent to bluegrass (folk)

Table C.12: Selected musical functions from Schäfer et al., 2013 for experiment 1

Factor	Function	Mean	SD	Factor.Loading
arousal/mood regulation	Because it can enhance my mood.	5.04	1.15	0.539
arousal/mood regulation	Because it can take my mind off things.	4.52	1.45	0.627
arousal/mood regulation	Because it is a great pastime.	3.97	1.68	0.640
arousal/mood regulation	Because I'm less bored then.	3.99	1.75	0.584
arousal/mood regulation	Because it helps me relax	4.84	1.18	0.520
self-awareness	Because it mirrors my feelings and moods.	4.92	1.31	0.610
self-awareness	Because it can make me dream.	4.49	1.50	0.562
self-awareness	Because it lets me forget the world around me.	4.48	1.57	0.551
self-awareness	Because it gives me the energy I need for the day.	4.44	1.47	0.531
self-awareness	Because it gives comfort to me when I'm sad.	4.10	1.73	0.645
social relatedness	Because it is something I can talk about with my friends.	2.04	1.65	0.567
social relatedness	Because it makes me feel connected to my friends.	2.02	1.73	0.671
social relatedness	Because I can learn something about other people.	2.49	1.76	0.629
social relatedness	Because it helps me develop social values.	2.44	1.80	0.622
social relatedness	Because it helps me develop my personal values.	2.34	1.79	0.581

Table C.13: Selected congruent, non-congruent, and bimodal musical tracks for each selected functions

Function	Conducive	Unconducive	Bimodal.1	Bimodal.2
Enhance Mood	M2	S5	S1	U2
Helps Me Relax	I2	U4	S1	S4
Take My Mind Off Things	M3	U3	S1	S5
Comfort When I'm Sad	M3	S5	I1	S4
Energy For The Day	U4	I1	U1	U2
Forget The World	C3	S5	S2	U1
Talk About With Friends	M2	C5	C3	M4

^a Note: S = Sophisticated, U = Urban, I = Intense, M = Mellow, C = Campestral

Appendix D

Aesthetic emotions in music: Theory, measurements, and cross-cultural comparison

D.1 Aesthetic emotions in music

Timmers, R., and Bannister, S., and Lennie, M. T., (in press). Aesthetic emotions in music—theory, measurements, and cross-cultural comparison. In Bogunovic, B., Timmers, R., and Nikolic, S. (Eds.), *Aesthetic emotions in music*. OUP.

Abstract

D.1.1 Introduction

An important reason for listening to music relates to the emotions expressed and elicited by it (Schäfer et al., 2013), with some listeners describing strong emotional responses to music that are memorable (Gabrielsson, 2011). Music and emotion research has often focused on how emotions are perceived in music (Balkwill & Thompson, 1999) and what psychological mechanisms underlie emotions elicited

by music (Juslin, 2016; Juslin et al., 2015). Much of this research has focused on a small set of basic emotions (Ekman, 1999), linked to adaptive functions, action readiness, and goal orientation, and on Western participants and listening contexts (Jacoby et al., 2020). In this chapter, we step back and reflect on emotion perception and induction processes with the central assumption that emotions in musical contexts are instances of aesthetic emotions (linked to aesthetic appeal and evaluation), and consider how such aesthetic emotions may operate in various cultures. To do so, we discuss concepts, measurements, processes, and cross-cultural comparisons centralising the aesthetic affordances relevant to music-related emotions. This discussion takes us from aesthetic evaluation being relevant to aesthetic emotions and a level of disconnect from everyday consequences, to considerations of value and affordances of music to listeners, including functional uses, which we argue facilitate translation of the notion of aesthetic emotions in music to diverse cultures.

D.1.1.1 Aesthetic vs. everyday emotions

It has been proposed that musical emotions, and emotions in aesthetic engagements broadly, may have distinct features and should be separated from ‘everyday’, basic adaptive emotions (Menninghaus et al., 2019; Zentner et al., 2008). For example, common musical engagements like listening have no clear goal-relevance (Scherer & Zentner, 2001). Furthermore, most common emotions in everyday life may not be the same as emotions commonly perceived in the context of music (Zentner et al., 2008). Indeed, emotional responses to music may differ, for example, in terms of physiological activity (Krumhansl, 1997). Kant (1790/2001) described the idea of aesthetic emotions as being ‘disinterested’; such emotional responses have no utilitarian or survival purpose. Recent formulations of aesthetic experiences have developed this idea. For example, Konečni (2005) noted that whilst awe, a prototypical aesthetic response to the sublime, can be elicited in the face of physical grandeur, including elements of threat, an essential requisite for the experience is the guarantee of existential security. Frijda and Sundarara-

jan (2007) differentiate between ‘coarse’ and ‘refined’ emotions, the latter being more detached from real-world concerns, involving more self-reflection and little associated action. Whilst the distinction between aesthetic and utilitarian emotions is intuitive, it is hard to objectively separate them. Despite the consistency in listings of prototypical aesthetic emotions, including awe, enjoyment, interest, and nostalgia, these emotions may occur in non-aesthetic circumstances (Keltner & Haidt, 2003; Silvia, 2008). Juslin (2016) highlighted that there was no clear evidence for emotions specific to music or aesthetic contexts broadly. In a complementary view, Koelsch (2010) proposed that musical emotions are ‘true’ emotions, as they reflect brain region activity linked to emotional responses with action tendencies and goal-orientation.

Given these issues, a contemporary view is that aesthetic judgments and aesthetic modes of engagement are key elements of aesthetic emotions. Brattico and Pearce (2013) propose that, in a music listening context, causal inattentive listening may result in everyday basic emotions, whereas focused listening with an aesthetic attitude can induce aesthetic emotions. Juslin (2016) suggests that instead of considering ‘coarse’ and ‘refined’ emotions (Frijda & Sundararajan, 2007) as distinct sets of emotions, we should consider the ‘refined’ category as a special mode of experiencing ordinary emotions, i.e., as an aesthetic mode of listening. In Juslin’s BRECVEMA framework of music and emotion (2013), aesthetic judgment is included as one of the mechanisms of emotion induction; this accompanies other mechanisms derived from general adaptive functions, such as brain stem reflex, rhythmic entrainment, and musical expectancy. As it is possible that aesthetic judgments may precede aesthetic emotion responses, and vice versa (Huron, 2016), the causal directionality remains undetermined (Egermann & Reuben, 2020). In recent theoretical work, Menninghaus et al. (2019) emphasised the importance of aesthetic evaluation in the definitional scope of aesthetic emotion; for instance, being moved may be an everyday emotion, an art-elicited emotion (elicited by an art object), and an aesthetic emotion (elicited by aesthetic qualities of the art object, involving aesthetic evaluation). Thus, not all emotions elicited by art are

aesthetic (Wassiliwizky & Menninghaus, 2021), and those that are should involve an evaluation of and response to aesthetic qualities of the stimulus. The question remains as to what these aesthetic qualities are and how they may give rise to emotional responses. To investigate, we need the right instruments in place.

D.1.2 Aesthetic emotions: Measurement scales and physiology

D.1.2.1 Self-report instruments: Labelling the emotional response

Self-report is one of the most common methods of measuring emotions, which requires an appropriate list of emotion terms. Systematic characterisations of the emotions frequently associated with music have been conducted by various researchers, as early as Hevner's list of adjectives (1936) (for an overview, see Timmers & Loui, 2019). Of specific interest are those studies that have investigated emotional responses in ecologically valid listening situations. For example, the Geneva Emotional Music Scale (GEMS; Zentner et al., 2008) has been validated with audiences attending music festivals and concerts. Nevertheless, this scale was later adapted to better capture responses to a range of musical genres. The updated Geneva Music-Induced Affect Checklist (GEMIAC) contains fourteen clusters of feeling terms ranging from being moved or touched, feeling joyful and wanting to dance, being filled with wonder and amazement, to feeling indifferent and bored or tense and uneasy (Coutinho & Scherer, 2017).

A broader examination of aesthetic emotions has been conducted by Schindler et al. (2017), who attempted to capture aesthetic emotions in various contexts. They collated emotion terms used in research describing responses to music, literature, theatre, film, and visual art, and combined these with common aesthetic emotions described in theoretical and philosophical research. Terms were clustered into five factors: prototypical aesthetic emotions, pleasing emotions, epistemic emotions, negative emotions, and self-forgetful emotions. Following confirmatory and exploratory factor analyses of results, the Aesthetics Emotion Scale (AES-

THEMOS) was proposed, comprised of twenty-one subscales including beauty, fascination, awe, being moved, nostalgia, humour, vitality, joy, interest, intellectual challenge, ugliness, boredom, and sadness, amongst others. It will be of interest to examine further adjustments of these scales if the cultural contexts of examination are expanded.

These self-report tools provide opportunities for exploring emotional experiences found during engagements with music as well as in other aesthetic contexts. Nevertheless, it remains unclear as to how these self-report measures are positioned relative to contemporary conceptualisations of aesthetic emotions (e.g., Menninghaus et al., 2019). Having a specialised list does not tell us whether an emotion is aesthetic in nature, as most, if not all of these emotions might occur in non-aesthetic circumstances; a key step in understanding the association between these tools within an aesthetic emotion context will be to evaluate appraisal patterns within questionnaire tools that may link emotion categories with aesthetic judgments. For example, Juslin et al. (2015) asked participants to evaluate the mechanism that they deemed responsible for their emotional responses in addition to the responses themselves. A further avenue for exploration of mechanisms is to consider the physiological manifestations accompanying aesthetic emotions in addition to self-report.

D.1.2.2 Physiological measurements: Chills and tears

Physiological measurements can be used to corroborate emotional responses and to offer insight into moment-to-moment developments (Benedek & Kaernbach, 2011). Such measurements aim to capture bodily experiences including chills, shivers, tension, excitement, or tearfulness.

Aesthetic chills have been described as emotional experiences accompanied by goosebumps, shivers, or tingling sensations (Bannister, 2020). Chills have been associated with increased skin conductance, heart rate, and pupil dilation (Laeng et al., 2016; Rickard, 2004; Sumpf et al., 2015); additionally, chills have been

linked to brain activity associated with reward and pleasure (Ferreri et al., 2019; Salimpoor et al., 2011). Theoretically and empirically, chills reflect prototypical qualities of aesthetic emotions; they are pleasurable and rewarding, involve increases in arousal, and can often be linked to aesthetic features of the music (Bannister & Eerola, 2018; Grewe et al., 2007; Panksepp, 1995). Additionally, chills are associated with common aesthetic emotion concepts such as awe and being moved (Benedek & Kaernbach, 2011; Konečni, 2005; Schurtz et al., 2012), feelings of beauty (Gabrielsson, 2011), and nostalgia (Bannister, 2020).

Further physical reactions indicative of strong emotional experiences are crying or tears in response to music (Gabrielsson, 2011). Crying is a multifaceted phenomenon with several subtypes (Vingerhoets, 2013), and whilst adaptive accounts describe the function of tears in terms of signals to elicit social support during times of distress (Gračanin et al., 2018), crying also seems prevalent across aesthetic engagements (Eerola & Peltola, 2016; Pelowski, 2015) where these functions are less apparent. Cotter et al. (2018) explored experiences of crying and feeling like crying in relation to music, finding that these mostly occurred with familiar music, music that held special meaning for the listener, and when participants were listening alone; furthermore, whilst crying to music was sometimes linked to awe and being touched, inspired, and amazed, most accounts were linked to sadness and more distressing experiences, and to memories of events (Cotter et al., 2019).

Hanser et al. (2021) found in a large survey of over 2,000 participants that tears were most commonly reported in the context of being moved (65%), sadness (53%), and nostalgia (28%), followed by powerlessness (24%). Nearly 50% of crying-to-music episodes also involved goosebumps, suggesting that chills and tears may be related experiences in aesthetic contexts (though see Mori & Iwanaga, 2017).

Several methodological challenges remain when recording tears and chills, including measurement using physiological and muscle tension signals. But, together with self-reports of aesthetic emotions, these phenomena can be used to further

investigate the musical and contextual characteristics in which aesthetic emotions occur, with the aim of linking them to emotion induction processes. These phenomena may afford investigations of aesthetic emotions as they happen, exploring concurrent physiological activity patterns and brain activity via neuroimaging approaches, reflecting a burgeoning area of work labelled ‘neuroaesthetics’ (for a review of methods that includes neuroimaging, see Timmers & Loui, 2019).

D.1.3 Relationships to musical material, context, and person

In ecological terms, it is not just a matter of who listens to what in what context, but of their interactions: emotional meaning arises through listeners interacting with music in particular contexts for particular purposes (Lennie & Eerola, 2022). This means that context and person need to be considered in combination with relationships with musical properties.

D.1.3.1 Musical and acoustical properties

An important basis for defining links between emotions and music seems to be associations between emotions and acoustical characteristics of vocal expression (Juslin & Laukka, 2003), as well as emotional movement characteristics (for a review, see Timmers & Loui, 2019). Such relationship patterns may be adjusted to a degree by the particular genre-context to indicate relative rather than absolute intensity, activity, and positivity (Eerola, 2011). Emotional contagion has been suggested as a mechanism to mediate between perceived and felt emotions (Juslin, 2016).

A relevant dimension in the discussion of aesthetic emotions has been the dimension of tension-relaxation. Tension has been associated with harmonic progressions (e.g., away from and return to the tonic), intensity patterns, pitch height, and consonance and dissonance (Arthurs et al., 2018; Farbood, 2012). As musical properties often reinforce each other, it may be a collection of features that sig-

nify patterns of tension-relaxation. Whilst primarily modelled in the context of the Western classical and romantic repertoire (Lerdahl & Krumhansl, 2007), Solberg and Dibben (2019) investigated a contemporary example and its embodied emotional effect, specifically the break routine in electronic dance music where the release of tension is associated with heightened pleasure and physiological responses, including chills.

D.1.3.2 Dynamic change, deviation, and probability

In line with the examples of tension-relaxation, several authors have argued that it is the dynamic nature of music that creates its emotional effects. Rather than purely static music-acoustical qualities, emotional response is informed by variation across and within pieces (e.g., Coutinho & Cangelosi, 2011; Warmbrodt et al., 2022). A key strand of research in this context is the attempt to model the information dynamics of music, specifically variations in predictability and uncertainty, which has been modelled using information entropy. Entropy is high if uncertainty is high and multiple possibilities are equally likely, while entropy and amount of information reduce with greater predictability (Pearce, 2018). As Huron (2006) famously explained, such predictability concerns the what (e.g., what pitch) and when in time of musical events. Indeed, both tonal and temporal structure generate predictability for upcoming events. Musical expectancy has been indicated as one of the mechanisms for felt emotion (Juslin, 2016). However, there is debate around the relevance of it as an emotion induction mechanism. Tension-relaxation may give rise to micro-affects (Huron, 2006) that are nevertheless important for an engaging and absorbing experience.

The link to strong aesthetic emotional response may be found at the intersection between two forms of prediction: Cheung et al. (2019) found that music is experienced as most rewarding or pleasurable when high predictability (a highly expected event) occurs in an uncertain context or, conversely, when low likelihood (an unexpected, surprising event) is combined with high predictability. The break routine (Solberg & Dibben, 2019) seems an effective example of the first

combination: the return of the original groove is highly predictable, but the timing is uncertain and delayed. The classical *appoggiatura* in a recursive harmonic sequence can be seen as an illustration of the second combination: a dissonant non-chord tone with low probability occurs in a highly predictable manner and context. This is used, for example, in Barber's *Adagio for Strings*, which is experienced as strongly sad-inducing (Krumhansl, 1997); it is also liked by many as is evident from its occurrence in top-charts of classical music. Such interactions between predictability and surprise extend notions of 'deviation as expressive'. Deviation in performance may be particularly valued if operating in a close to predictable manner (Todd, 1995), and are influenced by familiarity (Timmers, 2007). They also offer an interesting perspective on the well-known inverted-U curve between complexity and preference: it is not just about the appreciation of a balanced level of complexity (Berlyne, 1970), but specific affective tensions that afford affective responses: seeing something familiar in new ways or predicting the unexpected.

A special case of combining predictability and innovation may be the widespread tradition of ornamentation, variation, and partial improvisation that is so very common in many music traditions. Some evidence exists for the emotional effect of ornamentation (Timmers & Ashley, 2007), but further work in this area is warranted, including how the balance between predictability, uncertainty, and certainty shifts within and across musical phrases.

D.1.3.3 Musical affordances as aesthetic emotional response

An interactional perspective on relationships between music and aesthetic emotions takes into account what music may afford to listeners in particular contexts: music affords an opportunity to dance, celebrate, and socialise at a party; to mourn and share grief at a funeral; and to aid spiritual reflection or expression at religious gatherings. This aligns with identified emotion mechanisms such as entrainment and emotional contagion, or 'sharing' of emotion (Juslin, 2016). Memory is another identified mechanism. Whilst recall may give rise to felt emotion due to a particular incidental association, this process of association and recall

can also be seen as something that music affords, a positive attribute of music, as applications of music in therapy and dementia care illustrate.

An illustration of the complex relationship between music and aesthetic emotional responses is the appreciation of negative music and, indeed, the pleasurable experience of tears. Some people report that they enjoy listening to sad music (Garrido & Schubert, 2011), and a subgroup of listeners enjoys what could be characterised as ‘violent music’ (Olsen et al., 2020). Capturing some of this variety, Peltola and Eerola (2016) subdivided experiences of sad music into three subcategories labelled ‘grief’, ‘melancholia’, and ‘sweet sorrow’. Pertinently, the last category of sweet sorrow was characterised by a positive experience of sad music, and included references to beauty and feeling moved; experiences of grief were sometimes also identified as cathartic. Olsen et al. (2020) also identify balancing positive and negative emotions as important to the liking of music with violent lyrics.

In their review, Eerola et al. (2018) used the distinction between hedonic and eudaemonic pleasure to account for positive experiences of sadness in musical contexts. Interpreting self-reported experiences, they infer ‘the pleasure of being moved [in relation to sad music] is far from being purely hedonistic; it is strongly intertwined with interpersonal aspects’ (p. 108). Furthermore, they state that ‘musical expression gives special meaning to the emotional states it portrays; it is not just pointless sadness, but there is some reason or meaning to it’ (p. 189). It is not a matter of not feeling the emotion. In contrast, interpersonal empathy and enjoyment of sad music seem to be linked, suggesting heightened experiences of the emotion in these listeners. Variations in trait empathy do not seem relevant to the enjoyment of violent music. Instead, the motivations for listening to violent music may differ from motivations for listening to other types of music, which is accompanied by differences in appraisal of what violent music offers, including experiences of power, joy, and peace (Thompson et al., 2019).

Empirical findings indicate that music is appreciated for its values in relation to listeners. Indeed, the effect of music and whether listeners use music to influence

their emotions is correlated with the relevance of music for listeners (Granot et al., 2021). This correlation may clearly operate in either direction if valued more, the influence is stronger, and vice versa. Such sensitivity to music varies strongly, ranging from little to no emotional response to peak experiences with music. What are experienced as aesthetic characteristics of music may depend on the values and meanings awarded to music in particular contexts, and the identification with those values and meanings in connection with the music. As many researchers have previously identified, aesthetic appreciation is historically and culturally situated.

D.1.4 Cross-cultural translations

D.1.4.1 Musical features, discrete emotions, and physiological responses

Cross-cultural music studies are sparse and concentrate almost exclusively on emotion perception using basic emotions or evaluations of emotional dimensions. To our knowledge, no explicit study of felt aesthetic musical emotions cross-culturally has been conducted, although evidence suggests that broad discrete emotion categories can be inferred across cultures (Balkwill et al., 2004; Balkwill & Thompson, 1999; Egermann et al., 2015; Fritz et al., 2009;). However, the degree of accuracy and number of emotion categories varies. There is also a clear in-group advantage to perceiving the correct emotion in one's own musical culture (Laukka et al., 2013). Limitations are noted in the design of some studies. Nelson and Russell (2013) cite the 'forced-choice paradigm' and 'unbalanced' methodological designs, while Matsumoto and van de Vijver (2010) acknowledge problems of conceptual 'equivalence' and 'construct bias'.

Laukka et al. (2013) showed that basic emotion terms were better perceived than more complex (aesthetic) terms. Acoustic cues correlated with the intended emotional expression of excerpts. Of twenty-six features, four acoustic cues ('spectral novelty', 'rhythmic novelty', 'tonal novelty', and 'novelty in pitch register') correlated with nearly all emotion terms. The only other cues that showed such

consistency for listeners across cultures and emotion terms were ‘spectral flux’ and ‘attack time’, providing tentative evidence for the importance of musical novelty cross-culturally.

Musical familiarity also plays a key role cross-culturally. The Mafa (Pygmy population) showed a greater dislike for tonally dissonant manipulations of their own music than for Western music (Fritz et al., 2009), highlighting familiarity as an important mediator of cues. One of the few cross-cultural studies using emotion dimensions and physiological measures (Egermann et al., 2015) studied affective response to Western music and the native music of the Congolese Mbenzele Pygmy population. Six low-level acoustic cues were correlated with subjective ratings of arousal, valence, and physiological measures for Western music in both populations. The study suggests that the greater number of acoustic cues in Western music leads to greater cross-cultural recognition and similar physiological responses, while the stronger use made of symbolic or associative meaning in Mbenzele Pygmy music requires a stronger reliance on enculturation.

A lack of focus on aesthetic emotional responses, combined with methodological limitations, leaves significant gaps in the research literature. Evidence converges on the conclusion that there are both universal and culture-specific cues (Balkwill & Thompson, 1999), many shared with an evolutionary history of vocal emotion communication (Juslin & Laukka, 2003), that allow listeners from different cultures to reliably perceive emotions at above chance levels, but below the universality threshold (Haidt & Keltner, 1999, p. 229). However, a singular focus upon stimulus-driven components can lead to reductive explanations, and future research must better acknowledge context (Jacoby et al., 2020).

D.1.4.2 Framing aesthetic emotions: Cross-cultural functions and affordances of music

Music’s functions have been well documented in the Western context: for example, meaning enhancement (Hays & Minichiello, 2005), supporting behaviours

(DeNora, 2000; Greasley & Lamont, 2011), and mood management (Juslin et al., 2008). Cross-culturally, anthropologist Alan Merriam (1964) documented ten musical functions, including ‘aesthetic enjoyment’. One key distinction Merriam offers is the differentiation between musical ‘functions’ (its broader purpose) and ‘use’ (in a specific situation; p. 210). Clayton (2016) notes the importance of this distinction, as a list of ‘uses’ would lead to a countless number of categories (e.g., lullabies, courtship, sports, trance, etc.). Since Merriam, a greater focus upon the underlying dimensions of these functions has emerged (Schäfer et al., 2013). Differences in functions have been linked with cultural distinctions in musical experiences including emotional differences (Saarikallio et al., 2020), emotion mechanisms and motivation (Juslin et al., 2016), behaviours (Mehr et al., 2019; Saarikallio, 2008), preferences (Schäfer et al., 2012; 2013), and musical form (Mehr et al., 2019).

Saarikallio et al. (2020) compared music-evoked emotions and functions between Finland and India. The emotion factor ‘peacefulness-transcendence’, that captured several aesthetic terms, appeared more prominently in the Indian sample, suggesting a greater prevalence of aesthetic emotions in Indian listeners, and supporting findings in other aesthetic contexts (Sundararajan, 2010). The musical function ‘aesthetic enjoyment’, understood as a focus upon musical qualities, emerged as a single function with no subcategories. Whilst other music functions showed significant cultural differences, ‘aesthetic enjoyment’ showed similar moderate emergence and links to typical musical genres in both cultures.

Links between musical preferences and musical functions were investigated by Schäfer et al. (2012) in a comparison of German and Indian listeners. Musical functions were shown to correlate with preferences in both cultures. The function of ‘diversion’ was most closely linked with aesthetic satisfaction (p. 378), and appeared in both cultures as the second strongest predictor of musical preferences. Nevertheless, ‘diversion’ was operationalised differently in these two cultures. German participants placed a greater focus on dancing than on appraising

the music's qualities, which was most relevant for Indian participants. The findings of Saarikallio (2020) findings note the importance of dancing as a diversion for Kenyan teenagers. These differences relate to variations in 'uses' whilst serving a similar function. Apart from preferences for music that enables 'diversion', aesthetic enjoyment has been associated with reflective experiences, grouped under the factor of 'self-awareness' by Schäfer et al. (2013), including items with an inward focus (solace, escapism, absorption).

Juslin et al. (2016) compared emotional experiences of music across individualist and collectivist cultures. The 'aesthetic judgment' mechanism was found to be more prevalent in collectivist cultures although the effect size was small ($d = .18$). The strongest effects related to preferences in collectivist cultures for low arousal states (nostalgia-longing, spirituality-transcendence, love-tenderness) and socially orientated emotions. All functions appeared across cultures, although several functions showed significant differences in their prevalence. Individual and collectivist cultures also differed in listening motivations. The collectivist cultures included in the study placed greater importance on the motivations to 'relax', 'reflect', 'appreciate beauty', and 'enhance health'. Despite cross-cultural differences, to 'appreciate beauty' and 'interest in music' (important aesthetic items) appeared in the top three most highly rated motives for music listening cross-culturally. This contrasts with findings by Mehr et al. (2019), who analysed a large ethnographic dataset. They found that vocal music from sixty societies could be collapsed into four types of behaviours (dancing, lullabies, healing, and love songs). Aesthetic experiences were not included in this analysis. Nevertheless, one could argue these functions are aesthetic by nature, as they do not 'heal' in a biomedical sense or literally generate love.

Whilst many musical functions appear cross-culturally relevant, the principle difference is the prevalence and cultural value associated with them. Aesthetic emotional responses are set within a complex and culturally bound process of meaning-making. For example, musical functions that highlight intrapersonal and

contemplative functions may emerge more or less commonly in certain cultures and influence the commonality of an aesthetic mode of listening. Ultimately, the cross-cultural approach allows a better understanding of how music may afford meaningful experiences that have a functional significance, whether by affording a heightened emotional experience or a more reflective and contemplative one.

D.1.5 Conclusion

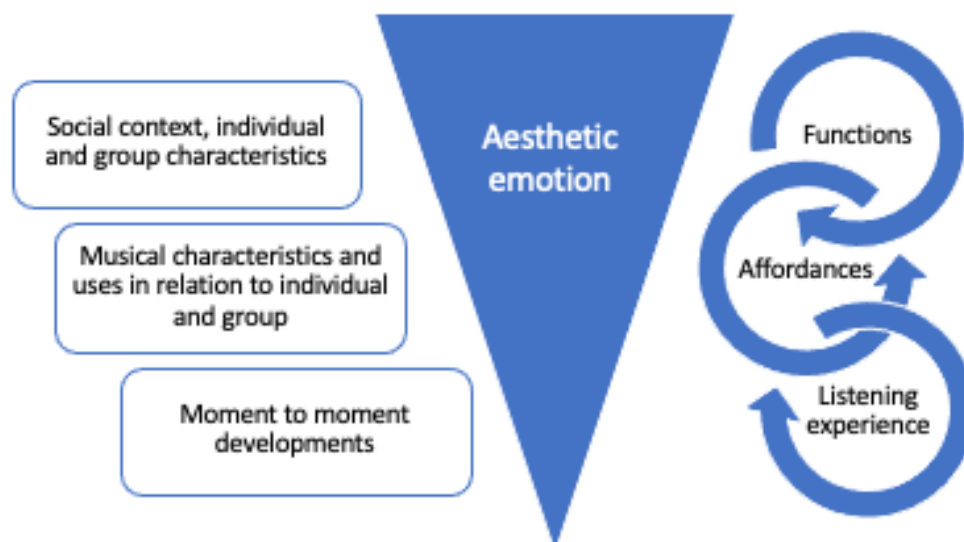


Figure D.1: Interactions between contextual, group, individual, and musical characteristics shaping listening experiences and aesthetic emotion.

The notion that musical emotions result from the interaction between music, person, and context is not new. Yet it is important to revisit this understanding with respect to aesthetic emotions as illustrated in Figure 14.1: what is experienced as an aesthetic affordance and an aesthetic property of music is dependent on the interaction between music, listeners/users, and context. Moreover, we argue that for the cross-genre, cross-cultural, and historical understanding of aesthetic emotions in response to music, it is important to consider what the meaningful encounters with music are for listeners. To find hedonic and eudaemonic pleasure in music is for that music to afford meaningful engagement, which relates to body, mind, and social and material context. This position brings musical functions and

uses into the realm of aesthetic emotions, seemingly blurring the distinction with utilitarian emotions. However, the differences between aesthetic and utilitarian emotions lie in the safety and relative control, as well as the close association with music-aesthetic properties. It is necessary to consider musical functions in order to go beyond the expectation that aesthetic emotions are confined to a sense of beauty, transcendence, or 'high art'.