2013

The effect of background music on emotional processing : evaluation using a dot probe paradigm

Haans Drieberg
Edith Cowan University

2013

The effect of background music on emotional processing : evaluation using a dot probe paradigm

Haans Drieberg
Edith Cowan University

The Effect of Background Music on Emotional Processing:

Evaluation Using a Dot Probe Paradigm

Haans Drieberg

A Report Submitted in Partial Fulfilment of the Requirements for the Award of Bachelor of Arts (Psychology) Honours, Faculty of Health, Engineering and Science,

Edith Cowan University.

Submitted October, 2013

I declare that this written assignment is my own work and does not include:

(i) material from published sources used without proper acknowledgement; or

(ii) material copied from the work of other students.

Signed: [redacted]

Date: 27/10/2013

The Effect of Background Music on Emotional Processing: Evaluation Using a Dot Probe Paradigm

Abstract

Music plays an important role in all of the world's cultures, and background music is an ever-present phenomenon. Despite this, few studies have formally addressed whether background music influences the way people think. The aim of this study was to discover whether the presence of background music can influence cognition. Specifically, the differential effects of music rated as being positive (inducing happy emotions) and negative (inducing anxiety) on a person's allocation of attention was investigated. A dot probe task with positive and negative word pairings, matched for length and frequency was used in order to test the hypotheses that the presence of negative music would increase a person's tendency to notice threatening words, and happy music would decrease this tendency. Each participant performed the task in silence. Following this, they were required to perform the task again in the presence of positive background music, and then again in the presence of negative background music. The mean reaction times for each of the musical conditions was recorded and compared. The data failed to support these hypotheses. It was concluded that if positive and negative background music does differentially influence attention, it happens at a later processing stage rather than at the initial orienting stage. Future research directions are briefly discussed.

COPYRIGHT AND ACCESS DECLARATION

I certify that this thesis does not, to the best of my knowledge and belief:

(i) *Incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education;*

(ii) *Contain any material previously published or written by another person except where due reference is made in the text; or*

(iii) *Contain any defamatory material.*

(iv) *Contain any data that has not been collected in a manner consistent with ethics approval*

Signed: [redacted]

Date: 27/10/2013

Acknowledgements

I would like to give my sincere thanks to:

Professor Craig Speelman for his expert advice, encouragement, patience and support.

All the friends, students of Edith Cowan University, family and other participants who generously gave their time to take part in the research.

Andrew P and Andrew P for their help with the computer software troubleshooting at the start of this project.

My father and mother who always gave me encouragement, and were the first to introduce me to the world of music.

Elizabeth, Daniel and Joel, for giving me time, coffee and encouragement.

This project is dedicated to my mother who sadly passed away before seeing its final draft.

Table of Contents

The Effect of Background Music on Emotional Processing: Evaluation Using a Dot Probe Paradigm

Does background music influence our thoughts, or is it merely an external stimulus we can filter out when we choose to? Can happy music really make us feel happy, and if we are happy are we less likely to notice danger? Conversely, will hearing fearful music make us more vigilant in assessing our environment for threat? Such questions concern the potential influence of background music on our emotions and cognition.

Music is a ubiquitous element of our society, and has been found in all known human cultures throughout history (McDermott, 2008). According to Rentfrow and Gosling (2003), more people engage in music listening as a leisure activity than television watching, reading books or watching movies. Few things have the power of the sound of a national anthem to quell the din of a thousand sports fans. Archaeological evidence of musical instruments is suggestive that music-making is at least 40,000 years old (Fitch, 2006). Some theorists believe that music may be an evolutionary adaptation, shaped directly by natural selection (Andrade & Bhattacharya, 2003; Huron, 2001), while Justus and Hutsler (2005) argue that music is more likely an exaptation, a by-product of culture. It can be speculated that music originated from the early verbal exchanges between mothers and babies (Dissanayake, 2008, 2012). While acknowledging its aesthetic qualities, Kant (1724-1804) commented that music performed no higher function, but merely "played with the senses" (Kant, 1790/2007). Pearce and Rohrmeier (2012) comment that in many ways, music is as complex as language, and involves a large number of brain resources in its perception and production. Despite the lack of consensus regarding the origins and evolutionary purpose of music, its pervasiveness and the importance of the many roles it plays in society highlights a need to understand whether music influences cognition.

The current research sought to answer the question of whether different kinds of background music can influence our ability to attend to certain aspects of our environment. Specifically, the notion that music can induce particular emotions in individuals that would then facilitate or inhibit detection of potentially threatening environmental stimuli was explored using a dot probe paradigm, which has proven to be effective in assessing how an individual allocates attention.

As a preliminary to the current experiment, it was important to undertake an examination of the academic literature in order to determine if music could affect emotional change in an individual. Following this, the question of whether emotion could exert an influence on an individual's cognitive process was addressed.

Can Music Influence Emotion?

Dating back to at least the times of the Ancient Greeks, many people have held the notion that different combinations of musical tones had emotive capacities. Plato (428 - 347 BC) affirmed that music had the power to convey emotions, which in turn exerted an influence on the emotions and characters of individuals (Stamou, 2002). One of the founding fathers of humanistic psychology, Abraham Maslow (1908-1970), believed that listening to music was one of the easiest ways of achieving 'peak experiences' which can be characterised as being emotion-laden and absorbing states of extreme intensity (Gabrielsson, 2002b).

Hevner (1937) conducted experiments where short musical excerpts were manipulated on variables such as tempo, tonality (major/ minor harmonisations) and rhythm. When played to a group of listeners who were asked to assess the music by choosing from a list of adjectives describing different emotions (such as *humorous, sad* or *agitated*), a strong uniformity was noted in responses, particularly with regard to the differential nature of music with predominantly major or minor harmonies. This was a continuation of previous investigations by the same author (Hevner, 1935) in which an overwhelming majority of listeners described music written in major keys as being sweet and happy, whereas music in minor keys tended to be dark and sorrowful. While the findings of Hevner (1937) offer compelling evidence that music can convey a sense of emotion, it does not confer upon the music an ability to *induce* those feelings upon the listener.

A distinction needs to be made between *perceived* emotion and *felt* emotion (Schubert, 2007). For example, it is plausible that a listener will be able to appraise a piece of music as conveying a sense of sadness, but remain emotionally unmoved (Hunter, Schellenberg, & Schimmack, 2010). Several studies have focussed on the difference between perceived and felt musical emotions (for example, Gabrielsson (2002a); Kallinen and Ravaja (2006)). While Krumhansl (1997) found that there was a general consistency amongst listeners pertaining to the perceived emotions of music, Kawakami, Furukawa, Katahira, and Okanoya (2013) found that music perceived as sad can have the consequence of inducing pleasant felt emotions. They propose that this may be a reason why people often listen to sad music. These findings are supported by the research by Gabrielsson (2002a). However, in a similar study, Garrido and Schubert (2013) found that listeners had increased levels of depression after listening to self-selected sad music. This discrepancy in results highlights the role of individual differences with respect to affective responses to music (Garrido & Schubert, 2011). Because of the potential incongruence between musical emotions felt and perceived, studies relying on participant reporting of emotional responses need to ensure this distinction is made (Vastfjall, 2002).

The ability to provide affective experiences is often given as a primary main reason for music listening among adolescents (Laiho, 2004; Saarikallio, Nieminen, & Brattico, 2013). A qualitative study of the role music plays in mood regulation by Saarikallio and Erkkilä (2007) revealed that among adolescents, music is regularly used as a means to strengthen positive feelings and escape from negative ones. The participants in their study often listened to mood-congruent music and reported wanting to become immersed with their feelings and sensations created by the music.

In a qualitative study focussing on the contribution of music to quality of life among older people, Hays and Minichiello (2005) found that the emotional response to music was an important reason for listening. One respondent in their study indicated that music had a strong intellectual and emotional influence on her sense of wellbeing. She commented that without music, a part of her life would be missing. Gabrielsson (2002b) found similar justifications for music listening among older people.

The mood and arousal-inducing capacity of music listening is also implicated in the findings of research by Hallam, Price, and Katsarou (2002). They established that in a sample of young schoolchildren, calm and relaxing background music had a positive effect on school performance and classroom behaviour. Conversely, music perceived as arousing and aggressive had the opposite results. Krahé and Bieneck (2012) extended this research by demonstrating that emotive music had the capacity to influence anger and provoke aggressive behaviour by eliciting negative mood, which in turn lead to aggression-related responses.

In a study by Laukka and Quick (2011) it was discovered that during pre-event preparations, elite athletes often listen to music. The main reasons given by the athletes was that they felt the music helped to increase pre-event alertness, motivation, performance levels, as well as helping them achieve a state of flow. Similar conclusions pertaining to music listening by athletes were arrived at by Bishop, Karageorghis, and Loizou (2007) who used qualitative research methods to determine that athletes consciously select music to elicit various emotional states.

Physiological Responses to Emotion in Music

Emotional responses to stimuli in general have been shown to create physiologically measurable changes in individuals. With regard to music, Krumhansl (1997) found differences in psychophysiological measures (such as heart rate, blood pressure, skin conductance, finger temperatures and depth and rate of respiration) between pre-listening conditions and while listening to music. Interestingly, different pieces of music precipitated differential responses on the various measures, leading to the notion that physical changes were mediated by the character of the music, rather than simply a general tendency for any type of music listening to provoke a uniform response.

Sloboda (1991) noted that when asked about intense physical responses to emotional musical passages, more than 80% of those who took part in his study reported shivers down the spine when listening to musical passages containing unexpected harmonies, while passages containing appogiaturas (momentary dissonant harmonies which later resolve to consonant harmonies) tears were most reliably evoked. It was also noted that among amateur choral singers, experiences of emotion while singing occasionally resulted in a 'lump in the throat,' disrupting normal singing mechanisms (Sloboda, 1991).

Neurological Responses to Emotion in Music

Blood and Zatorre (2001) used positron emission tomography in order to investigate neural mechanisms underlying emotional responses to music. They found that when listening to music that was self-selected for being intensely enjoyable and pleasant, participants in their study showed activation in key areas of the brain that are triggered in response to other euphoria-inducing stimuli such as food, sex and addictive drugs. In a similar study using functional magnetic resonance imaging by Koelsch, Fritz, Müller, and Friederici (2006), it was found that the activation of brain regions was different for dissonant than consonant music. In their study, Koelsch et al. presented listeners with two versions of the same pieces of music. One was manipulated to include a simultaneously playing pitch-shifted parallel of the original piece of music, resulting in music the participants described as being unpleasant.

It was found that the dissonant music activated areas of the brain that have been implicated in the processing of negatively-valenced stimuli.

Wieser, Hungerbühler, Siegel, and Buck (1997) discuss a condition known as musicogenic epilepsy, where seizures are cued exclusively by listening to music. While considered a relatively rare condition, Sacks (2006) suggests that 'formes frustes' or attenuated manifestations of the condition may be relatively common. He proposes that susceptible individuals may initially feel uncomfortable, causing them to turn off or retreat from the precipitating music before a full-blown seizure takes place. Wieser et al. (1997) note in their review of the musicogenic epilepsy literature that the emotional content of the music appears to be significant, leading to speculation that the pathogenesis of the condition lies in the affective capacity rather than the pure auditory content of the music.

Mechanisms of Music's Emotive Capacity

A debate concerning the underlying mechanisms that contribute to an individual's emotional response to music centres on whether music itself produces emotional change in a listener (the 'emotivist' perspective) or whether music simply express emotions that listeners recognise (the 'cognitivist' perspective) (for a more in-depth account of these two perspectives, see Krumhansl (1997); Radford (1989)).

In studies by Nawrot (2003) and Zentner and Kagan (1996), it was demonstrated that infants less than one year old tended to react differently depending on whether they were played dissonant or consonant music. While it cannot be said that the infants were able to understand the emotional content of the music, the fact that they showed contrasting behaviours to the different musical examples suggests that infants are born with, or develop very early an ability to discriminate between consonant and dissonant music. Masataka (1999) showed that 2-day-old hearing infants of deaf parents have a preference for singing that is higher in pitch and slower in tempo - a common feature of lullabies. Given the ages of the infants in these studies, it is unlikely that this discriminative ability is a product of acculturation. This would be to some extent in support of the emotivist perspective of music emotion.

From a more cognitivist viewpoint, Västfjäll (2002) suggests that sometimes it may not be the purely audio component of music that affects emotion, but music's ability to take a listener to a previous experience (i.e. activate a memory of an emotional experience) which then triggers an emotional response. Sloboda and O'Neill (2001) offer similar ideas, suggesting that in many instances, interplay between memory and affective processes are quite likely. Juslin and Västfjäll (2008) posit a system based on contagion, where a piece of music is perceived as being representative of a particular emotion, and that causes a process of internal mimicry which directly activates relevant emotional representations in the brain, leading to an induction of an analogous emotion. Regardless of the underlying mechanics, or which side of the emotivist/cognitivist debate one is situated, the view that music listening has the capacity to influence emotions has widespread support within the research community.

Kreutz, Ott, Teichmann, Osawa, and Vaitl (2008) examined the viability of using music as a means of emotion induction in a laboratory setting. They found that music was a reliable form of stimulus, with the strongest effect being for induction of happy and peaceful emotions. A meta-analysis of experimental emotion elicitations by Lench, Flores, and Bench (2011) found that the efficiency of music to induce emotions in laboratory settings was comparable to other established methods such as those employing emotionally valenced pictures and films. Västfjäll (2002) cautions that experimenters using music containing sung words need to be mindful that listeners may be primed by the affective content of the lyrics rather than just the musical component.

Can Emotion Influence Cognition?

Beck (1991) argues that the term 'cognition' refers to various processes in information processing, such as perception, interpretation and recall. He postulates that cognition, affect and motivation are all interconnected, and a change in one may be reflected in reciprocal changes in the others.

The relationship between emotion and cognition has attracted much research attention. For example, emotion has been shown to be an important influence in the encoding and retrieval of memories (Bower, 1981; LaBar & Cabeza, 2006; Lyubomirsky, Caldwell, & Nolen-Hoeksema, 1998; Schacter, 1999). Mild positive affect has been shown to promote effective decision making by encouraging cognitive flexibility, where an individual is better equipped to consider multiple aspects of a situation (Isen, Daubman, & Nowicki, 1987). It has also been demonstrated that the presence of positive affect can improve coping skills when faced with negative materials or stressful situations such as serious illness (Aspinwall & MacNamara, 2005).

Central to many aspects of human cognition is the concept of attention. Attention may be defined as the process of concentrating on specific features of one's environment, often to the exclusion of other environmental features (Goldstein, 2008). One of the most widely used paradigms in the investigation of attentional processes is the Stroop task. The task requires an individual to identify the colour of the ink used in a word or non-word. Stroop (1935) discovered that colour naming took longer for words than non-words. He found that the colour naming slowed to an even greater degree if the letters of the word spell an incongruent colour (for example, if the word *blue* is written in red ink) as opposed to if it were written in blue ink. In other words, the semantic information of the written word was thought to capture the attention of the subject, leading to an interference with the primary task of colour naming (Stroop, 1935).

This notion that the meaning of the carrier word was the source of interference precipitated a number of research designs where the effect of manipulating the semantic information in the words was investigated. Klein (1964) noted that any word produced greater interference than a series of non-letter symbols. However, it was observed that the level of interference was governed by the relative meaningfulness of the words. The more easily a word could be associated with a colour (e.g., the words *lemon, sky, fire, grass*) the more marked the interference effect when paired with incongruent ink colours.

The Emotional Stroop Task

Several researchers investigated the differential interference effects of neutral words and words relating to negative emotions (see Williams, Mathews, and MacLeod (1996) for a review). This has given rise to the emotional Stroop task, which is commonly used to assess attentional processes as a function of emotion. Researchers have generally found that there is a greater interference effect when colour naming is coupled with a negatively valenced word than with a neutral word, although the precise mechanisms leading to this have divided opinions (for example, see Estes and Adelman (2008) and Larsen, Mercer, Balota, and Strube (2008)). This is in accord with the earlier findings of Jung (1910) which indicate that negative emotional words elicit longer reaction times during free association tasks, as well as the findings of Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) which show that negative information is commonly processed slower and more fully than positive information.

A number of studies have shown that the level of interference for threat words is often associated with the relatedness of material to personal concerns. For example, Ashley, Honzel, Larsen, Justus, and Swick (2013) showed that war veterans with Post-traumatic stress disorder displayed a unique bias for trauma-related words, but not all negative words in general. Similar domain-specific attentional biases have been observed in populations diagnosed with generalised anxiety disorder (Mathews & Klug, 1993), spider phobia (Lavy, van den Hout, & Arntz, 1993), rape victims (Foa, Feske, Murdock, Kozak, & McCarthy, 1991) as well as social phobia (Maidenberg, Chen, Craske, Bohn, & Bystritsky, 1996) and major depressive disorder (Gotlib et al., 2004). Interestingly, Kuhl and Kazén (1999) found that levels of Stroop interference could be reduced under induction of positive affect.

While emotional Stroop tasks are regularly used in researching patterns of attention in clinical populations, several studies have employed them to assess attention in non-clinical populations (e.g. Dresler, Mériau, Heekeren, & van der Meer, 2009; Fox, Russo, Bowles, & Dutton, 2001; Kuhl & Kazén, 1999; MacLeod & Rutherford, 1992; Richards, French, Johnson, Naparstek, & Williams, 1992).Typically, subjects undergo some sort of mood manipulation (such as modifying levels of state anxiety), and Stroop interference levels are compared with results from controls.

Criticisms of the Emotional Stroop Task

The emotional Stroop paradigm has attracted some criticism. Algom, Chajut, and Lev (2004) comment that a key requirement of any task designed to measure a Stroop interference effect is a relationship between the two presented stimuli. With the potential to draw a logical relationship between the two stimuli, a situation of congruence or incongruence can be offered. The Stroop effect is the decreased speed in correctly identifying the colour of a word if the letters of the word spell an incongruent colour (e.g. the word *blue* printed in red ink). This is often interpreted as the participant not being able to exclusively focus on the target dimension of colour when the semantic value of the word is in conflict, thereby compromising colour-naming efficiency (Algom et al., 2004; McKenna & Sharma, 2004). In the original Stroop (1935) conception, there is a logical relationship between the colour stimulus and the word stimulus. The emotional Stroop paradigm typically has no relationship between colours and the meanings of the accompanying threat words (e.g. the colour blue and the word *cancer* bear little similarity).

In the original, or "classic" Stroop paradigm, the lack of a noticeable delay in colour naming for incongruent trials may be interpreted as a consequence of the participant ignoring the meaning of the written word. However, if there is a lack of delay in colour naming for emotional words in an emotional Stroop task, it could be argued that both emotional and neutral words are being ignored to the same extent (Algom et al., 2004). This may call into question the emotional Stroop paradigm's effectiveness as a tool in the assessment of the direction of one's initial attention.

Mogg and Bradley (1998) posit that when an anxious individual sees a negative word cue, it temporarily increases levels of anxiety and consequently disrupts task performance. This in turn can lead to a slowing down in colour naming. McKenna and Sharma (2004) demonstrated that in emotional Stroop designs where there are a mix of emotional and neutral words in the same block of trials, a neutral word that follows an emotional word can also show a latency effect. They discuss this phenomenon in terms of two separate effects: a *fast* effect, which they explain as a pre-conscious immediate processing of emotional stimuli (and is generally assumed to be the source of interference), and a *slow* effect, which can be conceptualised as a residual emotional effect operating between trials and influencing subsequent neutral words (Frings, Englert, Wentura, & Bermeitinger, 2010; McKenna & Sharma, 2004). Algom et al. (2004) agree with the assertion made by McKenna and Sharma (2004) and note that colour naming was slower, regardless of the valence of the word, if it was *preceded* by an emotional word. Therefore, in a block of trials where there is a mix of emotional and neutral words, the neutral word that follows an emotional word will often show a greater colour-naming latency than the emotional word.

The Dot Probe Task

The dot probe task (also known as the attentional probe or visual probe task) is another research paradigm commonly used to assess the effects of emotion on attention allocation (MacLeod, Mathews, & Tata, 1986). The task involves the simultaneous presentation of a neutral word and a threat word on a computer screen followed by a visual probe which is typically a dot, or a directional arrow pointing left or right (< or >). This probe assumes the place of one of the previous words. Participants are required to press a key on the computer as soon as they detect the probe. In the case of experiment designs involving the directional arrows, they are required to indicate the direction the arrow is pointing in by pressing the corresponding arrow key on a computer keyboard. Reaction time is calculated for each of the presentations. A faster reaction time to probes that appear where a threat word was, compared to a neutral word, is typically interpreted as attentional bias toward the threatening word. Conversely, slower reaction times can be interpreted as a bias away from those threatening words. The reasoning behind this is that presumably it will be quicker to respond to a probe that appears in an area where the responder's attention is already directed (MacLeod et al., 1986; Mogg & Bradley, 1998). An alternative version of the task where the word stimuli are replaced with threatening and neutral faces has also been used in various studies (Ajilchi & Nejati, 2013; Bradley, Mogg, Falla, & Hamilton, 1998; Staugaard, 2009) as well as with pictures of threatening animals and neutral pictures (Koster, Crombez, Verschuere, & De Houwer, 2004; Lipp & Derakshan, 2005; Yiend & Mathews, 2001). Several studies employing the dot probe paradigm have reached consensus that it is effective in detecting orientation toward threatening stimuli (Asmundson & Stein, 1994; Conrad, 2009; Egloff & Hock, 2003; MacLeod et al., 1986; Mogg, Bradley, De Bono, & Painter, 1997; Salemink, van den Hout, & Kindt, 2007).

Advantages of the Dot Probe Task

The dot probe task offers advantages over the emotional Stroop task in measuring attentional bias. Firstly, it has the benefit of being able to provide a directional measure of attention by assessing reaction time toward a threat cue, or away from it (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002a). Secondly, unlike the emotional Stroop task, it does not rely on interference effects. Instead, participants are required to provide a neutral manual response (button pressing) to a visual probe that appears after the words. This may increase the likelihood of measurements which reflect the fast effect of attentional bias, instead of measures being confounded by response demands as implicated in the emotional Stroop task, previously noted by McKenna and Sharma (2004). Thirdly, because emotional and neutral words are presented simultaneously, artefacts that result from blocked presentations of emotional stimuli are not an issue. From their meta-analysis, Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van Ijzendoorn (2007) assert that the dot probe task is more effective in detecting early attentional processes than the emotional Stroop task.

While the dot probe task has the support of several researchers, Schmukle (2005) has criticised its utility as a reliable instrument. A test-retest assessment of reliability with an interval of one week between tests returned different measures of attentional bias. However, Schmukle based his results on a non-clinical sample. In order to find biases to threat-related stimuli in a non-clinical sample, Mogg et al. (1997) assert that a level of state anxiety needs to be induced in the participants. The lack of any induced anxiety in Schmukle's research may explain his results.

Research using the dot probe task has commonly reported differential attentional patterns toward neutral and anxiogenic stimuli, whether it be threatening faces, objects or words. This tendency gives support to the argument that emotion can influence thought processes.

Can Music Influence Cognition?

Based on the aforementioned research, we can conclude that music has the ability to influence emotions. Similarly, given the general consensus of the findings from the research into attention, we may acknowledge that an individual's emotions can influence their cognitive processes. Therefore, by logical extension, we might conclude that music has the ability to influence cognition. The next section reviews the evidence that bears on this issue.

Affective priming through music. Sollberge, Rebe, and Eckstein (2003) conducted research in order to discover whether music was able to act as a priming stimulus for target words. "Priming" occurs when a stimulus presentation influences the response to a later stimulus (the 'target' stimulus). In their experiment, participants were required to quickly evaluate whether a computer-displayed word was positive or negative, by pressing one of two computer keys (marked 'positive' or 'negative'). Shortly before each word presentation, participants were played a musical chord that was previously independently rated as either being pleasant (consonant) or unpleasant (dissonant). Results indicated that target words were evaluated faster when they were preceded by an affectively congruent chord (i.e. a consonant chord/positive word or dissonant chord/ negative word), rather than an incongruent chord (i.e. consonant chord/negative word or dissonant chord/positive word).

Graham, Robinson, and Mulhall (2009) attempted to discover whether background music exerted an influence on an individual's tendency to attend to emotional words, by having subjects listen to music while performing an emotional Stroop task. It was found that the expected level of interference usually observed when subjects identify the font colour of emotional words was lessened when the task was administered while listening to a specially constructed musical passage comprising alternating Amaj^{7} /Amaj^{7}add^{13} chords (an Amaj^{7} chord comprises the notes A, C$^{\#}$, E and G$^{\#}$, while an Amaj^{7}add^{13} has the same notes with the addition of F$^{\#}$ above the other notes). Respondents typically identified what they heard as being both peaceful and happy.

The research by Sollberge et al. (2003) and Graham et al. (2009) show that isolated chords and short musical passages based on two related chords can affect the outcome of two linguistic-based tasks. While these studies are suggestive of the effects of music on cognition, it can be argued that most music in Western societies has more structural complexity. In order to address this, Atkinson (2012) extended the Graham et al. (2009) emotional Stroop research by including longer examples of real music taken from movie soundtracks. They chose two musical excerpts that were independently verified in a study by Eerola and Vuoskoski (2011) as being happy and fearful respectively. Like Graham et al. (2009), they found that levels of Stroop interference decreased in the presence of happy music. The level of interference was observed to increase when the Stroop task was performed with concurrent fearful music.

The findings of Atkinson (2012) and Graham et al. (2009) support the notion that music has an ability to induce emotional states, and those states can have an influence on one's tendency to attend to negatively valenced stimuli. However, accepting these findings as conclusive evidence may be premature, based on the presence of alternate explanations for their results. Firstly, it is plausible that the presence of music in the Graham et al. (2009) experiment facilitated colour naming in accord with the over-investment theory of cognitive resources offered by Olivers and Nieuwenhuis (2006), which postulates that performance of a cognitive task can paradoxically be facilitated when demands for cognitive processing are increased with the addition of another concurrent task-irrelevant activity. They theorise that subjects who performed attentional blink tests (where target detection of consecutively-occurring letters displayed in rapid succession is required) found the task challenging because of an overinvestment of attentional resources in the primary task. Execution of the task was optimised when attention was divided between the primary task and an additional memory task (Olivers & Nieuwenhuis, 2006). Kuhl and Kazén (1999) found that performance on a Stroop task was also facilitated when participants were required to perform another task in addition to the primary task. Secondly, as previously mentioned, the reliability of results obtained from emotional Stroop tasks may be compromised by virtue of the fact that measurements of overall response times can instead be reflections of the inter-trial *slow* effect, where neutral words are influenced by preceding emotional words.

The Current Study

Because of the equivocal nature of conclusions reached by the previously-mentioned emotional Stroop based experiments, the issue of what influence background music has on the cognitive processing of emotions remains unresolved. Therefore, the current research employed a dot probe paradigm to investigate whether music can influence cognition. Specifically, the extent to which the affective priming capacity of music can modulate the deployment of attentional mechanisms was addressed. Based on the previous research by Atkinson (2012), it was hypothesised that listening to fearful music would result in a reduced response latency to threat words and listening to happy music would result in an increased response latency to threat words when compared to a silent control condition.

Method

Design

The current study utilised a repeated measures protocol. This design was chosen in order to minimise the impact of individual differences among participants on results. The independent variables were music condition (silent, fearful, happy) and word type (emotional, neutral). The dependent variable was reaction time (measured in ms).

Ethical Considerations

Prior to commencement, this research project was reviewed by the School of Psychology and Social Science Ethics Sub-Committee (SPSSESC) at Edith Cowan University. It was determined that it met the requirements of the National Statement on Ethical Conduct in Human Research.

Participants

Participants were recruited from the student community of Edith Cowan University, Western Australia, as well as from the personal network of the researcher. Based on the experimental design previously used by Atkinson (2012) it was assumed that a similar sized sample (N = 60) would provide sufficient power to this research. The participants comprised 34 females and 26 males, with the ages of both females and males ranging from 18 to 58 years (*Mfemale* = 33.27, *SD* = 11.16; *Mmale* = 37.04, *SD* = 10.04). All indicated that English was their first language.

Materials

Stimulus music. The two musical excerpts used in this study are the same as those previously used by Atkinson (2012). They are taken from a study by Eerola and Vuoskoski (2011), which systematically analysed the perceived emotion of music by having listeners subjectively rate the level of emotion of a musical excerpt on a scale of 1-9. A level of 9 for valence indicates the listener feels the excerpt is extremely pleasant, and a level of 1 would indicate extremely unpleasant. Similarly, a level of 9 for tension arousal would indicate the listener perceives the music as being very tense and a level of 1 would indicate an appraisal of the music as being very relaxed. A parallel system operates for the appraisal of energy arousal (wakeful-tired). Both excerpts have similar levels of energy arousal, but have opposite levels of valence and tension arousal. The fear music has a valence of 2.31, tension arousal of 8.10 and energy arousal of 6.31. The happy music has a valence of 6.00, tension arousal of 3.60 and energy arousal of 6.00.

A 12-minute excerpt was created for each of the musical stimuli using Audacity Version 2.0.3 digital audio editing software (Audacity Team, 2013). (The happy music had an initial duration of 17 seconds, and the fear music had an initial duration of 14 seconds.) During the creation of the excerpts, care was taken to ensure seamless joints between repetitions of the source material. In addition to the musical excerpts, a separate recording of a pure tone (440 Hz) was used for participant volume self-adjustment. All music was played to the participants on an Apple iPod Touch 4th Generation through Roland RH-50 High Definition headphones.

Stimulus words. 360 word pairs divided into 3 sets of 120 word pairs were used in this study. Each word pair comprised one negative emotional word and one neutral word, matched for lexical characteristics such as word length and frequency of usage (see Appendices A-C). 96 of the word pairs were taken from previous research employing the dot probe task by MacLeod, Rutherford, Campbell, Ebsworthy, and Holker (2002b), and were distributed equally among the 3 sets of words. An additional 264 negative and neutral word pairs were sourced from lists of affective word norms (Warriner, Kuperman, & Brysbaert, 2013). On a scale of emotional valence ranging from 1 (*very negative*) to 9 (*very positive*), the negative words included in this study had a mean rating less than 3.5, and the neutral words had a mean rating between 4.5 and 6.

Dot probe task. The presentation of the dot probe task was controlled by Inquisit 4.0.3 software (Millisecond Software, Seattle, USA, 2013) and administered using a Toshiba Portege M-400 (Toshiba Corporation, Tokyo, Japan.) laptop with Microsoft Windows XP operating software.

Each trial commenced with a visual fixation point of three crosses in the middle of the computer screen. Following this, paired stimulus words were displayed for a period of 500ms separated on the vertical axis by a visual angle of between 2° and 3°. These words (written in "Arial" font, capitalised) then disappeared, and one of them was replaced by the probe stimulus (either "<" or ">"). The participant was required to press the corresponding key on the keyboard as quickly as possible after the presentation of the probe. The software recorded the response latency between the presentation of the probe and the depression of the key, in addition to whether the correct identification of probe direction was made. The position of the emotional word was randomised, so that it appeared in the upper and lower location with equal probability. The probe location was also controlled in order to ensure that it assumed the place of the emotional and neutral words an equal number of times (60 times per block of 120 trials). The next trial would not start until a response for the previous trial had been registered. Each block of 120 trials was preceded by a block of 10 practice trials using neutral/neutral word pairings.

Questionnaires. Two questionnaires were used: The first comprised questions from the *Positive and Negative Affect Schedule (PANAS)* (Watson, Clark, & Tellegen, 1988) which provided an assessment of the participant's current mood, as well as other questions relating to music listening habits (Appendix D). The *PANAS* is a 20-item scale in which responders are required to self-rate how they are currently feeling (by way of a 5- level Likert scale). 10 of the items assess positive affect and 10 items assess negative affect. Values from the responses pertaining to the two affective states are added (with the highest possible score being 50 for each affective state, and the lowest possible score being 10 for each affective state). Higher values indicate higher levels of positive or negative affect. Watson et al. (1988) found that it had high internal consistency (Cronbach's coefficient $\alpha = .89$ for positive affect, and .85 for negative affect) and was sensitive to temporal fluctuations in mood.

The second questionnaire was designed to gather basic demographic information (age, gender, primary language spoken and previous musical training) as well as a subjective appraisal of the musical excerpts used in the experiment (Appendix E). All participants were asked to rate the excerpts in two ways. Firstly, they were asked how the two pieces of music made them feel (felt emotion). Secondly, they were asked how they thought others would feel when listening to the same pieces of music (perceived emotion). This approach was employed by Kawakami et al. (2013) in order to discriminate between the emotions actually felt, and appraisals based on cognitive perceptions of the mood of the music excerpts.

Procedure

Each participant was tested individually in a quiet location. Upon entering the room, participants were asked to take a seat at a desk in front of the computer. They were then told that the study sought to investigate the effect of background music on performance. In order to minimise any possible demand artefacts, there was no mention of emotion or the dichotomous nature of the word pairings or musical extracts. Participants were given time to read the Information Letter (Appendix F) and Informed Consent form (Appendix G). Once informed consent had been obtained, they were asked to complete the first questionnaire which assessed current mood and music listening habits. Following this, they were given the headphones, and were asked to self-adjust volume levels of the audio playback device to a comfortable level using the pure tone mp3 track. The dot probe task was then demonstrated via an information page on the computer, and participants completed a block of 10 practice trials using pairs of neutral words. They were given the opportunity to seek clarification of any of the instructions, and were reminded that they were to respond as quickly and accurately as possible. This was followed by the experimental task. The presentation order of the musical conditions was the same for all participants (Silence, Happy music, Fearful music) based on the assumption that arousal would increase monotonically as a function of the music. Operation of the iPod Touch was by the experimenter, and musical excerpts were set to repeat for the duration of each presentation condition. In addition to the musical conditions, participants wore headphones during the silent condition. The three word lists were counterbalanced across the three musical conditions and across participants in accord with a counterbalancing schedule (Appendix H). After the experimental task, participants were asked to complete the second questionnaire, which collected demographic information and evaluations of the musical stimuli. At the end of the test session, participants were thanked and provided with debriefing information. Each session lasted for approximately 25 minutes.

Results

Manipulation check

To ascertain whether the music excerpts evoked the intended emotions, all participants were asked to describe how the music made them feel. For the fearful music, the most frequently used adjectives were *uncomfortable*, *tense*, *scared* and *anxious*, although six of the respondents felt that the fearful music was relaxing. For the happy music, there was general consensus that the music made the participants feel positive. Adjectives such as *happy*, *relaxed*, and *uplifted* were most commonly reported. Based on these results, it may be assumed that the music was successful in inducing the intended feelings.

Results from the *PANAS*

The affective state of the participants was assessed in order to control for situational influences on mood induction outcomes. In general, the participants reported to be in a relaxed mood prior to the experiment. The sample had a higher level of positive affect (M = 30.73 out of 50, SD = 5.13) than negative affect (M = 12.28 out of 50, SD = 2.26).

Pearson product-moment correlation coefficients were computed to assess the relationship between the sample means of pre-intervention positive and negative affect, and the reaction times for the different music conditions. There was a moderate positive correlation between positive affect and reaction times to threat words in the silent condition, $r = .317$, $p = .014$. This indicated that the more positive someone felt, the longer it took for them to react to threatening words. There was also a moderate positive correlation between positive affect and reaction times to neutral words in the silent condition, $r = .357$, $p = .005$. All other correlations were non-significant at $\alpha = .05$. As the silent condition was the first experimental condition, we may assume that the absence of significant correlations between affect and reaction times in the subsequent conditions is evidence that affective states of participants had changed in the happy and fearful music conditions.

Descriptive statistics

Prior to analysis, reaction times were examined for normality of distributions using a Shapiro-Wilk test. It was found that the distribution of reaction times to threat words in the silent condition was significantly non-normal, $W(60) = .954$, $p = .023$. Similarly, reaction times to neutral words in the silent condition were significantly non-normal, $W(60) = .921$, $p = .001$, and also with neutral words in the fearful music condition $W(60) = .936$, $p = .004$. An inspection of graphical representations of these data (Q-Q probability plots, Appendix I) suggested that departures from normality were slight, and not likely to impact on consequent statistical analyses. Therefore, no transformations of the data in an attempt to achieve normal distributions were undertaken.

Table 1 presents reaction times and standard deviations according to musical conditions. There was a difference of 3.92ms between the longest mean reaction time (threat word with happy music) and the shortest mean reaction time (neutral words with fearful music).

Word type and music condition	Mean reaction time (ms)	Standard deviation
Threat word in silence	459.43	58.99
Neutral word in silence	458.05	59.61
Threat word with happy music	460.44	48.69
Neutral word with happy music	459.37	47.07
Threat word with fearful music	457.42	50.50
Neutral word with fearful music	456.52	55.18

Table 1: Mean reaction times and standard deviations according to experimental condition

Figure 1 shows a graphical representation of the distribution of the data, indicating the presence of outliers. However, these measurements were retained, as it was decided that they reflected a real distributional dimension rather than anomalies.

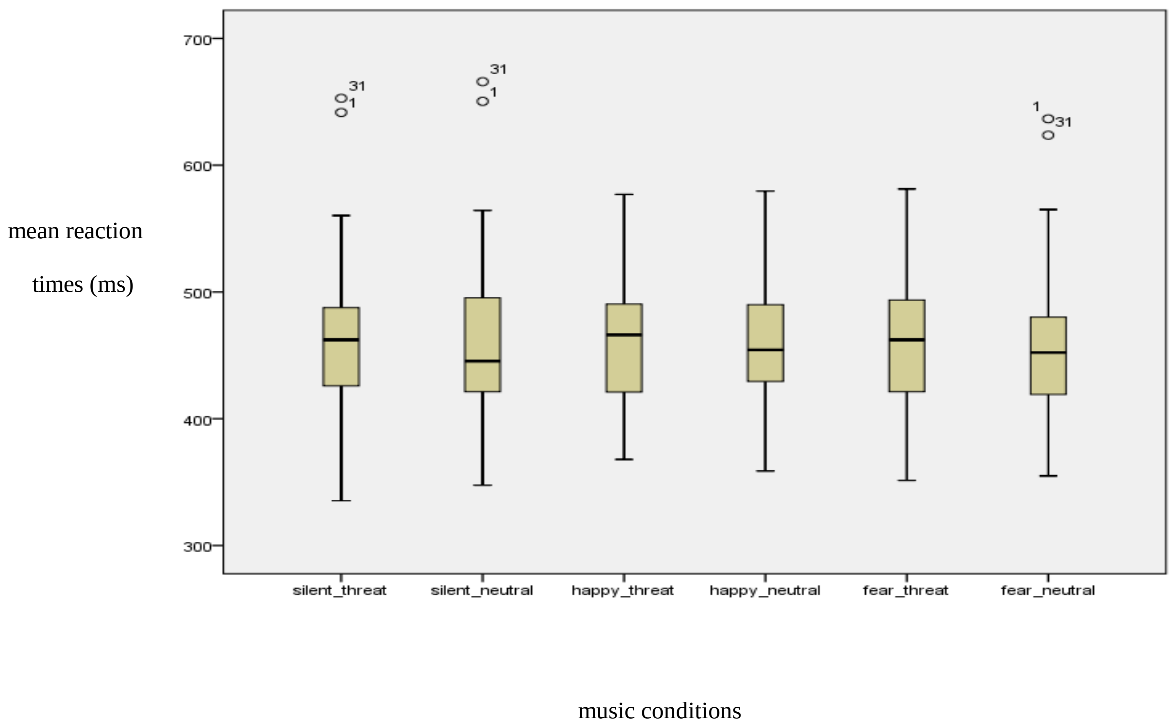

Figure 1: Reaction times according to each musical condition

Due to its robustness against violations of normality, a within-subjects factorial ANOVA was conducted to examine the effect of experimental condition (silence, happy music and fearful music) on reaction times to probes in neutral word and threat word positions. The results of the ANOVA were confirmed with a Friedman test, indicating that non-normality of the data did not affect the ANOVA.

ANOVA results

Main effect of music on reaction times

Statistical analysis using Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (2) = 8.02, *p* = .018, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .91). The results from the factorial ANOVA showed that at α = .05 there was a non-significant difference in reaction time between the three musical conditions $F(1.82, 107.51) = .18$, $p = .82$, $\eta^2 = .002$. These results suggested that the happy and fearful background music had the same effect on attending behaviour as the silent condition.

Main effect of words on reaction times

There was a non-significant difference between the reaction times for threat words and neutral words $F(1, 59) = 2.11$, $p = .15$, $\eta^2 = .002$ indicating that participants responded to probes in the threat position and in the neutral position with similar speed.

Interaction between word type and music type

Statistical analysis using Mauchly's test indicated that the assumption of sphericity had been violated, χ^2 (2) = 10.82, *p* = .004, therefore degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (ε = .88). The results from the factorial ANOVA showed that at α = .05 there was a non-significant interaction between music type and word type

$F(1.76, 103.55) = .35$, $p = .68$, $\eta^2 < .001$ indicating that no combination of music type and word type elicited significantly slower or faster reaction times than others.

Discussion

The current research investigated the effects of happy and fearful background music on cognition. Specifically, it looked at the effect differently valenced music had on an individual's initial orientation toward or away from negative stimuli in the form of threatening words. Employing a dot probe task as a way of assessing attention, the investigation can be viewed as a triangulation of the research undertaken by Atkinson (2012) which employed an emotional Stroop task to assess the same phenomenon. In an attempt to maintain comparability between the current research and the Atkinson investigation, the same stimulus music was employed, in addition to keeping the sample sizes the same.

In contrast to the results from the Atkinson (2012) study, the current research did not detect any statistically significant differences in attention as a consequence of listening to happy or fearful music. In fact, there was no significant difference in reaction times between the silent control condition and either of the musical conditions, calling into question the effect of background music on attentional processes.

The inability of the current research to detect statistically significant differences in reaction times between the music conditions is unlikely to be due to insufficient power in the design of the investigation. Given that there was a range of only 3.92ms between the lowest and highest mean reaction times between conditions, it is doubtful that a larger sample size would have produced figures drastically different to what was obtained here.

This disparity between the results obtained by Atkinson(2012) and the current research underscores a need for further investigation into the effects of music on cognitive processes. One possible source of this difference may be found in the two methods of investigation used in these studies. While the emotional Stroop task and the dot probe task are commonly used to investigate attention, there is a growing body of research suggesting that interference often observed in studies involving the emotional Stroop task is a result of a later attentional mechanism rather than earlier orienting processes.

There is evidence to suggest that the human attention system is divided into at least three distinct processes: alerting, orienting and executive control (Petersen & Posner, 2012). Alerting may be viewed as an individual's level of arousal or readiness for action, prior to a given task. A distinction between two forms of alertness is often made. *Tonic* alertness, or vigilance refers to a sustained level of activation over an extended period of time, whereas *phasic* alertness is a temporary increase in response readiness due to an external warning stimulus (Roca, Castro, López-Ramón, & Lupiánez, 2011).

Orienting, on the other hand is the process of prioritising particular sensory stimuli over others. Executive control may be seen to reflect a more conscious control of focussing attention, where one must select between task-relevant and task-irrelevant information (for example, finding a face in a crowd). Petersen and Posner (2012) and Finucane, Whiteman, and Power (2010) have noted that tasks requiring evaluation and control over task-irrelevant information (such as is required in Stroop tasks), and 'top-down' processing place particular demands on the executive control resources. This has been supported by studies employing functional magnetic resonance imaging (fMRI) which have shown increased activity in key areas of the brain associated with executive control (such as the anterior cingulate cortex) during Stroop tasks (Milham, Banich, & Barad, 2003).

Rather than being exclusively a reflection of an individual's initial direction of attention resources (orienting), an observed latency for colour naming in an emotional Stroop task can be interpreted as an outcome of an inability to disengage from a negative stimulus after assessment of its valency has been made (de Ruiter & Brosschot, 1994; Fox et al., 2001). Therefore the delay in colour naming of emotional words that can occur in the emotional Stroop task may take place at the response -selection stage rather than during the initial information-processing stage (Bar-Haim et al., 2007; Mogg & Bradley, 1998). This further implicates the role of executive control processes in findings from emotional Stroop-based research. Therefore the research by Atkinson (2012) may in fact be capturing the effect music has on an individual's ability to disengage attention from an aversive stimulus (the negative words) and to return to the primary task of colour identification. Given this, the Atkinson study demonstrates that fearful music heightens an individual's difficulty to disengage from the negative meaning of the words, and conversely, happy music makes it easier to return to the primary colour-naming task by facilitating disengagement. The dot probe task, on the other hand, may be better equipped to detect an earlier stage of attention (initial orienting). In light of this, the current study's failure to detect a mediating effect of music on orienting points to the conclusion that the influence of music on attention takes place in the later executive control stage of attention.

Limitations of the Present Research

One factor the current research did not take into account was individual reading abilities of the participants. The dot probe task that was employed relied heavily on reading speeds. While it can be argued that the potential impact of reading abilities on the current results is unlikely, given that the sample was predominantly made up of tertiary students, it does warrant further investigation. One of the strengths of the dot probe paradigm is that pictures can be used in place of words. Using pictures instead of words may help to minimise the impact of individual differences in reading abilities, while still maintaining threatening/neutral stimulus pairings.

Beat induction is another variable that could have potentially confounded the results of the current study. One characteristic of the happy music used in this study was the presence of an identifiable isochronous pulse. In their discussion of rhythmic entrainment, Molinari, Leggio, De Martin, Cerasa, and Thaut (2003) comment that people can often react to the rhythmic components of music without overt perception. In other words, it is possible that some of the participants in the current study were actually unconsciously pressing the computer response keys in time with the music, rather than the rate of key depressions being precipitated exclusively by the probe detection. In fact, three of the participants commented that they 'fell into a rhythm' during the happy music condition. The fearful music had a less-easily identifiable rhythmic pulse. Lenti Boero and Bottoni (2008) have suggested that humans generally have a natural preference for periodic sounds (i.e. sounds that have a predictable meter, or regularity of rhythm). If this is held to be true, then a discernible rhythmic periodicity may be an important feature of any music endowed with the capacity to induce positive feelings in a large number of people. Finding positively-valenced music that does not contain a definite rhythmic cycle may prove a challenge for future researchers undertaking similar investigations where inferences are contingent upon the rate of participant motor response (e.g. button or key pressing) to a stimulus presentation.

Future Research Directions

While the initial hypotheses of the current research have not been supported by the data, the findings have given rise to important avenues for further exploration. The idea that dot probe tasks and emotional Stroop tasks are capturing different stages of the attention process is a likely explanation for the disparity in data gained from such investigations. In order to test the veracity of this conclusion, it would be valuable to develop an understanding of the time course of visual attention, and the influence background music has on it. One way researchers may investigate such a phenomenon is to examine saccadic eye movements during free-viewing tasks with the use of video-oculography (VOG). Individuals could be presented with a picture depicting a scene that comprises predominantly neutral elements, but with the subtle inclusion of one or two threatening elements (e.g. a picture of a group of people socially interacting, with two people arguing in the background). With VOG, researchers will be able to follow the saccades of test participants, in order to observe the subjective salience of visual information. Additionally, and importantly, this technology would allow for the measurement of how long a particular visual stimulus engages attention. Such an investigation may enable researchers to gain information pertaining to whether different musical conditions influence initial detection of visually presented threatening stimuli, as well as whether engagement times are also impacted upon.

Recently there have been great advances in neuroimaging techniques (see Hajcak, MacNamara, and Olvet (2010) for a review). For example, several studies have involved the examination of electrical activity in the brain as measured by electrodes placed directly on the scalp. Changes in activity can be linked with specific events (e.g. the presentation or detection of a stimulus) and these temporal fluctuations are referred to as event-related potentials (ERP). Various studies have demonstrated the differential ERP patterns elicited from viewing emotional and neutral stimuli (for example, Leppänen, Moulson, Vogel-Farley, and Nelson (2007); Moser, Hajcak, Bukay, and Simons (2006); Simola, Torniainen, Moisala, Kivikangas, and Krause (2013)).

A free-viewing task where information gained from VOG measurements of saccades is coupled with the concurrent recording of ERP dimensions will allow for a more detailed analysis of the temporal dynamics of attention and emotional response. From this base, future researchers may be better equipped to examine the interaction between attention to threat and music-induced emotions.

Conclusions

These findings explore the relationship between music-induced emotions and subsequent cognitive processes. It was hypothesised that listening to fearful music and happy music would differentially influence an individual's orienting behaviour, as measured by a dot probe task. Results of this research indicate that the valence of music has little bearing on whether an individual allocates initial attention toward neutral or threatening stimuli. Instead, these findings, when incorporated with those from previous research by Atkinson (2012) suggest that the influence of music-induced emotions is confined to the later executive control stage of attention rather than at the earlier orienting stage.

References

Ajilchi, B., & Nejati, V. (2013). Attention bias to sad faces and images: Which is better for predicting depression? *Open Journal of Depression*(2), 19-23. doi: 10.4236/ojd.2013.23005

Algom, D., Chajut, E., & Lev, S. (2004). A rational look at the emotional stroop phenomenon: A generic slowdown, not a stroop effect. *Journal of Experimental Psychology. General, 133*(3), 323-338. doi: 10.1037/0096-3445.133.3.323

Andrade, P.E., & Bhattacharya, J. (2003). Brain tuned to music. *Journal of the Royal Society of Medicine, 96*(6), 284-287. doi: 10.1258/jrsm.96.6.284

Ashley, V., Honzel, N., Larsen, J., Justus, T., & Swick, D. (2013). Attentional bias for trauma-related words: Exaggerated emotional stroop effect in Afghanistan and Iraq war veterans with PTSD. *BMC Psychiatry, 13*(1), 86-86. doi: 10.1186/1471-244X-13-86

Asmundson, G.J.G., & Stein, M.B. (1994). Selective processing of social threat in patients with generalized social phobia: Evaluation using a dot-probe paradigm. *Journal of Anxiety Disorders, 8*(2), 107-117. doi: 10.1016/0887-6185(94)90009-4

Aspinwall, L.G., & MacNamara, A. (2005). Taking positive changes seriously. *Cancer, 104*(S11), 2549-2556. doi: 10.1002/cncr.21244

Atkinson, P. (2012). *'What's that coming over the hill?' The role of music on response latency for emotional words* Paper presented at the 12th international conference on music perception and cognition and the 8th triennial conference of the European Society for the Cognitive Sciences of Music, Thessaloniki, Greece.

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M.J., & van Ijzendoorn, M.H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin, 133*(1), 1-24. doi: 10.1037/0033-2909.133.1.1

Baumeister, R.F., Bratslavsky, E., Finkenauer, C., & Vohs, K.D. (2001). Bad is stronger than good. *Review of General Psychology, 5*(4), 323-370. doi: 10.1037/1089-2680.5.4.323

Beck, A.T. (1991). Cognitive therapy. A 30-year retrospective. *The American Psychologist, 46*(4), 368-375. doi: 10.1037/0003-066X.46.4.368

Bishop, D.T., Karageorghis, C.I., & Loizou, G. (2007). A grounded theory of young tennis players use of music to manipulate emotional state. *Journal of sport & exercise psychology, 29*(5), 584.

Blood, A.J., & Zatorre, R.J. (2001). Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion. *Proceedings of the National Academy of Sciences, 98*(20), 11818-11823.

Bower, G.H. (1981). Mood and memory. *The American Psychologist, 36*(2), 129-148. doi: 10.1037/0003-066X.36.2.129

Bradley, B.P., Mogg, K., Falla, S.J., & Hamilton, L.R. (1998). Attentional bias for threatening facial expressions in anxiety: Manipulation of stimulus duration. *Cognition & Emotion, 12*(6), 737-753. doi: 10.1080/026999398379411

Conrad, J. (2009). *Test anxiety, the looming maladaptive style, and behavioral manifestations of anxiety in response to threat: A laboratory study in a university population*: ProQuest.

de Ruiter, C., & Brosschot, J.F. (1994). The emotional stroop interference effect in anxiety: Attentional bias or cognitive avoidance? *Behaviour Research and Therapy, 32*(3), 315-319. doi: 10.1016/0005-7967(94)90128-7

Dissanayake, E. (2008). If music is the food of love, what about survival and reproductive success? *Musicae Scientiae, 12*(1 suppl), 169-195.

Dissanayake, E. (2012). The earliest narratives were musical. *Research Studies in Music Education, 34*(1), 3-14. doi: 10.1177/1321103X12448148

Dresler, T., Mériau, K., Heekeren, H.R., & van der Meer, E. (2009). Emotional stroop task: Effect of word arousal and subject anxiety on emotional interference. *Psychological Research, 73*(3), 364-371. doi: 10.1007/s00426-008-0154-6

Eerola, T., & Vuoskoski, J.K. (2011). A comparison of the discrete and dimensional models of emotion in music. *Psychology of Music, 39*(1), 18-49.

Egloff, B., & Hock, M. (2003). Assessing attention allocation toward threat-related stimuli: A comparison of the emotional stroop task and the attentional probe task. *Personality and Individual Differences, 35*(2), 475-483. doi: 10.1016/S0191-8869(02)00265-9

Estes, Z., & Adelman, J.S. (2008). Automatic vigilance for negative words is categorical and general. *Emotion, 8*(4), 453-457. doi: 10.1037/a0012887

Finucane, A.M., Whiteman, M.C., & Power, M.J. (2010). The effect of happiness and sadness on alerting, orienting, and executive attention. *Journal of Attention Disorders, 13*(6), 629-639.

Fitch, W. (2006). The biology and evolution of music: A comparative perspective. *Cognition, 100*(1), 173-215.

Foa, E.B., Feske, U., Murdock, T.B., Kozak, M.J., & McCarthy, P.R. (1991). Processing of threat-related information in rape victims. *Journal of Abnormal Psychology, 100*(2), 156.

Fox, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclinical anxiety? *Journal of Experimental Psychology: General, 130*(4), 681-700. doi: 10.1037/0096-3445.130.4.681

Frings, C., Englert, J., Wentura, D., & Bermeitinger, C. (2010). Decomposing the emotional stroop effect. *The Quarterly Journal of Experimental Psychology, 63*(1), 42-49. doi: 10.1080/17470210903156594

Gabrielsson, A. (2002a). Emotion perceived and emotion felt: Same or different? *Musicae Scientiae, 5*(1 suppl), 123-147. doi: 10.1177/10298649020050S105

Gabrielsson, A. (2002b). Old people's remembrance of strong experiences related to music. *Psychomusicology - A Journal of Research in Music Cognition, 18*(1-2), 103-122. doi: 10.1037/h0094048

Garrido, S., & Schubert, E. (2011). Negative emotion in music: What is the attraction? A qualitative study. *Empirical Musicology Review, 6*(4), 214-230.

Garrido, S., & Schubert, E. (2013). Moody melodies: Do they cheer us up? A study of the effect of sad music on mood. *Psychology of Music*. doi: 10.1177/0305735613501938

Goldstein, E.B. (2008). *Cognitive psychology: Connecting mind, research, and everyday experience*. Belmont, CA: Thomson/Wadsworth.

Gotlib, I.H., Kasch, K.L., Traill, S., Joormann, J., Arnow, B.A., & Johnson, S.L. (2004). Coherence and specificity of information-processing biases in depression and social phobia. *Journal of Abnormal Psychology, 113*(3), 386.

Graham, R., Robinson, J., & Mulhall, P. (2009). Effects of concurrent music listening on emotional processing. *Psychology of Music, 37*(4), 485-493. doi: 10.1177/0305735608099689

Hajcak, G., MacNamara, A., & Olvet, D.M. (2010). Event-related potentials, emotion, and emotion regulation: An integrative review. *Developmental Neuropsychology, 35*(2), 129-155. doi: 10.1080/87565640903526504

Hallam, S., Price, J., & Katsarou, G. (2002). The effects of background music on primary school pupils' task performance. *Educational Studies, 28*(2), 111-122. doi: 10.1080/03055690220124551

Hays, T., & Minichiello, V. (2005). The contribution of music to quality of life in older people: An Australian qualitative study. *Ageing and Society*, *25*(2), 261-278. doi: 10.1017/S0144686X04002946

Hevner, K. (1935). The affective character of the major and minor modes in music. *The American Journal of Psychology*, *47*(1), 103-118.

Hevner, K. (1937). The affective value of pitch and tempo in music. *The American Journal of Psychology*, *49*(4), 621-630.

Hunter, P.G., Schellenberg, E.G., & Schimmack, U. (2010). Feelings and perceptions of happiness and sadness induced by music: Similarities, differences, and mixed emotions. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(1), 47-56. doi: 10.1037/a0016873

Huron, D. (2001). Is music an evolutionary adaptation? *Annals of the New York Academy of Sciences*, *930*(1), 43-61.

Isen, A.M., Daubman, K.A., & Nowicki, G.P. (1987). Positive affect facilitates creative problem solving. *Journal of Personality and Social Psychology, 52*(6), 1122.

Jung, C.G. (1910). The association method. *The American Journal of Psychology, 21*(2), 219-269.

Juslin, P.N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and Brain Sciences, 31*(5), 559-575. doi: 10.1017/S0140525X08005293

Justus, T., & Hutsler, J.J. (2005). Fundamental issues in the evolutionary psychology of music: Assessing innateness and domain specificity. *Music Perception: An Interdisciplinary Journal, 23*(1), 1-27. doi: 10.1525/mp.2005.23.1.1

Kallinen, K., & Ravaja, N. (2006). Emotion perceived and emotion felt: Same and different. *Musicae Scientiae*, *10*(2), 191-213. doi: 10.1177/102986490601000203

Kant, I. (1790/2007). Critique of judgement (J. H. Bernard, Trans.). In N. Walker (Ed.): Oxford University Press.

Kawakami, A., Furukawa, K., Katahira, K., & Okanoya, K. (2013). Sad music induces pleasant emotion. *Frontiers in psychology, 4*, 1-15. doi: 10.3389/fpsyg.2013.00311

Klein, G.S. (1964). Semantic power measured through the interference of words with color-naming. *The American Journal of Psychology, 77*(4), 576-588.

Koelsch, S., Fritz, T., Müller, K., & Friederici, A.D. (2006). Investigating emotion with music: An fMRI study. *Human Brain Mapping, 27*(3), 239-250. doi: 10.1002/hbm.20180

Koster, E.H.W., Crombez, G., Verschuere, B., & De Houwer, J. (2004). Selective attention to threat in the dot probe paradigm: Differentiating vigilance and difficulty to disengage. *Behaviour Research and Therapy, 42*(10), 1183-1192. doi: 10.1016/j.brat.2003.08.001

Krahé, B., & Bieneck, S. (2012). The effect of music-induced mood on aggressive affect, cognition, and behavior. *Journal of Applied Social Psychology, 42*(2), 271-290. doi: 10.1111/j.1559-1816.2011.00887.x

Kreutz, G., Ott, U., Teichmann, D., Osawa, P., & Vaitl, D. (2008). Using music to induce emotions: Influences of musical preference and absorption. *Psychology of Music, 36*(1), 101-126. doi: 10.1177/0305735607082623

Krumhansl, C.L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology, 51*(4), 336-352.

Kuhl, J., & Kazén, M. (1999). Volitional facilitation of difficult intentions: Joint activation of intention memory and positive affect removes stroop interference. *Journal of Experimental Psychology: General, 128*(3), 382-399. doi: 10.1037/0096-3445.128.3.382

LaBar, K.S., & Cabeza, R. (2006). Cognitive neuroscience of emotional memory. *Nature Reviews Neuroscience, 7*(1), 54-64. doi: 10.1038/nrn1825

Laiho, S. (2004). The psychological functions of music in adolescence. *Nordic Journal of Music Therapy, 13*(1), 47-63. doi: 10.1080/08098130409478097

Larsen, R.J., Mercer, K.A., Balota, D.A., & Strube, M.J. (2008). Not all negative words slow down lexical decision and naming speed: Importance of word arousal. *Emotion, 8,* 445–452.

Laukka, P., & Quick, L. (2011). Emotional and motivational uses of music in sports and exercise: A questionnaire study among athletes. *Psychology of Music, 41*(2), 198-215. doi: 10.1177/0305735611422507

Lavy, E., van den Hout, M., & Arntz, A. (1993). Attentional bias and spider phobia: Conceptual and clinical issues. *Behaviour Research and Therapy, 31*(1), 17-24.

Lench, H.C., Flores, S.A., & Bench, S.W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin, 137*(5), 834–855. doi: 10.1037/a0024244

Lenti Boero, D., & Bottoni, L. (2008). Why we experience musical emotions: Intrinsic musicality in an evolutionary perspective. *Behavioral and Brain Sciences, 31*(5), 585-586. doi: 10.1017/S0140525X08005396

Leppänen, J.M., Moulson, M.C., Vogel-Farley, V.K., & Nelson, C.A. (2007). An ERP study of emotional face processing in the adult and infant brain. *Child Development*, *78*(1), 232-245. doi: 10.1111/j.1467-8624.2007.00994.x

Lipp, O.V., & Derakshan, N. (2005). Attentional bias to pictures of fear-relevant animals in a dot probe task. *Emotion, 5*(3), 365-369. doi: 10.1037/1528-3542.5.3.365

Lyubomirsky, S., Caldwell, N.D., & Nolen-Hoeksema, S. (1998). Effects of ruminative and distracting responses to depressed mood on retrieval of autobiographical memories. *Journal of Personality and Social Psychology, 75*(1), 166-177. doi: 10.1037/0022-3514.75.1.166

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology, 95*(1), 15.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002a). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology*, *111*(1), 107.

MacLeod, C., Rutherford, E., Campbell, L., Ebsworthy, G., & Holker, L. (2002b). Selective attention and emotional vulnerability: Assessing the causal basis of their association through the experimental manipulation of attentional bias. *Journal of Abnormal Psychology*, *111*(1), 107-123. doi: 10.1037/0021-843X.111.1.107

MacLeod, C., & Rutherford, E.M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimu. *Behaviour Research and Therapy, 30*(5), 479-491. doi: http://dx.doi.org/10.1016/0005-7967(92)90032-C

Maidenberg, E., Chen, E., Craske, M., Bohn, P., & Bystritsky, A. (1996). Specificity of attentional bias in panic disorder and social phobia. *Journal of Anxiety Disorders, 10*(6), 529-541. doi: http://dx.doi.org/10.1016/S0887-6185(96)00028-X

Masataka, N. (1999). Preference for infant-directed singing in 2-day-old hearing infants of deaf parents. *Developmental Psychology*, *35*(4), 1001-1005. doi: 10.1037/0012-1649.35.4.1001

Mathews, A., & Klug, F. (1993). Emotionality and interference with color-naming in anxiety. *Behaviour Research and Therapy, 31*(1), 57-62.

McDermott, J. (2008). The evolution of music. *Nature, 453*(7193), 287-288.

McKenna, F.P., & Sharma, D. (2004). Reversing the emotional stroop effect reveals that it is not what it seems: The role of fast and slow components. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 30*(2), 382-392. doi: 10.1037/0278-7393.30.2.382

Milham, M.P., Banich, M.T., & Barad, V. (2003). Competition for priority in processing increases prefrontal cortex's involvement in top-down control: An event-related fMRI study of the stroop task. *Cognitive Brain Research, 17*(2), 212-222.

Mogg, K., & Bradley, B.P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour research and therapy, 36*(9), 809-848. doi: 10.1016/S0005-7967(98)00063-1

Mogg, K., Bradley, B.P., De Bono, J., & Painter, M. (1997). Time course of attentional bias for threat information in non-clinical anxiety. *Behaviour Research and Therapy, 35*(4), 297-303.

Molinari, M., Leggio, M.G., De Martin, M., Cerasa, A., & Thaut, M. (2003). Neurobiology of rhythmic motor entrainment. *Annals of the New York Academy of Sciences, 999*(1), 313-321. doi: 10.1196/annals.1284.042

Moser, J.S., Hajcak, G., Bukay, E., & Simons, R.F. (2006). Intentional modulation of emotional responding to unpleasant pictures: An erp study. *Psychophysiology, 43*(3), 292-296. doi: 10.1111/j.1469-8986.2006.00402.x

Nawrot, E.S. (2003). The perception of emotional expression in music: Evidence from infants, children and adults. *Psychology of Music, 31*(1), 75-92. doi: 10.1177/0305735603031001325

Olivers, C.N.L., & Nieuwenhuis, S. (2006). The beneficial effects of additional task load, positive affect, and instruction on the attentional blink. *Journal of Experimental Psychology. Human Perception and Performance, 32*(2), 364-379. doi: 10.1037/0096-1523.32.2.364

Pearce, M., & Rohrmeier, M. (2012). Music cognition and the cognitive sciences. *Topics in Cognitive Science, 4*(4), 468-484. doi: 10.1111/j.1756-8765.2012.01226.x

Petersen, S.E., & Posner, M.I. (2012). The attention system of the human brain: 20 years after. *Annual Review of Neuroscience, 35*(1), 73-89. doi: 10.1146/annurev-neuro-062111-150525

Radford, C. (1989). Emotions and music: A reply to the cognitivists. *The Journal of Aesthetics and Art Criticism, 47*(1), 69-76.

Rentfrow, P.J., & Gosling, S.D. (2003). The do re mi's of everyday life: The structure and personality correlates of music preferences. *Journal of Personality and Social Psychology, 84*(6), 1236-1256. doi: 10.1037/0022-3514.84.6.1236

Richards, A., French, C.C., Johnson, W., Naparstek, J., & Williams, J. (1992). Effects of mood manipulation and anxiety on performance of an emotional stroop task. *British Journal of Psychology, 83*(4), 479-491.

Roca, J., Castro, C., López-Ramón, M.F., & Lupiánez, J. (2011). Measuring vigilance while assessing the functioning of the three attentional networks: The anti-vigilance task. *Journal of Neuroscience Methods, 198*(2), 312-324.

Saarikallio, S., & Erkkilä, J. (2007). The role of music in adolescents' mood regulation. *Psychology of Music, 35*(1), 88-109. doi: 10.1177⁄0305735607068889

Saarikallio, S., Nieminen, S., & Brattico, E. (2013). Affective reactions to musical stimuli reflect emotional use of music in everyday life. *Musicae Scientiae, 17*(1), 27-39. doi: 10.1177/1029864912462381

Sacks, O. (2006). The power of music. *Brain, 129*(10), 2528-2532. doi: 10.1093/brain/awl234

Salemink, E., van den Hout, M.A., & Kindt, M. (2007). Selective attention and threat: Quick orienting versus slow disengagement and two versions of the dot probe task. *Behaviour Research and Therapy, 45*(3), 607-615. doi: 10.1016/j.brat.2006.04.004

Schacter, D.L. (1999). The seven sins of memory. Insights from psychology and cognitive neuroscience. *The American Psychologist, 54*(3), 182-203. doi: 10.1037/0003-066X.54.3.182

Schmukle, S.C. (2005). Unreliability of the dot probe task. *European Journal of Personality, 19*(7), 595-605. doi: 10.1002/per.554

Schubert, E. (2007). The influence of emotion, locus of emotion and familiarity upon preference in music. *Psychology of Music, 35*(3), 499-515. doi: 10.1177/0305735607072657

Simola, J., Torniainen, J., Moisala, M., Kivikangas, M., & Krause, C.M. (2013). Eye movement related brain responses to emotional scenes during free viewing. *Frontiers in Systems Neuroscience, 7,* 1-15. doi: 10.3389/fnsys.2013.00041

Sloboda, J.A. (1991). Music structure and emotional response: Some empirical findings. *Psychology of Music, 19*(2), 110-120. doi: 10.1177/0305735691192002

Sloboda, J.A., & O'Neill, S.A. (2001). Emotions in everyday listening to music. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 415-430). New York: Oxford University Press.

Sollberge, B., Rebe, R., & Eckstein, D. (2003). Musical chords as affective priming context in a word-evaluation task. *Music Perception, 20*(3), 263-282.

Stamou, L. (2002). Plato and Aristotle on music and music education: Lessons from ancient Greece. *International Journal of Music Education, 39*(1), 3-16. doi: 10.1177/025576140203900102

Staugaard, S.R. (2009). Reliability of two versions of the dot-probe task using photographic faces. *Psychology Science Quarterly, 51*(3), 339.

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18*(6), 643.

Västfjäll, D. (2002). Emotion induction through music: A review of the musical mood induction procedure. *Musicae Scientiae, 5*(1), 173-211. doi: 10.1177/10298649020050S107

Warriner, A.B., Kuperman, V., & Brysbaert, M. (2013). Norms of valence, arousal, and dominance for 13,915 English lemmas. *Behavior Research Methods*, 1-17. doi: 10.3758/s13428-012-0314-x

Watson, D., Clark, L.A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*(6), 1063-1070. doi: 10.1037/0022-3514.54.6.1063

Wieser, H.G., Hungerbühler, H., Siegel, A.M., & Buck, A. (1997). Musicogenic epilepsy: Review of the literature and case report with ictal single photon emission computed tomography. *Epilepsia, 38*(2), 200-207. doi: 10.1111/j.1528-1157.1997.tb01098.x

Williams, J.M.G., Mathews, A., & MacLeod, C. (1996). The emotional stroop task and psychopathology. *Psychological Bulletin, 120*(1), 3-24. doi: 10.1037/0033-2909.120.1.3

Yiend, J., & Mathews, A. (2001). Anxiety and attention to threatening pictures. *The Quarterly Journal of Experimental Psychology, 54*(3), 665-681. doi: 10.1080/02724980042000462

Zentner, M.R., & Kagan, J. (1996). Perception of music by infants. *Nature, 383*(6595), 29-29. doi: 10.1038/383029a0

Appendix A

Word pairs - List A

Threat	Neutral	Threat	Neutral
SUNBURN	LYRICAL	PANIC	ADOPT
ANNOYING	RHAPSODY	FLU	CAR
EVASIVE	RUBDOWN	TACKY	SPUNK
STAGGER	TEATIME	SCURRY	MEMORY
GASSY	CREPE	REAPER	BAMBOO
POX	VOW	CONCUBINE	MARGARITA
PUSHY	SPICE	NAG	JET
WIMP	TACO	UPTIGHT	COLORED
MADHOUSE	MYSTIQUE	REJECT	SAVIOR
NEFARIOUS	LIMOUSINE	TATTLETALE	NONVIOLENT
TRICKERY	MAINTAIN	SHOOTOUT	EYELINER
TATTLER	CLOTHES	UGLINESS	UNHARMED
TEARFUL	LIGHTEN	MISPLACE	COMPLETE
WITLESS	BURRITO	JUNK	EXPO
LOUSE	FLOAT	ENVIOUS	ORDERLY
APOCALYPSE	RETIREMENT	JERK	RUBY
HECTIC	EXPERT	STING	COMET
SICK	BABE	HOVEL	PHONE
PATRONIZE	RECONNECT	ABSINTHE	MATCHING
DINGY	HAVEN	MANIACAL	SERENADE
BORING	THRIVE	CRASH	FAVOR
RATTLER	STUDENT	DROPOUT	CREATOR
GUILTY	HUMBLE	BILE	PEAR
TENSE	FLIRT	SNUB	SAGA
SPAM	BUCK	DEFECTIVE	WHOLESALE
GLARE	GIDDY	LONER	CEDAR
SLOB	POOL	STRETCHER	RECLINING
OVERWEIGHT	SUPERHUMAN	CARTEL	EQUATE
ANIMOSITY	JELLYBEAN	UNABLE	FRISKY
ENEMA	FAITH	PROSECUTE	CHILDHOOD
BOMB	FOND	MORBID	PARROT
ENSLAVE	SUPPORT	ORPHAN	DANCER
SURRENDER	OUTSPOKEN	FATHEAD	REVIVAL
UNINVITED	TOLERANCE	PANICKY	CLARETS
ACID	VINE	DESPERATE	VARIABLES
DISLIKE	SHELTER	CRINGING	NECKLACE
SUSPICION	DRAGONFLY	CAUTIOUS	EDITIONS
CRAZED	DECIDE	SCARED	PLANET
RECLUSE	MESSAGE	CANCER	SADDLE
QUIT	TAME	DANGER	LEAGUE
EMBARRASS	AWAKENING	ALARMED	SHELVES
WETBACK	CHARITY	CORONARY	RECEIPTS
TRAVESTY	WONDROUS	TRAUMA	ENJOIN
SMUG	BARN	EDGY	RINK
AUDIT	GRAPE	EMERGENCY	LISTENING
SLUR	LAND	DISTRESS	CREATURE
EXTORT	FLAVOR	UNSETTLED	ADVOCATED
STUMBLE	PASTURE	HOSTILE	ROLLING
FIB	DUO	CONFUSED	ARRANGED

Threat	**Neutral**
REVOLVER	RECOVERY
INTESTINE	INTUITION
HEARSAY	COUNTRY
PISS	ABLE
PIRANHA	GALLANT
SPEW	NOOK
WARY	FOLD
SINISTER	INTEGRAL
MUTILATED	DECANTING
NERVOUS	OUTCOME
ASSAULT	BOTTLES
SUFFOCATING	CONSTITUENT
CATASTROPHE	APPROXIMATE
UNPOPULAR	SHORELINE
SAD	PAT
POINTLESS	LUNCHROOM
GLUM	KITE
TOUCHY	TINTED
FRIGHT	SIPPED
WORRIED	CONTEXT
NAUSEA	CONFER
DISEASE	REMARKS

Appendix B

Word pairs - List B

Threat	Neutral	Threat	Neutral
BLISTER	ESSENCE	ONCOLOGY	GRANDEUR
INCORRECT	NOSTALGIC	GODDAMN	MAESTRO
MISER	CHAMP	HAZARD	SEXUAL
VULGAR	SIESTA	GEEZER	DYNAMO
CHASE	SOUTH	MONOTONOUS	SUMMERTIME
EXPENSIVE	DECORATOR	MOBSTER	COTTAGE
SYMPTOM	BISCUIT	NEGRO	MANLY
IRRITATE	MAHOGANY	BEWARE	ACCEPT
PROWL	SAINT	BEG	WIZ
MISREAD	ANATOMY	SNIPER	KARATE
ANGINA	WONDER	SPIDER	CANARY
DECEPTIVE	TREATABLE	JAB	KIT
BUSYBODY	ACTIVITY	SLUM	HERB
CRAZINESS	INTEGRITY	DISAGREE	INFINITY
RUT	GIG	AIDS	MENU
LURK	CHIP	IMPEACH	NURSING
DEMISE	ELATED	TETANUS	TRIBUTE
SHAM	JIVE	SHYSTER	SWEATER
TAX	OAK	PROSTRATE	ALLEVIATE
JAILER	FELINE	CUSTODIAN	SENSATION
SCURVY	WAFFLE	SPINAL	GARNET
STEROID	PROPOSE	BOSSY	HOLLY
PROBE	STEAK	EJECTION	MUSCULAR
FLOOD	RIVER	DISTORT	ELEVATE
TOMBSTONE	FIRSTBORN	BRIBE	BASIL
JOCKSTRAP	ORGANIZER	POOP	WIFE
ACHY	HAWK	DUNGEON	PRIVACY
BREECH	RARITY	PHOBIA	SKATER
POUT	SLED	THEFT	SPACE
SETBACK	CONSOLE	WEASEL	TICKLE
APPALLING	CLEANSING	VILE	CALM
COSTLY	WORTHY	CRAP	KEEP
ILLOGICAL	LIGHTNESS	ARSENIC	HAYRIDE
GOUT	HAIR	FOOL	LUST
BINGE	TEPEE	POLIO	EARTH
PIGHEADED	SYMBOLISM	FEE	NAP
POUTY	PROMO	MANURE	ARCADE
MALICE	FRUITY	CONFOUND	PLAYBOOK
SNOOTY	WIZARD	UNWORTHY	ATHLETIC
ANTISOCIAL	BLACKBERRY	REJECTED	QUANTITY
FREAK	CHOIR	POWERLESS	MULTITUDE
SAD	FAN	SICKLY	TOKENS
WEAKNESS	POWERFUL	DEVASTATED	STAGECOACH
ALARMING	FOLKLORE	INFERIOR	SHEARING
BEREAVED	HANDYMAN	FAIL	EARS
BERSERK	CATERER	DEFEAT	MUSEUM
CUTOFF	NUDITY	LONELY	JERSEY
HEADLOCK	TOMATOES	FATIGUE	AVOCADO
WASTEFUL	STRENGTH	IGNORED	LIGHTED

Threat	Neutral
SLUGGISH	TEXTURED
GROAN	FLUTE
MISERABLE	STATEWIDE
BROODING	PROTEINS
UNFORTUNATE	COMMODITIES
DESPISED	TOMATOES
PATHETIC	CLEANERS
HUMILIATED	WATERPROOF
HAZARD	BALLOT
INTIMIDATED	COEFFICIENT
QUAKING	ANAGRAM
TIMID	SATIN
TEASE	AISLE
DISMAL	MIDWAY
LOST	READ
HARM	NOON
TENSE	BACKS
JUMPY	LOTUS
DEFENSIVE	GEOMETRIC
EMBARRASSED	MICROSCOPIC
LETHAL	RACKET
APPREHENSION	INSTRUMENTAL

Appendix C

Word pairs - List C

Threat	Neutral	Threat	Neutral
INSIDIOUS	NARRATIVE	CESSPOOL	GRAPHICS
SHADY	LUNAR	GALLOWS	TAKEOUT
CLAMMY	SELECT	WRETCH	AUTHOR
MEANIE	MIGHTY	HEFTY	BLOND
HYPODERMIC	BELIEVABLE	HOLLER	NORMAL
MOUSY	SKIRT	VULTURE	BONFIRE
BOOTLEG	CHATEAU	BURN	STAY
UGLY	SNOW	BLUBBER	COWGIRL
BOGUS	PETAL	PRICK	SAVOR
FREAKISH	REKINDLE	TURMOIL	VALIANT
INDICT	STURDY	STD	AWE
IMPAIR	RETIRE	MUCUS	UNITY
CELIBATE	MOONWALK	SUBDUE	LIMBER
PROFANITY	COOPERATE	TAUNT	SMELL
EX	GO	DELUSION	SOCIABLE
TAKER	VOICE	FLAKY	GREET
PILEUP	ARTIST	CHOLERA	CUISINE
CLUELESS	VITALITY	INVADE	BONSAI
HORRID	NECTAR	PINCH	BAGEL
RETALIATE	HOT SAUCE	LATE	FACE
WRINKLED	ELEPHANT	ADDICTION	LIFEGUARD
MORTGAGE	HEIRLOOM	CHLOROFORM	INTERESTED
DITCH	PRIDE	WARRANT	TWOSOME
CAPTIVE	PERFORM	MOOCH	TRAIL
ZOMBIE	STUDIO	EMBEZZLER	MASTERFUL
DESPAIR	SWEETEN	FORBID	BANANA
RATTY	RHYME	HORNET	VIOLET
SHRIEK	TONGUE	GRUDGE	EDIBLE
CYNIC	EAGER	MISTAKE	JASMINE
GUNK	JEST	OOZE	JADE
OGRE	SEEK	HOOLIGAN	CAMPFIRE
BADNESS	SAUSAGE	SCREAM	SPLASH
HANDICAP	SKILLFUL	SCOFF	PLAZA
TRIAGE	ROBUST	SKEPTICAL	SLEEPOVER
HOMEWORK	FOOTWEAR	EGOMANIAC	PROMENADE
BASH	SAND	LOATHE	DESIGN
WARFARE	CURIOUS	TYRANNY	FLORIST
RAT	WOO	MESSY	SAUCE
SHIPWRECK	POTASSIUM	NOSY	FINE
VIRAL	KOOKY	DRAB	SLIM
CRYPT	PEACH	ATTACK	SEASON
CLOG	PINE	HORROR	WAGONS
BLOODSHED	POCKETFUL	STRANGLED	SIGNATURE
PURGATORY	VISIONARY	AGITATION	FIREPLACE
DESPERATE	UNIVERSAL	INSECURE	FETCHING
BLOODY	FOREST	INCURABLE	RECLAIMED
WEAKEN	PEANUT	SUICIDE	SUMMERS
STOCKADE	POPSICLE	FUNERAL	HUNTING
EVICT	HORNY	GRIEVING	HALLMARK

Threat	Neutral
GRIEVING	HALLMARK
TRAGEDY	REQUEST
WORTHLESS	BATTERIES
HOPELESS	FEATHERS
AWFUL	TRACT
DESERTED	MARCHING
FUTILE	ATTIRE
MOURN	SCANS
DISCOURAGED	CONNECTIONS
INADEQUATE	TRANSITION
DISCONTENTED	HOUSEHOLDERS
INFORM	DEPOTS
MISUNDERSTOOD	MANIFESTATION
GLOOMY	PASTEL
USELESS	FLOWING
FORLORN	KEYHOLE
TORMENTED	MYTHOLOGY
DEATHBED	SOFTENER
UNHAPPY	BRIDGES
DULL	FLEW
DREADFUL	COMPUTER
COFFIN	EDITED
MISTAKE	QUARTER

Appendix D

Questionnaire 1

Read each item and then list the number from the scale below next to each word. **Indicate to what extent you feel this way right now, that is, at the present moment**

1	2	3	4	5
Very Slightly or Not at All	A Little	Moderately	Quite a Bit	Extremely

__________ 1. Interested
__________ 2. Distressed
__________ 3. Excited
__________ 4. Upset
__________ 5. Strong
__________ 6. Guilty
__________ 7. Scared
__________ 8. Hostile
__________ 9. Enthusiastic
__________ 10. Proud
__________ 11. Irritable
__________ 12. Alert
__________ 13. Ashamed
__________ 14. Inspired
__________ 15. Nervous
__________ 16. Determined
__________ 17. Attentive
__________ 18. Jittery
__________ 19. Active
__________ 20. Afraid

2) Which styles of music do you like to listen to? (select as many as you like)

i. Pop ___ ii. Rock ___ iii. Classical ___ iv. Jazz ___

v. Country ___ vi. R&B ___ vii. Rap ___ viii. Other ___

3) Are there any styles of music you *don't* like listening to? (list)

____

4) Do you usually listen closely to the lyrics (words) of a song? (Y/N) _______

5) How many times in the last month did you go out to see a live musical act? ________

6) What was the last musical act (band/ singer/ orchestra, etc.) you saw?

____

Appendix E

Questionnaire 2

Music Attitude and Experience Questionnaire

The aim of this questionnaire is to gather information about your musical experience and attitude to music. There are no right or wrong answers.

Age: ____________

Gender: _________

Is English your main spoken language? (Y/N) ______

1) Do you play a musical instrument? (Y/N) _______

2) If you answered 'Yes' to question 1, how long have you been playing? (if more than one instrument, choose the one you have been playing the longest). __________

3) How did the music you just heard make you feel?

music 1__________________________ music 2_______________________________

4) How do you think other listeners would feel after listening to the same music?

music 1__________________________ music 2_______________________________

3) Have you ever sung in a choir? (Y/N) ______

4) Do you listen to music on the radio every day? (Y/N) ________

5) Which of the following music playing devices do you regularly use? (place X where appropriate)

i. I don't use any _____ ii. Record player ______ iii. iPod/ mp3 player _____

iv. Radio _____ v. CD player _____ vi. Other ______

Thank you.

Appendix F

Information letter

JOONDALUP CAMPUS

270 Joondalup Drive,
Joondalup
Western Australia 6027
Telephone 134 328
Facsimile: (08) 9300 1257
CRICOS 00279B

ABN 54 361 485 361

Effects of Music on Performance

The effect listening to music has on performance will be investigated. It will involve listening to different musical excerpts while performing a computer-based reading task.

In addition, you will be asked to complete a short questionnaire about your past and present musical experiences and your attitudes toward music. Participation is completely voluntary and anonymous, and you can withdraw at any time. The whole procedure should only last approximately 20 minutes.

Knowledge from the research will form the body of an honours thesis, and may be published in an academic journal in the future.

For any further information regarding this project, please contact the following:

Chief researcher: Haans Drieberg 9309 5616 hdrieber@our.ecu.edu.au

Supervisor: Professor Craig Speelman 6304 5724 c.speelman@ecu.edu.au

Honours Co-ordinator: Dr. Bronwyn Harman 6304 5021 b.harman@ecu.edu.au

If you have any concerns or complaints about the research project and wish to talk with an independent person, you may contact:

Research Ethics Officer- Edith Cowan University
20 Joondalup Drive
Joondalup WA 6027
Ph: 6304 2170
Email: research.ethics@ecu.edu.au

Appendix G

Informed consent form

JOONDALUP CAMPUS

270 Joondalup Drive,
Joondalup
Western Australia 6027
Telephone 134 328
Facsimile: (08) 9300 1257
CRICOS 00279B

ABN 54 361 485 361

LETTER OF CONSENT

Effects of Music on Performance

I ______________________________ (name) have been provided with information regarding the research being undertaken by Haans Drieberg into the effects of music on performance. I have read and understood the information provided.

I understand that I will be required to perform a computer–based reading task as well as listen to short extracts of music and fill in a questionnaire.

I have been informed that any data obtained in the research will be entirely confidential, and the identity of participants will not be disclosed.

I am aware that knowledge gained from the research will form the body of an honours thesis, and may be published in an academic journal in the future.

Participation in this research is purely voluntary, and I am aware that I may withdraw at any time without penalty.

Participant's signature _________________________________ Date ______________

Haans Drieberg (Principal researcher)
[redacted]

20th June, 2013.

Appendix H

Word list counterbalancing schedule

1	A B C	21	B A C	41	C A B
2	A C B	22	B C A	42	C B A
3	B A C	23	C A B	43	A B C
4	B C A	24	C B A	44	A C B
5	C A B	25	A B C	45	B A C
6	C B A	26	A C B	46	B C A
7	A B C	27	B A C	47	C A B
8	A C B	28	B C A	48	C B A
9	B A C	29	C A B	49	A B C
10	B C A	30	C B A	50	A C B
11	C A B	31	A B C	51	B A C
12	C B A	32	A C B	52	B C A
13	A B C	33	B A C	53	C A B
14	A C B	34	B C A	54	C B A
15	B A C	35	C A B	55	A B C
16	B C A	36	C B A	56	A C B
17	C A B	37	A B C	57	B A C
18	C B A	38	A C B	58	B C A
19	A B C	39	B A C	59	C A B
20	A C B	40	B C A	60	C B A

Appendix I

Q-Q probability plots of reaction time data