Blinding the Mind's Eye: Comparing the Effectiveness of Three Suppression Tasks on Music- Induced Visual Mental Imagery and Felt Emotion

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Sarah Hashim

Abstract

Visual mental imagery refers to the spontaneous occurrence of a visual image in the mind's eye, without the influence of an external stimulus. Visual imagery has seen a boost within music research in the last few decades and has become a key component within a framework of mechanisms underlying music-induced emotions. As a result, a number of studies have suggested that visual imagery possesses the ability to enhance felt emotion during music listening, but will inhibiting visual imagery then have a negative effect on felt emotion ratings? The present research aimed to investigate the effects of three types of distractor tasks (visuospatial, visual, and verbal) on visual imagery and felt emotion ratings. Previous research into the clinical effects of visual imagery suppression has found strong evidence that a visuospatial task would perform the best in cognitive interference, whereas a verbal task would perform the worst. Thus, the hypothesis was that a visuospatial eye-movement task would negatively affect visual imagery and felt emotion the most, followed by a dynamic visual noise task, with a verbal articulatory suppression task having minimal interference effects. Thirty-five participants reported their visual imagery and felt emotion ratings in response to eighteen short film music excerpts. Participants also reported on the content of their visual imagery to each musical excerpt. The results show that the verbal task in fact performed best in visual imagery suppression, closely followed by the visuospatial task, with the visual task performing the worst. These findings appear to partly oppose that of several previous studies, and results are discussed in relation to previous research on visual imagery function and content.

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Table of Contents

List of Tables and Illustrations

Statement of Copyright

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Chapter 1: Overview

One of the most appealing incentives for interacting with the physical environment is the emotional connection we can feel towards it. Humans are drawn to objects or activities that can modulate their emotional experience for various reasons, such as poetry (Belfi et al., 2017) or listening to our favourite song (Schulkind et al., 1999). Researchers have been perplexed by music's overwhelming presence in our lives and the sheer importance that we place upon it. The focus of the current project will be on how our visual mental imagery (VMI) evoked by the music we listen to can lead to felt emotional responses and whether this relationship can be manipulated to elicit the opposite effect. Our emotional ties with music are still a heavily investigated topic that is far from concluding. To highlight this, this project will draw on prominent theories of musical and aesthetic emotions, as well as ideas outside of music cognition regarding modality specific interference, to formulate the final experiment

In this chapter, the theories surrounding emotion research are considered. Topics pertaining to our interactions with music and the ways in which we use it will be introduced. These include our day-to-day interactions with music and our psychophysiological responses to music. In the following section, the theoretical framework in which VMI has been proposed will be outlined to provide context and will lead the main argument encompassing this project. Next, emphasis will be placed on VMI and the research surrounding spontaneous thought. Research on VMI will be presented to provide perspective on the current research climate surrounding VMI, and the necessary future developments needed to further our knowledge on the phenomenon. Ultimately, this project will offer preliminary insight into the inner workings of VMI and music-induced emotion, providing a novel methodology in which this understudied mechanism can be approached in future research.

1.1 Introducing Musical Emotions

The importance of sound recognition can be traced back to our ancestors. Music or sound can be regarded to exist in an abstract form, yet the physical properties are often argued to have aided our survival by enabling us to identify and react to patterns in sound (Ekman, 1992). However, it is not usually just the sound itself that provided us with the ability to discern its emotional content, but also its situational context, the subsequent event, and the manner in which they are executed that have assisted in fundamentally differentiating between emotions such as happiness and fear (see Huron, 2001, for review). Generally speaking, emotions are based on action dispositions that are biologically driven, meant to motivate how we encode behaviour (Lang, 1995). Apart from this view, the Theory of Mind propagates the human ability to empathise with others and understand their emotional states (Livingstone & Thompson, 2009), signifying the benefits of emotion that exist across multiple domains, such as through music, dance, art, etc., and refers to a deep connectedness that is meant to promote interpersonal relationships.

Humans are social creatures, and are able to communicate with one another using more ways other than speech. Merker (1999) highlights the significance of how our awareness of tempo and meter allow us to synchronise our interactions by entraining to the other's behavioural cues – an ability unique to humans and beyond the capabilities of non-entraining species, with the exception of some who do so in a non-musical manner. Our engagement with music has aroused several key debates within music cognition research, including the notion that emotions in music can be perceived, expressed and/or induced, which has received numerous support in the last several decades (Gabrielsson, 2002; Juslin & Laukka, 2004; Livingstone, Mühlberger, Brown, & Loch, 2007), as well as whether emotional experiences should be recognised in terms of ‘discrete’ or ‘dimensional’ categories (Eerola & Vuoskoski, 2011; Rubin & Talarico, 2009; Russell, 1980).

This project will focus on the notion that music is capable of inducing emotions within a listener by assessing the extent to which VMI mediates the relationship. The following sections will introduce how attributing and feeling emotions to music can be dichotomised and the empirical research that surrounds it, before finally concentrating on emotion induction and discussing how music might encourage VMI formation.

1.1.1 Research on Perceived and Induced Emotions in Music

Research into music and emotions has produced significant empirical evidence on its psychological, physiological and neuroscientific underpinnings. Whilst, cross-culturally, music is not always just used for the purpose of leisure, it permeates widely for its ability to promote social environments, modulate personal experience, and enrich ritualistic ceremonies. It is often an exciting endeavour for research to understand why and how music might express or induce emotions, and is one that has received a lot of attention and has been the cause of much discussion (Scherer, 2004) . Music can convey emotional contours, but can it then induce a felt emotion within the listener? These types of questions have been explored to various lengths, leading to the formation of opposing camps known as the cognitivists and the emotivists. Where the cognitivist perspective substantiates the idea that music is capable of representing emotion which can be recognised by the listener, the emotivist perspective, in contrast, supports that an affective response can indeed be *felt* towards the music. The former view has been subject to less empirical support, despite some theoretical associations that render musical knowledge to be utterly ineffable (Raffman, 1993), not least because it stands in opposition of the aforementioned principles of universal standpoints of emotional bonding through artistic domains. But despite the existence of such factions, the past couple of decades have produced considerable evidence that music listening can induce affective responses in an individual (Krumhansl, 1997; Lundqvist et al., 2009). For instance, Hunter, Schellenberg, and Schimmack (2008) found that participants were able to report feeling a mix of induced happiness and sadness in response to music containing inconsistent cues of happiness and sadness, essentially confirming that qualitatively opposing emotions can be felt simultaneously.

Research into musical emotions has seen an upsurge in researcher attention around the early-to-mid 20th century (see Juslin & Laukka, 2004, for overview). The aims of such studies include not only examining the extent to which listeners are able to extract emotional information from a piece of music, but also where their perceived emotions of the music are identical to their own felt emotions across samples. Where perception has, to date, been an extensively discussed topic, emotion induction still suffers from a lack of comprehensive reviews (Gabrielsson, 2001). However, investigations into this area have begun to pick up in the last couple of decades (Juslin & Zentner, 2001; Lundqvist et al., 2009).

Research into the perceived and induced emotional responses to music can be attributed to the cognitivist and emotivist camps, respectively, as they represent identical ideals. The relationship between perceived and induced emotion is by no means strictly binary and can more accurately be thought to occur on a spectrum. At one end, perceived emotion, being the extent to which the emotional content of a piece of music is recognised and understood; and at the other end, induced emotion, the moment an emotion becomes felt by the listener in response to a piece of music. Individuals are most often understood to lie at any point on the spectrum at any time, with the possibility of adopting more of a neutral position where an objective stance might be necessary, such as that of a music analyst, for example. Moreover, an emotional response may also manifest itself or be accompanied by physiological markers, such as chills, or modulated skin temperature. Thus, we can classify three main indicators on how research oversees musical emotions: recognised emotional expression, felt emotional response, and physiological response (see Scherer, 1993); which will be approached in greater detail in the following sections.

The reasoning behind why any of type of emotional reaction occurs can be attributed to a number of contributory features. For example, Stratton and Zalanowski (1994) found that the mood of lyrics interacted with the tempo of the melody in the affective impact of a musical piece. Furthermore, acoustical features might be strong influencers of an expressed or induced emotional response, such as timbre, harmony, or the instrumentation. Using isolated musical sounds, Eerola, Ferrer, and Alluri (2012) asked participants to rate perceived affects of instrument sounds uniform in duration, pitch and dynamics, and found that they were able to discern and recognise affectively expressive cues, such as spectral and temporal elements. But emotional appraisal is highly dependent on not only the particular components that make up or accompany the music, but also on other factors influencing the experience, such as mood, environmental influences, etc., both directly and indirectly.

However, these issues may not be associated with the listener. Musical character is usually quite evident; at the will of the composer or even the performer, the emotional meaning is rarely stable and varies between situations. If a listener is able to report that a piece is conveying enjoyment, will they also feel joy, or a different emotion entirely? Gabrielsson (2002) contributes to this discussion with his model that categorises these phenomena as such (pp. 131-138):

1. *Positive Relationship:* when the emotion perceived matches that of the emotion felt
2. *Negative Relationship:* when the emotional reaction is the ‘opposite’ to that of the emotion perceived (p. 134), (e.g. listening to happy music, but feeling sad in response)

3. *No Systematic Relationship:* emotional neutrality, or no correlational emotional responses that vary between listenings
4. *No Relationship:* no tangible link between the perceived and felt experience

Some researchers have endeavoured to test the prevalence of these interactions. Evans and Schubert (2008) asked participants to rate their felt responses to pieces of experimenter- and subject-selected music and were also asked to report what emotions they thought the music was expressing. Aggregated across all types of musical stimuli, their study produced reports of 61%, 22%, 12%, and 5%, for each of Gabrielsson's (2002) categories, respectively, indicating that a positive relationship between expressed and induced emotion is most likely to prevail. This positive relationship is further supported by Kallinen and Ravaja (2006) in a similar paradigm, giving similar partial support to the negative relationship between perceived and felt emotion, as their fearful excerpts had been perceived as negative but had elicited higher levels of positive activation than negative. An identical phenomenon that is receiving increased traction is the paradox of enjoying sad music (Schubert, 1996). The enjoyment of sad music has been found to correlate with certain personality features (Vuoskoski et al., 2012) as well as objective underlying mechanisms of emotion (Juslin, 2013b), such as empathy and being moved (Eerola et al., 2016; Vuoskoski & Eerola, 2012, 2017). Such mechanisms will be discussed at greater length in a later section.

In the case of music acoustical features, some studies demonstrate a link between the performance quality and structure and the identical perception of emotion (Baraldi et al., 2006; Gabrielsson & Lindström, 1995; Juslin, 1997). Gabrielsson and Juslin (1996) carried out two experiments where one features the playing of three different instruments, and in the other, six performances using the same instrument. They found that participants were usually accurate in perceiving the intended emotion, although these were more accurate for ‘basic’ emotions (such as, happy, sad, or angry), than the more ‘complex’ ones (such as solemnity). Attempting to provide a consolidation for the emotion divide, Kim (2013) proposes a framework incorporating the notions of aesthetic empathy and kinaesthetic simulation for the expressive experience of music that goes beyond either of the approaches of the cognitivists and the emotivists.

1.1.2 Physiological Measures of Musical Emotions

As Gabrielsson (2002) indicates, and as can be seen throughout psychological research, verbal reports and self-reports are the most popular choice for data collection because they tend to allow for complete subjective freedom. However, many researchers will covet towards a multi-method approach in order to account for other indicators of emotions, such as heart rate, skin conductance and respiration measurements (Sandstrom & Russo, 2010). Subjective and objective forms of data collection are often used in conjunction, as they render it possible to make well-rounded conclusions, and are becoming utilised more often as research continues (Davis & Thaut, 1989; Krumhansl, 1997; Lundqvist et al., 2009; Miu & Balteş, 2012; Wilson & Aiken, 1977). Krumhansl (1997) obtained cardiac, vascular, electrodermal and respiratory physiological measures, and found significant correlations between the self-report ratings of emotion and physiological data, such as that between happy ratings and increased respiration, for example. Similarly, Nyklíček, Thayer, and Van Doornen (1997) used cardiorespiratory indices to find categorical distinctions between excerpts conveying Happy, Serene, Sad, Agitated and Neutral. Using all cardiorespiratory variables in a discriminant analysis, the categories were successfully differentiated with 62.5% of variance accounted for just between high and low arousal emotions.

On the basis of emotional arousal, many studies have gathered the help of physiological markers in pacifying the debate between perceived and felt emotion. Lundqvist et al. (2009)

found that the emotions perceived and felt by the listener resulted in increased zygomatic facial muscle activity that corresponded to the presented emotion in the music (i.e. happy music led to more zygomatic activity). Sad music, however, did not lead to high corrugator muscle activity, an indicator of negatively valenced facial reaction. Furthermore, Salimpoor, Benovoy, Longo, Cooperstock, and Zatorre (2009) looked into the rewarding aspects of listening to music using electrodermal activity. They found strong evidence showing a correlation between increases in pleasure ratings and increased physiological indicators of emotional arousal, even during the least pleasurable moments of the music, in comparison to excerpts participants considered to be neutral.

Others have found links between the emotions aroused from acoustic characteristics and physiological measures (Gomez & Danuser, 2004; Sloboda, 1991). Gomez and Danuser (2007) compared several musical characteristics, such as mode, rhythm and pitch, against respiratory and skin conductance measures and found physiological responses to vary depending on the structural characteristics of the musical stimuli. They found rhythm to significantly determine physiological responses to music, as faster tempo and accented and staccato rhythms lead to shorter respiratory time and higher skin conductance levels. In a study by Guhn, Hamm, and Zentner (2007), they compared subjective chills ratings with skin conductance response and heart rate and found higher levels of skin conductance when subjective responses were also rated highly. Additionally, the physiological experiences tended to occur throughout slower pieces of music, characterised by alternations between solo and orchestral instruments as well as sudden or gradual changes in volume, and unusual melodic and harmonic progressions.

Nevertheless, certain physiological measures for assessing emotion are not always successful. And, like some methodological issues, caution needs to be taken in choice of techniques. For example, although Guhn et al. (2007) found successful skin conductance activity in response to subjective ratings, they were unable to find group differences in terms of heart rate. Alternatively, studies will sometimes utilise indirect self-report measures to eliminate individual biases as much as they can, but are not always successful. Vuoskoski and Eerola (2015) for example, found indirect measure of facial expression judgements to be an ineffective technique for assessing differences in participants' emotional responses. Still, combining different types of measures can only increase our understanding of how subjective and objective responses can interact effectively, and further research will elucidate more clearly how common certain emotional responses are and how much they can differ between individuals and circumstances.

1.1.3 Situational Antecedents of Musical Emotions

In their overview of past research, Juslin and Laukka (2004) address the issue that past emotion research has often neglected to take into account the everyday circumstances in which people engage with music. They posit that, to disregard the social context of musical engagement is to misunderstand the reasons behind feeling an emotional response to music, which has been put down to the paradigmatic methodology of past research that assumes the need for a particular level of intellect for musical appreciation. Despite this, some have endeavoured to acknowledge the importance of context (Miller & Strongman, 2002; Roe, 1985; Tarrant et al., 2000).

In order to accurately measure how music is used in natural everyday life, some have looked to the use of the Experience Sampling Method (ESM), where participants report their responses to a survey using their own devices in a day to day setting. Juslin, Liljeström, Västfjäll, Barradas, and Silva (2008) gave thirty-two participants palmtops that would emit a sound signal at several random intervals in a day that would prompt questions about their current engagement with music. They found that music was present in about 37% of the sampled episodes, and that in 64% of those episodes, the music had influenced how the participant was feeling. This is in contrast to the survey carried out by Juslin and Laukka (2004) who had found an average of 55% musically-induced emotion during everyday listening; and with North, Hargreaves, and Hargreaves (2004), who found for about 20% of the instances that participants chose to listen to music, it was to help create or accentuate an emotional response.

Whilst it is clear that people spend a considerable portion of their everyday lives engaging with music and that it has a strong link with their emotional response, some have alluded to the personal reasons why people might interact with music. For example, Saarikallio (2011) found that adults tend to use music as a method of emotional self-regulation, such as monitoring attention or mood. The use of music for self-benefit has received a lot of attention in research. Using ESM, Sloboda, O'Neill, and Ivaldi (2001) found that the passive use of music led to more positive feelings in adults, such as improved mood and attention. Skånland (2013) investigated the last decade's increase in the use of MP3s and concluded that participants would mostly use their devices for the purposes of mood maintenance and self-rumination rather than mood improvement, which is in opposition of Juslin and Laukka's (2004) assertion that individuals are drawn towards choosing music that made them feel better. Sloboda et al. (2001) describes how music has embedded itself so deeply into our environment that we often use it for the purpose of self-actualisation. Some researchers have supported this utilisation of music. Using interviews, DeNora (1999) asked fifty-two women to reflect on the music they encounter socially featured in karaoke evenings, music therapy sessions, aerobics classes, and clothing outlets. Respondents often offered details into music's ability to regulate or enforce their current moods, or even as a reference tool used to give past events meaning and temporal structure to be relived. Furthermore, Lamont and Webb (2010) illustrate the importance of considering temporal changes. They found that individuals differed in their short- and long-term use of music, which was heavily attributed to personal experience. Taken together with the studies that have investigated the extent of everyday musical engagement, Lamont and Webb show that music is often changed and recycled to avoid over-saturation and is heavily rooted in their current emotional state as well as the music's situational appropriateness.

1.1.4 Individual Differences in Musical Emotions

Research into the situational antecedents of music and emotion sheds light on a key feature provoking the personal use of music. Several papers have identified specific individual differences that can cause a sample to differ in their responses, such as, personality traits (Cattell & Anderson, 1953; Cattell & Saunders, 1954), and social status (Abrams, 2009; Schwartz & Fouts, 2003; Tekman & Hortaçsu, 2002). Whilst it can be agreed that individuals listen to music for the common goal of masking mundane tasks or during travel, how music is chosen is idiosyncratic and can reveal moderating variables between our personal choice of music and how/when we use them.

Several studies have investigated the demographic, social, and personality traits that may determine musical preference. Litle and Zuckerman (1986), for example, highlight explicit personality traits and found that high thrill seekers are positively correlated to preferring rock and punk music, but negatively correlated to preferring religious music. Moreover, McCown, Keiser, Mulhearn, and Williamson (1997) found differences in terms of gender, where males showed a greater preference for bass enhanced music, psychoticism and extraversion; whereas females seemed to prefer music with more treble and were linked with neuroticism.

More recent studies have found links between people's perceived importance of music, personality traits, and preferred musical genre. In a series of experiments, Rentfrow and Gosling (2003) concluded that individuals who scored highly in Openness to Experience personality factor tended to enjoy intense and rebellious music, perceived themselves as intelligent and were more likely to take risks. Conversely, those linked with Extraversion personality factor were more likely to enjoy upbeat and conventional music, are cheerful and socially outgoing. Furthermore, Rentfrow, Goldberg, and Levitin (2011) sought to factorise a framework that would structurally represent the link between certain personality factors and musical preferences that is independent of genre preference. They identified five latent factors: Mellow, Unpretentious, Contemporary, Intense, and Sophisticated; and found that, when genre was excluded, individuals used music acoustic features to drive their choices. Taken together, all of these findings highlight the extent to which individual variables can covary and emphasise their importance on further investigating situational aims on the various affective states to music.

1.1.5 The Neuroscience of Musical Emotions

The neuroscientific side to research into musical emotions has gained increased traction in recent years, and more studies are finding indications of a general emotion brain network that is activated in response to music. A recent review by Koelsch (2014) gives emphasis to the role of limbic and paralimbic brain systems in how they contribute to emotional appreciation. An fMRI study by Koelsch et al. (2013) gives support to the role of the auditory cortex (AC) and superficial (SF) amygdala for affective responses to emotion-specific music, finding increased blood-oxygen-level-dependent (BOLD) signals for joy-evoking music and lower signals for fear-evoking music. In a similar study, Skouras, Gray, Critchley, and Koelsch (2014) demonstrate significant bilateral processing in the hippocampus as well as the SF amygdala and AC in processing music-evoked joy and fear. Clusters surrounding the SF and laterobasal (LB) amygdala, hippocampus, and left striatum have also been supported to underly sustained joy (Koelsch & Skouras, 2014). Higher centrality values shown by the SF amygdala seem to play a more pronounced role with music-evoked joy, and supports Koelsch et al.'s

(2013) findings using shorter durations of the same musical stimuli. Similar findings can be found when measuring indirect markers of induced emotion, such as self-report chills. Blood and Zatorre (2001) found that self-reported chills felt in response to self-selected music was associated with increased heart rate, electromyogram and respiration depth, which also seemed to be correlated with regional cerebral blood flow (rCBF) activity in paralimbic areas and areas associated with arousal and motor activities, such as the striatum, amygdala, thalamus and cerebellum.

To summarise, the above research highlights specific key areas of the brain that can be associated with affective processing of music-evoked emotion, including the amygdala, striatum, AC and hippocampus. These findings demonstrate preliminary efforts for suggesting a widespread emotion network in the brain, whilst looking ahead towards mapping a more structured brain network for specific types of emotion. Current efforts are undoubtedly underway for honing how such investigations are approached. For example, Daly et al. (2015) have recently formulated a model that can predict a participant's induced emotional response based on features from their EEG data and acoustical features extracted from the music itself, implicating the listener's internal processes as well as the stimuli presented to them in their subsequent responses. It is likely that, from synthesising contributory aspects including individual differences and acoustical musical features, research will be able to make more conclusive predictions about structurally mapping the neural correlates of certain music-evoked emotions.

Research into musical emotions has grown considerably in the last couple of decades (see Eerola & Vuoskoski, 2012, for review), with more studies focusing on the phenomena of music inducing emotions within the listener. Listeners will often report feeling emotions in response to music throughout various situations, including depending on who they are with or where they are during listening (Juslin & Laukka, 2004; North et al., 2004). Differences in the type or propensity of their emotions can be attributed to individual differences, such as personality factors (Chamorro-Premuzic & Furnham, 2007). Emotions can even be enhanced when providing narrative descriptions of the music (Vuoskoski & Eerola, 2015) or sometimes when attending performances (Balteș & Miu, 2014; Vuoskoski et al., 2016).

The following section will continue on the topic of music-induced emotion but will introduce the objective mechanisms through which music has been theorised to induce emotions with a listener. In doing so, the argument will move away from discussing the everyday occurrences that might lead to an emotional response, but rather explain *how* exactly they are induced. This will refer to several types of underlying psychological occurrences that one is likely unconscious to. The next section will discuss the empirical evidence behind some of these mechanisms and how others, such as VMI, are yet to have received as much attention in research.

1.2 The Underlying Mechanisms of Musical Emotions

1.2.1 Introducing the Theoretical Framework

The most important prerequisite to implicating psychological mechanisms that contribute to musical emotions is whether music even has the capacity to arouse an emotion within a listener. Despite the fact that countless findings have provided empirical support for the everyday emotional responses to music, this still remains a contentious issue. One argument is that this could be said to stem from the perceived/induced emotion debate, but, as demonstrated in the previous sections, this can compellingly be put to rest by findings that differentiate the two concepts. Perceived emotion research covers a wide range of important research questions on how individuals interact with music in everyday life, but research into music-evoked emotions does not seem to have reached the same level of attention. Therefore, to address these peculiarities, Juslin and Västfjäll (2008) have formulated the BRECVEMA theoretical framework of musical emotions (including *brain stem reflexes, rhythmic entrainment, evaluative conditioning,* emotional *contagion, visual imagery, episodic memory, musical expectancy*, and *aesthetic judgement*) – an initial step in supplementing and even explaining incidences of everyday emotions at a rudimentary level.

As aforementioned, some believe that music lacks the properties that promote a goal-oriented interaction to incentivise an emotional response, which has led to some questioning whether emotions can be felt to music at all. This relates to other debates existing within emotion research, such as about the types of emotions that music has the capacity to induce, the spontaneity of the emotions, and the difference between everyday emotions and music-induced emotions. Another issue is that the conditions for inducing a mechanistic emotional response (e.g. emotional contagion, VMI) and those for promoting an everyday emotional response (e.g. via social engagement, attending a concert, etc.) can wildly differ and pose important difficulties for lab investigations. A further issue is that participants do not tend to think about their emotional experiences to music on a "'mechanistic' level" (Juslin, Liljeström, Västfjäll, & Lundqvist, 2010, p. 611), a pitfall usually present with self-reports that are most often relied on in emotion research.

Whilst some researchers have begun to hint at possible underlying processes involved in music inducing emotions (Berlyne, 1971; Meyer, 1956), the BRECVEMA framework additionally hypothesises the significance of each mechanism in simultaneously supporting a range of types of emotional responses to music. This section aims to provide a summary of the wider goal of the theoretical framework and its implications on further musical emotions research. Previous research on the mechanisms will be summarised to give a view of how researchers have progressed in understanding them, before considering other researchers' perspectives on the feasibility of the framework and other point of views. Taken together, this section should highlight how our understanding of some mechanisms is currently promisingly underway, but where others lack from the same level of attention, and why.

1.2.1.1 Overview: the BRECVEMA Framework

The BRECVEMA framework for felt emotion was conceived through a series of investigations as a means to address a part of music-induced emotion research that situational factors cannot always account for (Juslin et al., 2010). Its purpose comprises a set of eight suggested underlying processes largely aimed to fill the void in theorising *how* a given musical situation leads to emotional responses. The components of the framework target aspects of our behaviour that we are or have become largely predisposed to and can generally be regarded as evolutionarily developed brain functions which can be loosely grouped into the types of experiences they represent, i.e. brain stem reflexes as sensations, and musical expectancy as syntactical processing (Juslin & Västfjäll, 2008). They can be thought of as mediatory events in which information is processed, using music as the initial stimulus and emotion as the subsequent output (provided, of course, that the process indeed develops in that specific order, which is yet to be found).

A brief outline of the individual BRECVEMA mechanisms will be provided below, including the most up-to-date inclusion of *aesthetic judgement* into the framework (Juslin, 2013b). These will first be presented individually to distinguish each of their roles and characteristics. This will be followed by a summary of the theoretical predictions postulated by the original authors for the benefit of theorising and empirically supporting the prevalence of each mechanism. Using these two outlines, emphasis is placed on regarding each mechanism as an independent influence on emotional output as well as mutually inclusive interactive phenomena.

Brain stem reflexes, the first mechanism in the framework, refers to key acoustical features of the music inducing an emotional response due to the brain stem responding to them as crucial and urgent events. This heavily links back to more primitive evolutionary inclinations that are hardwired into our behaviour and treats the music as a sound object in the most basic level. Therefore, any unexpected or sudden change in our immediate environment can lead to the arousal of our central nervous system. As brain stem reflexes are automatic reactions, relevant acoustical musical features could therefore refer to fast, loud, sudden and accelerating musical patterns. These may lead to feelings of increased subjective arousal and surprise, for example, and so may even be linked to physiological factors that can relate to induced emotional responses (Berlyne, 1971). Although still not well understood, the brain stem has been long associated with sensory and motor functions, such as auditory perception, attention regulation and physiological functions.

Rhythmic entrainment refers to the locking-in of certain bodily functions (such as heart rate) with the periodicity of a piece of music, leading to an induced emotional response. The music may present a particular appealing rhythm or pulse strong enough to lead to a heart rate or breathing pattern to gradually entrain to the rhythm (Harrer & Harrer, 1977). According to Clayton, Sager and Will (2005), this occurs through the involvement of two necessary components: (1) there should be at least two or more autonomous rhythmic processes or oscillators (individually occurring oscillations that are able to interact, excluding resonance), and, (2) the oscillators must weakly interact, enabling them to retain their individuality. Its evolutionary underpinnings range from productivity and efficiency (Clayton, 2009) to feelings of connectedness and bonding (Kneutgen, 1970), suggesting that it is not an innate instantaneous occurrence such as brain stem reflex, but rather a gradual synchronisation (Clayton et al., 2005; Demos et al., 2012).

Evaluative conditioning refers to an emotion being induced by a piece of music simply due to the music having previously been associated with a positive or negative event, such as seeing a friend. Repeated exposure to this type of interaction will eventually lead to an automatic feeling of happiness, even without the initial pleasant encounter. This type of process is widely used as a strategy within musical composition, e.g. Wagnerian Leitmotifs. As it is such an unintentional and subconsciously learned process, other domains benefit from it by creating positive associations with a target product (i.e. marketing strategies; Blair & Shimp, 1992). This learned association can be so effective, that it is usually resistant to extinction, i.e. the associated emotion being weakened over time (Bolders et al., 2012).

Emotional *contagion* occurs as a result of internally mimicking the same perceived emotion of a piece of music. As previous sections have shown, there is plenty of evidence showing that an individual can feel the same emotion that they perceive a piece to be expressing. The way in which this has been suggested to occur is by the music conveying voice-like qualities akin to a real human voice expressing the emotion (Juslin & Laukka, 2003), causing an innate automatic response from the listener to mimic the emotion. Some have alluded to a neural network of pre-motor representations for vocal sounds activated during listening of pleasant and unpleasant music, even in the absence of observing any singing (Koelsch et al., 2006). However, this also heavily relates to research on a possible system of mirror-neurons (Molnar-Szakacs & Overy, 2006; Overy & Molnar-Szakacs, 2009), which refers to a mechanism that allows one to understand the meaning of a gesture by creating an identical representation of that gesture in the brain.

Visual Imagery, the mechanism of focus for the current project, refers to an emotion being felt as a result of conjuring visual mental images in response to listening to a piece of music. The listener is conceptualising the musical structure via a metaphorical non-verbal mapping. This mechanism can hold many similarities to other visually based mechanisms, such as memory, but is distinct in its characteristics. Despite the ability for a visual image to spontaneously appear in the mind, the listener may also have the ability to control the image, be able to manipulate or create new images, or willingly dismiss the images altogether. Although this mechanism has been vastly unexplored, the effectiveness for music to evoke a visual image has led to the development of therapeutic methods where an individual is invited to share their imagery during a curated music listening programme (Helen Bonny's Guided Imagery and Music; Lin et al., 2010).

Episodic memory refers to a personal memory of a particular event in the listener's life being conjured in response to a piece of music, resulting in an associated emotion being induced. The intensity of the memory can vary between individuals, and, depending on its strength, can coincide with physiological responses that have been stored in memory (Lang, 1979). This has previously been referred to as the "Darling, they are playing our tune" phenomenon (Davies, 1978). As such, individuals might even approach music listening as rekindling feelings of nostalgia (Janata et al., 2007; Juslin et al., 2008) or even driving a sense of self-actualisation and belonging through the memories it generates (DeNora, 2000).

Episodic memory has been suggested to have very close ties with evaluative conditioning, but they still hold enough distinctive characteristics to be treated as separate mechanisms. Whilst evaluative conditioning is a form of associative memory, episodic memory holds a great deal of contextual associations, organised into various levels of complexity (Conway & Rubin, 1993).

Musical expectancy refers to an emotion being induced within a listener due to a particular feature of the music violating, delaying or confirming their expectations of how the music should have progressed. This can refer to an unexpected harmonic progression or structural change and is heavily based on the listener's previous experience with the musical genre (Pearce et al., 2010). Meyer (1956) formulated a theory, albeit difficult to test, to approach this relationship, suggesting that subsequent increases in arousal to the violation only had value if the violation had a pleasing resolution. Moreover, Meyer suggests that this interaction in itself is bound to result in the induction of further specific emotions. Further studies have suggested other ways to empirically test expectancy (Margulis, 2005), with promising potential in the neurophysiological domain of research, implicating areas responsible for syntactical processing associated with both music and language (Koelsch et al., 2002; Maess et al., 2001). Violation of expectancies has been associated with a variety of musical emotions, such as anxiety (Meyer, 1956), surprise (Huron, 2006), as well as physiological shivers and thrills (Sloboda, 1991).

Aesthetic judgement is the most recent addition to the framework and has been included to account for the experience of 'aesthetic emotions', where the former seven mechanisms can be used to account for more 'everyday emotions' such as 'basic' or 'complex' emotions (Juslin, 2013b). It is a unique case (alongside *cognitive appraisal*) when compared to the previous mechanisms as it lacks an evolutionary basis and surrounds current conceptions and values of art and aesthetics. The type of response that would warrant an aesthetic emotion is one where the music is being valued as art. This does not exclude the possibility of having an intense emotional experience to the music but involves a change in attitude and a process of aesthetic judgement (see Fig. 1 in Juslin, 2013a, for judgement process). According to Leder, Belke, Oeberst, and Augustin's (2004) theoretical model for aesthetic experience, once an object is perceived as art, this initiates a judgement process acting on the perceiver's subjective criteria of the art, such as originality and skill (criteria often used in philosophies of aesthetics; Krauss, 1986; Sparshott, 2014).

There are multiple facets to consider in an endeavour to provide empirical support for the mechanism framework and their role within music-induced emotion. This is especially given that the evolutionary history varies between mechanisms and that they might occupy different brain regions yet to be highlighted. Thus, the overarching predictions that drive the BRECVEMA framework ensure to regard (1) the qualities of the mechanisms, and (2) the induction process resulting in the induced emotion (Juslin et al., 2010). For the first prediction, the mechanisms are judged across a wide spectrum of characteristics. These include their survival benefits, their information content, approximate ontogenetic timing for its effect on musical emotions to become apparent, the brain regions they effect, and their cultural impact. The second prediction can be said to regard the subjective listener. Whilst a wider range of emotions is expected to be achieved through activating multiple mechanisms, this accounts for the emotions that each mechanism is most likely to arouse. These include the induction speed, the individual's influence on the induction process, introspective abilities of the individual (i.e. their awareness of the induction process), modular informational independence from the other mechanisms, and its dependence on the musical structure.

All of these criteria are highly dependent on the mechanism in question. Considering all these factors would be fruitful for the perceived and induced emotion debate, as well as fuelling our own understanding of the emotion induction process to music and possible causal relationships, as the current project aims to address. There are numerous implications and practical applications for research into the mechanisms. With careful manipulation of the intended mechanism, research will be able to supplement previous findings on everyday emotions in clarifying the underlying mechanism that resulted in particular emotions. For example, the types of relationships between a perceived and induced emotions to music outlined by Gabrielsson (2001) might be investigated from the perspective of emotional contagion should the same emotion be perceived and induced. Conversely, a piece perceived as happy might lead to emotions of sadness if it evoked a particularly sad memory, implying the involvement of episodic memory. Its implications extend to therapeutic settings. Individuals often use music to change or regulate their moods, with interdisciplinary approaches being explored to understand how mediatory mechanisms can aid therapeutic interventions (Helsing et al., 2016).

The next section will consider the current progress on research into the mechanism framework, highlight the various areas and mechanisms that are still in need of understanding and try to explain why our knowledge of some mechanisms has not yet developed to a similar extent.

1.2.2 Previous Research on the Mechanisms

It is clear that only a small handful of the underlying mechanisms have received attention in research, many of which have been outside the domain of music. Juslin et al. (2008) asked participants to report on the frequency with which they experienced the different mechanisms during everyday music listening. Participants reported up to 32% emotional contagion, 25% brain stem response, 14% episodic memory, 7% visual imagery, 6% evaluative conditioning, and 4% musical expectancy. What can be grasped at this stage is that each individual mechanism is capable of inducing a distinct array of emotions. The following review will begin summarising existing research into the mechanisms, starting with those that have received the most amount of attention to the least, and will consider why that is.

Of all the mechanisms, emotional contagion has received the most headway within the musical domain as well in interdisciplinary work. In a monograph by Hatfield, Cacioppo, and Rapson (1993), they illustrate the existence of emotional contagion using facial expression methodology and discuss the ability to 'infect' others with contagion using findings from human and animal subjects. Neumann and Strack (2000) also found evidence of emotion 'sharing', but instead present the induction of contagion through indicators of emotional expression within speech. However, because theories underlying contagion have been linked to speech, many interdisciplinary studies have been carried out to link non-verbal emotional expressions found in speech with voice-like sound patterns of music (Juslin & Timmers, 2010). Juslin and Laukka (2003) carried out a review comparing findings on vocal expression with musical performances. They found that basic emotion categories were effectively communicated through the music, revealing similarities between emotion-specific acoustical patterns in music performances and vocal expression. The notion of voice-like qualities is similarly reflected in brain imaging findings. An fMRI study by Koelsch et al. (2006) showed perception of pleasant music to activate pre-motor circuitry representations for vocal sound productions, which they link to mirror-function mechanisms. Mirror neurons can characterise another non-verbal representation of emotional contagion but are mostly thought to prompt feelings of empathy through shared representations of perception and action (Preston & de Waal, 2002; Prinz, 1997).

The prevalence and induction of episodic memory has also benefitted from interdisciplinary work, but not to such a frequency as contagion has. Research has often looked into individual's retention abilities, and, within the music domain, on the influence of emotive music on memory retrieval. Eschrich, Münte, and Altenmüller (2005) found that felt valence and arousal dimensions were important for facilitating the encoding and retrieval of episodic memory in response to music.. Studies also show that listeners often associate particular tasks or events to music-induced episodic memories (Janata et al., 2007; Juslin & Laukka, 2004; Rentfrow & Gosling, 2003; Sloboda et al., 2001).

There are still few studies that have explored ideas into manipulating the causal role between the mechanisms and emotion induction. It is clear, however, that some mechanisms possess characteristics or inductive features that are more plausible to manipulate (e.g. episodic memory, as you can directly recall a memory) than others (e.g. visual imagery, as it is more of allusive and spontaneous). One additional method to do so comprises manipulating the music's acoustical features that are suspected to activate a relevant mechanism. In a series of listening experiments by Juslin, Harmat, and Eerola (2013), they altered a piece of music to individually target brain stem reflex, emotional contagion, episodic memory and musical expectancy, and asked participants to rate their felt emotion in response. The authors confirm that, by manipulating the piece of music accordingly, the conditions appeared to arouse emotions relating to the target mechanism, with brain stem reflex arousing the most surprise, contagion the most sadness, episodic memory the most happiness and nostalgia, and expectancy the most irritation. These findings suggest that, when regarded carefully, it is possible to extract information when manipulating the relevant features in a musical piece, especially as they mostly confirm participants' felt emotions across a wider range of manipulated musical stimuli in a follow-up (Juslin et al., 2015).

The notion of acoustical manipulation could be extended to other mechanisms such as rhythmic entrainment if you take metre and rhythm as the target manipulating factors. Rhythmic synchronisation holds a strong link with ritualistic dance settings where movement and synchronisation (either bodily or hand clapping) with the music is a key component for mutual entrainment (Merker et al., 2009). However, rhythmic entrainment has only recently started to gain traction as a music-induced emotion mechanism (Trost et al., 2017; Juslin et al., 2010; Juslin, 2013b). Entrainment has been previously defined as music leading to a locking-in of certain bodily processes to a metrical periodicity leading to varying levels of arousal (Juslin, 2013b). However, this definition lacks in specifying the types of entrainment music can lead to, as well as the types of affect that may be induced (Clayton et al., 2005; Russell, 1980; Trost & Vuilleumier, 2013). Listeners are usually able to discern the underlying pulse of a piece of music (Lartillot et al., 2008), even within the first few beats of a piece (Krumhansl, 2000). Trost et al. (2014) found that pleasant consonant music led to the synchronisation to small periodicities of the musical rhythm, whereas dissonant unpleasant music diverted attention to synchronise to slower periodicities. Moreover, higher tempo led to higher enjoyment ratings when in a major key, and slightly higher enjoyment ratings when tempo was slower in a minor key (Husain et al., 2002; McConnell & Shore, 2011). Janata, Tomic, and Haberman's (2012) paper on groove appears to show that participants strongly associate specific genres with certain rhythms and metres, and that a piece of music that confirms their associations can lead to a higher pleasurable state. Moreover, Landreth and Landreth (1974) found that participants' changes in heart rate were related to changes in tempo in the music.

Rhythmic entrainment has been suggested to act as a specific kind of musical expectancy due to the listener's rhythmical anticipations and metrical expectations (Trost et al., 2017, p. 97). Sauvé, Sayed, Dean, and Pearce (2018) found pitch and temporal onset were effective predictors of a listener's perceived expectancy and emotional response. However, a listener's musical expectancies are not limited to rhythm and metre. Steinbeis, Koelsch, and Sloboda (2006) found violations in harmonic expectancy to affect ratings of tension and emotional response, which was also reflected in participant's electrodermal activity and heart rate. The time in which the violation occurs is also suggested to have an effect (Nittono et al., 2000). The outcome of these expectations had been suggested to relate to dopamine release in the event of rewarding wants and expectations (Huron & Margulis, 2010; Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011).

There is little literature exploring the link between evaluative conditioning and music-induced affect, however there are many points that can be extracted from existing papers that can relate to music (De Houwer et al., 2001). Blair and Shimp (1992) show that those who were exposed to a piece of music during an unfavourable situation then had negative feelings towards the brand associated with the music, as opposed to those who were not pre-exposed to the music. This relationship has also been found to be able to alter negative associations to positive ones using repeated exposure. Eifert, Craill, Carey, and O'Connor's (1988) findings show that they were able to positively modulate participants' animal phobias using multiple therapy sessions where they were encouraged to get into the mood of the music whilst being in the same room as their respective feared animal. Many occurrences of evaluative conditioning accompanied by an associated induced emotion have even been found to occur without our awareness (Martin et al., 1984), and preferences can be formulated even without our specific intention to do so (e.g. the mere exposure effect; Zajonc, 2001).

1.2.3 Criticisms Towards the Mechanism Framework

A well-known account on the phenomenon of music composition that appears to comment on key arguments within music and emotion research is that of Kivy (1990):

'Georg Philipp Telemann, for example, wrote yards and yards of mournful music, but it would be bizarre to describe very much of it as "moving"' (p. 162)

This statement undoubtedly implicates much of the theoretical approaches offered on the aesthetic appeal, understanding of, and emotional reactions to music, especially as the author is clear that the ability to encourage or harness an emotion using music ultimately transcends the capabilities of any composer. Kivy further goes on to say:

‘... music provides neither the objects nor, therefore, the belief-opportunities that would make it possible for musical works to arouse such emotions as anger, sadness, joy, hope, and the like.’ (p. 165)

His argument links back to certain arguments that music does not offer itself as viable a tool for inspiring an emotional response (Scherer, 2005). However, in refute of this (and in response to Kivy’s need for ‘some special explanation’ (p. 148)), countless studies since then have supported the claim that listeners are indeed able to feel or be moved by the conveyed emotion of a piece of music (Bogert et al., 2016; Juslin et al., 2008; Kallinen & Ravaja, 2006; Vuoskoski & Eerola, 2012, 2017; etc.). Further, Juslin and Västfjäll’s (2008) framework aimed to present a set of psychological mechanisms that can broaden investigations into musical emotions to account for how our felt emotions to music come to light. The framework has certainly spurred conversation and debate, inviting comments from all facets of music research who agree, disagree, and provide alternative as well as suggested extensions. Given the breadth of these commentaries, this review will be limited only to those about the concept of the framework, and the mechanisms themselves.

Many of the commentaries about the BRECVEMA framework regard it as an exciting feat with potential to shape research into music-induced emotion. In terms of these types of responses, they provide fewer criticisms, but rather extensions by incorporating additional issues that would benefit from a mechanistic prevalence. Mechanisms that appeared to receive the most attention were emotional contagion and musical expectancy, for greater elaboration on the implications of voice-like qualities and a call for greater attention, respectively. These even present the initial exploration into rhythmic entrainment as a proposed mechanism, which they incorporated into a later update of the framework (Juslin, 2013b). What can most interestingly be extracted is the suggestions for additional mechanisms to be considered for the framework. The aforementioned mere exposure effect (Zajonc, 2001) and one referring to semantic association pose fascinating implications, however fall short in that these mechanisms can be somewhat accounted for using the existing mechanisms.

These comments can be extended to one of the authors' iterations of the emotion research behind the framework. Konečni (2003) provides a review of the previous 2001 edition of Juslin and Sloboda's (2010) *Handbook of Music and Emotion*. Konečni's account is split between commenting on the lack of evidence behind many important questions asked from the editors and his approval of several chapters for the ways in which they present new ideas and offer value to the book. However, what can be taken from this in relation to the framework is his scepticism over music's supposed direct effect on emotion, whilst proposing that music and emotion possess a bi-directional causal relationship. This interpretation has in fact received recent attention and support with regard to visual imagery (Vreogh, 2018), and may even subserve a different avenue for research into the mechanisms framework to explore.

1.2.4 Alternative Perspectives

In formulating the principles behind the BRECVEMA framework, Juslin and Västfjäll (2008) adopt the approach that there is no limited set of emotions that the mechanisms are able to induce, but mentions that some emotions are more common than others. They acknowledge that these are highly dependent on listener's context and musical style, as well as changes that are likely to take place throughout an individual's lifespan. Therefore, the authors advocate the inclusion of the possibility of mixed emotions but excluding models that preclude feeling multiple emotions at the same time (Larsen et al., 2001; Russell & Carroll, 1999).

Many emotion models review and dissect theories and research into how emotions can be *expressed* in music (Cespedes-Guevara & Eerola, 2018; Juslin, 1997, 2003, 2013a; Juslin & Lindström, 2010), and only more recently have researchers begun to apply these conceptualisations to the *induced* emotions within music (Cespedes-Guevara & Eerola, 2018). By amalgamating these perspectives, what can be extracted is a proposal for using more holistic approaches for examining the types of affects perceived (and induced) from a piece of music, in place of basic emotions, the contents of which still seem to face much disagreement within literature. Perhaps the main issue in cultivating a model of basic emotions is the assumption that they are must be categorical. However, as illustrated by Barrett (2006), the perception of emotion can be best visualised as similarly existing along the spectrum of a colour wheel, where extremes are free to fluctuate and exist on intermediating levels. However, as Cespedes-Guevara and Eerola (2018) summarise, linguistic and conceptual processes lead us to provide discrete labelling of what we perceive while recognising that they are still loosely attached to that label, which they argue can be similarly applied to emotions perceived in music. The overarching proposition from the presented literature states that a listener's emotional processing of music involves an automatic deconstruction of the acoustical cues integrated with referencing past experiences, and contextual information that subsequently result in a discrete emotional label.

Some researchers have suggested alternative methods for approaching emotional responses to music. To name a specific example, Konečni's (2005) Aesthetic Trinity outlines three main prototypic experiences to music surrounding aesthetic appreciation, and rejects and aims to replace previous suggestions of aesthetic judgement and musical emotions. He talks about states of awe, being moved, and thrills. The clear ways in which this model differs from any previously mentioned approach is that it sets particular guidelines for music to meet before supposing that it is capable of inducing states of awe or being moved. However, these states appear to act in a cumulative fashion in that, as Konečni illustrates, awe is always accompanied by being moved; awe and being moved only sometimes accompany thrills should the target stimulus reach a certain level of sublimity; etc. The Aesthetic Trinity seems to elevate music to a divine and transcendent level, which holds very few comparative features with the principles behind the BRECVEMA framework or the previously mentioned emotion models. Given that the author provides strong preferences for his model to replace contemporary nomenclature of emotional responses to music, his view poses a significantly Eurocentric standpoint which is likely to hold very little weight when applied cross-culturally.

Taken together, Juslin and Västfjäll's (2008) BRECVEMA framework for music-induced emotions provides a starting point for music and emotion research with which to closely scrutinise the mechanisms underlying involved in our responses to music. The aim was to provide a detailed background into the conception and collation of the mechanisms to highlight their importance and potential need in music emotion research. The next section will closely examine visual imagery, the mechanism of focus. This section will highlight the empirical research currently available on visual imagery, its comparative features to other visual phenomena, and will act as an initial introduction for the subsequent research project on its prevalence in music.

1.3 Visual Mental Imagery (VMI)

1.3.1 Manifestations of Spontaneous Thought

The concept of spontaneous thought can be difficult to summarise, as it manifests itself across a variety of different forms with their own independent components as well as functions, content and use. Definitions will often refer to its varying components: the task-related or unrelated nature of the phenomenon; whether it is done during a wakeful or unconscious state; its valence; and whether it is a reflection of our past, present or future. But it is most commonly understood as an involuntary and inaccessible process that can influence how we perceive our surrounding environment. Individuals will often implicate these thoughts with a magnified sense of existential meaning (Gilbert, 1991; Pronin et al., 2004), a central concept for most relaxation therapies such as meditation and hypnosis (Bowers & Farvolden, 1996; Jacoby & Kelley, 1992; Poole et al., 1995). For instance, in a series of studies, Morewedge et al. (2014) found that participants attributed more of a sense of meaning and self-insight towards positive or negative spontaneously occurring thoughts rather than deliberate thoughts, and that these spontaneous thoughts had great influence over judgement. This included determining their attraction and commitment to a relationship with a significant other. Spontaneous thinking is largely ubiquitous, and processes such as mind-wandering have been stated to occupy around half of our waking state with potential adverse effects on subsequent mood regardless of what we are thinking of (Killingsworth & Gilbert, 2010). These can encompass, and are certainly not limited to, mind-wandering, dreaming, involuntary memory, and VMI. The various forms of synaesthesia have also been reported to manifest themselves as a number of perceptual and physical experiences and as it has been suggested to occur within a similarly automatic and uncontrolled manner, it will be briefly addressed as a unique form of spontaneous thought.

Mind wandering is generally understood to be a spontaneous mental occurrence, that significantly varies in mode and frequency from person to person (Smith et al., 2018). Using the experience sampling method, Klinger and Cox (1987) sought to understand the naturalistic flow of thought in everyday life. They found significant variability due to individual differences, and that 46% of overall reports to be either moderately or very visual, whilst 29% were rated as auditory. Furthermore, Taruffi et al. (2017) found increased mind wandering and decreased meta-awareness whilst listening to sad music rather than happy music, and when aggregated together, thoughts were predominantly visual. What these studies highlight is a potential important link between mind wandering and VMI. The content of mind wandering is thought to be primarily characterised by its relevance and relatedness to our personal lives (Andrews-Hanna, Reidler, Huang, et al., 2010; Stawarczyk et al., 2013), and will vary between past- and future-oriented thoughts (D’Argembeau & Van der Linden, 2004; Ruby et al., 2013). Stawarczyk et al. (2013) found that future-oriented thoughts were more self-relevant, more structured and involved more inner speech, than past-oriented thoughts. The frequency of neuroscientific research into spontaneous thought varies depending on the phenomenon. What also tends to vary is the extent of consistency with regard to finding indications of specific brain patterns occurring alongside them. In terms of mind-wandering, research will often implicate the default mode network (DMN; including the posterior cingulate cortex/precuneus, medial prefrontal cortex, and inferior, medial and lateral parietal cortex) in regulating internally oriented thoughts (Mittner et al., 2016). For instance, Johnson et al. (2006) asked participants to either think about their hopes and aspirations or their duties and obligations (self-relevant items) and compared this with a distraction condition where they thought about non-self-relevant items. They found thinking about self-relevant items showed increased activation in dorsomedial prefrontal cortex and posterior cingulate cortex/precuneus than when thinking about non-self-relevant items, supporting the role of the DMN during states of mind wandering.

Instances of mind wandering have even been captured using pupillometry, implicating arousal as a key proponent (Konishi et al., 2017).

A similarly associated phenomenon that is sometimes referred to by researchers in conjunction with mind wandering is involuntary autobiographical memories (AM). As the name would suggest, involuntary AM have been referred to as spontaneous and unintentional memories of past events appearing in the mind during any moment of the day or activity (Mace, 2018). Research into involuntary AM is still in its infancy, and as a result there are still many questions regarding what differentiates involuntary AM from voluntary AM. But the most striking and consistent difference that has been observed until now is the qualitative content that they each tend to possess (Mace et al., 2011). Berntsen (1998) compared diary entries of involuntary AM and a matched laboratory study using verbal cues of voluntary AM. The findings show that voluntary AM were often to be less specific, more rehearsed, more negative, and less recent than involuntary AM, but showed no differences in terms of prevalence of unusual events. In understanding the relationship between involuntary AM's and our everyday activities, some speculate that its occurrence is neither directly cued nor completely randomly occurring. Ball and Little (2006) asked participants to provide a single diary entry of an involuntary AM, finding that 50% of these cases were triggered from current active goals and intentions of the participants, 35% from sensory information unrelated to goal-directed activity, 93% from external features of the participants' physical environment, and 15% had no clear sensory or goal cue. Functionally, it can be said to hold limited benefits as it occurs independently of our goals and intentions, which would relate it closely to mind wandering and daydreams (Rasmussen et al., 2015). Rasmussen and Berntsen (2011) support this view by finding that voluntary AM were more associated with problem solving and social sharing, whereas involuntary AM, despite occurring more frequently, was more associated with daydreaming, boredom, and occurred most during moments of unfocused attention. In spite of this, the fact that involuntary AM occur more frequently than voluntary AM might provide us with ample opportunity with which to interact with certain details of our past, with little expense to our current situations.

One can inevitably approach the topic of spontaneous thought from a cross-modal outlook. The phenomenon of synaesthesia alone can manifest itself in numerous perceptual and physical experiences. Many of the approaches taken to confirm the authenticity and consistency of a synesthetic experience are no different to how one might understand spontaneous thought (Linkovski et al., 2012). Generally defined, synaesthesia refers to the stimulation of one sensory modality eliciting an experience in a different sensory modality, from experiences such as mirror-touch synaesthesia (Santiesteban et al., 2015), odour-colour synaesthesia (Speed & Majid, 2018), and sound-colour synaesthesia (Ward et al., 2006). It has been suggested that 1 in 1150 females are synesthetes whereas 1 in 7150 males are, but despite the varying numbers, many are challenged by the notion that some synesthetes' experiences are mainly the result of early life learning (Rich et al., 2005). Given the wide range of synaesthesia that is available, the most closely related to the current research would be that of sound-colour, given the potential associated with visual attributes (Curwen, 2018; Linkovski et al., 2012; Menouti et al., 2015). Interestingly, some have alluded to the involvement of VMI in synaesthesia experiences concerning colour, given the similarities in describing internally generated representations (Baron-Cohen et al., 1987; Mills et al., 2003). Barnett and Newell (2008) asked synesthetes to complete the Vividness of Visual Imagery Questionnaire (Marks, 1973), once with their eyes open and once with their eyes closed, and compared these results to a group of age-matched controls. They found enhanced vivid VMI to be a key characteristic of synaesthesia when compared to the age-matched controls, and that this was especially true when completing the questionnaire with eyes open. Despite this, non-synaesthetes have been found to be more appreciative of synaesthetic animated auditory-visual clips, suggesting certain parallels that might exist in terms of how the wider population perceive auditory-visual art forms. Some researchers have attributed synaesthetic behaviour to personality characteristics pertaining to schizotypy (a range of personality traits from normative dissociative states to extreme states associated with schizophrenia; Banissy et al., 2012). Janik McErlean and Banissy (2016) investigated the link between grapheme-colour synaesthesia, schizotypy, VMI, and other conceptually similar personality characteristics, sensation seeking and self-monitoring. Synaesthetes for colour showed higher ratings in positive schizotypy and imagery vividness but found no significant findings regarding sensation seeking and self-monitoring. What these findings preliminarily suggest is that certain personality traits may be attributed to certain synaesthetic experiences, which, with further work, could be extended by considering further traits of different synaesthetic experiences.

Whilst the intention here was certainly not to provide an exhaustive review of the abovementioned phenomena that fall under the umbrella of spontaneous thought, it is currently evident that it is still a significantly growing area (Christoff et al., 2016; Taruffi & Küssner, 2019). Despite being generally an understudied area, research into mind-wandering is making headway by identifying specific brain areas and patterns that co-occur with such automatic behaviour (Callard et al., 2013). Knowledge into goal-directed thinking perhaps lends itself to be more readily studied, due to the various directions one can take to provoke goal-driven behaviour. Similarly, with involuntary AM, greater objective research into their functionality would help differentiate it further from voluntary AM, should the methodology identify a way this can be done alongside diary entries. Synaesthesia, thus far, remains to be a contentious area of research, and an even more challenging condition to identify, induce and regulate. With increased investigations on the personality traits that characterise synaesthetes’ behaviours, this will offer one independent measure with which to distinguish between various forms of synaesthesia and those without it. The following section will introduce the general and music-related research on VMI, summarising what is currently understood about the phenomenon and where research in still in need of development.

1.3.2 Psychological Research on VMI and Music

Investigations into VMI can be traced back to Galton (1880) who writes: ‘Many men and ... women, and many boys and girls, declared that they habitually saw mental imagery, and that it was perfectly distinct to them and full of colour’ (p. 302). Conjuring a mental image is not an uncommon phenomenon, and most individuals will spend a significant amount of their time daydreaming, recalling past memories, or just mentally visualising acoustic cues whilst listening to their favourite song. Despite its ubiquity, VMI did not reach the widespread attention of research until the late 20th-century. A review by Sterelny (1986) describes a heated debate that developed amongst cognitive psychologists regarding the nature of VMI, namely by Pylyshyn (1973, 2002) and Kosslyn (1975, 1994), who offer opposing definitions of VMI falling into Descriptionalism and Pictorialism, respectively. In general terms, VMI is commonly referred to seeing within the ‘mind’s eye’ and occurs when perceptual information is taken and modified from memory where it is stored (Kosslyn et al., 2001). However, imagery experiences are not confined to visuals and comprise a multimodal phenomenon that encompasses auditory (Halpern, 2001; Schaefer, 2014), olfactory (Krishna et al., 2014; Plailly et al., 2012), gustatory (Drummond, 1995; Tiggemann & Kemps, 2005), and motor senses (Overy & Molnar-Szakacs, 2009). These modalities will often interact and have been suggested to shape a lot of our everyday perceptual events. Nanay (2018) proposes that this is an integral and involuntary part of our perception, the outcome (which may just be visual) of which is formulated through the interaction of multiple modes (visual, auditory and olfactory, for example).

Despite VMI's predominant role within Juslin and Västfjäll's (2008) BRECVEMA framework, VMI is still growing in research prevalence with regard to its link with music (see Taruffi & Küssner, 2019, for review). However, indications of its potential are fraught within the literature of music-induced emotion. Music-induced VMI refers to mental images being conjured in response to a musical stimulus. The prevalence of VMI in music-induced emotion research shows that VMI (alongside other factors) is often referred to as a trigger through which music leads to an emotional response. Baltes and Miu (2014) aimed to measure participants' empathy, VMI, mood and emotional response during a performance of Madame Butterfly, finding a robust link between the three individual differences and emotional reactivity throughout the opera performance. They complement the findings of other studies who have similarly investigated empathy and VMI on emotion (Garrido & Schubert, 2011; Vuoskoski & Eerola, 2011, 2012). Moreover, Vuoskoski and Eerola (2015) provided contextual information for sad-sounding music and measured participants' emotional response. They found that providing a narrative contextual description impacted emotional responses, possibly by promoting VMI relating to the descriptions as participants had around 80% of reported instances of VMI. VMI's role as an underlying mechanism of music-induced emotion has received recent attention by Küssner and Eerola (2019). They found that VMI was the most common feature during participants' music listening, with around 77% reports of VMI during listening.

In uncovering inter-individual predisposition to forming VMI, Stratton and Zalanowski (1992) measured VMI in matching music, non-matching music, and no music conditions. They found reduced vividness ratings for music that did not match the images participants were asked to form, especially for participants with right hemispheric cognitive style. Furthermore, Brochard, Dufour, and Després (2004) considered the impact of musical expertise on VMI abilities. Musicians demonstrated faster reaction times when associating a visual stimulus with a particular motor task than when compared to non-musicians, which they attribute to their perceptual and anatomical motor enhancements due to long-term instrumental practice. This is not the first paper to associate VMI and motor senses. A number of studies have suggested that we conjure metaphors that make up our bodily experience to imagine and conceptualise motion in music (Eitan & Granot, 2006; Godøy, 2003; Johnson & Larson, 2003; Overy & Molnar-Szakacs, 2009). Not only does this ability enable us to introspect through time (D'Argembeau & Van der Linden, 2006), but has also been found to have creative implications within writing (Gorman & Eastman, 2010) and educational settings (Jampole et al., 1994).

1.3.3 The Neuroscience of VMI

Combining behavioural and neuroimaging measures has produced valuable findings on the intersection between VMI and visual perception in the brain. In a review by Kosslyn and Thompson (2003), they outline numerous papers that highlight the prominent role of the early visual cortex (areas 17 and 18 in the brain) in creating visual mental images by constructing geometric properties of shapes received from the retina. These perceptual events involving imagery have also been found to incorporate multiple sensory modalities (Kosslyn et al., 2001). Interestingly, there appear to be some associations between the early visual cortex, VMI and visual memory (Albers et al., 2013; Ishai et al., 2000; Schaefer et al., 2013). In an fMRI study by Ganis, Thompson, and Kosslyn (2004), they found clear indications of similar neural structures when engaged in a visual perception and VMI, with emphasis on frontal and parietal cortices which have also been previously implicated for memory encoding (Kosslyn et al., 1997).

Previous neuroimaging studies have implicated certain brain areas in regulating cognition related to spontaneous thought. In particular, Andrews-Hanna, Reidler, Sepulcre, Poulin, and Buckner (2010) mention the DMN, which has been found to interact with the

Salience Network and Frontoparietal Control network (Seeley et al., 2007; Vincent et al., 2008) in modulating constraints related to thought (Christoff et al., 2016). With regard to music listening, many have linked affective responses to music with VMI and mind-wandering, finding brain activation in similar areas. In an fMRI study by Taruffi, Pehrs, Skouras, and Koelsch (2017), they asked participants to listen to happy and sad pieces of music and report on the types of mind-wandering (VMI or inner language) that they may have experienced. They found that sad music led to more mind-wandering as well as increased activity in the DMN, when compared with happy music. These findings suggest that, not only is the DMN strongly associated with resting state activities such as mind-wandering but is also affected by the emotion and arousal level of the musical stimulus. The study found a predominance of VMI (rather than inner language) reports, supporting previous papers on the involvement of the primary visual cortex (Koelsch & Skouras, 2014). Research suggests that the content of self-generated thought has a significant influence on mood, especially negative (Levinson, 1997). Ruby, Smallwood, Engen, and Singer (2013) found that self-generated thought can precede as well as follow negative mood changes, with thought content that was past- or other-related leading to decreased mood even if the thoughts were positive, and thoughts about future and the self increased mood. Smallwood and O’Connor (2011) found similar results, further suggesting that the subsequent negative mood can diminish task performance and are linked with depressive symptoms.

Furthermore, there is some evidence for the involvement of individual differences in conjuring VMI to music. Martarelli et al. (2016) found that those in a negative mood preferred sad music that led to less vivid and more negative daydreams. This directly led to more feelings of relaxation which were a result of the daydreams themselves. These results show that daydreams can have a functional role in music listening, which can be moderated by individual mood states. Moreover, in an fMRI study by Taruffi, Pehrs, Skouras, and Koelsch (2018), they asked participants to listen to 4 mins of happy and sad sounding music and to complete a self-report measure of empathy. Using Eigenvector Centrality Mapping, they found that high levels of empathy were linked to high centrality values in the ventromedial prefrontal cortex while listening to sad music (compared to happy music), which was connected to considerably higher centrality levels in the primary visual cortex (compared to other associated areas). This suggests a strong link between VMI underlying high trait empathy responses to sad music. Levinson (1997) proposes that by embodying the perceived emotion of the music as well as its implied physiological properties, we become able to feel and empathise with its emotional content through imaginational means.

Taken together, these findings have aided in illuminating further questions into the claim of VMI as an underlying mechanism of music-induced emotion. In particular, the causal and directional relationship presents itself to be the most controversial issue of this claim. Whilst some have attempted to clarify this relationship as existing in a bi-directional fashion (Konečni, 2003; Vreogh, 2018), it is clear that incorporating objective and physiological measures in combination with behavioural measures can offer more conclusive and motivating findings. It is also important to not underestimate the possible complexity of this relationship. For example, Vreogh (2018) found that the quality of the felt emotion can affect the direction of the relationship between VMI and emotion. Participants had chosen one piece of music to listen to from a pool that differed in valence and arousal. Using structural equation modelling, positive emotions appeared to facilitate a unidirectional relationship whereby emotion led to VMI. However, in the case of feeling mixed emotions, the opposite relationship was true whereby VMI led to emotion.

1.3.4 Individuals Differences in Imagery: High and Low Imagers

There is limited research on different individual's unique abilities to visually imagine presented stimuli. Aphantasia, for instance, refers to the condition in which individuals are entirely unable to conjure visual images in their mind's eye. In a recent study by Keogh and Pearson (2018), aphantasics performed below average on visual tasks but not during spatial tasks, suggesting a lack of sensory visual imagery rather than an inability to metacognitively introspect. Those individuals that belong to such extremes comprise a very small portion of the population, but raise many interesting questions on the content, consistency and prevalence of VMI, especially in response to a variety of stimuli.

Studies often describe differing recall and retention strategies for individuals with contrasting imaging abilities. When presented with an image that was subsequently altered, high imagers were able to identify immediate overall changes in the second picture using their memory of the original and exhibited faster response times, whereas low imagers performed item-by-item comparisons and exhibited slower response times (Gur & Hilgard, 1975). Rodway, Gillies and Schepman (2006) suggest that high imagers tend to strategically focus on salient and memorable aspects of an image to maximise retention, whereas low imagers are possibly less accurate in identifying such features and may possess questionable attention. Furthermore, research has also shown neurological differences to understand what brain patterns are involved during such information consolidation. An fMRI study by Fulford et al. (2018) showed that high and low vividness groups demonstrated distinct differential brain patterns when looking at or imagining famous faces and buildings. Logie, Pernet, Buonocore, and Sala (2011a) found high imagers to be more accurate in a mental rotation task with fMRI data showing greater activation in the premotor cortex for high imagers, and greater activation in the SMA for low imagers suggesting contrasting mental rotation strategies.

Research into these populations is significantly more limited when using musical stimuli. However, similar differences between high and low imagers have still been demonstrated in response to particular genres of music. McKinney and Tims (1995) found that classical music significantly enhanced the activity and vividness of imagery within high imagers than low imagers, and that the music intensified the emotions felt within both imaging groups. Unique populations may extend to those in varying stages of life. Adolescents use music listening as a manifestation of inner dialogue and playing out issues, creating emotional mental images to sustain their story (Larson, 1995). This is an evident example showing how instances of VMI and felt emotions can intermingle (Janata et al., 2007). For the adolescents the mental narratives they conjure can serve as anchors for stability as they progress in their years whilst simultaneously escaping the reality of everyday events (Arnett, 1991; Kurdek, 1987). Conversely, in older adults, pieces of music were found to be more memorable if they evoked more autobiographical memory and had more intense felt emotions attached to them (Schulkind et al., 1999).

It is clear that further research on this topic is required for understanding how individuals form and retain images differently. This would not only benefit our knowledge of unique populations but would also aid understanding for how visual images can form differently as a function of the particular task that is being carried out, musical or otherwise. Individuals differ in their ability to generate visual mental images, and a further point of research may even endeavour to distinguish the effects of involuntary versus voluntary VMI formation. Those that fall under either end of the spectrum are undoubtedly likely to shape results differently, meaning that research would benefit from accounting for them in their methodological designs as well as in their findings.

1.3.5 Practical Benefits of Imagery Research

1.3.5.1 Music Performance

The experience of VMI has been shown to have a functional role in the practice for and participation in musical performances, as well as in observing them. Keller (2012) explains that music performance is a multimodal activity, and the benefits of mental imagery manifest themselves in different ways. Several studies have proposed the significance of visual motor imagery in preparing for musical performances (Bernardi et al., 2013; Keller, 2012; Lotze & Halsband, 2006; Schuster et al., 2011). Johnson (2011) compared the benefits of using motor and non-motor techniques during the mental rehearsal of the tempo of a musical piece. Using musicians of different voice and instrument types, the results showed that motor techniques facilitated practice for vibrato and dynamic changes to more lyrical pieces (than technical pieces) in slower tempos. They suggest that motor techniques of movements are most beneficial when followed by physical practice, making it less resistant to decay. However, these results showed substantial variability. In support of a multimodal framework for mental practice, Bernardi, Buglio, Trimarchi, Chielli, and Bricolo (2013) compared mental practice with physical practice, finding that despite similar levels of performance improvement, mental practice incorporated anticipatory mechanisms that aided learning using multiple imagery modes. Visual motor imagery was found to improve movement velocity, and auditory imagery was found to improve movement anticipation. With regard to the latter, there are several accounts of the use of auditory imagery for performance improvements. During ensemble playing, Pecenka and Keller (2009) found auditory imagery to be significantly linked with sensorimotor synchronisation as well as anticipatory mechanisms. Individuals who performed better in an auditory imagery task were more precise than those tapping in synchrony with a metronome and were also found to engage in more prediction when tapping with a changing tempo signal. Overall, these findings highlight how musicians often rely on multiple mental imagery modalities and kinaesthetic awareness for performance practice, which is dependent on the goals of the performer and even on the time of mental rehearsal (e.g. online/offline, Di Rienzo et al., 2016).

The audience listener can also be highly influenced by the techniques, gestures, and facial expressions that the performer decides to adopt. There is much support on the listener's perception of the portrayed expressivity and emotional intention of a musical performance, but there is also growing literature on how performative visual features are conducive to emotional responses. Krahé, Hahn, and Whitney (2015) analysed whether visual (body movements) or auditory (musical material) domains more effectively portrayed the emotional content of a musical performance. They found that individuals felt more sadness when listening to a sad piece performed with happy body movements, than when listening to a sad piece with sad body movements. This mismatch of emotions between the intended and felt emotion calls into question of whether gestures of happiness are more salient and unambiguous than sadness. Further research aimed to clarify this methodology using objective indices. Vuoskoski et al. (2016) found that listening to the audio of a musical performance led to higher emotional arousal as well as higher levels of skin conductance, than in solely visual or audio-visual presentations, which contradicts the findings of previous papers that have emphasised the importance of the visual component for performance appreciation (e.g. Platz & Kopiez, 2012). Despite the unexpected findings, the authors suggest that the audio-only condition may have allowed participants to conjure more of their own VMI due to lack of visual stimulation.

1.3.5.2 Music Therapy

The effects of intrusive VMI underlays several types of psychological disorders but there is also mounting evidence that carefully constructed visual mental images can be greatly beneficial towards the rehabilitation of clinical and non-clinical populations (Grocke, 2010). The healing implications of music has received significant attention in previous evaluations of the breadth of its benefits, including the use of music to facilitate feelings of comfort for sleep and in reducing anxiety during noisy medical treatments (Cardozo, 2004). This is also true of increased mood and relaxation during interactive music-making as opposed to passive music listening (Bradt et al., 2015). The effects of music-based therapies have already been recognised to aid mental as well as physical illnesses. Imagery-based therapies have been used in aid of chronic or terminal illnesses for improving psychological wellbeing and counselling. The use of therapies such as Guided Imagery and Music (GIM) has been shown to be effective for patients experiencing PTSD, psychiatric disorders and terminal illnesses. This widely-used intervention was initially coined by Helen Bonny (1983), who emphasised the importance of music as a healing method over three decades ago (Bonny, 1986). Such practices highlight the real-world applications that additional research into VMI would benefit from.

In research involving healthy adults, GIM interventions are often used to assess its effect on mood levels, simulating approaches that could similarly be applied to those with psychiatric disorders. Following a 13-week intervention run by McKinney, Antoni, Kumar, Tims, and McCabe (1997) found GIM intervention to attenuate mood and fatigue levels, additionally finding reduced cortisol levels after a 7-week follow-up. Interestingly, neuroimaging studies have been able to highlight the unique parallels that can exist between the therapist and the client undergoing GIM. Fachner et al. (2019) used occipital alpha power to assess VMI processing and central markers of emotion processing using a dual-EEG of a music therapy session between a client and therapist. The content of the session was categorised into moments of interest and of no-interest, which generally focused on potential deaths of family members.

One important feature that underlays the process of GIM is the use of metaphor in the formation of VMI during sessions, especially in conceptualising movement in dynamic VMI that the client of GIM would often be encouraged to do (Johnson & Larson, 2003). For example, Bonde (2007) found that the general reports of cancer patients taking part in GIM primarily consisted of six prominent themes, including enhanced perspective on mortality, increased mood and sense of self, and enhanced love of music. More specifically, the patients' VMI content strongly suggests music to be effectively conducive of representational imagery relating to negative or prospective issues, encouraging mental exploration and existential awareness. Some perceive these metaphors to symbolise archetypal systems that reflect changes in our behaviour. This notion is not a new concept with regard to music, as composers will often strive towards writing melodic lines and structuring their works to reflect specific narratives. With regard to GIM, it is possible to notice the influence of such music features by extracting visual and emotional content from patients' responses. Dukic et al. (2019) emphasise the importance of extracting archetypal information from GIM reports in an attempt to understand issues that may be unconscious to the individual.

It is clear that music holds considerable influence over its healing properties and its influence over tapping into prevalent themes and issues that may be used for the benefit of a clinical patient. Research has shown that GIM possesses the capacity to modulate mood and anxiety for those suffering from mild to more serious illnesses, and even following several weeks after the initial intervention. Apart from the parallels present between the therapist and the client, GIM possesses a distinct ability to extract rich and transparent narratives from clients under any sort of life situations. The use and continued ecological investigations into GIM will undoubtedly shape our understanding of its benefits, as well as aid in spreading awareness of the healing properties that music can hold.

Chapter 2: The Current Research

This chapter will introduce previous clinical and non-clinical research into modality specific interference, before outlining the current research into the effects of suppressing music-induced VMI and felt emotion using three interference tasks. A recent study by Hashim et al. (in review) found an eye-movement visuospatial task to successfully reduce instances of VMI and felt emotion. Following on from these findings, the current research compares the effectiveness of other tasks, using the same eye-movement task, a dynamic visual noise task (primarily visual), and an articulatory suppression task (primarily verbal). Results in Chapter 3 are discussed in relation to existing research into visuospatial suppression, music-induced emotions, as well as the implications, limitations and future directions of the research.

2.1 Introduction

2.1.1 Previous Research on Modality-Specific Interference

In order to understand why the careful selection and use of an interference task is so important to the current study's methodology, it is necessary to acknowledge the principles that underlay the modality-specific tasks and how previous clinical research has executed their own selection process. The effectiveness of a given distractor task can be understood in terms of the dynamics of Baddeley and Hitch's Working Memory Model (1974) and two of its primary components, the visuospatial sketchpad (VSSP; responsible for processing visual and spatial information) and the phonological loop (PL; responsible for processing language-learning and verbal information). According to the model, and owing to the nature of short-term memory, the VSSP and PL are functionally limited in cognitive capacity and are sensitive to being overloaded. This would imply that should the VSSP be presented with multiple visually interactive tasks, and the PL with multiple verbal or linguistic tasks, then it is unlikely that an individual would be able to successfully and completely carry out both tasks simultaneously due to the competition for limited cognitive resources. Research into the notion of dual-task interference was bred several decades ago and many research findings (mostly with regard to the PL) have been able to confirm the hypothesis that carrying out tasks that interact with the same domain will ultimately lead to diminished performance (Johnston et al., 1972; Murdock, 1965).

With regard to information maintenance in the PL, Longoni et al. (1993) found that long words were more difficult to recall than shorter words, and that this was especially the case for phonologically similar words rather than phonologically dissimilar. This not only supports the notion of dual-task interference, but also emphasises the presence of two subcomponents of the PL: the phonological store and an articulatory rehearsal system. Evidence of the distinction functions between these two stores is important for understanding why certain suppression tasks are most effective in disrupting the PL. This is especially the case for the articulatory rehearsal system which essentially regulates subvocal and unarticulated speech (i.e. subtle movements of the mouth/lips/tongue) and is a paramount notion for the current research's methodology. Paulesu et al. (1993) found increased cerebral blood flow in the left inferior parietal cortex and the left inferior frontal cortex when participants had shown poor performance in memorising six visually presented English words, as opposed to Korean words for which the sounds were unknown to the participants. This activity was found to support brain areas related to subvocal rehearsal. The authors further dissociated this from brain regions associated with the phonological store when carrying out an English rhyming task which was thought to engage rehearsal, but not storage. In this case, they found increased blood flow in only the left frontal cortex. Further neuroscientific research has also shed light on the possible brain areas that are likely involved in phonological storage by assessing individuals who have experienced extensive brain damage in the relevant areas (Baldo & Dronkers, 2006; Vallar & Baddeley, 1984; Vallar & Papagno, 1986).

Within the context of visual cognition, a key function of this aspect of working memory necessitates the ability to formulate and scrutinise a visual mental image. A study by Brooks (1968) found interference tasks were an optimal way for testing these functions. The findings suggest that mental navigation of a capital letter whilst being instructed to point to certain areas of the letter took significantly longer than when they verbalised their answers, suggesting interference caused by spatial movements from the pointing. Thus, as the name would suggest, the VSSP can be broken down into a spatial and a visual component. Some researchers have suggested that these subsidiary components allow us to manipulate, magnify and transform a given visual mental image (Kosslyn, 1975). Further, the visual and spatial components have been associated with processing in certain brain areas, the ventral and dorsal pathways, respectively (Ungerleider & Haxby, 1994). The extent to which these two components of the VSSP are co-dependent for VMI suppression is still under scrutiny. For example, Farmer et al. (1986) found that an articulatory suppression task disrupted simultaneous performance of a verbal reasoning task, but not on a spatial reasoning task, supporting the argument for a separate system. The therapeutic benefit of utilising such tasks for patients suffering from post-traumatic stress disorder (PTSD) sparked research interest over three decades ago. Shapiro (1989a, 1989b) was involved in developing the Eye Movement Desensitization (EMD) procedure, and aimed to assess its effectiveness in modulating traumatic memories and the anxiety levels linked to them. She found that even just one session of EMD was enough to reduce unwanted flashbacks. This technique quickly grew traction over the following decades (Gosselin & Matthews, 1995; Puk, 1991), with some showing variance in the effectiveness of the treatment (Jensen, 1994). However, what these studies show is that the act of disrupting intrusive memories is rooted in creating conflict within the imaginal mental space against the object representation and spatial relationships of the mental pictures, therefore influencing the negative emotions strongly associated with the memories.

Research investigations into the effectiveness of modality-specific interference have pursued testing clinical as well as non-clinical healthy samples. As aforementioned, the effectiveness of interference was initially studied in aid of those suffering from PTSD, and several further studies have aimed to design experimental analogues of such a disorder (James et al., 2015; Krans et al., 2009, 2010). Deeprose et al. (2012) asked participants to watch a stressful film immediately followed by either a visuospatial tapping task, a verbal task, or a no-task control. They found the visuospatial tapping task to be most effective in reducing encoded involuntary intrusive memories 30 minutes post-film, but that this did not affect voluntary memories assessed one week later using a recognition task. In a series of experiments using a healthy sample, Baddeley and Andrade (2000) found an interaction between the mode of stimulus recalled and the type of disruption. They were able to suppress the vividness of visual images by disrupting the VSSP, and auditory images by disrupting the PL. Andrade et al. (1997) aimed to disrupt the vividness and emotionality of imagined traumatic events by overloading the VSSP using an eye-movement task, finding vividness to be significantly reduced with only mild reductions in intensity of emotions. The authors suggest that greater changes in emotionality might be achievable if VMI reductions were even larger. Despite the findings, follow-up investigations have found more promising results. van den Hout et al. (2001) found eye-movements to effectively disrupt the vividness of negative autobiographical memories, emotionality and even future recollections of the imagery in healthy volunteers. Furthermore, Kemps and Tiggemann (2007) asked participants to either form visual and auditory images based on their own happy and distressing memories. Their findings show that concurrent eye-movements successfully reduced the rated vividness and emotional intensity of visual images, and articulatory suppression (here characterised by counting backwards) produced similar effects for auditory images.

Cognitive overloading is still regarded to be effective for memories that have been reconsolidated over time. James et al. (2015) tested the fragility of recalled intrusive memories when participants were also playing the computer game *Tetris*, a visuospatial activity. They found that the simultaneous interaction between playing *Tetris* and recalling a previously encoded memory 24 hours after the first exposure led to the intrusive memories to be almost completely eliminated. This poses serious further implications for the concerns facing PTSD patients with regard to memory recall and unwanted flashbacks, finding *Tetris* to be a successful visuospatial method for addressing and dealing with such issues (Holmes et al., 2010; Lau-Zhu et al., 2017). In further affirmation of the effects of reconsolidation and modality specific interference, Deeprose et al. (2012, Exp.2) found that even when incorporating a 30-minute memory consolidation window as well as making their control task more difficult (counting backwards in sevens rather than threes), their visuospatial task still showed the best performance. This, therefore, supports their aim for targeting selective interference, rather than any effects found by increased cognitive load.

The importance of modality-specific interference is made more apparent when assessing the negative effects that modally incompatible interference can have on suppressing visual mental images and intrusive memories. Holmes et al. (2004) asked participants to report visual intrusions after watching a trauma film. They found successful decreases in VMI reports after carrying out a visuospatial tapping task, but significant increases in reported intrusions whilst carrying out a verbal task (compared to a no-task control). Other studies with identical designs have reported very similar findings (Bourne et al., 2010). Similarly to previously mentioned studies, Holmes et al. (2010) found that playing *Tetris* reduced traumatic flashbacks when compared to a no-task control, whereas a computer game with verbal features, *Pub Quiz*, was found to worsen post-trauma symptoms compared to a no-task control, despite both games being rated as enjoyable and of similar difficulty.

The clinical literature surrounding modality-specific interference holds great potential for its applicability to music cognition and is crucial for the development of the current research's methodology. There have been extensive reports for music's ability to hold unique and emotionally saturated associations with our past memories (Janata et al., 2007; Jäncke, 2008), and some have examined how music might affect memory recall. Mado Proverbio et al. (2015) asked participants to listen to either joyful or emotionally touching music, the sound of rain, or silence whilst carrying out an old vs. new face memory task. They found that participants exhibited enhanced memory recall of the faces when listening to the emotionally touching music rather than when in silence, listening to joyful music or the sound of rain. They suggest that the music may have increased feelings of arousal, which may have helped improve memory performance. This demonstrated that musical distraction might be subject to the genre of the music, however, further developments of this study might examine how memory recall during music listening can be interfered with further using a visuospatial distractor task. Using an alternative strategy, Herff et al. (2019) tested whether memories for melodies, pictures and words were susceptible to cumulative interference by indicating whether they had previously heard the presented stimuli before. They found that memories for melodies were surprisingly more resilient then memories for pictures or words. In relation to the aims of the current project, the BRECVEMA framework proposed by Juslin and Västfjäll (2008) (and later extended by Juslin, 2013b) implicates several mechanisms that may underly music-induced emotions. Emotion induction by music can be quite allusive to trace, and the mechanisms have so far challenged researchers in how each is triggered by music listening (Juslin et al., 2013, 2015). Visual mental imagery, one of the eight mechanisms, is the mechanism of focus for the current research and will be scrutinised under the principles of selective interference. All in all, it is clear that the notion of cognitive interference is not a new concept when using musical stimuli. However, modality-specific interference presents itself to be uncharted territory in this regard, with hopes that it will offer alternative approaches that future investigations into the mechanisms underlying musical emotions can take.

2.1.2 The Present Research

The primary aim of this research is to investigate the extent to which ratings of music-induced VMI can be reduced whilst taking part in a visuospatial distractor task, and if this effect would have a subsequent negative effect on felt emotional response more so than a mainly visual and an articulatory verbal task. This study aims to build on a previous investigation by Hashim et al. (in review), who found successful VMI and felt emotion suppression using an identical eye-movement task as the one used here. In contrast, this study will examine whether successful VMI suppression can also be applied to other feasible distraction tasks. This study also differs due to measuring felt emotion by asking participants to rate specific emotion categories, in place of the GEMS-9 as the previous authors had used to avoid relying on broad emotional factors that may hinder the interpretation of the results. Similarly to previous research (Holmes et al., 2004), each condition was preceded by a practice trial in order to avoid surprise and possible tension, especially during the eye-movement task. Additionally, highly familiar musical excerpts were accounted for in a pilot study by Hashim et al. (in review) and so were excluded from the current selection, to avoid participants' VMI responses being led by their previous memories of the music. All in all, this research aims to contribute to the literature into the causal relationship between music listening, VMI and emotion induction.

Within this experiment, participants were asked to carry out three types of distractor tasks whilst listening to a series of film music representing either Happy, Sad, or Tender emotions. In one task, participants followed a white square flash on alternate sides of screen and is almost identical to previous iterations of this task within the scope of clinical research that aimed to challenge the visual and spatial components of the VSSP. In another task, participants carried out a more passive task of observing an array of small squares alternate between black and white. In the third task, participants took part in a verbal task, most often used to challenge an individual's phonological loop. Given that this third task is functionally distinct from the initial two tasks, findings of minimal distraction during this task is expected. For each (counterbalanced) condition, the participant was required to keep carrying out the task until each musical excerpt had ended. In the interest of ensuring that the musical excerpts utilised here are capable of inducing visual imagery, assurance of this was obtained in a previous pilot study carried out alongside a similar design aimed at suppressing music-induced VMI (Hashim et al., in review). The musical stimuli that were chosen represent excerpts that are some of the mostly highly rated in VMI prevalence. Their capacity to induce a range of discrete and dimensional categories of emotion was examined and confirmed in a study by Eerola and Vuoskoski (2011), where this stimuli originates from. To examine individual differences with respect to general VMI abilities, the Vividness of Visual Imagery Questionnaire was administered. If these techniques are found be robust for the aim of VMI suppression, this will hopefully pave the way to opening further investigations into similar paradigms for some of the remaining mechanisms under the BRECVEMA framework. Secondly, these results would support the findings of previous clinical research, whilst extending the range of stimuli to music listening with the potential of understanding the affective responses to other mediums within the creative and performing arts. The main hypotheses of the study were as follows:

1. A visuospatial task will outperform a primarily visual and a verbal task in suppressing VMI and felt emotion responses
2. A verbal task will have minimal influence on suppressing instances of VMI and felt emotion ratings.

As an additional exploratory aim, the content of VMI was examined in response to each emotion category of the musical stimuli across the three conditions. The primary aim for this was to understand the content of the VMI that individuals tend to experience in response to music. Whilst an increasing number of investigations into this topic are growing in traction (Küssner & Eerola, 2019; Taruffi et al., 2017) within the realm of visually based phenomena, continued research will allow for the amalgamation of themes to be made available on the content and functions of music-induced VMI.

2.2 Methods

2.2.1 Design

The experiment used a within-subjects design that incorporated and counterbalanced three conditions and three music sets across participants. This resulted in 36 complete counterbalancing permutations between the conditions and music sets. The dependent variables were the VMI and felt emotion self-report ratings, and the imagery free description. The independent variables were the eye-movement, dynamic visual noise, and articulatory suppression conditions.

2.2.2 Participants

Thirty-five participants were recruited, which accounted for almost all possible rotations for counterbalancing between the three conditions and three sets of musical stimuli. One participant was removed due to not executing the task correctly and for extensive missing data. Participant's ages ranged from 20 to 71 years (20 female, 15 male; M_{age} = 35.54, *SD* = 14.87). The participants were recruited using opportunity sampling, through university newsletters, posters, social media and word-of-mouth. Participants had a variety of musical backgrounds with 6% referring to themselves as Professional Musicians, 11% Semi-Professional Musicians, 23% Serious Amateur Musicians, 17% Amateur Musicians, 34% Music-Loving Non-Musicians, and 9% Non-Musicians. The study included participants who were 57% employed, 26% PhD students, 14% Master's students, and 3% unemployed.

2.2.3 Materials

Musical Stimuli. The musical stimuli used were 18 short excerpts of film music obtained from Eerola and Vuoskoski's (2011) compiled set of 360 excerpts, which have been empirically supported in their study to convey a wide range of discrete and dimensional categories of emotions. The stimuli sets were revised from a previous study that used a similar set of twenty excerpts from the same catalogue (Hashim, et al., in review), to offer a more modest selection of the emotions conveyed by the music. The music stimuli here were split into three sets of six excerpts that were matched in the emotions that they conveyed. In total, they comprised six Happy, six Sad, and six Tender excerpts of music (see Appendix 1, for a full list), which contrasts with the previous study's additional inclusion of excerpts conveying Fearful, High Valence, and Low Valence emotions.

Concurrent tasks. All the tasks were created and carried out using OpenSesame Version 3.2.7. The eye-movement task (EM) was created using the Python inline script provided by the programme. This task comprised a white square sized 3 × 3 mm that flashed on alternate sides of the screen approximately 25 cm apart. The square would flash for 200 ms with a 200 ms inter-stimulus interval. The task was modified from previous studies (Andrade et al., 1997; Kemps & Tiggemann, 2007) to include a catch trial square meant to ensure the participants' compliance with the instructions. This catch trial comprised a square that would flash once in either red, blue or yellow at any random point during a single trial, before continuing as normal with white squares.

For the Dynamic Visual Noise (DVN) task, a video clip obtained from the original authors of the task (Quinn & McConnell, 1996) was used and uploaded to OpenSesame with recordings of the musical stimuli attached to the video file. The video file was edited to loop for the full duration of a musical excerpt before continuing to the next trial of the study.

For the articulatory verbal suppression task (AS), participants were only presented with a blank grey screen whilst repeating the syllable, 'Tah, Tah, Tah, ...', until the music excerpt finishes.

Behavioural measures. The VMI ratings were collected using three imagery-specific items from Pekala's (1991) Phenomenology of Consciousness Inventory (PCI), a 53-item questionnaire designed to assess different perceptual experiences. The first item asked about the prevalence of VMI ([Q.12] *I experienced a great deal of visual imagery/I experienced no visual imagery at all*); then about the control of the VMI ([Q.3] *The thoughts and images I had were under my control; I decided what I thought or imagined/Images and thoughts popped into my mind without my control*); and lastly about the vividness of the VMI ([Q.18] *My visual imagery was so vivid and three-dimensional, it seemed real/My visual imagery was so vague and diffuse, it was hard to get an image of anything*). These items were rated along a 1-7 Likert scale, which was modified from the original 0-6 Likert scale. These will henceforth be referred to as PCI-Prevalence, PCI-Control, and PCI-Vividness, respectively.

The induced emotion ratings were collected using a five-item questionnaire compiled by the experimenter. These comprised Valence, Arousal, Happiness, Sadness, and Tenderness. These items were rated along a 1-7 Likert scale, with 1 representing the most negative end of each item, and 7 representing the most positive.

In order to collect the content of VMI the participants may have experienced in response to the musical stimuli, the following question was asked: ‘Can you briefly describe or give some key words for the types of imagery you experienced throughout this listening?’. Participants reported their VMI in an open text box.

To measure participants’ general VMI ability, the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973) was used. The questionnaire includes 16 descriptive statements to which the participant is instructed to form visual mental images to. Participants rated the vividness of the VMI they formed on a 1-5 Likert scale, from 1 = *No image at all, you only ‘know’ that you are thinking of an object*, to 5 = *Perfectly clear and vivid as real seeing*.

2.2.4 Procedure

The experiment was carried out individually in a quiet room, and the session lasted approximately 45 to 60 minutes. Participants were seated approx. 45 cm away from the monitor screen and were provided with noise-cancelling headphones. Instructions were provided verbally as well as on the monitor before beginning the study and were adapted depending on the counterbalancing order. Participants were first asked to read and sign a consent form that contained all the relevant information about the experiment and data security. Before beginning each condition, participants took part in a practice phase of the main trial, which comprised an 11-second musical excerpt followed by the questions they would be presented with in the main trial. Participants were provided with definitions of each behavioural item they were required to rate. For each condition, participants were presented with a different musical set.

For the eye-movement task, participants were instructed to follow a small white square flash on alternate sides of the screen using just their eyes whilst keeping their head as still as possible whilst listening to an excerpt of music. In order to ensure compliance with the instructions for this task, the participants were instructed to watch out for a deviant square that would appear once in either red, blue or yellow. After each trial, participants rated their VMI and felt emotions in response to the musical excerpt they had just heard, as well as the colour of the deviant square. Participants were not required to rate the control and vividness imagery items if they gave a ‘1’ rating for PCI-Prevalence. They were subsequently asked to provide some terms or sentences to describe the imagery they had experiences, and, if no imagery was experienced, to write ‘No imagery’.

For the DVN task, participants were told that an array of small squares continuously changing between black and white would appear on the screen, and that their task was to keep watching the display until the music finished playing. After each trial, they were prompted to report their VMI and felt emotion ratings, and to describe their VMI.

For the AS task, participants were told that they will be presented with a blank grey screen, and that their task was to repeat the syllable, ‘Tah, Tah, Tah, ...’, until the music finished. They were instructed to do so in no particular rhythm and at a fairly quick pace demonstrated by the experimenter. The syllables were not required to be loud, but marginally audible and articulated. After each trial, participants were asked to report the same VMI and felt emotion ratings, and to describe their VMI.

After all conditions have been completed, participants completed a demographics questionnaire and the VVIQ. Participants were reimbursed for their time by entering a draw to win one of three £15 Amazon gift cards.

2.2.5 Ethics Statement

This research was reviewed and approved by the ethics committee of Durham University. All participants provided written informed consent before participating in the experiment.

2.2.6 Data Analysis

Data analysis was carried out using R (Version 3.5.1; R Core Team, 2018) and the R-packages *afex* (Version 0.24.1; Singmann, Bolker, Westfall, Aust, & Ben-Shachar, 2019), *dplyr* (Version 0.8.3; Wickham, François, Henry, & Müller, 2019), *emmeans* (Version 1.3.5.1; Lenth, 2019), *gdata* (Version 2.18.0; Warnes et al., 2017), *ggplot2* (Version 3.2.0; Wickham, 2016), *gridExtra* (Version 2.3; Auguie, 2017), *HH* (Version 3.1.35; Heiberger & Robbins, 2014), *knitr* (Version 1.23; Xie, 2015), *lattice* (Version 0.20.35; Sarkar, 2008; Sarkar & Andrews, 2016), *latticeExtra* (Version 0.6.28; Sarkar & Andrews, 2016), *lme4* (Version 1.1.21;

Bates, Mächler, Bolker, & Walker, 2015), *MASS* (Version 7.3.50; Venables & Ripley, 2002), *Matrix* (Version 1.2.14; Bates & Maechler, 2018), *multcomp* (Version 1.4.10; Hothorn, Bretz, & Westfall, 2008), *mvtnorm* (Version 1.0.11; Genz & Bretz, 2009), *NLP* (Version 0.2.0; Hornik, 2018), *papaja* (Version 0.1.0.9842; Aust & Barth, 2018), *psych* (Version 1.8.12; Revelle, 2018), *purrr* (Version 0.3.2; Henry & Wickham, 2019), *RColorBrewer* (Version 1.1.2; Neuwirth, 2014), *reshape2* (Version 1.4.3; Wickham, 2007), *SnowballC* (Version 0.6.0; Bouchet-Valat, 2019), *survival* (Version 2.42.3; Terry M. Therneau & Patricia M. Grambsch, 2000), *TH.data* (Version 1.0.10; Hothorn, 2019), *tm* (Version 0.7.6; Feinerer, Hornik, & Meyer, 2008), and *wordcloud* (Version 2.6; Fellows, 2018).

The relationships of participant's subjective ratings on each of the dependent variables between the three conditions were first examined through plotting and graphical means. These plots and graphs allowed for the inference for meeting assumptions for the statistical analyses used here, such as normality.

To examine the primary hypothesis, a repeated measures multivariate analysis of variance (MANOVA) was carried out on the VMI and felt emotion ratings separately between the three conditions. This was seen to be the most appropriate analysis method, as opposed to an analysis of variance (ANOVA), due to the nature of having multiple DVs, most of which are highly correlated with one another. Further univariate tests, including ANOVAs and t-tests were subsequently carried out to assess any significant interactions or effects found from the MANOVA results.

In a further exploratory investigation, participant's VMI content was examined with the hope of shedding light on the content of music-induced VMI. In order to analyse participants' open text responses for describing their VMI experience, frequency analysis was used to compute the most common terms used by participants to describe VMI. Specifically, this analysis was carried out between the emotion categories of the musical stimuli (Happy, Sad and Tender). From this, a word cloud was also generated for in order to create a visual representation of the data.

2.3 Results

Initial examinations of the descriptive statistics outlining participants' VMI self-report ratings and Felt Emotion self-report ratings are shown in Tables 1 and 2, respectively, for each of the three conditions. Table 3 present the musical stimuli categories across the Felt Emotion self-report ratings and indicate that participants responded to the musical stimuli as expected. Reliability analysis of the VVIQ ratings showed a Cronbach's Alpha of, α = 0.91. Visual examination of the VVIQ mean scores displayed a normal distribution (see Appendix 2), indicating that participants represented equal general VMI abilities. Cohen's *d* was used to determine effect size cut-offs, with: 0.2 = small, 0.5 = medium, and 0.8 = large (Cohen, 1988).

Table 1. Means and standard deviations for participant VMI ratings across conditions

	VMI item means (standard deviations)			
Conditions	PCI-Prevalence	PCI-Control	PCI-Vividness	PCI-Prevalence Control (Hashim et al., in review)
EM	3.21 (1.9)	3.6 (1.9)	3.84 (1.67)	4.65 (1.13)
DVN	3.57 (2.02)	3.58 (1.84)	4.15 (1.68)	4.65 (1.13)
AS	3.18 (1.95)	3.58 (1.92)	3.65 (1.88)	4.65 (1.13)

Note. Hashim et al. recruited an identical N = 35.

Table 2. Means and standard deviations for participant Felt Emotion ratings across conditions

	Felt Emotion item means (standard deviation)				
Conditions	Valence	Arousal	Happiness	Sadness	Tenderness
EM	4.36 (1.65)	3.73 (1.73)	3.43 (1.89)	3.06 (1.95)	3.78 (1.87)
DVN	4.34 (1.69)	3.85 (1.7)	3.53 (1.84)	3.26 (1.96)	3.51 (1.93)
AS	4.3 (1.54)	3.8 (1.7)	3.65 (1.79)	2.99 (1.93)	3.4 (1.9)

2.3.1 Behavioural Ratings

2.3.1.1 Self-Report VMI Ratings

A repeated measures MANOVA was conducted to compare the effect of Condition (EM; DVN; AS) on self-report VMI ratings (PCI-Prevalence; PCI-Control; PCI-Vividness). The results showed that there is a significant main effect of Condition across the three PCI items, $F(2, 126) = 2.64$, Wilks' $\Lambda = .85$, $p = .03$, partial $\eta^2 = .04$. Univariate tests also indicate that there is a significant main effect of Condition on PCI-Prevalence, $F(1.88, 63.88) = 3.74$, $p = .03$, partial $\eta^2 = .1$, and a significant main effect of Condition on PCI-Vividness, $F(1.78, 55.29) = 3.32$, $p = .05$, partial $\eta^2 = .1$. But there is a non-significant difference in terms of PCI-Control, $F(1.6, 49.70) = .07$, $p = .89$.

Planned contrasts were carried out to assess differences of PCI-subscales between the three Conditions (see Figure 1). Results show that PCI-Prevalence exhibited lower ratings in the AS Condition than in the DVN Condition, $t(68) = 2.52$, $p = .03$, $d = 0.18$, and lower ratings in the EM Condition than in the DVN Condition but showing only marginal significance, $t(68) = 2.18$, $p = .08$, $d = 0.163$, but no significant difference between the EM and the AS Conditions, *t*(68) = .34, *p* = .93. In terms of PCI-Vividness, lower ratings were exhibited in the AS Condition rather than in the DVN Condition, *t*(62) = 2.54, *p* = .03, *d* = 0.227, but no significant differences between the EM and DVN Conditions, *t*(62) = 1.62, *p* = .24, or between the EM and AS Conditions, *t*(62) = .92, *p* = .63. PCI-Control showed no significant differences between either of the three Conditions.

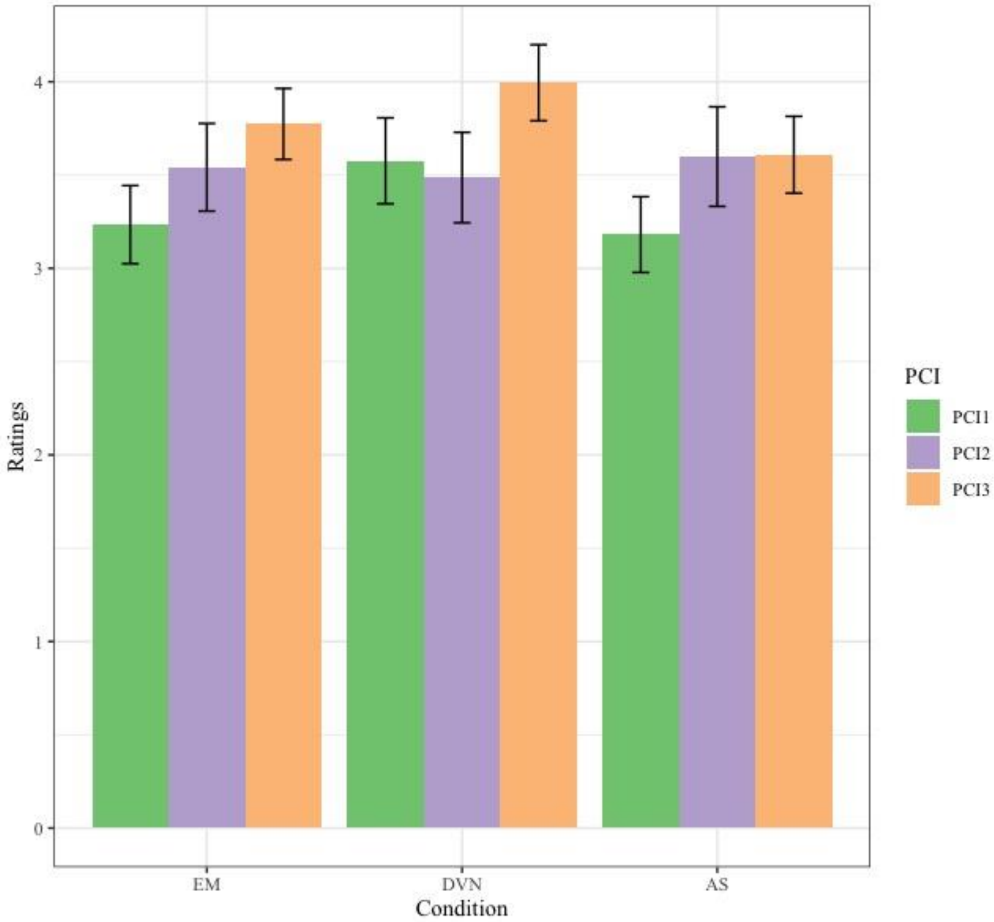


Figure 3. Mean ratings (and ± standard error of the mean) of self-report VMI, PCI1 (Prevalence), PCI2 (Control), and PCI3 (Vividness) between Conditions (EM, DVN, AS).

2.3.1.2 Self-Report Felt Emotion Ratings

A repeated measures MANOVA was conducted to compare the effect of Condition (EM; DVN; AS) on self-report Felt Emotion ratings (Valence; Arousal; Happiness; Sadness; Tenderness). The results show that there is a significant main effect of Condition across the

Felt Emotion items, $F(2, 128) = 2.37$, Wilks' $\Lambda = .71$, $p = .01$, partial $\eta^2 = .04$. Univariate tests showed non-significant differences for Valence, $F(1.9, 64.49) = .05$, $p = .95$, for Arousal, $F(1.93, 65.68) = .4$, $p = .66$, for Happiness, $F(1.92, 65.16) = .1.3$, $p = .28$, and for Sadness, $F(1.67, 56.82) = 2.35$, $p = .11$. But there was a significant main effect for Tenderness, $F(1.96, 66.63) = 3.37$, $p = .04$, partial $\eta^2 = .09$.

Planned contrasts were carried out to assess the differences in Tenderness between the three Conditions. Results show that Tenderness exhibited lower ratings in the AS Condition than in the EM Condition, $t(68) = 2.5$, $p = .038$, $d = 0.164$. Other Conditions showed no significant differences in terms of Tenderness.

Table 3. Means and standard deviations for participant Felt Emotion ratings across music stimuli categories

	Felt Emotion item means (standard deviation)				
Stimulus Category	Valence	Arousal	Happiness	Sadness	Tenderness
Happy	4.66 (1.52)	4.28 (1.75)	4.42 (1.6)	2.11 (1.47)	2.91 (1.8)
Sad	3.71 (1.71)	3.53 (1.61)	2.29 (1.45)	4.49 (1.81)	3.52 (1.81)
Tender	4.63 (1.45)	3.56 (1.65)	3.91 (1.74)	2.71 (1.69)	4.27 (1.86)

2.3.2 Free Descriptions

In order to understand the content of participants' VMI, the open-text descriptions completed by the participants were examined using a frequency analysis to find the most common words referred to in response to each emotion category of the musical stimuli (Happiness; Sadness; Tenderness). For this analysis, descriptions were aggregated across all conditions. Firstly, the text was transformed and reformatted by excluding any unnecessary special characters and turning them into empty spaces. Certain words including ‘music’, ‘imagery’, and ‘nothing’, were excluded as they were either indicative of the participant experiencing no imagery in response to the music or simply represented biases as a result of the study requirements. After the text had been cleaned, the descriptions were aggregated across the three Conditions and grouped into the three emotion categories of the musical stimuli. From this, each word’s total frequency was transformed into a word cloud (see Figure 2), with the words scaled in size to represent the extent of their occurrence (i.e. the bigger the word, the more frequently it occurred). Finally, colour was added to the words to distinguish between the groups and labels were added to clarify this further.

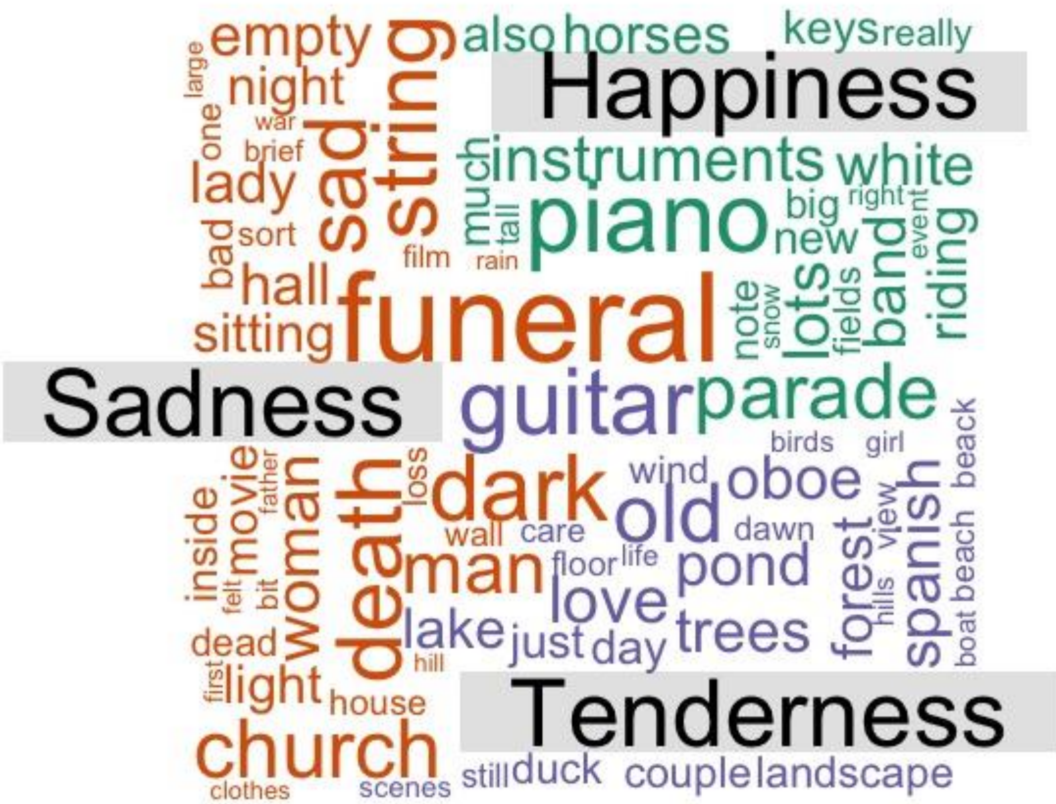


Figure 4. Word cloud of most frequent VMI words grouped by musical stimuli emotion category.

Chapter 3: General Discussion

3.1 Introduction

The aim of the current research project was to investigate the differing effects that cognitive distractor tasks may have on self-reported VMI and felt emotion ratings during music listening. The primary hypothesis of the study was that a visuospatial eye-movement task would perform the best in reducing instances of VMI, followed by a dynamic visual noise task showing an intermediary performance, with an articulatory verbal task performing the worst in reducing instances of VMI. As an additional exploratory aim, descriptions of VMI experiences were also obtained in order to understand the content of the VMI that participants would experience in response to music.

The current results show that the AS task was most effective in producing lower ratings of VMI, when compared to the EM which followed, and with the DVN which produced the highest ratings of VMI by exhibiting high ratings in PCI-Prevalence and PCI-Vividness. These findings are not entirely in line with the initial hypothesis. Despite the EM showing effective VMI suppression, which could be accounted for by the excessive cognitive load that the task posed, the AS was expected to lie at the opposite end of the spectrum, as previous research has found in several instances (Andrade et al., 1997; Kavanagh et al., 2001; Kemps & Tiggemann, 2007; van den Hout et al., 2001). With regard to the felt emotion ratings, similar effects were not found to the same extent across the items, except for felt tenderness showing differences specifically between the AS and EM conditions. This result here suggests that the intensity of felt tenderness was suppressed most significantly during music listening whilst carrying out a verbal task in which you are repeating a nonsense syllables, as opposed to during an eye-movement task which seemed to have little effect. However, there is no discernible overall trend being displayed by the felt emotion ratings, reflecting neither the primary hypothesis nor the trend exhibited by the VMI ratings. As indicated in the felt emotion mean values shown in Table 2, it is evident that participants had rated their felt emotions rather similarly across conditions, thus making it difficult to find any impact between the task manipulations on emotional response. Therefore, it can be preliminarily suggested that the suppression tasks were more effective in influencing VMI ratings than felt emotion ratings, reinforcing the notion that VMI and music-induced emotion display an intricate relationship where the causal relationship remains increasingly unclear.

With regard to previous clinical research, the current study majorly conflicts with previous findings despite the usage of similar paradigms and intentions. It is clear that the findings did not follow the principles behind modality-specific interference and in fact behaved in the opposite manner. In contrast with the findings of Kemps and Tiggemann (2007), for example, the current results were unable to replicate that the AS task would be ineffective in reducing VMI ratings. When compared to the mean PCI-Prevalence ratings found in the control condition from Hashim et al. (in review), it is evident that eye-movements have a great potential to reduce the instances of music-induced VMI, supporting several examples of previous clinical research (Andrade et al., 1997; Kavanagh et al., 2001; van den Hout et al., 2001). Previous research on the effects of the DVN on disrupting VMI formation have also shown promising effects (McConnell & Quinn, 2004; Quinn & McConnell, 1996). Despite these, however, Borst et al. (2012) provide some insight into why one might face difficulties in finding interference effects using a DVN task. They suggest that given the likelihood that VMI will be depictive of a particular scene or object, then using a visually unstructured (and thus non-depictive) series of changing squares should cause very little disruption (Andrade et al., 2002). They confirmed this theory but finding that structured (as opposed to unstructured) visual patterns interfered with VMI of letters. Conversely, Parker and Dagnall (2009) found that the DVN task is able to interfere with recalled concrete words (e.g. chair, house, etc.) than abstract words (e.g. justice, honesty, etc.), due to the visual processes involved in recalling the nature of the concrete word. It is evident that research support thus far has sought to interfere with VMI in the form of past memories, which begs the question about whether certain interference techniques may be most effective for VMI recalled from long term memory stores – a feasible endeavour for future music cognition research to take regarding musically triggered autobiographical memories.

The current research has posed interesting questions additional to those that previous clinical research has offered. Within the context of music cognition, considering alternative modes of VMI interference, or at least certain modifications to the current ones, could be considered for future investigations. Depending on the theoretical approach to the sub-components of the VSSP, many researchers have opted to assessing primarily spatially-oriented tasks for the aim of VSSP interference (Allen et al., 2015). Some have found evidence that an eye-movement task is in fact more able in disrupting spatial imagery rather than VMI in general. de Vito et al. (2014) argue that their eye-movement task had no effect on disrupting visual object imagery due to its depictive nature, which is in direct contrast with previously mentioned DVN literature. Nevertheless, in opposition with this, van den Hout et al. (2001) found that eye-movements were superior to a spatial finger tapping task in reducing the vividness and emotionality of negative as well as positive recollections. Furthermore, Postle et al. (2006) suggest that it is the control of voluntary eye-movements that produce the most VMI interference due to the regulation of such movements sharing common characteristics with imaginal information retrieval processes. Other researchers have explored other means of visuospatial suppression. Stuart et al. (2006) asked participants to construct small pyramids and cubes out of plasticine modelling clay following watching a trauma film of a road accident. They found clay modelling to hinder the development of intrusive memories following the trauma film, compared to a no-task control. Moreover, Krans et al. (2010) asked participants to listen to a verbal trauma report whilst either modelling clay, carrying out an articulatory suppression task, or in a no-task control. They found intrusive VMI and feelings of negative emotions in response to listening to the verbal report were reduced in both the visuospatial and the verbal tasks. All in all, despite clear trends in the effectiveness of different visuospatial tasks, there is still little consensus on the extent of the benefits of certain tasks over others in response to intrusive VMI. Whilst the current findings also demonstrate some conflict in comparison to most clinical research, further understanding into the VMI produced by music would be important for subsequently ascertaining the most appropriate distraction strategy.

The current findings have demonstrated preliminary insights into the effects of music-induced VMI suppression. However, given the unexpected similarities in VMI interference between the EM and AS conditions it is unclear whether the effects found were really due to the nature of the distraction tasks themselves or due to mere distraction effects and shifts in attention. Furthermore, it is highly possible that the effectiveness of the EM task was in fact hindered by the addition of the catch trial, which was meant to maintain task compliance. It is likely that as the participants were required to retain the colour of the catch trial until after listening introduced a memory component thus interfering with the primary purpose of the task. The implications of this would mean that the VSSP was perhaps never isolated as was intended. Nevertheless, such tasks are a novel methodological technique for music cognition, but it is unclear whether music listening presents itself to be attentionally distracting to the extent that this interacts with additional cognitive interference in an unprecedented way. At least within the context of clinical research, several researchers have addressed this issue (Stuart et al., 2006). Holmes et al. (2004) investigated whether increasing the difficulty of a tapping task, from simple to practiced complex to unpractised complex levels, would lead to increased levels of intrusive VMI disruption. They found disruption levels to linearly increase as task difficulty increased, even when the task was sufficiently over-practised. Using a different approach, Elliott et al. (2014) asked whether using multiple types of interference methods would hinder response time performance on four variations of the Stroop task. They found that coupling an auditory task with a multi-modal version of the Stroop task reduced interference effects. These authors and others believe that such effects may be due to the simultaneous over-integration of differing modalities (Gibney et al., 2017); an effect of dilution whereby tasks eventually begin to pose attentional demands outside the researcher’s primary intentions (Kahneman & Chajczyk, 1983).

It is of no surprise that the VMI item Control used here was unreliable in showing any consistent effects due to its underuse in research providing little knowledge on the nature of the item. Control of VMI refers to whether an individual experienced an image appearing into their head spontaneously or whether they controlled and purposely thought of the image. This definition may be misleading however; even if an image does spontaneously appear in the mind, the individual may still subsequently seek to control and develop that image further. Therefore, it would be unclear what the true controllability of the VMI would be and how a participant might rate it. Thus, the task may be phenomenologically counterintuitive. In another sense, the issues surrounding control of VMI could be down to terminological and definitional inaccuracies. Some researchers have defined control differently. Richardson (1977) acknowledges control of VMI as the ability to change, manipulate and replace a given mental image at will. The importance of control is readily acknowledged in literature. Lorenz and Neisser (1985) were able to distinctly identify control as a VMI component, as well as vividness, spontaneous elaboration, spatial manipulation and childhood memory. However, others have approached obtaining this information in different, possibly more approachable ways. Pearson et al. (2011) investigated into whether individuals are able to relay their internally generated experiences, including mental imagery. They asked participants to rate the vividness of their imagery and how effortful generating the image was. They show that metacognitive awareness and evaluation are better predicted by vividness than self-reported effort, suggesting clear distinctions between perception and mental imagery. The ability to reliably measure control will be greatly beneficial for future research into VMI, and subsequent studies may consider contrasting different terminology with which to obtain such data with the potential aim of distinguishing between voluntary and involuntary VMI.

A further exploratory aim of the current study was to examine the types of VMI participants tend to experience during music listening. Through observation of the word cloud in Figure 1, it is clear that the musical stimuli under each emotion category evoked a number of different VMI themes. The most frequent words in the Happiness group often refer to the instrumentation present in the music, suggesting that VMI may have included images of the performer playing. Words in the Tenderness group appeared to offer more landscape VMI, referring to concrete features of natural scenery. The Sadness group appeared to evoke more abstract VMI, with complex notions associated with ‘death’, ‘dark’, ‘empty’ and ‘sad’ being some of the most prominent.

Further examination of the types of VMI that participants tend to experience to music would call into question certain cross-modal interactions (Spence, 2011). Are participants’ VMI experiences primarily visual in nature or simply an intuitive *feeling*? Research into musical narratives has acknowledged that certain individuals formulate mental ‘stories’ in response to music (Dukic et al., 2019; Margulis, 2017). Others have highlighted that musicians and non-musicians tend to visualise music differently. Tan and Kelly (2004) found that 30% of participants described pictorial representations and 70% abstract representations. They showed that musicians tended to focus more on the intrinsic musical features and usually focused their attention on one aspect, whereas non-musicians focused on the emotional content of the music and were more flexible in the musical features to address. As a result, they were able to identify four styles of representation, atmosphere, terrain, landmarks, and structure. The notion that the combination of music listening and visual stimuli eliciting emotional responses has also received research support. Geringer et al. (1997) asked participants to answer cognitive and affective questions to three conditions: music only, music shown with an orchestral performance video, and music shown with an animation video of a story. In terms of affect ratings, they found the music-animation condition to consistently score the highest compared to the other conditions. Neuroimaging research has also revealed similar findings from the combination of music with visual stimuli on brain areas responsible for emotion processing, compared to when listening to music alone (Eldar et al., 2007). Whilst it is evident that there is a fascinating cross-modal interaction between auditory and visual stimuli, further research into the content and emotionality of VMI occurring more spontaneously will expand our knowledge on additional common themes that can be uncovered from music-induced VMI, encouraging more consistency across investigations.

3.2 Implications of the Research

Some researchers have sought to investigate further mechanisms on their effect on music-induced emotion, which opens questions into whether a similar methodology as the one used here may be applied to other mechanisms in the BRECVEMA framework (Juslin, 2013b; Juslin & Västfjäll, 2008). As most of previous clinical studies have focused on interfering with memory recall, episodic memory lends itself to be a likely candidate for the research into understanding music-induced emotion. Moreover, Miu and Baltes (2012) offer a strong link between empathy and music-induced emotions by asking participants to listen with either high empathy or low empathy. They found that participants listening with high empathy reported feeling emotions that were similar to the emotional content of the music being performed. Furthermore, Baltes and Miu (2014) suggest that empathy and VMI may be more closely related than one might think. Participants attended a showing of the opera, Madame Butterfly, and were asked to complete the GEMS-9 in between acts. They also completed the VVIQ to assess their VMI and the Trait Empathy Questionnaire (TEQ) a few days prior. They found empathy, VMI and mood to predict up to 20% of the emotions reported in response to the opera performance. Alternatively, some have enquired into whether amplification may reach a similar goal as interference research (Holmes et al., 2008; Renner et al., 2019). Vuoskoski and Eerola (2015) provided participants either with a negative or a neutral contextual description of a sad-sounding piece of music, with the aim of examining whether the descriptions will affect subsequent emotional responses due to the corresponding VMI induced. They found that the negative description enhanced feelings of sadness by intensifying immersion into the music, and that 80% of participants reported experiencing VMI during the study. It is clear that there is much potential using other mechanisms for suppression/amplification designs, where future research must select the suitable approach with which to execute this.

In unpacking how visualisers may possess differential abilities in responding to music and their emotional reactions, it would be fruitful to consider individual differences between those that generally experience a great deal of VMI, and those that do not. Within the context of this study, it is possible that low visualisers would show no differences between experimental and control conditions, whereas high visualisers would show greater VMI ratings during controls and greater interference during the experimental condition. It has been stated previously that high and low visualisers use distinct cognitive strategic processes during VMI tasks (Gur & Hilgard, 1975; Rodway et al., 2006; Sheehan, 1967). For instance, D'Argembeau and Van der Linden (2006) assessed individuals' abilities for 'mental time travel' into the past and future between high and low visualisers, as determined by the VVIQ. They found that higher visualisers associated their past and future events with increased visual and other sensory details such as time and spatial information, whereas low visualisers seemed to exhibit emotion suppression strategies that led to decreases in reported characteristics of their past and future events. Furthermore, Keogh and Pearson (2011) found that these specific introspective differences help to reflect their differing strategies for visual working memory. During a binocular rivalry task, they found that adjusting background luminance affected high visualisers' performance in visual working memory and imagery tasks but did not affect memory for number-strings. Whereas, low visualisers were largely unaffected, suggesting they utilise linguistically based strategies. These strategic differences have also been highlighted through brain imaging research. Logie et al. (2011b) found that, despite showing little differences in response times during a mental rotation task, high imagers performed better than low imagers in angle rotation accuracy. During the task, high imagers also exhibited more brain activation in the premotor cortex, whereas low imagers showed more activation in the supplementary motor area, supporting the notion that high and low imagers use different mental strategies to execute the same task. Investigating these individual differences will surely expand our understanding of the different behaviours and distinct neural patterns pertaining to participating in VMI within multiple contexts, especially during music. Coupling this knowledge with the vast research on music-induced emotions will address key questions into the influence of individual differences on behaviour.

Furthermore, the qualitative data that has been collected in this survey holds potential for further and more sophisticated analyses involving thematic extraction. In doing so, this would offer implications in identifying the particular functions that VMI may have in our relationship with music and its interactions with our felt emotions. In a recent survey study by Küssner and Eerola (2019), they sought to understand the content, prevalence and function of VMI during music listening. Over 600 participants completed questions regarding their visualisations to music, the VVIQ, musical expertise questions, and about their interactions with the arts. Cluster and factor analyses revealed two prominent components of music-induced VMI, Vivid Visual Imagery and Soothing Visual Imagery. They also found that those with high and low musical expertise both used music for calmness and relaxation, whereas those with high expertise also used music for energy. To a similar end, Schaerlaeken et al. (2019) examined musical meaning from the metaphors present in the music descriptions of musicians and non-musicians They were able to create a dimensional model characterising five factors on the experience of VMI during music listening: Flow, Movement, Force, Interior, and Wandering. In contrast with Küssner and Eerola’s survey, they were unable to find any apparent differences between the ratings of musicians and non-musicians. Such investigations into the functions and content of VMI are still very limited in scope, but continued interest in qualitative investigations into VMI is important to develop our understanding into VMI and music-induced emotions. What these studies also suggest is that there is a motivation for incorporating musical expertise as an individual difference factor, as those with high and low expertise appear to place differing levels of importance on music that can be manifested thought their VMI reports. This research also holds therapeutic implications, such as during guided imagery, for highlighting potential themes present within the unconscious mind as well as the emotions that they might embody and drawing them to the surface.

3.3 Limitations and Future Directions

The current study aimed to theorise the use of the AS task as serving a dual purpose of a comparative distracter task against the EM and DVN tasks, and as a control task due to the significant body of previous literature into the ineffectiveness of verbal tasks on VMI suppression. The findings show that this was in fact not the case, instead suggesting that the visual DVN task was the most poorly performing VMI distractor task. This is one of the most striking issues of the current research, and further revisions of the design whereby a no-task control condition is incorporated alongside a revised set of experimental interference tasks would surely provide more conclusive results regarding the initial aims of this study. It is very clear from the current findings that the decision not to include an explicit control condition meant that it was difficult to find any clear indications of manipulation effects between each of the suppression tasks. Therefore, the current design is highly lacking in its ability to comment more conclusively on the causal relationship between VMI and music-induced emotion. However, it has provided a robust theoretical foundation for modified follow-up investigations to continue to closely examine the interwoven relationship between VMI and music-induced emotion.

A further limitation of the current research may be attributed to the choice of using musical stimuli taken from film. It is likely that many VMI reports may have been closely associated with musical tropes and patterns usually found in film music scores and visual scenes. One issue could be familiarity with the music, but even if the participant is unfamiliar with the origin of a particular piece of music, certain characteristics are highly recognisable. The authors of the music collection, Eerola and Vuoskoski (2011), did acknowledge this caveat in their paper, stating that whilst they had tried to avoid familiar excerpts from triggering any episodic memory, it is also difficult to avoid listeners' previous exposures to other music that resemble those in their collection. Despite this, they did find in a pilot study that 89.9% of their participants were unfamiliar with the music, and subsequently discarded those that were familiar. Nevertheless, certain extraneous factors are unavoidable, such as the likelihood of musical expectancy to an extent. In building upon the current study's design, not only would it be useful to obtain familiarity ratings, but further investigations into how VMI is induced using alternative genres of music would also contribute uniquely to the current literature.

Coupling the current design with objective markers of VMI and emotional processing would assist in validating the underlying processes occurring during music-induced VMI, the associated felt emotion, and the effects that a suppression task might have on them. A pathway that has yet to be explored includes incorporating measures of skin conductance (SC) or physiological ‘chills’ with self-reported VMI ratings. Furthermore, pupil dilation might offer some insight into how music-induced VMI can relate to indications of arousal, and possibly feelings of absorption (Lange et al., 2017). For example, Vroegh (2019) aimed to further elucidate the relationship between VMI and music-induced emotion by considering different types of absorption. Participants listened to self-selected music that they found particularly engaging, then completed two scales on absorption and consciousness. He identified two types of absorption, zoning in and tuning in, as well as identified several distinct factors related to meta-awareness and consciousness, each holding a unique link with the imagery and emotion factors. Furthermore, Bannister and Eerola (2018) investigated the suppression of musical chills by removing predefine chills moments in well-known songs. Participants listened to normal and manipulated versions of music whilst self-reports (including GEMS and emotional intensity) and SC were measured. Whilst overall felt emotion did not change between conditions, chills frequency and continuous SC measurements consistently reduced in the manipulated condition. Although emotion was unaffected by chills suppression in this particular study, continuous SC measurements could be assessed using visuospatial interference on VMI and felt emotion during music listening in order to understand how physiological chills coincides with VMI. Given the growing literature into VMI and its relationship with emotion, there is still great potential in what objective markers may convey about internal and automatic responses toward music-induced VMI.

3.4 Conclusion

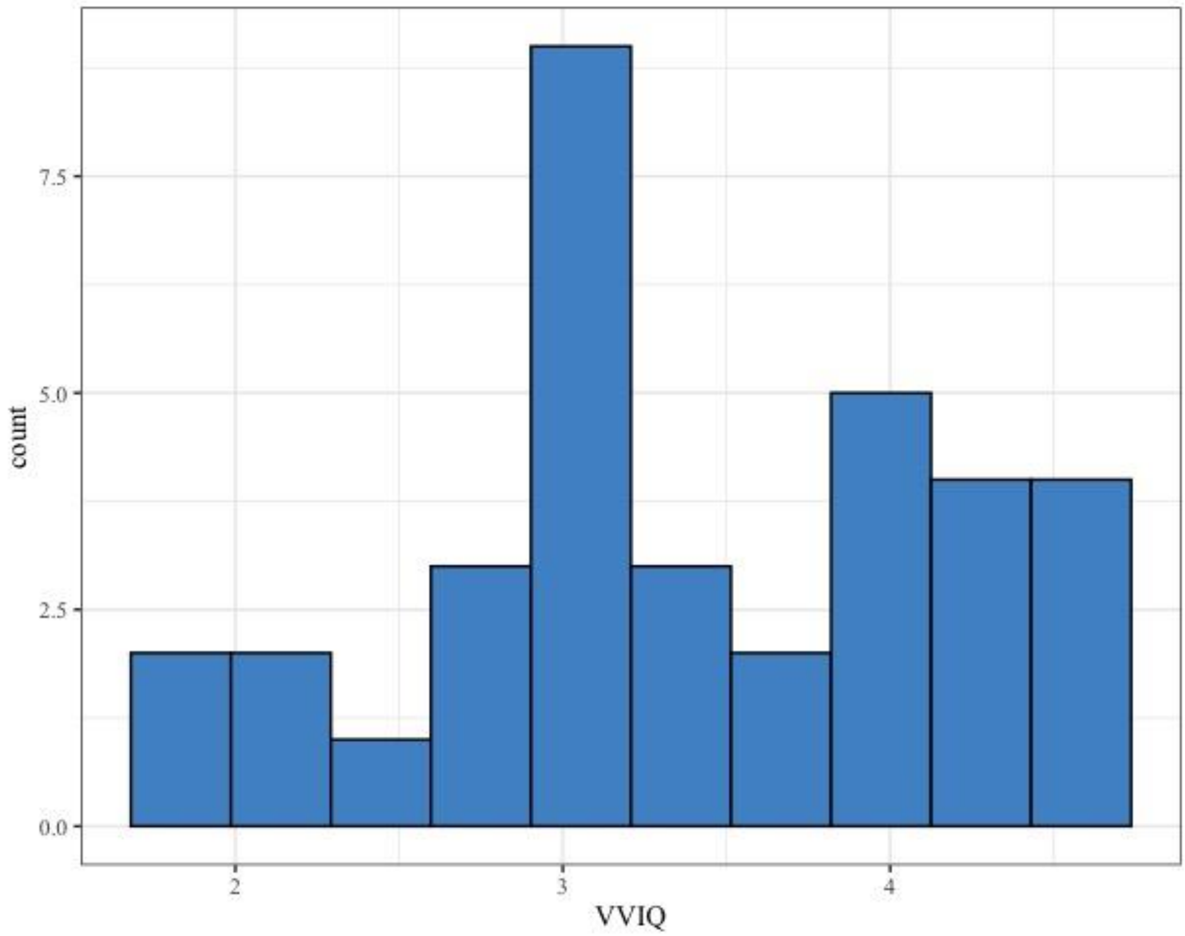
In conclusion, the present thesis has produced a number of useful insights into the relationship between music and VMI and has contributed in introducing a novel methodology to music cognition. The findings show that there is potential for VMI suppression during music listening, with minimal changes in subsequent emotional response. In contrast, with several examples of previous research, the tasks used in this study resulted in almost an inverse of the initial expectations, with an articulatory verbal task affecting instances of VMI the most, closely followed by a visuospatial eye-movement task, followed by a dynamic visual noise task performing the worst. Although felt emotion ratings did not produce the expected differences, this further emphasises the need for careful considerations into how induced emotion is measured to optimise the findings. As previous studies used memory recall as their dependant variable of focus, it is possible that differing mechanisms are utilised in comparison to spontaneous VMI production during music listening. This research contributes to our understanding of VMI generated during music listening, and the frequency of the descriptive content reported. Furthermore, the study has highlighted several pathways for future investigations to take. Additional research in conjunction with this particular methodology might focus on the influence of musical features, potential modulations to the interference tasks, closer examination of the differences in thematic content of music-induced VMI, and, finally, the implementation of psychophysiological markers in conjunction with VMI induction during music listening.

Appendices

Appendix 1 – List of musical stimuli used in the current study, complete with collection (~360) number, emotion, album name, track number, and soundtrack time frame.

No.	Emotion	Album Name	Track	Min:Sec
012	Happy	Shine	13	00:00 – 00:20
015	Happy	Big Fish	21	00:00 – 00:15
026	Happy	The English Patient	7	00:33 – 00:58
030	Happy	The English Patient	7	00:00 – 00:31
038	Sad	Psycho	3	00:58 – 01:24
041	Sad	Big Fish	22	00:00 – 00:20
044	Sad	Gladiator	7	02:15 – 02:38
063	Tender	Running Scared	2	00:00 – 00:25
073	Tender	Man of Galilee CD1	7	02:28 – 02:53
075	Tender	Nostradamus	14	00:54 – 01:17
H2	Happy	Dances with Wolves	10	00:00 – 00:46
H3	Happy	The Untouchables	6	01:26 – 02:06
S1	Sad	The English Patient	18	00:00 – 00:59
S2	Sad	The Portrait of a Lady	9	00:00 – 00:23
S3	Sad	Running Scared	15	01:45 – 02:40
T1	Tender	The Portrait of a Lady	3	00:23 – 01:08
T3	Tender	Pride & Prejudice	1	00:10 – 00:49
T4	Tender	The Godfather III	5	01:13 – 02:19

Appendix 2 – Histogram distribution of VVIQ mean scores across all participants.



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