



Music: A Help or a Hindrance to Creative Thinking?

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Abstract

Creative thinking is a highly useful skill on both an individual and a societal level (Sternberg & Lubart, 1999). The aim of this study is to provide understanding of what can help and what can hinder creative thinking. Many people choose to listen to music during study, while others do not (Etaugh & Ptasnik, 1982). Therefore, the current study investigates whether musical study preferences reflect performance, and if different thinking processes, often cited as important to creative thinking, are affected by music in the same manner. It was hypothesised that, music would affect performance on a convergent thinking (CT) task and a divergent thinking task (DT) differently. Furthermore, it was hypothesised that musical study preferences would produce contrasting effects of music on CT and DT. The study adopted a 2 (study preference: with music vs. no music) x2 (test condition: with music vs no music) x2 (performance: DT and CT) multivariate within-subjects experimental design. 38 participants (31 female, $M = 22.5$ yrs, $SD = 3.70$) were opportunistically recruited via email from the Edinburgh Napier University participant pool and fourth year Psychology students. A three-way mixed factorial ANOVA could not support the two main hypotheses: background music did not produce differences in CT or DT and musical study preferences did not produce any main effect or interactions between CT and DT. Further analyses revealed that participants performed better in all tasks in their most preferred condition and participants successfully identified the most distracting condition to performance. The study indicates that DT and CT performance is enhanced in the most enjoyed condition: be it with or without music. This suggests that people benefit from environmental conditions, such as music, which they enjoy. This implies that people should be given more choice when it comes to work, study and exam conditions as this may produce enhanced performance in creative thinking in terms of CT and DT. Future research is recommended to validate the results and to consider other environmental factors which may enhance creative thinking.

KEY WORDS:	MUSIC	CREATIVITY	CONVERGENT	DIVERGENT
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List of Abbreviations

AUT	=	Alternative Uses Task
CT	=	Convergent Thinking
DT	=	Divergent Thinking
EBR	=	Eye Blink Rate
EEG	=	Electroencephalogram
POMS	=	Profile Of Mood States
RAT	=	Remote Associates Task
SOI	=	Structure Of Intellect
STAI	=	The State-Trait Anxiety Inventory

Chapter 1: Introduction

1.1 Objectives

The aim of this study is to contribute to the understanding of what may enhance and what may inhibit creative thinking. The investigation focuses on the effects of environmental influences, specifically background music. There is a wealth of research investigating the effects of background music on cognitive abilities. However, there is much less

research which specifically investigates the effects of background music on creative thinking processes. This is surprising because creativity is "...a topic of wide scope that is important at both the individual and societal levels for a wide range of task domains." (Sternberg & Lubart, 1999, p3). Creativity is important at the individual level for solving problems in day to day life; at the societal level it is important for discovering new scientific findings, inventions and art etc. (Sternberg & Lubart, 1999).

A number of theories suggest that the production of a novel and productive creative idea requires two thinking processes (e.g. Finke, Ward & Smith, 1992; Kris, 1952, cited in Martindale, 1999). One process is involved in generating ideas, and the other is involved in evaluating those ideas for their appropriateness and usefulness to the situation. The two processes suggested appear to be opposites. Cropley (2006) proposes that generation of ideas requires the ability to think divergently, whereas evaluation of ideas requires the ability to think convergently. Runco (2003) further argues that creativity requires a combination of both DT and CT. There is a wealth of empirical evidence which demonstrates the importance of DT in creativity (e.g. Gibson, Folley & Park, 2009). In addition, empirical evidence suggests that CT is less important but still highly useful in creative thinking (e.g. Basadur, Runco & Vega, 2000), however it has been a less widely studied area.

A number of studies have attempted to reveal how these two thinking processes may be improved. For example, some studies suggest that DT is improved by elevated mood (Vosburg, 1998) and generative stages of creative thinking are believed by some theorists to be aided by a state of defocused attention (e.g. Kris, 1952, cited in Martindale, 1999). In contrast, the elaborative stages of creativity (likened to CT) are believed to benefit from focused and systematic thought (e.g. Finke, Ward & Smith, 1992) and baseline mood levels (Chermahini & Hommel, 2010).

Music can influence states of consciousness (Aldrige, Fachner & Schmidt, 2006) and levels of mood and arousal (e.g. Husain, Thompson & Schellenberg, 2002). There is therefore a wealth of research which has concentrated on how background music affects consumer behaviour; do we buy more if we go into a shop with thumping techno music; do we choose French wine over German wine if the background music is French (North, Hargreaves & McKendrick, 1997)? The majority of findings say that we do unconsciously alter our behaviour to fit the background music. Of

course, other research has concentrated on how background music affects more general cognitive abilities. The research findings are inconsistent: many studies find improved performance, and many find diminished performance (Kämpfe, Sedlmeier & Renkewitz, 2011). There is little research which investigates the effects of music on convergent and divergent thinking, therefore this study intends to provide more insight into this gap in our knowledge.

Creative thinking is seen as an important attribute and it is often sought in educational and occupational settings. However, the processes behind creative thinking are still debated, therefore understanding of what inhibits and what enhances creative thinking is lacking. Such an understanding may be of interest to institutions and individuals who use creative thinking. Furthermore, investigating the effects of background music on creative thinking is an ecologically valid area of study as background music is common in a number of settings and it is relatively easy to manipulate. For example, many students listen to background music during study (Adriano & DiPaola, 2010). Students and employers could use the information gleaned from this study, to enhance creative thinking via listening or not listening to music at different points during the creative process.

1.2 Literature Review and Theoretical Context

The literature review begins by discussing creativity in terms of definitions, theories and possible processes involved in creative thinking. Two of these processes: convergent and divergent thinking are considered in more detail, including empirical evidence for their role in creative thinking. The literature review will then move on to discuss the known effects of music on a variety of cognitive processes, including describing possible underlying reasons for these effects such as mood, arousal and cognitive capacity. Empirical evidence, of how these underlying reasons for musical effects, affect CT and DT is presented. Finally, the role that individual differences can play in producing contrasting effects is considered. These discussions provide the rationale for the research questions and hypotheses which follow the literature review.

1.2.1 Creative thinking.

Creativity can be defined as the ability to combine ideas in novel ways which are appropriate or useful to the situation or task at hand (Martindale, 1999). Although the ability to think creatively is extremely important on an individual and a societal level (Sternberg & Lubart, 1999), understanding of what enhances and conversely what diminishes creative thinking is not clear. This could be due to the complex processes that are involved in creative thinking, as well as problems with testing creative thinking, not to mention individual differences.

1.2.2 Theories of creativity.

There are a number of theories concerned with the processes involved in creative thinking. The theories can be divided into two sections; those that propose that

creative thinking involves one thinking process, and those that propose creativity involves two or more thinking processes.

1.2.2.1 Creativity with a single process.

There are a number of theories which propose that creative thinking involves a single thinking process and some of these will be discussed.

1.2.2.1.1 Associations.

Mednick (1968) proposed that creative thinking is the ability to combine associations which are mutually exclusive into novel and useful combinations. Mednick (1962) theorised that individual differences in creativity are based on the 'steepness' or 'flatness' of their associations with ideas and objects. According to Mednick (1962), creative individuals experience flat associations, therefore their thinking is not dominated by the first and second strongest associations but their mind is 'open' to less probable, more remote associations. Dewhurst, Thorley, Hammond and Ormerod (2011), propose that this is because differences in strengths of association are smaller and Nijstad, De Dreu, Rietzschel and Baas (2010) suggest that this is due to attenuated levels of latent inhibition. The result of this attenuation is that more 'irrelevant' stimuli or in this case, associations, enter the brain, which can increase the pool of stimuli to work with which can then lead to more novel responses.

1.2.2.1.2. Breadth of attention.

The work of Mendelsohn (1976) and Mendelsohn and Lindholm (1972) suggest that creative thinking is related to breadth of attention. They argue that people differ in breadth of attention; the wider the breadth of attention, the more stimuli attended to, thereby the greater the probability that more varied and unusual ideas come together (Kasof, 1997). The narrower the breadth of attention, the less stimuli attended to, therefore, the lower the probability that more disparate ideas come together.

1.2.2.1.3. Critique of single process theories.

Single process theories of creativity have been criticised on theoretical and empirical grounds. For example, Riegel, Riegel and Levine (1966, cited in Mendelsohn, 1976) argue that it is inappropriate to restrict creativity to only a simple associative process, rather the associative process should be regarded as only one element of creative thinking. Other thinking processes are not viewed as symbolising one process, so why should creative thinking be viewed in such a way (Riegel, et al, 1966, cited in Mendelsohn, 1976)?

1.2.2.2 Creativity with dual or multiple processes.

In contrast to single process theories of creativity discussed above, a large number of theories argue that creativity involves dual or multiple thinking processes. These will now be discussed in more detail.

1.2.2.2.1 Primary and secondary processes.

Kris (1952, cited in Martindale, 1999) discusses creative thinking in terms of the ability to switch between primary and secondary thinking processes. Primary process thinking according to is free associative and analogical, whereas secondary process thinking is logical and goal oriented (Kris 1952, cited in Martindale, 1995). According to Kris (1952, cited in Martindale, 1999), initial stages of creative thinking use primary processing; as it is associative, it facilitates the combination of new mental elements. A primary process state of mind is typically found in dreaming states or states of reverie (Martindale, 1999). The associative elements of the theory correspond to Mednick's (1962) flat associative hierarchy theory, although Kris's (1952, cited in Martindale, 1999) theory goes beyond that. He argues that it is a return to a secondary process state of mind that allows elaboration of creative ideas which will result in the appropriateness or usefulness of the idea. Furthermore, Kris (1952) implies that it is the extent of this ability to switch between primary and secondary process thinking states which determines individual differences in creativity. Importantly, Kris (1952) here, unlike Mednick (1962) suggests that there are two main stages involved in the production of a creative idea. These are idea generation and elaboration of those ideas, furthermore these two stages involve different thinking processes; respectively primary and secondary process thinking.

1.2.2.2.2 Geneplore model.

Finke, Ward and Smith's (1992) geneplore model of creative cognition is similar to Kris's (1952) in the sense that it describes how one thinking process is used for idea generation and another for exploring those ideas. Although Kris's model (1952) is derived from a psychoanalytic perspective and Finke et al's model (1992) is from a cognitive perspective, they are similar in the sense that they propose two similar thinking processes.

1.2.2.2.3 Wallas's four stage model.

Wallas's (1926, cited in Lubart, 2000) four stage model of the creative process also suggests that creative thinking may involve more than one thinking process. The initial stage involves preparation: conscious preliminary analysis and definition of the problem. Then follows a period of incubation: no conscious mental work is carried out but the mind continues to form ideas, rejecting some and keeping others. The third stage involves illumination: the promising idea comes to consciousness and the final stage, verification, involves evaluating and developing the idea. It could be argued that one process is used in the preparatory and verification stage, while the other in the incubation and illumination stages. According to Wallas's model (1926, cited in Lubart, 2000) all stages are important in the production of a creative solution.

1.2.3 Processes involved in creative thinking.

The query then is what thinking processes are involved in the two suggested stages of creativity. Guilford's (1967) structure of intellect model (SOI) has been highly

influential to the study and understanding of the processes in creativity. He argues that there are five separate, uncorrelated intellectual operations which contribute to performing mental tasks: cognition, memory, convergent thinking, divergent thinking and evaluation. Guilford (1967) proposes that creative production and problem solving are practically the same phenomenon and he therefore essentially treats them as one entity. He suggests that divergent thinking is highly important to the generative stages of creative production. However, evaluation is immensely useful to problem solving in regards to selecting the best possible solution. A number of more modern researchers similarly argue that creativity requires convergent and divergent thinking (e.g. Cropley, 2006; Runco, 2003).

1.2.4 Convergent and divergent thinking.

Convergent thinking (CT) involves an individual generating the single most well-established answer to a problem (Cropley, 2006) and requires focused and systematic thought (Fischer & Hommel, 2012). In contrast, divergent thinking (DT) requires generating a range of novel, atypical solutions to one problem or question (Nijstad, et al, 2010).

Kris's (1952, cited in Martindale, 1999) two process theory and Finke et al's (1992) model of creativity could be viewed in CT and DT terms. CT is viewed as a conscious, systematic process (Fischer & Hommel, 2012), which may be responsible for the elaborative process, whereas DT is viewed as an unconscious process (Nijstad et al, 2010) which could be responsible for idea generation.

Empirical evidence has displayed the importance of DT in creative thinking. Gibson et al (2009) concluded from their study comparing levels of divergent thinking in an externally validated group of musicians to a normal population, that creative individuals are characterised by enhanced DT. The empirical evidence for the involvement of CT in creative thinking is weaker as it has been studied much less. However, Basadur, et al (2000) found that behavioural skills such as generating quality options and evaluating options (which they likened to DT and CT respectively) were the most predictable variables for creative thinking.

Thus far, definitions, theories and possible processes involved in creativity have been discussed. The focus of attention will now shift to music: the effects that music has on cognition and possible underlying reasons for these effects will be discussed. This will be followed by consideration of the possible effects of music on CT and DT.

1.2.5 Musical effects on cognition.

The effects that listening to background music have on performance are not well understood and are certainly not consistent. Due to the widespread use of background music in commercial environments much of the research on musical effects has concentrated on consumer behaviour (Schellenberg & Weiss, 2013). The

overarching finding is that consumers unconsciously alter their behaviour to fit background music (e.g. Areni & Kim, 1993). However, the effects of background music on educational and occupational performance are also of great interest. Employers may be interested in whether background music can enhance work performance. Students who study while listening to music may also find the effects of music on academic performance of interest (Patton, Stinard & Routh, 1983). As music becomes more and more accessible through advancing technology, a greater understanding of these musical effects is desirable.

The research on the effects of background music on cognitive abilities is inconsistent. Many studies report improvements in performance, e.g. Schellenberg, Nakata, Hunter and Tamoto (2007) found that music improved creativity and IQ, and Mammarella, Fairfield and Cornaldi (2007) established that it improved working memory. However, many report a diminished performance, e.g. Crawford and Strapp (1994) found music to have a detrimental effect on associative learning and long term memory. In a recent meta-analysis by Kämpfe et al (2011), an over-all null effect of background music on cognitive abilities was reported. The researchers made clear that this null effect may be due to the averaging out of specific effects and should not be taken at face value (Kämpfe, et al, 2011). Schellenberg and Weiss, (2013) suggest that the inconsistent findings are due to three aspects of music which can produce either beneficial or detrimental effects on cognitive performance: music taking up limited cognitive capacity, music inducing mood and influencing levels of arousal. These three aspects will now be discussed.

1.2.5.1 Music and cognitive capacity.

The cognitive capacity model by Kahneman (1973, cited in Schellenberg & Weiss, 2013) stipulates that different cognitive processes draw from the same pool of limited resources, therefore while attending to the background music, the primary task will inevitably suffer. However, whether cognitive load is overtaxed depends on depth of processing (Lavie, 2005) which suggests that this effect may only occur in some task types and not others. This is supported by Uhrbrock's (1961) influential, although now slightly outdated, review on the effects of background music on working performance. Studies indicated that background music increased production in workers doing simple repetitive tasks, however this increase was not found in workers completing more complex tasks (Uhrbrock, 1961). This could partly be explained by the Yerkes-Dodson law (cited in Kotsopolou & Hallam, 2010) which states that there is an optimal level of arousal which increases performance. However, if arousal succeeds that level, performance will deteriorate. Furthermore, the law states that simple tasks require a high arousal level to maintain concentration, yet in complex tasks, level of arousal may become too high and performance will quickly deteriorate.

1.2.5.2. Arousal and mood hypothesis.

The other aspect identified by Schellenberg and Weiss (2013), is that music can influence emotions and potentially either improve or worsen the emotional mood of

the listener which can affect task performance. The Mozart effect phenomenon: listening to a Mozart piano sonata before performing tests of spatial abilities will enhance performance (Rauscher, Shaw & Ky, 1995), has been attributed not to Mozart (as previously believed) but to the between-condition differences in arousal and mood (Thomson, Schellenberg & Hussain, 2001).

1.2.5.2.1 Musical effects on mood.

Research suggests that music listening can enhance mood, for example, Boothy and Robbins (2011) found that 10 minutes of listening to music reduces negative mood levels measured by the Profile of Mood States (POMS) test and the State-Trait Anxiety Inventory (STAI) compared to a no-music condition.

1.2.5.2.2 Effects of mood on performance.

There are a number of theories concerning how mood affects cognitive tasks. Frederick and Branigan (2005) argue that positive mood broadens the range of thought-action repertoires, whereas negative mood narrows the number of available action tendencies. Similarly, Ashby, Isen & Turken (1999), theorise that positive mood enhances creative problem solving due to increased dopamine release (associated with positive affect) in the anterior cingulate which improves cognitive flexibility. Indeed, Rowe, Hirsch and Anderson (2006) found that positive affect enhanced access to remote associations which is often seen as important to creative thinking (discussed above). Furthermore, Driesbach and Goschke (2004) found that positive mood facilitated fluency in switching to novel stimuli in a picture viewing experiment although, it also increased distractibility. However, other research has shown that positive mood may adversely affect performance on cognitive tasks such as planning and working memory (Oaksford, Morris, Grainger & Williams, 1996; Spies, Hesse & Hummitzsch; cited in Kostosopolou & Hallam, 2010).

After having discussed the first two underlying aspects which may cause effects produced by music, attention will now shift to the third aspect: cortical arousal.

1.2.5.2.3 Musical effects on cortical arousal.

Cortical arousal is often measured by levels of alpha wave power measured by electroencephalogram (EEG) techniques. Higher alpha power equates to low cortical arousal and low alpha power equates high cortical arousal. The effects of music on alpha power are somewhat mixed and discuss the findings: Bruya and Severtsen (1984) found no musical effects, Duffy, Bartels and Buchfield (1981, cited in Katayama, Hori, Inokuchi, Hirata & Hayashi, 1992) found decreases and Breitling, Guenther and Rondot (1987) uncovered increases.

1.2.5.2.4 Summary of musical effects on mood, arousal and cognitive capacity.

The conflicting effects of music on arousal, mood and cognitive capacity are possible reasons for the null effects found in reviews concerning music and cognitive abilities (e.g. Kämpfe et al, 2011). These three effects have been discussed in detail. **Figure 1** illustrates how these three conflicting effects come together to produce the null effect described.

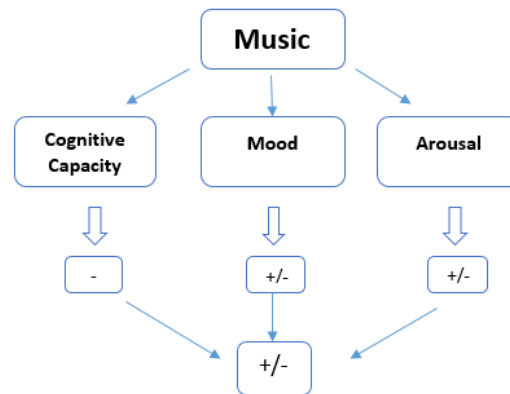


Figure 1: Conflicting Effects of Music on Mood, Arousal and Cognitive Capacity

1.2.5.3 Effects of mood and arousal on convergent and divergent thinking.

Research will now be discussed concerning the effects of music on mood, arousal and cognitive capacity and their respective effects on CT and DT.

1.2.5.3.1 Convergent and divergent thinking and mood.

Only a handful of studies have looked specifically at mood and divergent and convergent thinking separately. Research suggests that DT is enhanced by elevated mood. For example, Vosburg (1998) conducted a study looking specifically at how positive and negative mood affect performance on DT tasks. Firstly, mood was assessed using an adjective checklist prior to task performance. Secondly, participants were asked to generate as many solutions as possible to one real life problem presented in a vignette. Finally, solutions were counted to provide a fluency score for DT. The results led her to suggest that individuals in elevated moods could generate more ideas in a DT task. She attributed this to mood affecting the type of strategy chosen to go about the task. Those in an elevated mood may have used satisficing strategies which involve the individual creating and choosing their own achievable goals. Those in a negative mood may choose optimising strategies (trying to find the best solutions) and may be more concerned with the quality of their ideas leading to a smaller number of ideas being generated (Vosburg, 1998).

In a study conducted by Chermahini and Hommel (2010), Vosburg's (1998) conclusions are supported. Their findings also suggest that DT may be enhanced by positive mood. Furthermore, they found in contrast, that CT may be impaired by elevated mood. The research studied spontaneous eye blink rates (EBR) which is a clinical marker of dopamine functioning. High levels of dopamine are thought to

illustrate elevated mood. DT was measured by the Alternative Uses Task (AUT), designed by Guilford (1957, cited in Kaufman, Plucker & Baer, 2008) which involves participants noting down as many alternative uses to an object as possible. Performance of DT seemed to benefit most from medium eye blink rates (measured by the BioSemi ActiveTwoSystem), but high rates impaired performance creating an inverted U shape. This suggests that a certain amount of elevated mood will benefit DT as Vosburg (1998) suggested. However, very highly elevated mood can diminish performance on DT tasks. CT tasks were measured using the Remote Associates Task (RAT) created by Mednick (1962) and involves participants providing a fourth remotely associated linking word to a list of three given words. Performance on these CT tasks benefited from low EBR, suggesting that CT may be impaired by medium or highly elevated mood.

1.2.5.3.2 Convergent and divergent thinking and arousal.

Studies have found that higher alpha wave activity (an inverse measure of cortical arousal) is associated with the idea generation stage and lower alpha wave activity (i.e. higher cortical arousal) with the elaboration stage (e.g. Martindale and Hasenfus, 1978). Furthermore, Martindale and Mines (1975) measured the amount of EEG alpha wave activity during completion of the AUT, the RAT and an intelligence test. The highly creative group showed more cortical arousal variation across tasks; the highly creative group showed lowest arousal in the AUT task (generative task), somewhat higher arousal in the RAT task (generation and elaboration) and highest arousal during the intelligence task (logical problem solving). This pattern suggests that the creative group can more readily switch between low and high cortical arousal, therefore suggesting that they can switch between secondary and primary process thinking more easily, lending support to Kris's (1952) theory. Similar findings, discussed shortly, have also been uncovered when investigating CT and DT lending further support to the notion that DT is involved in idea generation and CT in elaboration. It has been found that a higher level of power in the alpha wave band of the EEG measure (which is a common marker for a decrease in cortical arousal) has been observed during DT tasks as compared to CT tasks (Möller, Marshall, Lutzenberger, Pietrowsky, Fehm & Born, 1996; Möller, Marshall, Wolf, Fehm & Born 1999).

1.2.5.3.3 Summary of effects of mood and arousal on CT and DT

To summarise, it appears that DT benefits from elevated mood and low cortical arousal, whereas CT is benefited from a more baseline mood level and higher cortical arousal. This suggests that musical effects which have been linked, in part, to effects on mood and arousal, may have contrasting effects on DT and CT. **Figure 2** illustrates this more clearly.

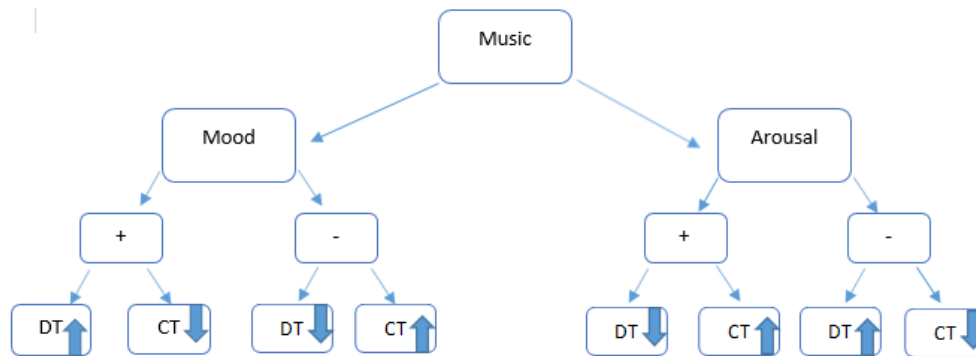


Figure 2: Possible Effects of Music on Arousal and Mood leading to possible Effects on CT and DT

1.2.5.4 Convergent and divergent thinking and cognitive capacity.

Researchers suggest that music is detrimental to performance because it draws from the same pool of limited resources as the cognitive task at hand (Schellenberg & Weiss, 2013). However, Uhrbrock's (1961) review of musical effects discussed suggests that background music will only hinder very complex processes. There is debate about whether DT or CT is more complex than the other which will not be discussed here but it something which may influence how music affects these two processes in different ways. If one were to consider the Yerkes Dodson Law as discussed above, it states that simple tasks require a high arousal level. Yet, in complex tasks high levels of arousal may become too high and performance will deteriorate. The literature discussed found that high levels of arousal enhance CT but impair DT. This may suggest that DT is a more complex process than CT. Therefore, if a certain environmental condition, such as music or silence, heightens arousal in an individual, it may hinder performance on DT but facilitate performance on CT and vice versa for conditions which keep arousal levels low. This is a further argument for why music and silence may aid or hinder CT and DT in different ways.

This leads to the next section of the literature review: people are different and environments are experienced by people in distinct ways. It would therefore be expected that these environments will affect performance differently in various people. Individual differences will now be discussed.

1.2.6 Individual differences.

The results of a number of studies suggest that individual differences influence whether background music facilitates or impairs performance (e.g. Furnham & Bradley, 1997). There have not been many studies found which take musical study preference into account as a moderating variable. However, Crawford and Strapp (1994) observed that although music was detrimental to the performance in participants who typically study without music, this effect was not found in participants who typically study with music. There are a number of possible reasons for this. Crawford and Strapp (1994) discovered that those who typically study with music scored higher on an extraversion scale and Furnham and Bradley (1997)

found that introverts and extroverts perform differently in the presence of music or silence. Furthermore, Etaugh and Ptasnick (1982) found that participants who rarely studied with background noise, showed better results in a laboratory study when learning in silence, whereas students who typically studied with music performed better when learning with music.

Therefore in the present research, musical study preferences are taken into account. The next section will describe the present study in detail.

1.3 The current study

This study does not aim to solve the debate of exactly which processes contribute to creative thinking; it aims to provide evidence of how music listening may affect two processes thought to be involved in it. DT and CT may both contribute to creativity but DT and CT seemingly use different processes. DT appears to be involved in idea generation and the research discussed suggests that a diffused, unfocused state of mind may aid idea generation (Nitjstad et al, 2010). CT involves systematic search and evaluation of possible solutions in order to provide the one best possible answer (Fischer & Hommel, 2012). How music affects these two, seemingly opposite, although related, thinking strategies is what this study attempts to answer. Research suggests that students are intuitively aware of whether music helps or hinders them during study (e.g. Etaugh & Ptasnick, 1982). This study will investigate whether students can identify whether music distracts or hinders them.

1.3.1 Formulation of Research Questions and Hypotheses

As can be seen from the studies mentioned above, the effects of background music have been tested on a number of cognitive tasks. Individual differences and three conflicting aspects of background music in itself (arousal, mood and cognitive overload) has resulted in a body of inconsistent research and conflicting findings. According to many researchers, convergent and divergent thinking are two important processes involved in creative thinking (e.g. Cropley, 2006; Runco, 2003). Research suggests that CT and DT appear to be affected by mood and arousal in contrasting ways and as music appears to affect mood and arousal, this study intends to investigate whether music affects CT and DT in contrasting ways. Furthermore, individual differences (specifically musical study preference) appear to moderate the effects of music on performance. Therefore, in this study musical study preference will also be considered.

Specifically, this study investigates whether background 'study' music (most popular genre selected by the sample) has the same effect on CT and DT, and whether it has the same effect on individuals who choose to study while listening to music compared to those who prefer to study without music.

The present study adopts a 2x2x2 mixed factorial within-subjects experimental design. The three factors include: 1. musical study preference: with music or without, 2. musical condition: with music or without, and 3. performance on task: convergent and divergent thinking.

This study will also consider other variables including perceived distractibility, preferred condition and familiarity with the music to uncover any possible effects that they may produce on performance.

1.3.2 Research questions.

1. Does silence or the most popular musical genre listened to while studying (according to the sample's choice), have different effects on convergent and divergent thinking performance?
2. Does silence or the most popular musical genre listened to while studying (according to the sample's choice), have different effects on convergent and divergent thinking performance in people who do or do not listen to music while studying?
3. Does familiarity with music from the most popular musical genre listened to while studying (according to the samples choice) produce different effects on convergent and divergent thinking in students who do or do not typically study with music?
4. Does perceived distractibility of silence or music from the most popular musical genre listened to while studying (according to the samples choice) produce different effects on convergent and divergent task performance?
5. Does most enjoyed condition: silence or music from the most popular genre listened to while studying (according to the samples choice) produce different effects on performance on convergent and divergent thinking tasks?

1.3.3 Hypotheses.

In regards to the first and main research question, the hypothesis states that music and silence will have differing effects on convergent and divergent thinking performance. This is based on the discussed research, which suggests that CT and DT may be affected by mood (Vosburg, 1998; Chermahini & Hommel, 2010) and arousal (Martindale & Hasenpus, 1978; Mölle et al, 1996; Mölle et al, 1999) in contrasting ways. Theories and research suggest that music can affect three factors: cognitive capacity, mood and arousal (e.g. Schellenberg & Weiss, 2013). It is therefore expected that music will affect performance on CT and DT tasks in contrasting ways.

In regards to the second research question, the second hypothesis states that musical preferences during study will result in differences to performance on the CT and DT tasks while music is played or not played. Furthermore, it is tentatively hypothesised that these differences will create an interaction between CT and DT due to the effects of mood and arousal created via the music. This hypothesis has been reached due to research which suggests that musical effects on performance are moderated by individual differences in musical study preferences (Crawford & Strapp, 1994) and/ or personality (Furnham & Bradley, 1997).

Chapter 2: Methodology

2.1 Design

The study adopted an experimental 2x2x2 within-subjects multivariate design. The three independent variables are 1. musical study preference: study preferred with music and study preferred without music and 2. musical condition: background music played and silence and 3. performance: on convergent thinking task and divergent thinking task. The dependent variables were the standardised scores from DT and CT. Before recruitment and experimentation, the study received ethical approval from the Edinburgh Napier Ethics and Research Governance Committee.

2.2 Participants

Participants were opportunistically recruited and are samples of volunteers from the Edinburgh Napier University participant pool and fourth year Psychology students. The pool is compiled of first to third year Psychology students who consented to be contacted regarding psychological studies at the beginning of the academic year. There were no exclusion or inclusion criterion. 38 Edinburgh Napier University undergraduate students participated in the experiment: 7 male (18.4%) and 31 female (81.6%) with a mean age of 22.47 years, $SD = 3.70$.

2.3 Apparatus and Materials

2.3.1 Musical stimuli.

Over one week, an initial electronic survey was distributed to determine musical preferences of study in the sample and the most popular genre of music listened to while studying. This was completed in order to provide a stronger ecological validity of musical stimuli. The survey (Appendix 1) was completed by 51 participants: 9 male (18%) and 42 female (82%) with a mean age of 23.47 years, $SD = 5.22$. The genres on offer for selection were the most popular genres by album sales in the UK in 2012, according to the Official Charts Company (2012). The most popular genres

were chosen to provide the most ecologically valid stimuli possible via this method. 51% of the participants indicated that they do typically study with background music. The results of the preferred genres are displayed in the **figure 3** below. 'Classical' was the most popular genre, followed by 'Other' and 'Pop'.

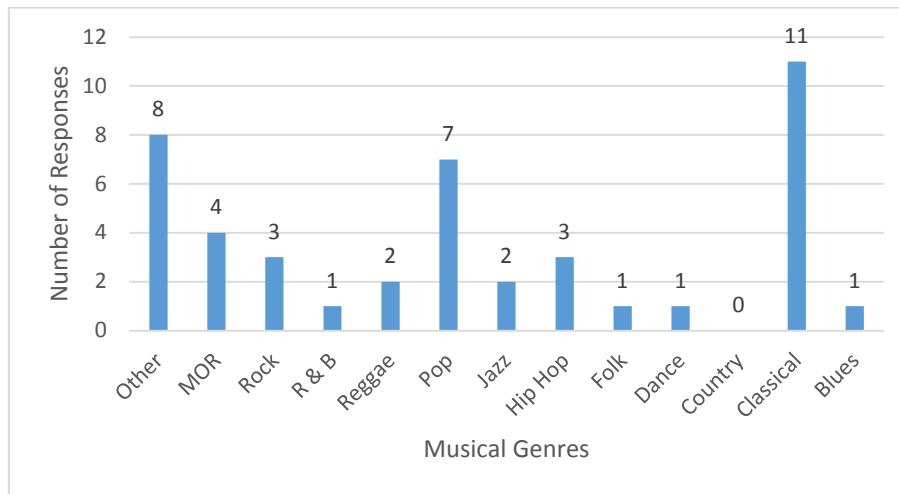


Figure 3: Typical Musical Study Genres chosen by Sample

As classical was chosen by the majority of participants, this genre was used in the experiment. More specifically, the most popular album of the classical genre, by album sales in the UK according to the Official Charts Company (2012), provided the musical stimuli. This was 'Magic of the Movies' by Andre Rieu which provided orchestral, instrumental music without lyrics. Music on the album was chosen at random for play in shuffle mode in order to provide a more ecologically valid stimuli with a range of titles. Examples of titles include 'The Rose', 'Edelweiss' and 'Stranger in Paradise'. Music was played at 60 decibels via speakers attached to a tablet and music was started when the participant indicated that they were ready to begin the task and paused after two minutes when the task was over. Music was then started again for the second musical task from the point when the music was paused and played again for two minutes. Generally participants heard two different musical titles during the experiment.

2.3.2 Study preference questionnaire.

In the experiment, participants were firstly given the same survey completed online to determine musical study preferences. If study was preferred with music, participants also indicated the typical genre of music that they listened to (this was to check that the samples choices in the online survey reflected those in the experiment- this was found) (Appendix 1).

2.3.3 Divergent thinking task.

This study uses the Alternative Uses Task (AUT) as a test of divergent thinking. The AUT was first developed by Guilford in 1957 and it involves the participant noting down as many unusual alternative uses for an ordinary item as they can (Kaufman,

et al, 2008). This test was chosen for its strong face validity in testing DT, for its relative easy use and the ability to score the DT aspect of creative thinking under investigation: fluency in idea generation. Furthermore, Silvia, Martin and Nusbaum (2009) argue that the alternative uses tasks perform better than other types of DT tasks at predicting creativity. The DT task was administered on paper. Participants were given the opportunity for questions and then given two minutes to complete the task. The two objects used included a brick and a newspaper. Copies of the task and instructions are provided in Appendix 2. DT scores were calculated by counting the number of responses given to each object (fluency) and calculating an overall score.

2.3.4 Convergent thinking task.

The convergent thinking task is based on the grammatical reasoning task designed by Baddeley (1968). This has been chosen as an equivalent to the AUT as it also uses words and can be limited to two minutes. This task was completed on a computer using E Prime Software. Participants sat approximately 60cm from the computer screen but could adjust seat and screen height to preferred level. Participants decided if a statement about the order of two letters was true or false and indicated this using the F and T keys on the keyboard, e.g. A does not follow B-BA: this statement would be false. Instructions for the task and a further sample of the questions asked are in Appendix 3. The CT scores were calculated by counting the number of correct responses to the problems.

2.3.5 Questionnaire: experiences of task completion.

Participants completed a final questionnaire on paper regarding their experiences of the experiment (Appendix 4). This questioned familiarity with the music and experiences of preferred condition and most distracting condition. These questions were asked to later analyse whether people's perceptions of distraction and preference affected their performance.

2.4 Procedure

Participants were firstly sent information electronically via Edinburgh Napier University's Psychology technician. The study was introduced and information regarding what would be expected of them as a participant was provided (Appendix 5). Upon interest, participants contacted the researcher. Participants were then sent a link to the online survey and asked for a convenient time to complete the experiment. The experiment was carried out in a psychology lab on the Sighthill campus of Edinburgh Napier University between the hours of 9am and 5pm over a one week period in January 2014. Participants were given an information sheet (Appendix 6) and permitted to ask questions. If satisfied, participants then signed their consent (Appendix 7). Participants were then requested to complete the same survey as described above but on paper (Appendix 1). Experimental conditions and tasks were counterbalanced by changing the order of tasks, and changing the order in which the music was played: this was to ensure that no practice effects could occur. Participants completed two AUT tasks and two CT tasks either with or without music. Musical titles were played at random at 60 decibels which is reported as a

typical background music level heard in shops and restaurants (Kellans & Rice, 1993). The whole procedure lasted no more than 30 minutes which provided ample time for debriefing and questions. Participants were also handed a debrief sheet which displayed information regarding the aims and objectives of the study (Appendix 8). Data was then inputted into the Statistical Package for Social Sciences (SPSS) for analysis.

Chapter 3: Results

3.1 Preliminary Analysis

Initial exploration of the data showed normal distribution. 22 of the participants indicated that they typically study with music and 16 indicated that they typically study without music. The raw scores are used to display the means for clarity, but for comparisons between tasks, standardised z scores were calculated and used due to the differences in scoring ranges between the CT and DT tasks. Scores on CT tasks ranged between 5 and 35, whereas in the DT task scores ranged from 2 to 14.

3.1.1 Correlational analysis.

To investigate the relationships between CT and DT and CT with and without music and DT with and without music and the relationships between them, a series of Pearson correlations were carried out. The results can be viewed in **Table 1**.

Table 1: Table of Pearson Correlations

	Overall CT	Overall DT	CT with Music	CT without Music	DT with Music	DT without Music
Overall CT ^a	1	.117	.913**	.911**	.074	.128
Overall DT ^a	.117	1	.125	.088	.869**	.855**
CT with Music ^a	.913**	.125	1	.662**	.097	.119
CT without Music ^a	.911**	.088	.662	1	.039	.114
DT with Music ^a	.074	.869**	.097	.039	1	.485**
DT without Music ^a	.128	.855**	.119	.114	.485**	1

** Correlation is significant at the .01 level (2 tailed), ^an = 38

3.1.1.1 Relationships between CT and DT.

There were no significant relationships found between CT and DT. Overall CT and overall DT were not significantly correlated. This suggests that there is no relationship between performance on CT and performance on DT.

3.1.1.2 Relationships between CT and DT with and without music.

Investigating convergent thinking, CT with music and CT without music were significantly positively correlated. This suggests that participants who performed well on the CT task with music, also performed well on the CT task without music.

Investigating divergent thinking, DT with music and DT without music were also significantly positively correlated. This suggests that participants who performed well on the DT task with music, also performed well on the DT task without music.

3.2 Research Questions 1 & 2: Differences between mode of Study Preference, Task Type and Condition

3.2.1 Means.

Table 2 displays the means and standard deviations of each task (CT and DT), each condition (with or without music) and the between subject's variable (preference of study mode: with music or without).

Table 2: Table of Means- Mode of Study Preference

Task	Study Mode Preferred	Musical Condition			
		With Music		Without Music	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Convergent Thinking	With Music ^a	18.73	7.60	17.91	7.49
	Without Music ^b	16.88	6.78	18.19	6.92
	Overall Score	17.95	1.17	18.03	1.16
Divergent Thinking	With Music ^a	7.59	2.77	7.86	2.59
	Without Music ^b	7.19	3.12	7.13	3.00
	Overall Score	7.42	0.47	7.55	0.45

^a*n* = 22, ^b*n* = 16 across conditions and tasks

3.2.2 Three-way mixed factorial analysis of variance.

In order to further investigate these differences, a three way mixed factorial analysis of variance (ANOVA) was conducted. The three factors included musical condition with two levels: with or without music; musical study preference: with or without music; performance: on the DT or the CT task. Standardised z scores for DT and CT were used to allow for direct comparisons. The ANOVA did not reveal any significant differences as can be seen in **Table 3**. There is no significant difference between study mode preference (with or without music) and performance in musical or non-musical conditions in either convergent or divergent thinking tasks.

Table 3: Preferred Study Mode: Results of the Three-way Mixed Factorial ANOVA using Standardised Scores

Main Effects/ Interactions	df effect, df error	F Distribution	Significance (p)	Partial Eta Squared
Musical Condition	1, 36	0.003	.953	.000
Task Type	1, 36	0.001	.970	.000
Preferred Study Mode X Musical Condition	1, 36	0.139	.712	.004
Preferred Study Mode X Task Type	1, 36	0.059	.810	.002
Musical Condition X Task Type	1, 36	0.026	.873	.001
Preferred Study Mode x Musical Condition X Task Type	1, 36	1.039	.315	.028
Between Subjects Main Effect of Preferred Study Mode X Musical Condition X Task Type	1, 36	0.507	.481	.014

Further analyses were conducted to investigate the differences that familiarity with the music, perceived distractibility and preference of condition brought to performance on the two tasks when completed with or without music.

3.3 Research Question 3: Familiarity with Music

3.3.1 Means.

Table 4 displays the means and standard deviations of performance under familiarity with the music.

Table 4: Table of Means- Familiarity with Music

Task	Familiarity with Music	Musical Condition			
		With Music		Without Music	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Convergent Thinking	Never Heard ^a	15.56	2.39	18.22	2.34
	Somewhat Familiar ^b	19.14	1.72	18.14	1.67
	Very Familiar ^c	17.50	1.90	17.50	2.41
Divergent Thinking	Never Heard ^a	7.67	1.00	7.67	1.24
	Somewhat Familiar ^b	7.05	0.60	7.48	0.59
	Very Familiar ^c	8.13	1.20	7.63	0.65

^a*n* = 9, ^b*n* = 21, ^c*n* = 8 across conditions and tasks

3.3.2 Three-way mixed factorial analysis of variance.

In order to further investigate the differences that familiarity with the music had on performance, a three way mixed factorial analysis of variance (ANOVA) was conducted. The three variables included musical condition: with or without music; familiarity: never heard, somewhat familiar and very familiar and performance: on CT and DT tasks. Again standardised scores for DT and CT were used to allow for direct comparisons. The ANOVA did not reveal any significant differences. **Table 5** below displays the results of the ANOVA.

Table 5: Familiarity with Music: Results of the Three-Way Mixed Factorial ANOVA using Standardised Scores

Main Effects/ Interactions	df effect, df error	F Distribution	Significance (p)	Partial Eta Squared
Musical Condition	1,35	0.003	.959	.000
Task Type	1,35	0.152	.699	.004
Perceived Familiarity with Music X Musical Condition	1,35	0.003	.699	.020
Perceived Familiarity with Music X Task Type	2,35	0.629	.629	.026
Musical Condition X Task Type	1,35	0.280	.600	.008
Perceived Familiarity x Musical Condition X Task Type	2,35	0.970	.389	.053
Between Subjects Main Effect of Perceived Familiarity X Musical Condition X Task Type	2,35	0.030	.971	.002

3.4 Research Question 4: Perceived Distractibility

3.4.1 Cross tabulation

Cross tabulation was conducted to investigate which condition was most distracting in relation to study preference. The results are displayed in **table 6**. To further investigate these differences, a chi square test of association was conducted. It revealed that study mode preference and most distracting condition (with or without music) are significantly associated: $\chi^2(1, n = 38) = 6.922, p = .009$. This suggests that a number of people who choose to listen to music during study also find it distracting.

Table 6: Cross Tabulation of Most Perceived Distracting Condition and Musical Study Preference

		Most Distracting Condition		Total
		With Music	Without Music	
Musical Study Preference	With Music	12	10	22
	Without Music	15	1	16
Total		27	11	38

3.4.2 Means.

In the final questionnaire participants were asked about their experiences of taking part. This included indicating which condition they found most distracting: with or without music. **Table 7** displays the means and standard deviations of performance under perceived distractibility of condition: with or without music. These differences are further illustrated in **figures 4 and 5**.

Table 7: Table of Means- Perceived Distractibility

Task	Condition Perceived as Most Distracting	Musical Condition			
		With Music		Without Music	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Convergent Thinking	With Music ^a	16.93	1.31	18.44	1.43
	Without Music ^b	20.45	2.40	17.00	2.04
Divergent Thinking	With Music ^a	6.74	0.51	7.56	0.51
	Without Music ^b	9.09	0.89	7.55	0.95

^a*n* = 27, ^b*n* = 11 across conditions and tasks

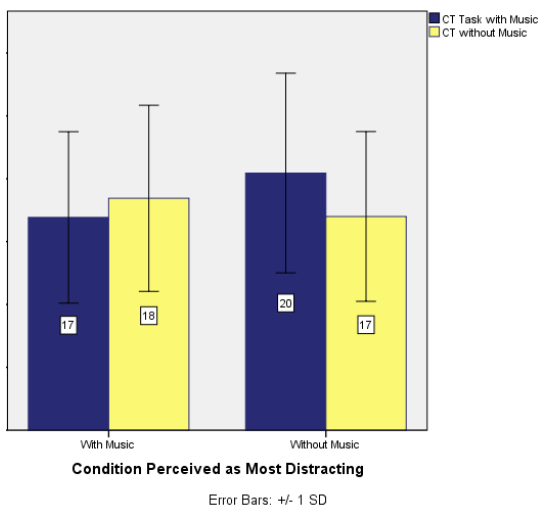


Figure 4: CT Mean Scores

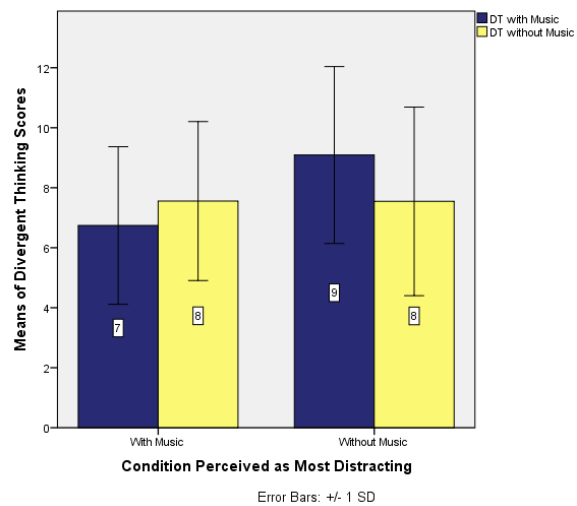


Figure 5: DT Mean Scores

Figures 4 & 5: Convergent Thinking and Divergent Thinking Scores and Perceived Distractibility of Conditions

3.4.3 Three-way mixed factorial analysis of variance.

In order to further investigate these differences, a three way mixed factorial analysis of variance (ANOVA) was conducted. The three factors included musical condition: with or without music; perceived distracting condition: with or without music and performance on either CT or DT tasks. Again using standardised scores for DT and CT to allow for direct comparison. The results of the ANOVA are presented in **Table 8** and reveal that the perceived distractibility by musical condition interaction was significant: $F(1,36) = 12.953$, $p = .001$, $\eta_p^2 = .265$. However, no other significant differences were revealed. This suggests that performance is diminished in conditions that are perceived as distracting. Additionally, it suggests that students can identify correctly when music distracts performance.

Table 8: Perceived Distractibility: Results of the Three-way Mixed Factorial ANOVA using Standardised Scores

Main Effects/ Interactions	df effect, df error	F Distribution	Significance (p)	Partial Eta Squared
Musical Condition	1,36	2.296	.138	.060
Task Type	1,36	0.007	.797	.002
Perceived Distractibility X Musical Condition	1,36	12.953	.001	.265
Perceived Distractibility X Task Type	1,36	0.378	.542	.010
Musical Condition X Task Type	1,36	0.014	.908	.000
Perceived Distractibility x Musical Condition X Task Type	1,36	0.077	.783	.002
Between Subjects Main Effect of Perceived Distractibility X Musical Condition X Task Type	1,36	0.254	.254	.036

3.5 Research Question 5: Effects of Preferred Condition

3.5.1 Means.

In the final questionnaire, participants were asked to indicate their most preferred condition: with or without music. **Table 9** displays the means and standard deviations of performance, taking into account most preferred condition for completing the task. These results are illustrated more clearly in **figures 6 and 7**.

Table 9: Table of Means: Condition Preferred

Task	Condition Preferred	Musical Condition			
		With Music		Without Music	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Convergent Thinking	With Music ^a	19.17	1.45	17.22	1.50
	Without Music ^b	16.07	1.84	19.27	1.86
Divergent Thinking	With Music ^a	8.17	0.58	7.57	0.56
	Without Music ^b	6.27	0.71	7.53	0.77

^a*n* = 23, ^b*n* = 15 across conditions and tasks

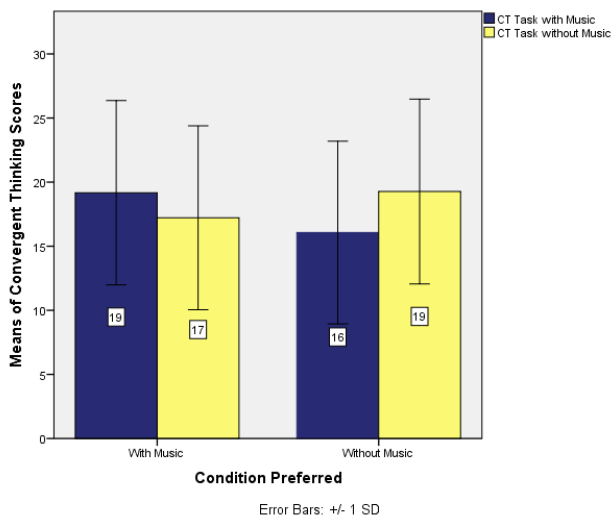


Figure 6: Convergent Thinking Scores

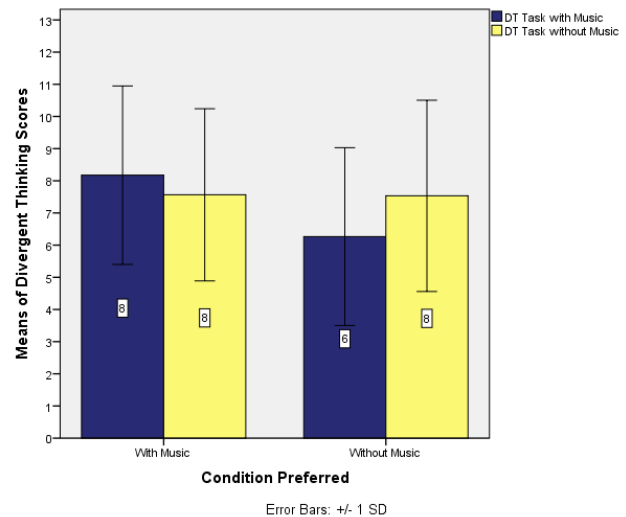


Figure 7: Divergent Thinking Scores

Figures 6 & 7: Convergent Thinking and Divergent Thinking Scores and Preferred Condition

3.5.2 Three- way mixed factorial analysis of variance.

In order to further investigate these differences, a three way mixed factorial analysis of variance (ANOVA) was conducted. The three factors included musical condition: with or without music; preferred condition: with or without music and performance on CT and DT again using standardised scores to allow for direct comparisons. The results are displayed in **Table 10**. The ANOVA revealed that the preferred condition by musical condition interaction was significant: $F(1,36) = 12.953$, $p = .001$, $\eta_p^2 = .265$. However, no other significant differences were revealed. This suggests that people perform better in conditions which they like, in this case, with or without music.

Table 10: Preferred Condition: Results of the Three-way Mixed Factorial ANOVA using Standardised Scores

Main Effects/ Interactions	df effect, df error	F Distribution	Significance (p)	Partial Eta Squared
Musical Condition	1, 36	0.0538	.468	.015
Task Type	1, 36	0.020	.889	.001
Musical Condition Preferred X Musical Condition	1, 36	12.133	.001	.252
Musical Condition Preferred X Task Type	1, 36	0.448	.507	.012
Musical Condition X Task Type	1, 36	0.001	.973	.252
Condition Preferred x Musical Condition X Task Type	1, 36	0.025	.875	.000
Between Subjects Main Effect of Condition Preferred X Musical Condition X Task Type	1, 36	0.038	.362	.023

Chapter 4: Discussion

4.1 Aims and Objectives of Study

The broad aim of this study was to investigate whether music affects creative thinking. It has previously been identified that music can affect levels of mood and arousal, which in turn produce effects on cognitive performance, e.g. spatial tasks (Husain, Thompson & Schellenberg, 2002). It has been proposed that creative thinking includes both convergent and divergent thinking (e.g. Cropley, 2006). The literature suggests that differing levels of mood and arousal affect convergent and

divergent thinking in contrasting ways (Martindale & Mines, 1975; Vosburg, 1998; Mölle et al, 1999; Chermahini & Hommel, 2010). Therefore, the main objective was to investigate whether music affects convergent and divergent thinking in different ways.

As people differ and experience music in distinct ways (Chamorro-Premuzic & Furnham, 2010), a further aim was to investigate if music affects people, who choose to study or not to study with music, in different ways on convergent and divergent thinking tasks. Further objectives were to investigate whether familiarity with the music had any effect on performance as previous studies have suggested (Lucaccini & Kreit, 1972, cited in Crust, 2004). Another objective was to investigate whether students can identify the most distracting condition to performance as this would have many implications about their ability to choose the most effective study conditions for themselves. Finally, it was investigated whether the most preferred condition (with or without music) had any effect on performance which again may have implications regarding optimal environmental conditions in both occupational and educational institutions.

4.2 Summary of Findings

Analysis did not find any significant results regarding the effects of background music to performance on either CT or DT tasks, and preference of study mode (with or without music) made no significant difference to performance.

Familiarity with the music also produced no significant differences on task performance. However, participants demonstrated an ability to identify the most distracting condition to performance (be it with or without music). Furthermore, participants consistently performed better in the condition they enjoyed over both tasks, again be it with or without music.

4.3 Discussion of Results from Preliminary Analysis

4.3.1 Convergent and divergent thinking.

Correlational analysis revealed that performance on CT and DT tasks are not significantly correlated. This supports the notion that CT and DT do use different processes and are independent from each other as Guilford (1967) proposes in his structure of intellect model. This does not support Sternberg and O'Hara (2000), who proposed that correlations between creativity and intelligence measures suggest that CT and DT are positively related. This suggests that an individual may be skilled at divergent thinking but unskilled at convergent thinking. It has been argued that both are essential for creativity. This would therefore signify that this individual would not be classified as particularly creative.

4.3.2 Analysis: convergent thinking and music.

Correlational analysis revealed that performance on CT tasks with and without music were correlated which suggests that music has no significant effect on CT. However, they were not as highly correlated as one would expect ($r = .662$). This is curious because the task is the same in both conditions and should therefore produce a very strong relationship. This could be explained by individual differences in the effects of music; the study proposed that people experience music differently. Therefore, it may aid performance in CT tasks in some people, but hinder it in others. However, such claims cannot be confirmed by correlational analysis. Further analysis, discussed later, revealed that these suggestions cannot be supported.

4.3.3 Analysis: divergent thinking and music.

DT scores with and without music were found to be significantly positively correlated, although the correlation was also not as strong as expected ($r = .485$). This may have been due to the differing effects of music on some people: aiding DT in some, while hindering it in others. However, further analyses has ruled this out. A further explanation for this weak correlation may be that the differences in objects produced an effect: two different objects were used (newspaper and brick) to avoid practice effects.

4.4 Addressing Research Questions 1 and 2

Does silence or the most popular musical genre listened to while studying (according to the sample's choice), have different effects on convergent and divergent thinking performance?

Does silence or the most popular musical genre listened to while studying (according to the sample's choice), have different effects on convergent and divergent thinking performance in students who do/ do not study with music?

The results do not support the first hypothesis that background music selected by students for study will produce differing effects on CT and DT performance. The results also do not support the second hypothesis that there is an interaction between preferred study mode and effects of music on DT and CT tasks. A mixed factorial multivariate analysis of variance produced no significant main effects or interactions, therefore both null hypotheses can be accepted.

There are a number of possible reasons why no significant effect has been found and these will now be discussed.

4.4.1 Arousal and mood.

The literature suggests that music may affect arousal and mood (Husain, Thompson & Schellenberg, 2002). Both arousal (Möller et al, 1996; Möller et al, 1999) and mood (Vosburg, 1998; Chermahini & Hommel, 2010) have been found to have contrasting effects on performance on CT and DT tasks. It was therefore expected that

background music would produce contrasting effects on CT and DT, yet this was not found. This could be explained in three ways: the music used was not cortically arousing or mood inducing; music has no effect on cortical arousal or mood as previous studies have suggested; the effects of music on cognitive load neutralise the effects of music on arousal and mood.

To consider the first point, the genre of music used was classical and reflected the genre chosen by the majority of people in the initial survey and in the experiment (in which they were again asked about preference of study genre). However, the music may not have been particularly arousing or sufficiently arousing to produce any differing effects in levels of cortical arousal or mood. On the other hand, potentially the classical music would have affected the levels of mood and arousal, but could not due to the length of the experimental procedures (music was listened to twice for two minutes with intervals in between). Possibly, this was not sufficient time to build a particular affect or induce a mood, or indeed change arousal and mood significantly between the silent condition and the musical condition. Furthermore, previous studies which attributed musical effects on cognition to between condition changes in mood and arousal, were conducted in a different way to the current study. Typically, in these studies, participants listened to music for a period of time before completing the task (e.g. Thompson, Schellenberg & Husain, 2001). It may be that there is a period in which music must be processed which then results in changes in levels of mood and arousal. In the present study, the focus was on how background music affected performance during tasks as it was thought that this was a more ecologically valid area of study. The results would be of interest to a population who listen to music during study, which according to the results of this study, is approximately half of the student population.

The second explanation put forward, that music simply does not affect cortical arousal or mood does not support the findings of Boothby and Robbins (2011) or Breitling et al (1987) but does support the research which has failed to find musical effects upon arousal and mood (e.g. Steel, Ball & Runk, 1997). Along this vein, a possible explanation may be that we are all so accustomed to noise and background music via music played in shops, restaurants and supermarkets that it no longer affects us to the extent that it changes our levels of mood or arousal which is discussed in detail by Hargreaves and North (1999). Furthermore, a study by Etaugh and Michals (1975) supports this notion. They found that the more frequently students listen to music during study, the less music impaired performance.

A third explanation may be the conflicting effects that music produces on cognitive load, mood and arousal. As mentioned earlier, Kämpfe et al's (2011) review found that overall, studies could not produce convincingly solid effects of music on performance and effectively music produces a null effect on performance. However, Kämpfe et al (2011) concluded that this is not because the studies did not find significant results, rather it is because many studies found positive results (Schellenberg et al, 2007; Mammarella et al, 2007), many uncovered negative results (Crawford & Strapp, 1994) and many found no significant differences (Steele, Ball & Runk, 1997). The explanation was that these differences then produce an overall

average which confers a null effect. Schellenberg and Weiss (2013) proposed that this is not because music does not produce any effects, but because music produces conflicting effects. Firstly it can enhance performance via mood and arousal which has been shown to have a positive effect on performance in many cases (e.g. Thomson, Hussain & Schellenberg, 2001). Secondly, music overtaxes cognitive capacity, therefore it should be detrimental to all performance (Schellenberg & Weiss, 2013). This may also be the case in the present study: the positive or negative effects of enhanced mood and arousal produced by music are fought by the generally negative effects of music overtaxing limited cognitive capacity. Although CT and DT may be enhanced and diminished by different things, perhaps both effects are averaged out.

Another possible reason why no effects of music on CT or DT were found may be due to the tasks used.

4.4.2 Convergent thinking task.

The convergent thinking task used was based on Baddeley's grammatical reasoning task (1968). Approximately 10% of participants independently reported that they found the task difficult and did not completely comprehend what they had to do. It is important to note, that although this is a small number, some participants may have also misunderstood but did not voice their concerns. This may have had some impact on the results. Yet, upon inspection, the scores varied across participants, therefore this does not seem to be the case. However, potentially, a different type of convergent thinking task could have produced different results. The convergent thinking task used in studies which found effects on CT via mood and arousal were typically RAT tasks (e.g. Chermahini & Hommel, 2010; Chermahini & Hommel, 2012). In the present study, the RAT was not used because it has been previously used as a test of both convergent and divergent thinking. It is argued that the RAT task requires idea generation of semantic associations via DT and finding the best solution via CT (e.g. Gibson et al, 2009).

4.4.3 Divergent thinking task.

The two alternative uses tasks employed were brick and newspaper. The majority of participants independently reported that they found it easier to think of unusual uses for the brick than for the newspaper. This may have had an impact on the results, however, conditions and tasks were carefully counterbalanced and an overall score for DT was calculated which should have combated possible differing effects between objects. In the studies mentioned which have shown effects of arousal on DT (e.g. Chermahini & Hommel, 2010), the alternative uses task was also implemented, and therefore it is surprising that these tasks would not be affected by possible changing levels of arousal produced by music. However, in the study which showed effects of mood on arousal, real life divergent thinking problems were used (Vosburg, 1998), therefore mood may have affected these to a greater extent because they were more realistic.

4.5 Addressing Research Question 3

Does familiarity with the music produce an effect and does familiarity of music enhance or diminish distractibility?

Familiarity with the music did not produce any significant differences to CT or DT performance. This does not support the findings of Fontaine and Schwalm (1979) who found that familiarity of music can increase arousal. It also does not support the hypothesis proposed by Wolf and Weiner (1972, cited in Etaugh & Michal, 1975) that unfamiliar sounds are more distracting than familiar ones.

This non-significant finding may have been due to the majority of participants (55%) indicating that they were somewhat familiar with the music, and therefore there were simply not enough differences to produce any significant results.

4.6 Addressing Research Question 4

Does distraction hinder or aid CT and DT performance, and are students aware of the distraction?

The results indicate that students are aware of how music distracts them. The results of a three-way ANOVA illustrated that the interaction between task type and distractibility was significant. Students were able to recognise when music distracted their performance. Using the cross-tabulation procedure it can be seen, as expected, that the majority of students (all but one) who typically study without music, found the condition with music the most distracting. Surprisingly, more than half (55%) of students who typically study with music found the musical condition the most distracting, furthermore a chi square test of association revealed that distractibility of condition and study mode preference were associated. Perhaps this is an indication that the musical stimuli used does not reflect the choices of most of the individuals. Alternatively, it may suggest that students listen to music, although it distracts them.

A further possible explanation for this finding is provided by discussions from Hargreaves and North (1999) which argue that the psychological functions of music in everyday life are changing due to the ever faster growing accessibility of music. Hargreaves and North (1999) further argue that musical effects should not only be considered in the emotional and cognitive psychological aspects (as this study does) but also social aspects. Studies suggest that individuals, in particular young people, use music to create and portray an external image to others (North, Hargreaves & O'Neill, 2000; Tarrant, North & Hargreaves, 2000). This is a possible explanation for why many people said that they listen to music while they study, not because it aids their concentration as Adriano and Di Paola's (2010) study suggests, but because it allows them to display a particular image of themselves.

4.7 Addressing Research Question 5

Does most enjoyed condition produce different effects?

Across all conditions, participants performed better in their preferred condition, and there was a significant interaction between preferred condition and musical condition. This is an interesting finding, as it could be that preferred condition is some indication of mood. It was hypothesised that performance in CT and DT would interact depending on individual differences of experiencing music. It was thought that mood may be manipulated in some ways by the music and this, partly, would explain differences seen in tasks and across conditions. Studies have shown that DT may benefit from elevated mood and CT from baseline mood levels. In this study, this does not appear to be the case. In all tasks (if preferred condition is some indication of mood), participants performed better in their slightly elevated mood. This was found, be it when condition was preferred with or without music. These results also support the notion that there are individual differences when it comes to listening to background music. Some participants preferred the non-musical condition which enhanced their performance, whereas, some preferred the musical condition which enhanced their performance. This, coupled with the result that participants can identify which condition most distracted performance, suggests that students should be given more credit and feel more confident about their study choices. These findings correspond with Etaugh and Ptasnick's (1982) study discussed, which observed that students performed better if they learned in their preferred study mode.

Furthermore, it may be assumed that test performance can be increased when the testing environment is similar to the learning environment. Memories, for example, are recalled with more accuracy when retrieval environments are similar to encoding environments (e.g. Kohnken, Milne, Memon & Bull, 1999). Therefore, perhaps listening to music during testing could be advantageous for those who typically study while listening to music.

4.8 Limitations

There are a number of limitations to the current study which may have had an effect on the results. These limitations will now be discussed.

A possible limitation is the musical stimuli. Although the musical genre was chosen by the sample, the music may not have reflected the individual musical choices of the participants. Therefore, the ecological validity of the study may be put into question. However, a pre survey was distributed in order to gain the most popular listened to genre during study from the sample to provide somewhat ecologically valid stimuli. In addition, participants did not listen to exactly the same musical excerpts, therefore this may be a further limitation. The various musical titles may have had differing effects on mood and arousal due to differences in tempo and key which have been found to have moderating effects on arousal and mood (e.g.

Husain, Thompson & Schellenberg, 2002). However, a variety of music was used so that the results would be generalizable to a greater range of music.

The DT and CT tasks used (alternative uses and grammatical reasoning) may be critiqued for their unrealistic nature. Although many studies have used a similar DT task (e.g. Chermahini & Hommel, 2012), some studies, for example Vosburg (1998) used realistic life examples as DT problems. Such problems represent a more ecologically valid set of stimuli. Similarly, the grammatical reasoning task does not represent a set of particularly realistic problems. However, these two tasks were selected as they both use word stimulæ and timing could be controlled in both tasks, therefore allowing comparison between results.

A further possible limitation is that the tasks were only two minutes long which is perhaps not reflective of real life creative problems. Furthermore, there may not have been time within and between these two minutes to develop or change any levels of mood or arousal in which the silent and musical conditions were predicted to differ. However, it has been argued here that CT and DT are two processes involved in creative thinking, it has not been argued that these processes are unidirectional or stage like in nature. Eindhoven and Vinacke (1952 cited in Lubart, 2001) describe the creative process as a dynamic blend of processes and Finke et al's (1992) geneplore model, discussed above, describes the two processes as cyclical. Breaks were therefore kept short so as to somewhat reflect the dynamic nature of the processes involved in creativity.

Participants were not asked why or for what type of study they listen to music, which may be a possible limitation. Research suggests that extraverted individuals are less affected by background music than introverts (Bradley & Furnham, 1997) and the results of qualitative studies suggest that people use music during study to help concentration (Adrian & Di Paola, 2010). Therefore, it was somewhat assumed that more extraverted people listen to music to aid their concentration. However, participants were not asked questions regarding their personality or the reasons that they choose to listen to music during study. In addition, studies have suggested that students are selective when it comes to listening to music. Students may use it for one task but not another (Patton, Stinard & Routh, 1983). Such information would be useful and may provide further moderating variables which could be controlled. For example, it was discussed above that music may not only be used to control cognitive or emotional processes but it can also have a social purpose. A simple questionnaire concerning reasons behind studying with music would have extinguished concerns and provided more information about people's uses for music.

Participants were all undergraduate Psychology students studying at Edinburgh Napier University which may have resulted in a sample bias. Additionally, experimentation was conducted between 9am and 5pm but further 'time of day' information was not noted. Time of day can have an impact on levels of arousal and

mood as shown by Revelle, Humphreys, Simon and Gilliland (1980), therefore this may have had some impact on the results although it could have been controlled for.

4.9 Recommendations for Future Research

Now that the limitations have been highlighted, suggestions and recommendations for future research in this area are discussed, some of which are directly linked to the limitations considered.

Although the hypotheses of this study were determined by the possible musical effects on mood and arousal, these two constructs were not measured. Future research could follow a similar design but measure mood and arousal before, during, and following task completion with and without music using for example the POMS, STAI tests and EEG measures. The effects of mood and arousal could then be tested and compared to the findings of previous studies discussed above (e.g. Chermahini & Hommel, 2010, Vosburg, 1998; Mölle et al, 1996; Mölle et al, 1999). Discussions concerning whether or not music relates to changes in arousal and mood would be answered.

Future research could also ask participants why they study with music or why they choose not to and for what tasks. A simple questionnaire would provide answers regarding the motivations behind listening to music during study: to aid concentration? To drown out more distracting noises? To portray a particular self-image? These reasons could then be controlled and differences between performance on CT and DT tasks could be analysed. Furthermore, to combat possible critique regarding ecological validity, future research could allow participants to use their own musical excerpts.

In regards to creativity, empirical evidence for the role of convergent thinking in creativity is scarce. Future research could focus attention on studying this which would provide a stronger rationale for studying creativity in terms of both DT and CT.

The main finding suggests that creativity can be enhanced by environments which are enjoyable to the individual. It is therefore recommended that future research investigate other environmental influences on convergent and divergent thinking. For example, future research could investigate the influence of time of day on CT and DT performance as this has been shown to affect levels of mood and arousal (Revelle et al, 1980). Lighting may also be an interesting area for study as it has been shown to influence cognitive performance (Barron, Rea & Daniels, 1992), furthermore the influence of others around us may be an interesting area of study as we are constantly surrounded by others, either in an open plan work space, in the library, or in an exam.

Chapter 5: Implications and Conclusion

The aim of this project was to contribute to the understanding of creative thinking and how environmental influences, in this case music, could help or hinder it. The findings suggest that music has no effect on convergent and divergent thinking, and if these two are understood as processes of creative thinking as this study argues, it may also be argued that music has no effect on creative thinking performance. The findings do suggest that the important factor in influencing performance is whether the condition is enjoyed (in this case with or without music). Furthermore, participants were able to correctly identify the most distracting condition to performance. Interestingly, some participants performed better with music and some without. Additionally, some participants found the musical condition distracting, while others indicated that they found the musical condition distracting. This implies and supports the notion that people experience music in different ways and individual differences should be taken into account when looking at the effects of music on performance.

If these main findings are considered holistically, they imply that people should be given more choice about whether they work, study etc. with or without music when working on a creative problem. The music itself makes no difference to convergent and divergent thinking, rather it is whether the musical or silent condition is enjoyed. If given such choice, educational institutions and employers may observe an improvement in convergent and divergent thinking and potentially creative production. Future research is needed to provide more robust evidence and research into further environmental factors is suggested.

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