Variations Of Auditory Distractions: The Effect Of Familiarity With Background Music On Cognitive Performance On The Concept Shifting Task

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CONTENTS

Abstract

Previous research has indicated the negative effect that background music can have on cognitive task performance. Building on the literature on novelty distractions of auditory stimuli, the purpose of the current study is to investigate the role of familiarity with background music on task performance on the Concept Shifting Test (CST). Participants were recruited using convenience method of sampling (N = 40; 45% male and 55% female). Response time (RT) and the number of errors performed on the CST were recorded for all participants, across three particular conditions; no music, familiar music, and unfamiliar music. The central question was to determine whether the presence of familiar background music will result in reduced performance on the CST as opposed to that of the unfamiliar background music. A one-way repeated measures ANOVA revealed that there was a statistically significant increased in RT from the unfamiliar condition to the familiar condition, indicating that familiar background music was more distracting than unfamiliar background music. Additionally, a one-way multivariate analysis of variance was conducted to compare three conditions on the CST between males and females, results indicate females outperforming males in all conditions. Limitations and implication for future research are further discussed.

Human performance, specifically in a cognitively demanding task is highly variable and depends on many internal and external factors (Broadbent, 1971). Internal factors such as fatigue and lack of motivation usually have adverse effects on performance, while others like physical fitness or stimulating drugs, such as caffeine can enhance performance (Plante & Rodin, 1990; Foskett & Gant, 2009). Besides these internal factors, the influence of the environment can have a significant consequence on our cognitive function and behaviour (Evans, 1984). Cognitive functions are defined as the cerebral mechanisms that allow for of acquiring and processing and comprehending of information (Mosby's Medical Dictionary, 2009).

Since environmental stimuli are a notable factor in influencing the level of performance in general, when engaged in a difficult task, it is essential to minimise potential environmental distractors to better concentrate on the task at hand (Shidara & Richmond, 2005). The focus of the current study is on the effects of external auditory stimuli, which is an example of a potent environmental distractor. Under most circumstances, cognitive processes are interfered by environmental noise. As individuals are exposed to noise on a daily basis, it is unsurprising that it has been found to be the source of many physical and psychological stress (Loeb, 1986). The broad effect of noise as for other environmental stimuli is measurable by the ranging level of interference or disruption with cognitive functions (Smith, 1991).

Cognitive Processes and Executive Functions

In general, while engaged in a cognitive task, external distractor have been found to increase the mental workload that imposed by the given task environment which reduces the availability of the cognitive resources, subsequently results to the impairment of the quality of task performance (Staub et al., 2013). Mental workload is defined as the mental processing capability of information that is necessary for task performance (Hart & Staveland, 1988). As mentioned, cognitive processing are dependent on the integration of several neuropsychological processes, such visual scanning, mental flexibility, sustained attention, and speed of information processing (Lezak, 1995; Van Hoof et al., 1998; Van der Elst et al., 2006). Cognitively demanding activities are reliant on two inter-related processes, in particular, mental flexibility and attentional control. Mental flexibility or cognitive flexibility refers to the mental ability of individuals to shift from one concept to another or to sustain attention to different concepts simultaneously (Scott, 1962). Attentional control refers to the capacity of individuals to focus on the relevant task and to neglect the irrelevant contents or interference, in other words, the ability to choose what to pay attention to and what to ignore (Astle

& Scerif, 2009; Treisman, 1964). These two interrelated but distinct processes are often described as components of executive functions (Cooper-Kahn & Dietzel, 2008).

In respect to cognitive processes, the role of the executive functions is a fundamental factor to acknowledge, as it allows an individual to engage in higher order operations such as attending to goal-directed behaviour. (Best & Miller, 2010). Apart from attentional control and cognitive flexibility, other basic components also include cognitive inhibition, inhibitory control, and working memory. Cognitive inhibition is the cognitive ability to either intentionally or otherwise neglect the irrelevant stimuli that are present in the environment that are unrelated to the focal task (MacLeod, 2007). Inhibitory control also known as response inhibition is the ability of the extent to which an individual can inhibit their prepotent responses, their natural habitual behaviour in order to select a more suitable behaviour more applicable with the task at hand (Diamond, 2013; Ilieva, Hook, & Farah, 2015). Additionally, Working memory (Baddeley & Hitch, 1974) which is often referred to as short-term memory is an essential component of executive functions, responsible for temporarily holding information available for processing. Baddeley and Hitch challenged Atkinson's and Shiffrin's (1968) multi-store model which supposes that STM is a single system, that all information is stored in one single area regardless of their informational content. In working memory, although it also has a limited capacity, the model presumes there are different systems for different types of information. Working memory is regarded as one of the most fundamental cognitive processes since it governs guidance of decision making (Diamond, 2013; Malenka, Nestler, & Hyman, 2009).

Attention and Distractibility

Higher-order operations of cognition are dependent on the integration of multiple basic components of cognitive processes, which require reasoning and problem-solving (Malenka et al., 2009). As the sensory modalities inherently take in information from the external environment which is then integrated and processed in the brain (Ernst & Bülthoff, 2004). The complex operations are believed to be primarily mediated by the anterior cingulate cortex in the frontal lobe region of the brain (Posner

& Peterson, 1990). The body continuously takes in new information from our surroundings; thus, various environmental elements can affect an individual's behaviour. Especially when engaged on a task, our attention can become divided when our perceptions are distracted by irrelevant stimuli in the environment. Distractibility can occur, which refers to the process of the diversion of attention of an individual away to an undesirable information or sensations from the relevant information thereby results in the blocking or reducing the availability of desired information (Schumm & Post, 1997). The source of distraction can occur both externally and internally, examples of daily life distractions are factors such as music, social interactions, and temperature (warm and cold) are external distractions, and illness and hunger are internal distractions. The level of distractibility on task performance can vary depending on each individual as well as the type of task, since certain individuals may be better at allocating more attention on the task and neglecting the task-irrelevant stimuli than others. An example of this circumstance, can be seen in individuals with attention deficit-hyperactivity disorder (ADHD), a disorder which is associated with attentional impairments, impulsivity, and motor overactivity (Cantwell & Baker, 1991).

The Role of Environmental Stressors on Task Performance

A substantial amount of effort has been devoted to the investigation of the effects of different distractors on other components of cognitive performance, such as information processing, attention, and memory. In one review carried out by Hockey and Hamilton (1983), the authors examined the effects of environmental stressors. It was stated that although there were commonalities that exist across stressors, such as noise, hunger, and fatigue (in a manner that they all reduces the level of alertness and activation), each distractor was considered to have a unique effect in performance. Furthermore, Hockey (1997) purposed that there are two types of effects of stress, structural and strategic. The changes in the basic processing components are categorised as structural changes e.g. attentional narrowing, and strategic effects manifest as compensatory response e.g. increased effort (Szalma & Hancock, 2011). The two types of stress effect exist in cognitive performance. For instance, a stressor may affect performance by impairing information processing, or by provoking changes in strategic response, by which the distractor may induce increased effort on the task or compromise the speed and accuracy of the performance. Moreover, a stressor may also increase the level of general alertness and attentional selectivity. Which is associated with the increase of the mental workload that consequently reduces the availability of the cognitive resources allocated to the task at hand (Becker et al., 1995).

With respect to the point above, the occurrence of the effect seems logical, since stressors have been shown to capture attention to task-irrelevant stimuli, as well as causes annoyance (De Coensel et al., 2009; Sarason et al., 1990; Smith, 2003). An alternative explanation for external influence on task performance is subjective appraisals of threat to current goals, simply put as, individuals' apprehension on the focal task. Matthews (2001) indicated that cognitive tasks may become a burden due to demand on attention and may potentially provoke stress for performers. Therefore, performers have to devote more effort to the task in the presence of a distractor. It is important to note that effects of some distractions may be less detrimental than others, even so, they all may potentially interfere with the successful concentration on the task performance, by capturing attention away from the task-relevant stimuli (Lavie, 2010).

The Effects of Auditory Stimuli on Cognitive Performance

A substantial amount of literature has shown the negative effects of auditory stimuli on cognitive performance. Evidence has demonstrated the potential impact of noise to interfere with our cognitive processes, thereby, capturing attention away from focal tasks in an involuntary action (e.g. Conway et al., 2007; Smith, 1983; Szalma & Hancock. 2011).

Acknowledging the mechanisms that governs the cognitive functions provides a better insight into the specific interaction between noise and task performance. Many interferences can occur in the presence of unwanted noise, as for other external stimuli. Evidence has shown that unwanted auditory stimuli may impair information processing, increase the mental workload, and increase attentional selectivity. According to Jones (1993), it was explained that noise effects are most likely to occur in the context of working memory tasks. This is due to the distraction of attention away from the task towards the task-irrelevant stimuli. Thereby, the cognitive resources in the working memory become impaired (Peterson & Peterson, 1959). The literature on the board effect of noise on cognitive performance is quite extensive, as a recent development in this area of research have led to the renewed interest in different forms and characteristics of auditory stimuli and the way they might influence performance on various tasks. Historically, noise has been predominantly regarded as distractors or stressors. However, advancement in the investigation of the broad effects of noise has challenged this view, since there is experimental evidence suggesting the beneficial effect of some form of auditory stimuli on cognitive performance. For example, several studies (e.g. Helps et al., 2014; Söderlund et al., 2010) demonstrated that certain noise may potentially enhance memory performance in children. Under certain circumstance, individuals with attention problems (e.g. ADHD) appear to benefit from specific forms of environmental noise, such as white noise. Although, the presence of white noise nevertheless interfere with the performance of the attentive group. In another similar study, Stansfeld and colleagues (2005) also found that under certain conditions, road traffic noise can improve cognitive performance in children. Nonetheless, certain stimuli that were found to be facilitative for some was found to be distractive for others, which seem to suggest that individual differences is a significant role to consider. The underlying cause of the beneficial effects of certain noises on performance is yet unclear; however, these studies highlight the importance of the role of individual differences as well as the form and characteristics of the auditory stimuli.

Theories of Auditory Distraction

Many relevant theories exist which delineates the relationship between task performance and distractors. For example, in the load theory of attention and cognitive control (Lavie, Hirst, De Fockert, & Viding, 2004), the assumption of this theory revolves around the idea that distractibility depends upon the workload of information. Since it supposes that perception has limited capacity and is an automatic process (it occur involuntarily and cannot be controlled at will), thereby, the level of distractibility is susceptible to the difficulty of the task. Which suggests that when engaged on tasks involving high perceptual load, this will leave no capacity for irrelevant distractor perception, on the other hand, tasks requiring low-perceptual load may be more susceptible to involuntary processing of irrelevant stimuli (Lavie, 2010).

Furthermore, an approach that seem more appropriate for the current study is the Duplex-Mechanism accounts of auditory distraction, which recent evidence suggests that cognitive task performance is susceptible to auditory stimuli in two ways (Hughes, Vachon, & Jones, 2005, 2007; Hughes et al., 2013). Firstly, distraction can occur on interference-by-process, which refer to the interference that may occur by interfering with the particular processes involved in the immediate task (e.g. Jones & Macken, 1993). However, this type of distractor mechanism has only been demonstrated in a limited type of cognitive tasks, such as short-term serial recall tasks (e.g. Elliott, 2002; Neath, 2000; Röer, Bell, Dentale, & Buchner, 2011) and semantic fluency task (e.g. Jones et al., 2012).

The duplex-mechanism also account for distraction that can occur by the process of attentional capture, through which attention is fleetingly stirred away or disengaged from the focal task by the task-irrelevant auditory stimuli (e.g. Parmentier, Elford, Escera, Andrés, & San Miguel, 2008; Sörqvist, 2010; Vachon, Hughes, & Jones, 2012). Attentional capture is categorised into two types, ‘specific' and ‘aspecific' (Eimer, Nattkemper, Schröger, & Prinz, 1996). 'Specific' attention capture occurs when the content of the sound is meaningful or of interest to a given individual which has an attention-grabbing effect. For example, an individual hearing their own name or a student hearing the sound of the bell ringing (Conway, Cowan, & Bunting, 2001; Wood & Cowan, 1995). 'Aspecific' attention is different in a way that the attention-diverting effect is produced by the context in which the auditory stimuli occur rather than the event itself. In other words, attention is captured due to the unexpected occurrence of the sound compared to the regular context (Hughes et al., 2005; Parmentier, 2008). The distinction between the two mechanisms of auditory distraction seem to be also be differentiated by the qualitative nature of the focal task (Hughes, 2014).

The duplex-mechanism account of auditory distraction seems the most suitable with the current study as it specifically targets the effect of auditory stimuli interference on cognitive task performance, whereas other theories may focus on the general relationship between attention and distractibility. Furthermore, under the current context of the current study, it is important to note the distinguish difference between noise and auditory stimulation. Noise are typically unwanted extraneous sound that are disruptive to a given individual (Mosby’s Medical Dictionary, 2009), whereas auditory stimulation are generally sound that are intentionally administered for their potential beneficial effects e.g. sensory therapy for individuals with disabilities (e.g. Richards, Malouin, Bedard, & Cioni, 1992). The premise of the current research is concerned with observing auditory stimuli as a form auditory distractor rather than it being facilitative.

The Effects of Background Music on Cognition

The current research is primarily focused on investigating the effect of auditory stimuli specifically in the form of music on cognitive performance. Multiple studies have indicated that performing cognitive tasks in the face of auditory stimuli, such as music, could possibly involve greater cognitive processing (Kiger, 1989). Background music can be described as music that is played either as an obtrusive or unobtrusive accompaniment while the listener’s primary focus is on another task (Radocy and Boyle, 1988). The literature on this domain have presented mixed and inconsistent findings, due to this, it is still unclear whether the presence of music can be beneficial, detrimental, or has no effects on cognitive task performance (Küssner, 2017). Based on the literature, several studies that have implemented the presence of background music during cognitive tasks to demonstrate its effect has found music to have a facilitative effect as a stimulus. Since there are both experimental literature on the potential benefits and drawbacks of background music (Hargreaves & North, 1997), although the results of many early studies are ambiguous mainly because of different type of tasks used.

For example, in a study by Konz (1962), the author examined the effect of background music on performance of college students on two cognitive tasks a manual assembly task and a letter matching task. Results demonstrated the beneficial effect of background music which improved performance on the manual assembly task by 18% and 17% improvement on the letter-matching task. The author also indicated that music could help increase productivity for simple, monotonous tasks. Moreover, a relatively recent meta-analysis review by Kämpfe and colleagues (2011), examined the effects of background music on different aspects of cognitive performance and reported as follows. Experimental literature have shown evidence that background music is associated with shown improvements in episodic memory (Ferreri et al., 2013), IQ scores (Cockerton et al., 1997), verbal and visual processing speed (Angel et al., 2010), as well as arithmetic skill (Hallam & Price, 1998).

The facilitative effect of these study may be depicted by the “Arousal-Mood Hypothesis” which was first proposed by Thompson, Schellenberg, and Husain (2001), which explains how music can elicit arousal or alertness in positive emotions that in turns results to better performance (Thompson, Schellenberg, & Letnic, 2012). Additionally, Abikoff, Courtney, Szeibel, and Koplewicz (1996) suggested that the facilitative effect of noise has been limited to non-vocal background music.

Conversely, there is also evidence for reduced performance on the immediate focal task in the face of background music. For example, Kirkpatrick (1943) found that music hinders performance on tasks demanding mental concentration. Similarly, in a more recent student, Angel, Polzella, and Elvers (2010) indicated that background music, specifically popular music may interfere with “challenging tasks and comprehension tasks”. Polzella and Schoeling (2004) found that the presence of background music can impose attention-grabbing effects on the performer which consequently disrupting the performance.

A possible explanation for the negative effects could be explained by the “cognitive-capacity hypothesis”, which is linked the notion that unwanted auditory stimuli increase the cognitive load which reduces that resources available for cognitive processing at any given time (Baddeley, 2003).

Therefore, background music can disrupt cognitive performance when there is a potential for interference as a result of divided attention (Norman & Bobrow, 1975). The duplex-mechanism account of auditory distraction can also illustrate how distractibility of cognitive task performance can be susceptible to background music. Since background music can endows attention-diverting effect from the task-relevant stimuli.

Furthermore, in certain cases, the potential effect of music stimuli are not always clear and cannot be simply categorised into positive or negative. It has long been postulated that background music has a different influence on performance depending on the tasks being performed (Smith, 1961). With regards to the conflicting results on the effect of background music, the outcomes of the effect also appear to be modulated by the complexity of the task, while music may have positive effects for routine tasks but may become a distraction for complex cognitive tasks. It was stated that the more complex and cognitively taxing the task is, the more detrimental the effect on the performance and cognition (Cockerton, Moore & Norman, 1997; Furnham & Allass, 1999).

Characteristics of Stimuli

Apart from the complexity of the given task, when studying the effects of background music on performance, the type and aspects of music is a fundamental factor to consider. Characteristics of the music administered such as tempo, loudness, and familiarity may compromise the effectiveness of the response or quality of performance. On this note, an important factor to consider is the type of music being played, as genre or type of music has been shown to contribute to the effect of the task performance. For example, Wu, Brush, and Ripley (2013) found that particular music genre (e.g. screamo/death metal) may have higher interference effects on working memory, similarly, Angel and colleagues (2010) also found that popular music may have greater interference with cognitive tasks.

Moreover, each genre of music is often associated with certain tempo or beat pattern, in respect to this, upbeat versus downbeat (fast versus slow) together with the emotional value of the music becomes a factor of interest in the investigation. Taking a theoretical consideration, the effect of upbeat and downbeat music influence on performance may be accounted by the "arousal and mood" hypothesis yet again (Thompson et al., 2001). In particular, the impact of music on mood and arousal (level of physiological activation) of individuals appears to affect cognitive performance (Hallam, Price, & Katsarou, 2002), which is generally determined by the tempo (upbeat vs downbeat) and the emotional content or mode (happy/positive vs. sad/negative) of the song itself (Gabrielsson & Lindström, 2010). There is evidence which suggests that positive upbeat music are more likely to induce a positive mood and elicit a higher level of arousal, and vice versa (e.g. Hunter & Schellenberg, 2010; Husain, Thompson, & Schellenberg, 2002). Although there has been evidence showing that the presence of positive upbeat background music can have a beneficial effect on cognitive performance due to the impact it has on mood and arousal (e.g. Schellenberg, Nakata, Hunter, & Tamoto, 2007).

In consideration of the duplex-mechanism account of auditory distraction, background music may still be a potent distractor; it is rather determined by the type of complexity of task engaged in. Furthermore, the manner in which the stimuli are administered may also influence task performance, whether it is the loudness or the way in which it is administered (with earphones or on speaker). Additionally, presuming that any category of 'sad' music can potentially trigger an emotional response in listeners (Eerola, Vuoskoski & Kautiainen, 2016), it is in the best interest of the current research to ensure that the stimuli do not elicit an emotional response which may disrupt the cognitive task. A precautionary action is taken by selecting from a positive upbeat genre of music.

The Role of Novelty Distraction of Auditory Stimuli

The current research focused primarily on the role of novelty distraction of auditory stimuli. There is abundant experimental literature that has demonstrated that novel stimuli affect performance specifically on focused attention tasks (e.g. Gronau, Sequerra, Cohen, & Ben-Shakhar, 2006; Madden, 1983), where the familiarity to the content of stimuli can divert our attention away from a focal task. Novelty distraction has been extensively researched in the past through electrophysiological studies, in particular, auditory stimuli (e.g. Schröger, 2005), but also visual stimuli (e.g. Barcelo, Escera, Corral, & Periáñez, 2006), and tactile stimuli (Knight, 1996).

These studies have brought to light that novel stimuli can trigger an automatic novelty-detection responses in the brain (Näätänen, & Winkler, 1999; Picton, Alain, Otten, Ritter, & Achim, 2000), which brings about the disruption of attention on the task at hand in an involuntary fashion by orientation response (Berti, Roeber, & Schröger, 2004; Friedman, Cycowicz, & Gaeta, 2001). Previous reports suggested that the performance efficiency of cognitive tasks is influenced by the familiarity with background music (e.g. Etaugh & Michals, 1975; Wolf & Weiner, 1972). The concept of stimulus familiarity relates back to the mechanism in working memory, how the competition between task-relevant and task-irrelevant sequences of information disrupts working memory processes (Macken, Phelps, & Jones (2009). Since the contents of the familiar stimuli (i.e. lyrics, melody) may hold more relevant informational value than its unfamiliar stimuli counterpart. Equivocally, this is not to say that unfamiliar auditory stimuli would not still a potent distractor. However, this informational value of familiar auditory stimuli may have more potential to interfere with the resources of information and thereby, distracting individuals' attention from task-relevant information which results to a more detrimental effect on the performance efficiency (Parmentier, Elsley, & Ljungberg, 2010).

Although evidence on the specific influence of the role of familiarity to background music is lacking, based on evidence supporting the role of novelty distraction, intuitively, it would be expected that the presence of familiar stimuli would be more cognitively taxing for performers as the task at hand may demand greater cognitive processing. Of importance, novelty distraction, as for all disruptive interferences that may occur, can results in measurable behaviour effects during a task such as reduced response accuracy and longer reaction time (e.g. Dawson, Filion, & Schell, 1989; Schröger, 1996; Schröger, & Wolff, 1998). Since attention capture can occur by an automatic analysis of novelty informational content which can influence the subsequent behaviour (Parmentier, 2008). It is this impact of distraction on behavioural responses that constitute the focus of the present study.

Objectives and Rationale

Buildings on the existing literature on this topic, regarding how different variations of auditory stimuli can influence attentional processing during cognitively demanding conducts. The rationale of the current study is guided by the interest to further the understanding of the role background music on cognitive processes. As in today's society, it has become a norm for people, especially students, to listen to music while engaged on other immediate tasks as music becomes an essential part of life. The key question of this study was thus whether or not familiarity to background music influence cognitive performance on the CST. If the presence of music during a cognitive task have a positive, negative or neutral effect on performance. This study also seeks to investigate if the factor of familiarity to musical stimuli plays a role in influencing performance efficiency. Whether there is greater interference with familiar stimuli or unfamiliar stimuli. The demographic variable of gender is also considered. Since previous studies reported that females outperformed males on the CST (Van der Elst et al., 2006) as well as on a similar cognitive task, Digit-Symbol Substitution Test (Kertzman et al., 2006; Sophie van der Sluis et al., 2006; Van der Elst et al., 2012). An explanation has been proposed that females and males are disparate in cognitive abilities.

The hypotheses that will be tested are as follows; H1: There will be a higher reaction time on trials on the familiar audio stimulus condition than that of the unfamiliar stimulus condition. H2: Both noise conditions (familiar and unfamiliar) is expected to negatively affect performance by exhibiting a slower reaction time than that of the control condition. H3: Females will perform better (lower RT) than males on CST performance across conditions.

Methods

Participants

The sample was gathered using a non-probability method of sampling, convenience sampling method. Due to accessibility, the majority of the sample was of undergraduate students attending

National College of Ireland, and a large number of them were psychology students. Other members were recruited from individuals in close proximity e.g. family members, coworkers, and immediate group of friends. There were a total number of 40 Participants (N=40), 18 males and 22 females. Initially, the variable of age and educational status (individuals attending or have attended college or university) was also assessed, however, since most of the sample were undergraduate students, it would be impractical.

Measures & Materials

The main measure is the Concept Shifting Test (CST; Van der Elst, Van Boxtel, Van Breukelen & Jolles, 2006), where items pattern on the trials were generated, which was printed out and completed on paper ((see Appendix B). Another measure for demographic information was included in the informed consent form (see appendix A). Other materials include; a stopwatch, which was used to record the response time (RT) on CST trials; a PC and headphones, used for administering background music. Two types of background music were chosen prior to the experiment. For the familiar background music condition, a popular upbeat song was selected, the instructor consulted with the participants to ensure that they are familiar with the song. For the unfamiliar background music condition, an upbeat unpopular song was selected from the same genre or music as the popular.

Concept Shifting Test

The CST is a relatively new neuropsychological test that will be utilised in this thesis. The CST was developed upon the foundation of the widely used Trial Making Test (TMT), a test which was frequently used in research as well as in clinical settings. As the conceptual background of the CST is comparable with the TMT, the tests were both used to assess executive functions and other cognitive processes. However, criticisms on the TMT led to the development of the CST as authors indicated that certain aspects of the TMT design could be improved (Gaudino, Geisler & Squires, 1995; Salthouse et al., 2000).

The CST consists of three basic parts, whereas there were only two parts on the TMT. In the TMT, Part A involves number tracing, and Part B which involves alternating between numbers and letters. The only difference between these two trials is the additional requirement to switch between groups of stimuli. The concept shifting ability is reflected by the extra time needed to complete Part B in comparison to Part A (Houx, 1991)**.** However, since Part A uses numbers as targets and Part B uses a mixture of numbers and letters, this makes the subtask not comparable with respect to the long-term memory processes involved in task performance (i.e. knowledge of the order of numbers and letters). Since there are only two trials in the TMT, the differences in the time it takes to complete Part A and Part B is often exaggerated. Subsequently, the slower response in Part B may be caused by poor knowledge of the alphabet or poor psychomotor abilities as opposed to impairment in concept shifting ability or executive functions (Jolles, Houx, van Boxtel & Ponds, 1995).

The additional trials present in the CST allows for a more comprehensive interpretation of the executive function measure. It consists of three consecutive test trials (CST Part A, B & C). It was proposed that in trials A and B, the factors recognised to be mainly attributable is attention, visual recognition, long-term memory, working memory, and visual scanning. Part C is also dependent on these processes, but it also requires additional shifting of concepts (alternating between numbers and letters). Thus, a measure of concept shifting or executive functioning is acquired by the timed response for trial C in comparison to trial A and B.

Design

The current study is quantitative, experimental designed study. The study employed a within-participants condition. The dependent variables are measured across three different conditions: Task performance on the CST - Reaction Time and Number of errors. Independent variable: Gender.

Procedure

Data collecting primarily took place in the National College of Ireland in a controlled environment, and in certain circumstances in a variety of places to accommodate the participants due to convenience. Generally, the experiment took approximately 10-12 mins to complete per participant. Participants were advised to read the information sheet and instructed to fill out the informed consent form (see Appendix A). This section of the form required signature consent from participants, as well as information regarding the participant's gender in order for participants to proceed with the experiment. Once this procedure is completed, participants confirmed with the instructor they understood what the experiment entailed. It was explained that participants would have to complete the CST in 3 different conditions on a total of 9 consecutive trials. A practice trial of the CST Part A was administered to ensure the participants understand the test instructions. This procedure was not timed, the test trial was for the purpose of allowing participants to become accustomed to the task.

A timer was used to record the reaction time of each trial. The order of conditions was kept the same for all participants. The condition with no background music (control), familiar music, and unfamiliar music was administered, respectively. CST Part A instructs participants to appropriately cross off the numbers 1-16 in its hierarchical order as quickly as possible while being timed. During each trial, the instructor's responsibility was to observe if any errors were made as well as time-keeping. The numbers of errors made in each trial were recorded without pointing out the error to participants. Errors were scored in instances where: participants did not start with the appropriate item. when items were skipped, and when items were crossed out in the wrong order. Participants were instructed to inform the instructor once they have completed the task. Similarly, the essence of CST Part B is the same as Part A with the alphabets, A-O. In CST Part C, participants are presented with a mixture of letters and numbers. In this trial, participants were required to alternate between letters and numbers. It was optional, whether they started with numbers or letters, however, which-ever they decide to start on, they must keep it the same throughout the experiment across all conditions of the CST Part C (1A, 2B… or A1, B2…). Once three trials of the CST has been completed for the control condition, participants were asked to put on headphones as preparation for the following experimental conditions. The test was repeated on familiar and unfamiliar music conditions. Data were recorded with pen and paper. Data were then transferred from paper to a PC.

Statistical Analyses

Given the experimental design of the study, the variables of the current study were measured by the reaction time of participants on three different conditions of within the CST trials. The total scores for conditions were computed by adding up all score values together (CST a + CST b + CST c). Similarly, the total scores for specific CST components were also computed by adding the same trial of the CST across all conditions (CST part a on control + CST part a on unfamiliar + CST part a on familiar etc.). Data were analysed using SPSS Statistics for Mac (version 24). Descriptives statistics were obtained for all continuous variables and for gender. Two separate tests were then conducted: a one-way repeated measures ANOVA was conducted to assess the differences in the mean scores of RT between conditions, using only CST part c data; a one-way multivariate analysis of variance was conducted to determine the role of gender on the CST total score performance. All data analysed reported the mean and standard deviation of variables.

Results

Descriptive Statistics

SPSS was used to analyse the results of the current study. Table 1, present the frequency for the variable of gender, the only demographic variable present in the current research. The descriptive statistics for all scores of all CST trials across three different conditions (continuous variables) including the mean score, standard deviation, and the range can be found in Table 2 and Table 3. Performance on CST total score was slowest on the Familiar condition (M=69.41, SD=12.50) compared to the Control (M=64.78, SD=8.95) and Unfamiliar condition (M=63.87, SD=10.43). Additionally, it was found that the trial with the longest RTs is CST Part C (M=81.70, SD=15.41), followed by CST Part B (M=60.40, SD=8.73) and CST Part A (M=55.95, SD=8.43), respectively. Data were then further analysed using a one-way repeated measures ANOVA and a one-way multivariate analysis of variance.

Table 1 **(for displaying information the variable of gender)**

Frequencies for the current sample of (N = 40)

Variable	Frequency	Valid Percentage
Gender		
Male	18	45
Female	22	55

Table 2.

Descriptive statistics of all continuous variables across all trials and conditions.

Conditions	Trials	Mean	Std. Error Mean	SD	Range
	CST a	18.07	0.45	2.83	12.84 - 23.53
Control	CST b	20.59	0.52	3.27	15 - 27.95
	CST c	26.12	0.73	4.59	19.20 - 36.89
	CST a	18.54	0.52	3.31	13.12 - 25.32
Unfamiliar	CST b	19.32	0.48	3.01	13.30 - 28.55
	CST c	26	0.84	5.30	14.53 - 43.75
	CST a	19.35	0.59	3.73	13.50 - 29.50
Familiar	CST b	20.49	0.58	3.70	14.75 - 33
	CST c	29.57	1.15	7.24	16.16 - 51.56

Table 3.

Descriptive statistics for the total score of CST trials (CST Part a, b, and c) and conditions (Control, Unfamiliar, and Familiar) of the CST.

	Mean	Std. Error Mean	SD	Range
Control total score	64.78	1.42	8.95	51.52-84.77
Unfamiliar total score	63.87	1.65	10.43	47.71-97.25
Familiar total score	69.41	1.98	12.50	48.74-98.65
CST a total score	55.95	1.33	8.43	42.72-74.93
CST b total score	60.40	1.38	8.73	50.17-85.90
CST c total score	81.70	2.44	15.41	56.36-119.84

One-way repeated measures ANOVA: Differences across CST Part C across conditions

A one-way repeated measures ANOVA was conducted to determine whether there were statistically significant differences between the CST Part C RT across the different noise conditions, to test for H1 and H2. There were several outliers in the data as assessed by inspection of a boxplot, they were retained. The assumption of normality was violated on certain conditions, as assessed by Shapiro-Wilk’s test ($p < .05$). Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, $\chi^2(2) = 9.169$, $p = .01$. Therefore, a Greenhouse & Geyser correction was applied. The score (RTs) of the CST Part C were significantly different across the different conditions of the CST Part C, $F(1.647, 64.230) = 14.624$, $p < .001$, partial $\eta^2 = .273$. Results of the Bonferroni post-hoc analysis indicated a significant increased (p < .001) in RT from the Unfamiliar condition (M = 26.01, SD = 5.30) to the Familiar condition (M = 29.57, SD = 7.24); significant increased (p < .001) from the Control condition (M = 26.12, SD = 4.59) to the Familiar condition; There was a slight decreased in RT from the Unfamiliar condition to the Control condition. View Figure 1.

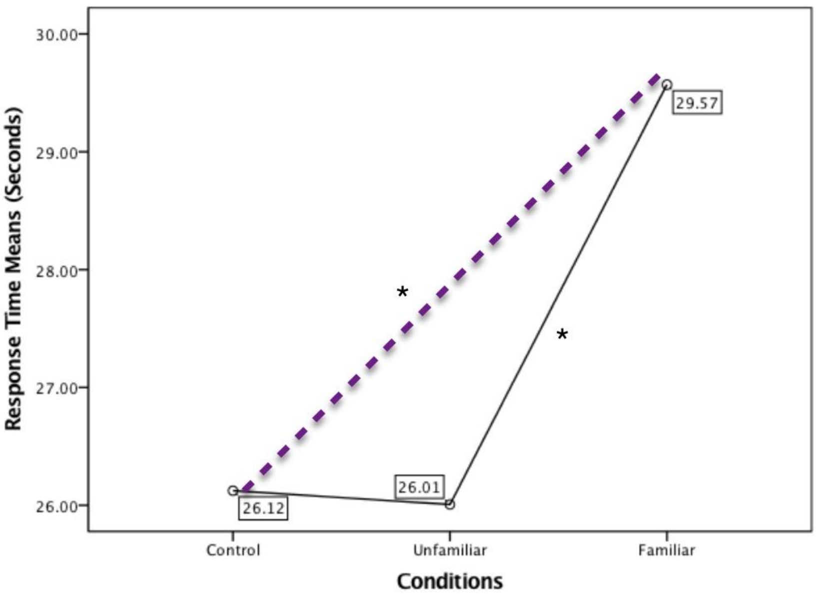

Figure 1. Line chart showing the difference between mean scores of CST Part C between three different noise conditions.

Multivariate analysis of variance: Gender and CST Total score across conditions

A one-way multivariate analysis of variance was run to determine the effect of gender (male and female) on performance on the CST to test for H3. Three conditions of the CST were assessed: The Total score for Control, Unfamiliar, and Familiar conditions. Preliminary assumption checking revealed that data was normally distributed, as assessed by Shapiro-Wilk test ($p > .05$); there were several univariate outliers present as assessed by boxplot, however, due to the nature of the study they were retained; there were no multivariate outliers, as assessed and Mahalanobis distance ($p > .001$), respectively; there were linear relationships, as assessed by scatterplot, no multicollinearity ($r = .830$, $p = .001$); and there was homogeneity of variance-covariance matrices, as assessed by Box's M test ($p = .483$). Male demonstrated longer RT on the CST Familiar condition (*M* = 70.60, *SD* = 14.16), followed by Control (*M* = 66.76, *SD* = 9.69) and Unfamiliar condition (*M* = 64.91, *SD* = 11.66), respectively, than females (*M* = 68.43, *SD* = 11.21; *M* = 63.16, *SD* = 8.17 and *M* = 63.02, *SD* = 9.50, respectively). There were no statistically significant difference between the gender variable on the combined dependent variables, $F(3, 36) = .897$, $p = .452$; Wilks' $\Lambda = .930$; partial $\eta^2 = .070$.

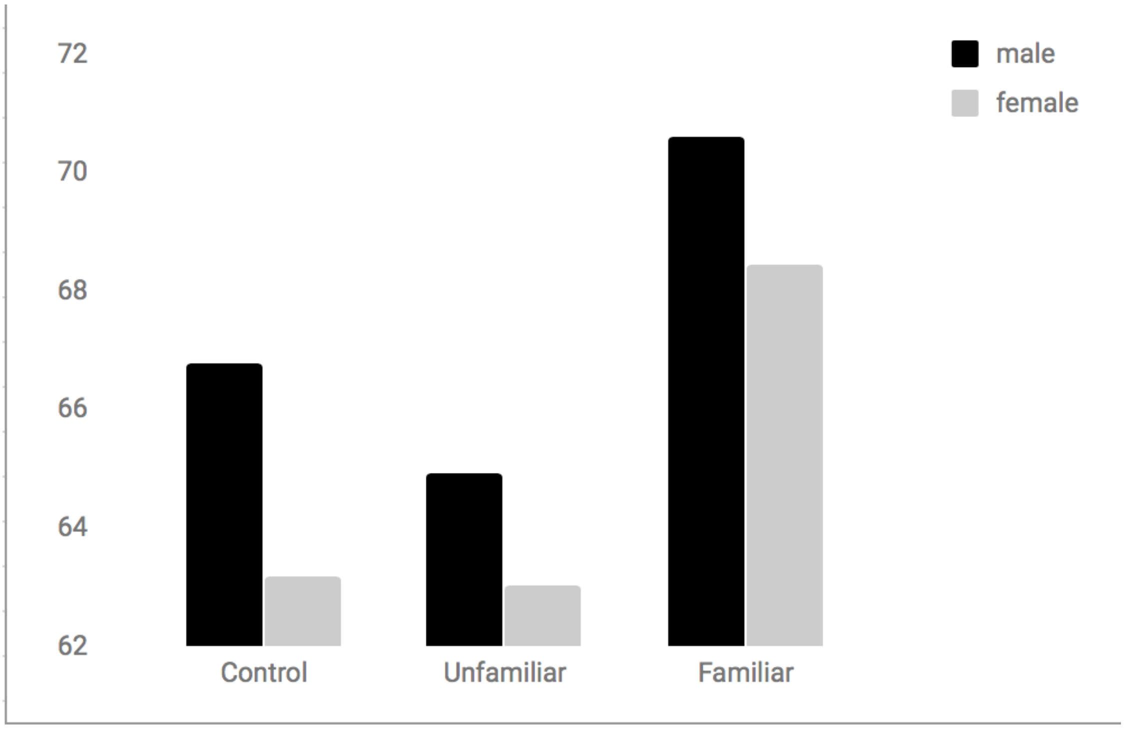

Figure 2. Bar graph demonstrating the mean total scores on of male and female on three different noise conditions. The X-axis represent the conditions, and Y-axis represent the mean total score (in seconds). Men demonstrated longer RT across all three conditions, longest in Familiar (*M* = 70.60,

SD = 14.16), Control (*M* = 66.76, *SD* = 9.69) and Unfamiliar (*M* = 64.91, *SD* = 11.66), respectively, than females (*M* = 68.43, *SD* = 11.21; *M* = 63.16, *SD* = 8.17 and *M* = 63.02, *SD* = 9.50, respectively).

Discussion

The primary purpose of the current study is to investigate the role of familiarity with background music and the potential effect it has on task performance on the Concept Shifting Test (CST). This investigation was carried by administering variations of background music while participants' immediate focus is on a focused attention task, thereby, background music was implemented to the CST. In the attempt to further the understanding of the level of distractibility on the specific familiarity of background music. Although the findings on the effects of background music has been mixed and inconsistent, it has been proposed that the outcome of these effects are generally modulated by the complexity of the task (Cockerton et al., 1997; Furnham & Allass, 1999). Along with the characteristics of the auditory stimuli being presented, and the factor of individual difference can play a role. Characteristics such as tempo, loudness, and familiarity may compromise the efficiency of the task at hand. The current study is primarily focused on the factor of familiarity; the interest is in the measurable behavioural responses as a result of auditory distraction, which is portrayed by RT and the numbers of errors scored on the trials. Since the number of errors indicates the accuracy of the response, it is important to mention that the prevalence of the errors made on the trails were quite low. However, in instances where errors were scored, the majority of these errors were made predominantly on the CST Part C trials.

The central question of interest was built upon earlier findings, whether the presence of familiar background music is more distracting than unfamiliar background music. Therefore, it was hypothesised that performance on the CST would be impaired in the face of familiar background music condition compared to that of the unfamiliar condition (demonstrated by the RT on the task). Results from a one-way repeated measures ANOVA indicated consistent results with this prediction. It was found that there was a statistically significant increased in RT from the unfamiliar condition to the familiar condition. This result indicates that familiar background music was more distracting than unfamiliar background music. This finding is consistent with previous literature on novelty distractions, where the familiarity to the content of the auditory stimuli can divert our attention away from a focal task (e.g. Schröger, 2005). Additionally, only the scores on the CST Part C were analysed for this section of the investigation, since Part C requires the shifting of concepts (alternating between numbers and letters) and took the most amount of time to be completed. As demonstrated by descriptive results (see Table 1. & Table 2.), it was the most appropriate trial within the CST to assess.

An additional aim the study was to examine whether performance on the CST is compromised in the face of background music in general (H2). This investigation was carried out by comparing the RT on the CST between the experimental conditions to the control also demonstrated by the one- way repeated measure ANOVA. It was hypothesised that RT on both familiar and unfamiliar noise conditions will be longer than that of the control condition (no background music). Results demonstrated the task performance between the control and familiar condition were found to be statically significant, with higher RT on the familiar than the control. However, the results of the analysis only support half of this hypothesis, as performance on the control indicated longer RT than the unfamiliar condition, although, this difference is very small. Moreover, the results of the following analysis support the central hypothesis, as that distractibility is highest with familiar background music, as exhibited by the high RT. The results can also be interpreted as neutral or no effect on performance between condition with no music and unfamiliar music, which was interesting to find. Nevertheless, although this differences between these two conditions were small, it was still unexpected that the RT on the control condition is larger than the unfamiliar. However, this could possibly be a result of the practice effect (further explained in the limitations), as the control was the first condition to be administered, followed the familiar and unfamiliar, this order may play a role in the outcome of the obtained results.

Furthermore, the role of gender in CST performance has been given particular attention. Regarding this variable, further interest is extended to the role gender has on task performance. It was hypothesised that females would demonstrate faster RT than males. With respect to the literature on this topic, past studies have shown that females tend to outperform males on similar cognitive tasks, the Digit-Symbol Substitution Test (Kertzman et al,, 2006; Sophie van der Sluis et al., 2006; Van der Elst et al., 2012), and of particular interest the CST (Van der Elst et al., 2006). An explanation proposed was that females and males are disparate in cognitive abilities. In general, gender differences have been investigated on task performance. Results of many of such studies postulated that males and females are disparate on certain cognitive ability, for example, it was suggested that males perform better on spatial tasks (Voyer, Voyer & Bryden, 1995), while females on nonverbal tasks (Mayo & Henley, 2012). Nevertheless, the nature of such research on gender often discovers heterogeneous results (e.g. memory tasks; Huguet & Regner, 2009). Overall, the comparative part of the study suggested consistent findings with previous literature as a one-way multivariate analysis of variance demonstrated that females did in fact outperformed males on the CST. Males had slightly longer RT on all conditions than females, as shown in Figure 2. The largest difference is evident in the condition, followed by familiar and unfamiliar, respectively.

Implications & Strengths

The results of the current research provide a practical contribution to the existing literature on the effect of background music, especially by expanding the current understanding on the detrimental effect of familiar background music on cognitive task performance. This information is important, since music has become an essential part of life, it has become a norm for people to carry out daily activities in the presence of background music. One commonly seen example is students studying or working on assignments while listening to music. Giving that familiar background music can negatively influence performance on specific tasks, increasing awareness of the distractibility of background music could potentially help individuals perform optimally on the immediate task. Additionally, results of the study have demonstrated better performance with unfamiliar music than with familiar music. This may have useful implications for individuals to optimise their performance when on a focal task, it is probably in their best interest to avoid listening to music that they know well, as it can be more distracting. Moreover, the findings of this study can be applied to many settings, especially in educational and work environments.

Limitations

Of importance, the limitations of this study should be addressed. A major methodological limitation evident is the small sample size. Since the study is a quantitative research, this makes the study underpowered. This also contributed to the non-normally distributed data, as a result, there was a violation of the assumption of normality in the one-way repeated measures ANOVA. Another methodological limitation concerned with the setting in which the tests were administered. Although, most data collection were conducted in a controlled environment, for the purpose of convenience, in certain instances data collected were carried out outside of the controlled environment. This may have compromised with the measurable data. Another limitation is the lack prior research on the specific topic. It is true that although there is abundant research on the role of novelty distraction of auditory stimuli, however, there is a lack of research on the specific effect of familiarity with background music. Another prominent limitation is the access to participants. Since participants were recruited through the method of convenience sampling, the majority of the participants were psychology undergraduate students. As the study originally intended also to assess the variables of age and levels of education (attending or have attended college or university, or not attending college), this limitation became considerably problematic. Since most of the participants were undergraduates, it became impractical to include this variable in the analysis. Similarly, for age, participants were roughly in the same age group, therefore, this variable was also removed. Lastly, a plausible limitation that may have tampered with the data may be explained by the practice effects, which refer to improvements in cognitive test performance when the same test is repeatedly assessed. Although the items on each CST trials were all different, participants may still improve on the task over time. Given the fact that participants completed a total of nine consecutive trials of the CST. This practice effects may be a logical explanation for why the unfamiliar condition was found the condition with the quickest RT rather than the predicted control condition. Considering that the control condition was administered first and the unfamiliar condition was last. The literature has suggested that practice effect tend to occur in young highly educated adults (Dikmen, Heaton, Grant, & Temkin, 1999; Miner & Ferraro, 1998)which is also congruent with the circumstances of the current study.

Despite the limitations listed, by acknowledging that this study is limited in these ways emphasises on the fact that there is a need for further investigation, to better the understanding in the role of familiarity with background music on cognitive task performance. These limitations are an indication of the direction for future research.

Future Research

Although there is abundant literature on the effect of background music on the different aspect of cognitive performance, there is limited evidence on the role of familiarity with background music as a form of auditory distraction. Therefore, future research should consider extending this investigation on the different types of cognitive tests. The current study has found familiar background music to reduce performance on the CST, other cognitive tests could perhaps suggest different results otherwise. Future research on this topic should also consider adding a control for potential mediating effect such as education and age on such investigation. Additionally, the factor of individual differences should be employed, it would be interesting the see whether aspects such as individuals preference of music and personality influence task performance. Since individual’s preference of music is believed to be a contributing factor, Huang & Shih (2011) suggested that the listener’s preference (like or dislike) towards the stimuli has a significant impact on their attention during the task. The literature has also propounded the influential role personality has on the degree of interference background music can inflict on a given individual (introversion and extraversion). Eysenck’s theory of personality (Eysenck, 1981) proposed that introverts and extraverts have different levels of arousal, that cortical arousal of extraverts is lower than introverts, therefore, they require a higher level of arousal to function optimally. This understanding led to the expectation that extraverts should perform better than introverts in the presence of music stimuli during cognitive tasks, as several studies have confirmed it (e.g. Avila, Furnham, & McClelland, 2012; Furnham & Strbac, 2002; Küssner, 2017). Although, what many of these previous studies neglected was to acknowledge the type of music being played as well as the role of familiarity, which highlights the need for further investigation, since cognitive performance is highly variable and depends on many factors. Lastly, it would also be interesting to test professional singers or musicians since music is in corporately to their daily life.

Conclusion

In conclusion, the majority of the hypotheses were supported by the results obtained, although there was an unexpected finding on the unfamiliar background music condition. Overall, for the most part ,the results were consistent with previous findings, showing that background music can distract listeners and consequently interfere with the performance on the CST (Angel et al., 2010; Polzella & Schoeling, 2004). More importantly, the results supported the central question in the current thesis, as familiar background music was found to negatively impact task performance, which provides evidence for the role of familiarity with auditory stimuli on distractibility on cognitive performance. The replicability of these findings many depends on the type and of the background music being presented. While these results suggest that background music can interfere and disrupt performance on the CST. The result would no doubt be different for different tasks, perhaps on simpler tasks, as inference appears to be modulated by the complexity of the task (Cockerton et al., 1997; Furnham & Allass, 1999).

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Appendix A

INFORMED CONSENT FORM

to participate in the behavioural experiment:

The Effects of Noise Distractions on Attention & Cognition

My name is Norawat Komlao and I am in my final year of the BA (Hons) in Psychology programme at National College of Ireland. I am conducting this research as a part of my undergraduate thesis to explore the effect of noise on attention and cognitive performance.

You are invited to take part in this study which will involve you completing a series of tasks. The information obtained will be use to provide a better understanding on the examined topic. It is important to know that your participation is completely voluntary and are are free to withdraw from study at any time.

Procedure:

- You will be introduced to the Concept Shifting Task. The layout showing16 small circles that are grouped in a larger circle. The small circles containing digits, letters, and a mixture of digits and numbers.
- In the three consecutive test trials, you will be required to cross out the stimulus according to their hierarchical order.
- During the 3 trials you will be on headphones. Noise conditions will vary across trials; 1) no noise, 2) song you know 3) Song you don't know.
- The time you take to complete the task will be recorded.

All information obtained during your participation will be strictly confidential and will only be used for this study.

All my questions have been answered to my satisfaction and I agree to participate in the trial.

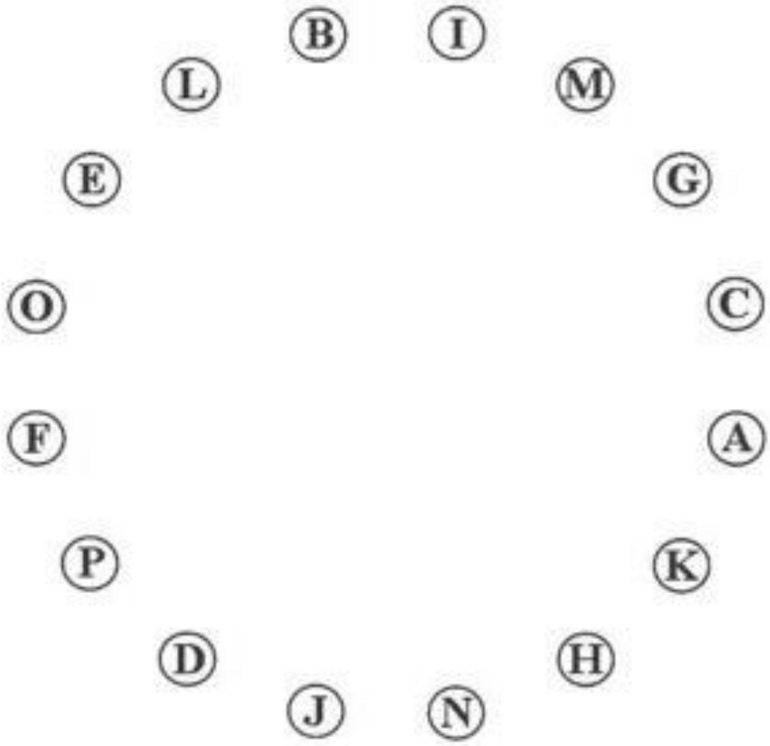
Gender: Male | Female

Signature: .... Date:......-……-……….

If you are interested in learning more or require further information about this research, please contact me at x15583017@student.ncirl.ie or my supervisor Dr. Joanna Power, Lecturer in Psychology, National College of Ireland, Email: joanna.power@ncirl.ie

Appendix B

CST Part A



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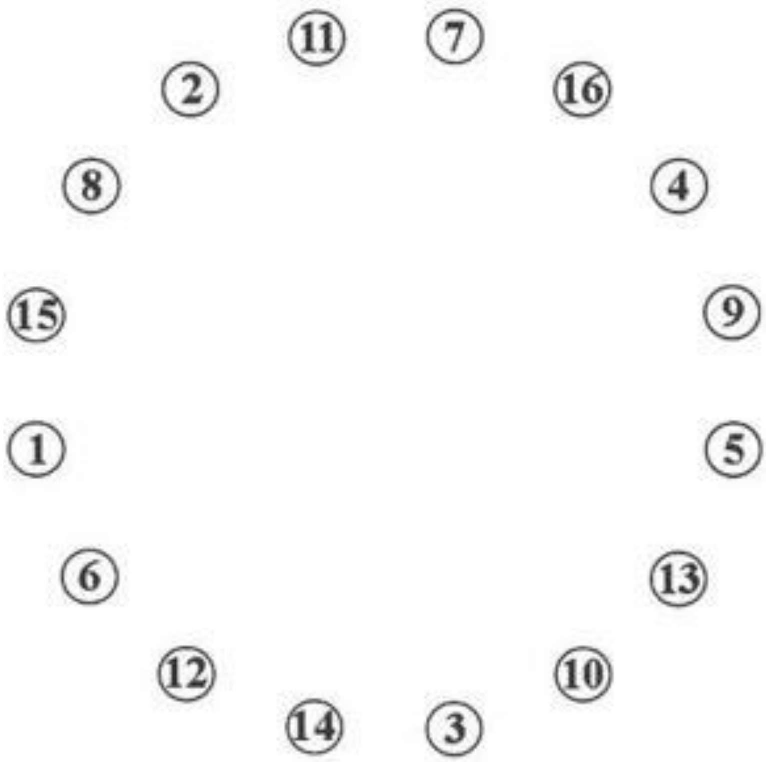

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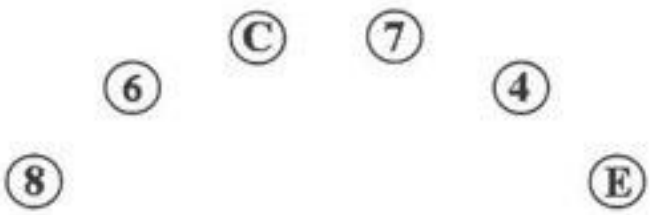
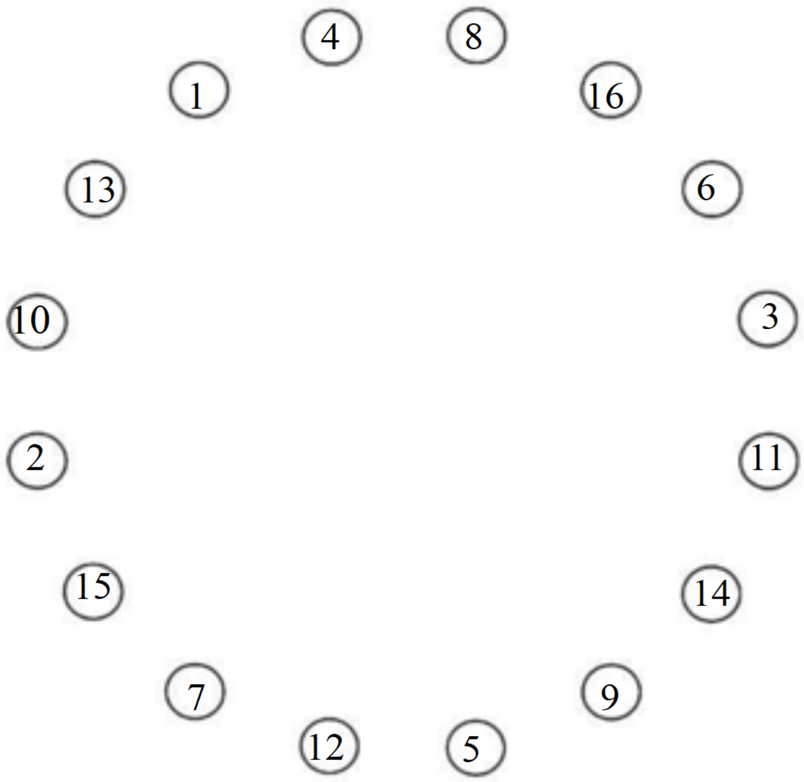


CST Part A



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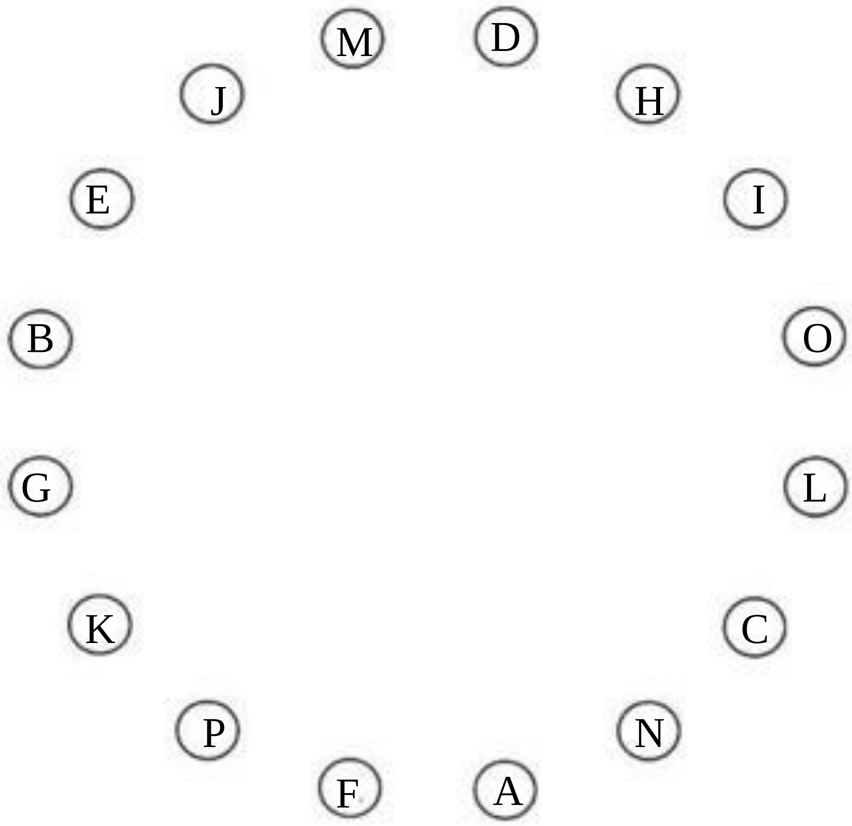

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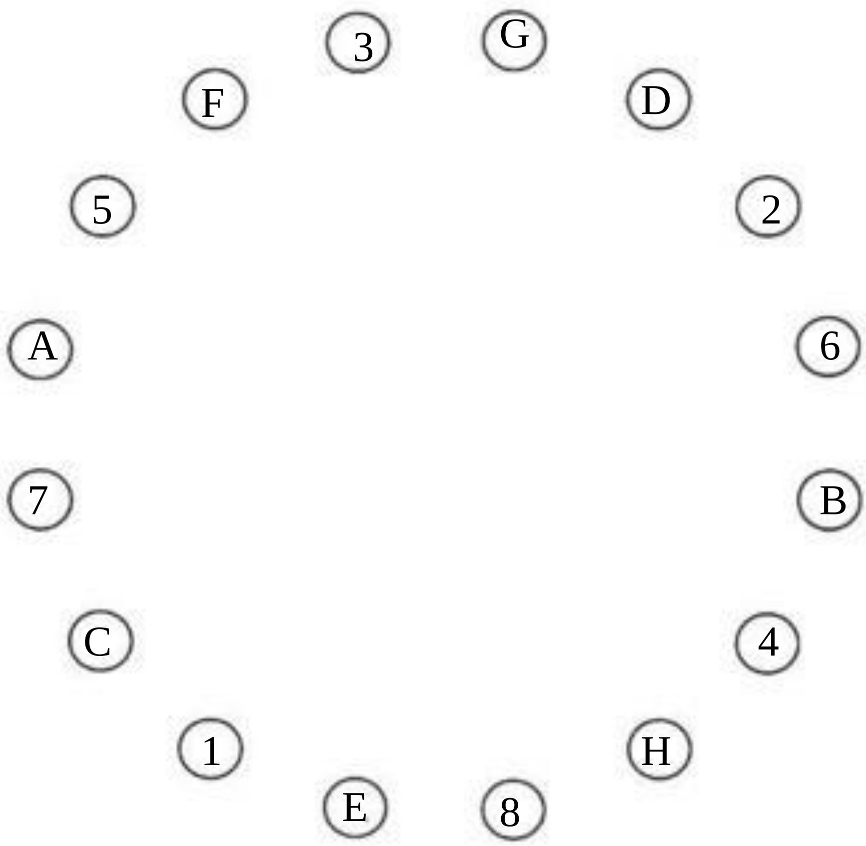
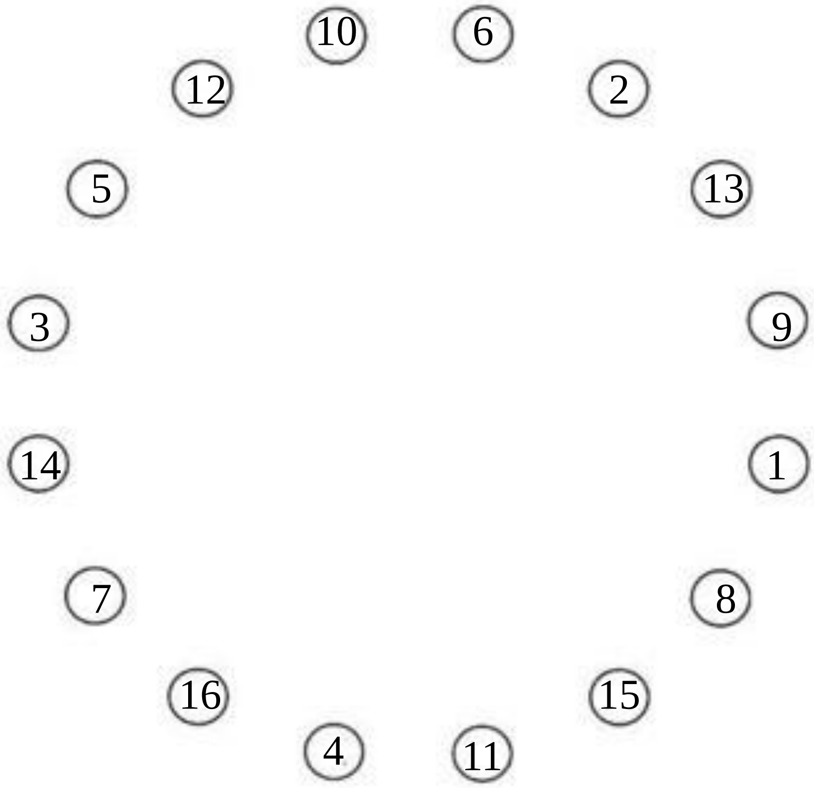
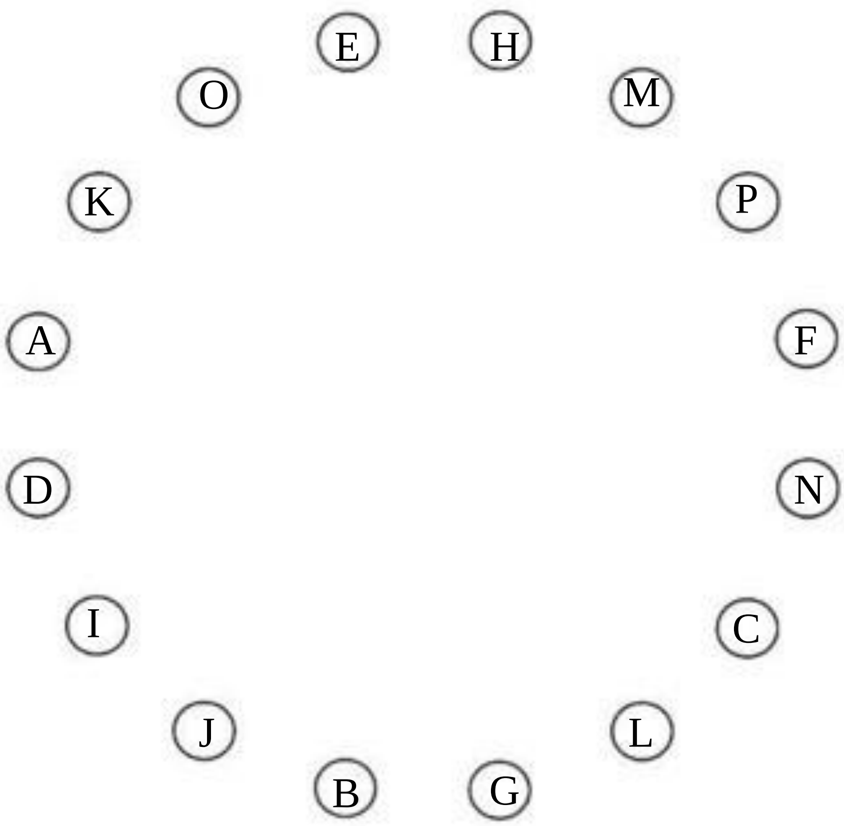




CST Part A

CST Part B



CST Part C