Psychology
School of Human & Community Development
University of the Witwatersrand
Private Bag 3, Wits, 2050
Tel: 011 717 4503
Fax: 011 717 4559

Master's Research Report

The Impact of Music on the Academic Performance of Undergraduate Students

By

Pakeezah Rajab

1363620

Supervised by Dr Michael Pitman

A research report submitted in partial fulfilment for the degree

Master of Arts in Social and Psychological Research by Coursework and Research Report

(PSYC7022)

in the

Department of Psychology, Faculty of Humanities

at the

University of the Witwatersrand

Johannesburg.

Abstract

Listening to music is a universal activity and with technological advances, more individuals are able to listen to their personal choice of music on their cellphones, MP3 players and iPods. Given that the brain has been shown to have limited capacity to process information, this study aimed to investigate how listening to music may affect the academic performance of undergraduate students when they are simultaneously studying or engaging in other academic activities. The study consisted of two parts; first, a survey was sent out to undergraduates currently registered at a South African university to gauge their current music usage behaviours, of which 197 undergraduates' complete responses were used. Following completion of the survey, these students were then invited to participate in a within-subject experiment to investigate whether different sound conditions affected their performance on working memory span assessments. The experimental responses of 35 participants were used to conduct a one-way repeated measures ANOVA, which indicated that although there is no significant difference in working memory performance between White Noise and Beethoven sound conditions, students' performance decreased significantly when they listened to the music of their choice. Whether or not students had been studying with music for many years did not have a significant impact on their performance on the corresponding working memory assessment. These findings indicate that working memory capacity may be overloaded when listening to one's own choice of music, which may affect how information is encoded when studying and completing other academic activities. Results further suggest that students can identify whether they are getting distracted by music, but this perception does not prevent them from listening to music, which could later affect how the studied information is recalled, thus having a negative impact on one's academic performance.

Keywords: *academic performance, music, working memory*

Acknowledgements

I would like to express my deepest gratitude to the following people, who have made this research possible.

Firstly, a huge thank you to my supervisor, Dr Michael Pitman, for his invaluable guidance, suggestions and insights regarding this project. Your expertise in the field has further grown my own curiosity and excitement towards cognitive research. Thank you for providing me with the space to imagine all the possibilities, and then gently guiding me towards the more practical procedures!

My parents, Saeed and Nazme, who have always been there for me in all that I do. Thank you for filling my life with music from my youngest days, encouraging me to do what makes me happy, and loving and supporting me through stressful times. Your own accomplishments continue to inspire me to always look for the best in every situation.

My brother Saahir, for being understanding and accommodating all the weekends at home, as well as providing technical assistance when necessary. Your own academic achievements and knowledge have inspired me.

To Imtiaz, Delarise, Daphne and Riaz, thank you for listening to all my stories and being the perfect trial participants for my seemingly endless list of surveys and tests. Thank you for being the relaxed, special individuals that you are, and for celebrating my small achievements with the enthusiasm that you do.

The University of the Witwatersrand for the Postgraduate Merit Award. My Master's would have been an even more challenging experience without this financial assistance.

All the participants who so willingly offered their time to complete the various measures for this study. Your eager participation means the world to me – this study could not have happened without you.

Lastly, I would like to thank my dearest granny, Alida, for all her love and care over the years. I chose this career path largely because of her, and in her loving memory, I hope to continue to grow my understanding in the field of Psychology.

Declaration

I, Pakeezah Rajab, declare that this research report is my own, unaided work. It is submitted for the degree of Master of Arts in Social and Psychological Research by Coursework and Research Report at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any other degree or examination at this or any other university.

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Chapter One: Introduction

<u>Music</u> [noun]: *Vocal or instrumental sounds (or both) combined in such a way as to produce beauty of form, harmony, and expression of emotion* ("English Oxford Living Dictionaries," 2017).

Music needs no introduction - it is a cross-cultural, universal phenomenon (Perlovsky, 2012) which is not only created and consumed by humans, but others in the animal kingdom (Fitch, 2006); a part of most of our lives, whether as an integral element of our recreational and entertainment activities, as a component in our religious and spiritual lives, or as a tool to help us relax and remain calm in times of stressful situations, such as when we are preparing for examinations or sitting in traffic. Listening to music fits into most of our daily routines and schedules almost effortlessly as a contemporaneous activity (Schellenberg & Weiss, 2013) - individuals tend to listen to music, a relatively low-engagement activity usually happening in the background, while simultaneously performing other tasks that require more deliberation and immersion-driving, reading, cooking, socialising, etcetera.

Evolutionary psychologists and musicologists alike are unsure of the purpose or origination of music. Whilst musical instruments older than 35000 years have been discovered (Fitch, 2006), it is unclear whether music has any adaptive, or evolutionary role in human evolution (Cabanac, Perlovsky, Bonniot-Cabanac, & Cabanac, 2013). One possible function of music is assisting individuals in overcoming cognitive dissonances – "a discomfort caused by holding conflicting cognitions" (Perlovsky, 2012). Cognitive dissonance is a common mental state of many, which may cause demotivation and disinterest in accumulating more knowledge but is typically resolved by devaluing or discarding conflicting cognitions. Music could thus be essential to the general person's ability to accumulate knowledge, overcome irrational decisions made by cognitive dissonance, and sustain human cultural evolution despite increasing pressures from such cognitive dissonance to devalue knowledge schemes (Perlovsky, Cabanac, Bonniot-Cabanac, & Cabanac, 2013).

Another explanation for the universality and commonality of music may be because of the health and psychological benefits it provides (Perham & Vizard, 2011). In a meta-study done by Kampfe and colleagues (2011), it was found that background music seems to have a positive effect on behaviour, tending to increase positive emotions (Kampfe, Sedlmeier, & Renkewitz, 2010). Research indicates that music itself has also been shown to invoke emotions which may cause the listener to respond physiologically (Blood & Zatorre, 2001; Lundqvist, Carisson, Hilmersson, & Juslin, 2009; Rickard, 2004), and these emotions may "help maintain a sense of purpose of one's life in the face of a multiplicity of contradictory knowledge" (Perlovsky, 2012). In simpler terms, music may be used to ground and calm individuals during overwhelmingly stressful times and as a result, their physical and psychological well-being may be improved. With findings such as this, it is no surprise that university students often listen to music whilst studying, perhaps not only to make the task more bearable, but also maintain a calm, positive attitude towards their academic future.

Van Goethem and Sloboda (2011) studied affect regulation in relation to music, and conceptualised the Goals, Strategies, Tactics, and Mechanisms (GSTM) framework. The following description provides an example of the entire framework: "An individual defines the goal as reducing sadness, and uses the strategy of distraction through the tactic of music listening, via the mechanism of emotional contagion." According to the GSTM framework then, the use of music is therefore based on different goals related to maintaining, improving, changing or inducing an affective state. Listening to music is therefore regarded as an affect regulation tactic with a high success level and large range of goals and strategies (van Goethem & Sloboda, 2011). Thus given the large of body of research which has indicated that music can impact on and regulate your mood (Groarke & Hogan, 2016; Lilley, Oberle, & Thompson, Jr, 2014; Lundqvist, Carisson, Hilmersson, & Juslin, 2009; Sallavanti, Szilagyi, & Crawley, 2016) it seems reasonable to suggest that this may be one of the reasons why students listen to music when studying. Music has been shown to be commonly used to regulate multiple components of emotion in the daily lives of children, adolescents and adults alike: mood, motivation, focus, impulses and arousal levels. As such, undergraduate students may choose to listen to music whilst studying to stay alert, motivated and optimistic whilst studying.

Connecting Music with Academic Performance

It is of global interest as to what factors play a role in the academic performance of university students. International studies have indicated that factors such as time management, responsibility, place of residence, quality of secondary high school education, familial background, study habits and level of motivation all affect undergraduate students' academic performance (Bangchang, 2015; Dweck, 1986). Students' affective states, motivational and cognitive processes are also said to influence academic performance. Furthermore, it is theorised that positive emotions in educational contexts might be associated with academic engagement (Dosseville, Laborde, & Scelles, 2011).

Studies conducted in South Africa have shown that a range of elements such as presentation and module content, getting feedback on assessments, student-lecturer interaction, language problems and time management influenced student's attitudes and motivation, and thus academic performance (Fakude, 2012; Fraser & Killen, 2003; Sikhwari, Maphosa, Masehela, & Ndebele, 2014).

For the purpose of the current study, academic performance will refer to the functioning of students in educational settings. It is the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments. Many of these goals are cognitive in nature, and may apply across multiple subject areas (such as critical thinking) or include the acquisition of knowledge and understanding in a specific intellectual domain or subject (Steinmayr, Meißner, Weidinger, & Wirthwein, 2014).

An early report by Cantril and Allport (1935) found that at the time, 68% of students worked with the radio playing in the background (as cited in Doyle & Furnham, 2012). Even in today's time, listening to music whilst studying and completing assignments appear to be a worldwide phenomenon (Dolegui, 2013), one that has likely increased with the availability of portable music devices – iPods and iPads, MP3 players and even cellphones. For the current study then, one of the aims was to obtain an estimate of undergraduate students' music usage behaviours. Furthermore, although it is common practice to listen to music whilst simultaneously completing other tasks, the current study wanted to assess the impacts of this multitasking on task performance – working memory performance in particular.

Chapter Two: Literature and Theoretical Overview

The aim of this study was to firstly determine undergraduates' music usage behaviours, and secondly explore whether or not they had an impact on their academic performance, which would be measured on their performance on working memory span assessments. These assessments were to be completed under different sound conditions. Literature has suggested that music may impact on both one's affect and working memory capacity. Given that working memory plays a significant role in many cognitive tasks, such as reading, comprehension, memorisation, problem solving and reasoning (Baddeley, 2003; Eiras & McNeil, 2010; Hallam & MacDonald, 2009; Schellenberg & Weiss, 2013; Schlittmeier & Hellbruck, 2009), which are all important skills used by undergraduate students while studying, it can be deduced that working memory has a significant role in the academic performance of students. As part of the learning and studying of new material process, information gets encoded and manipulated for the purpose of later retrieval. In short, working memory can be seen as the factor connecting music and academic performance.

Working Memory

The term ''working memory" was first used more than 40 years ago by Miller and colleagues in 1970, according to Sprague, McBee, and Sellers (2016). In 1974, Baddeley and Hitch defined working memory as "a cognitive system designed to temporarily store and manipulate information". This system is considered to be responsible for the control, regulation, and active maintenance of task-relevant information, particularly when performing ongoing complex cognitive tasks such as language comprehension, learning and reasoning (Baddeley, 1992, 2012; Baddeley & Hitch, 1974; Johnson & Gronlund, 2009; Souza & Oberauer, 2017).

Whilst the researcher is aware of the various theoretical approaches to working memory, the modified multi-component model developed by Baddeley (1992, 2010, 2012) and Baddeley and Hitch (1974) has theoretically guided this study to a large degree, given its exceptional influence in the field. Baddeley (2003, 2007) indicated that the concept was first evolved from short-term memory, that working memory is a component of executive functioning which enables the completion of higher cognitive tasks of reasoning, learning, problem-solving and comprehension. Working memory, as a limited capacity system, is viewed as a cognitive process that is involved in mental flexibility, where information is encoded, activated, retained, stored and manipulated for a brief period of time whilst individuals are simultaneously completing other mental activities. Both theoretical and empirical evidence propose that working memory is comprised of cohorts of separate, yet interconnected components which mediate connections between lower-level perceptual stimuli, long-term memory storage and action (Baddeley, 2003). Within this system, there are capacity limitations that determine how well or efficiently a task can be executed; in other words, the amount of information that is encoded, or can be made accessible at a given time is limited in capacity, whereby an increase in task complexity is directly proportional to a decline in performance (Lee, Ning, & Chin Goh, 2013; Oberauer, 2005).

Since the system consists of multiple components, if task interference occurs in one of the mechanisms, the whole system is put under stress, affecting the processing and integration of the information being encoded (Schuler et al., 2011). It also means though, that tasks requiring short-term retention or memory manipulation could use different strategies in terms of the recruited components performing the task, depending on task complexity. If the maintained information is relatively simple, such as highly trained memory items (letters, numbers), then the problem-state component of working memory can be omitted, with the items being directly rehearsed from declarative memory. With new information, however, the working memory problem state is used, to prevent forgetting or misremembering of task critical information (Nijboer, Borst, van Rijn, & Taatgen, 2016).

The efficient functioning of the working memory system is largely dependent on one's cognitive load capacity. Cognitive workload has been defined as the "interaction between the demands of a task that an individual experiences and his or her ability to cope with these demands." (Noyes, Garland, & Robbins, 2004). The ideal processing system is a focused, uncluttered working memory, with maximised speed and accuracy of processing, by preventing attention from switching to goal irrelevant representations (Dagry, Vergauwe, & Barrouillet, 2017). When an individual cannot cope with the demands of the task, or the irrelevant information available to them is in excess, the individual will experience a phenomenon known as information overflow. This concept is defined as "a situation in which 'an individual's efficiency in using information in their work is hampered by the amount of relevant, and potentially useful, information available to them" (Gruszka & Necka, 2017). Information overflow causes a deficit in efficient working memory processing, by reducing the ability to concentrate and attend to a task, restricting the range of cues that are encoded and processed.

Working memory capacity can become further derailed by task-unrelated thought, a phenomenon known as mind wandering, which may then compete with working memory processing demands for a limited pool of executive resources (Krimsky, Forster, Llabre, & Jha, 2017). However, to ensure that the working memory system is not overloaded, the inhibitory deficit view has been proposed by Hasher and Zacks (1988). This theory suggests that inhibitory control is defined as a mechanism of attentional selection, which includes three aspects: an access function (which prevents irrelevant information from entering the working memory store), a deletion function (which supports the updating of temporarily important information by suppressing the activation of no longer relevant information) and a restraint function (which serves for the suppression of strong, but unimportant, information and enables the activation of weaker, but potentially more relevant, information.). The three functions act in concert and thereby ensures accurate functioning of working memory (Zeintl & Kliegel, 2007).

The initial working memory model by Baddeley and Hitch (1974) only involved the supervisory attentional 'central executive' system and two distinct, yet related unimodal storage systems, the phonological loop and the visuospatial sketchpad, but in 2000 this model was further modified to include the episodic buffer to explain interaction with long-term memory and the other storage systems to form integrated memory episodes, and the limited capacity multimodal store responsible for integrating information in various codes and into unitary episodic representations (Baddeley, 2003, 2012) and creating a sense of continuity (Burunat, Alluri, Toiviainen, Numminen, & Brattico, 2014). According to Baddeley, all these systems have a limited capacity, although in different ways.

The central executive, phonological loop and visuospatial sketchpad.

The central executive.

The central executive, or 'control system', is a subsystem of working memory responsible for higher cognitive facilitation (Baddeley, 2003, 2012) This subsystem allows attention to be switched between tasks, planning and integration of short-term memory information, assigning information to one of the other subsystems, regulating working memory contents and linking them to long-term memory (Schuler, Scheiter, & van Genuchten, 2011). This system was envisioned as a control structure of limited attentional capacity, responsible for manipulating information entering working memory and controlling the subordinate subsystems: the phonological loop, visuospatial sketchpad and the episodic buffer (Gruszka & Necka, 2017).

Phonological loop.

The phonological (or articulatory) loop includes two components, namely the phonological store component, which identifies and temporarily holds verbal information for a small number of seconds until the component of subvocalisation occurs, allowing the information to be maintained via rehearsal through inner speech and then be brought back through the phonological loop (Baddeley, 2012; Eiras & McNeil, 2010; Salame & Baddeley, 1989). However, Salame and Baddeley (1982) reported that visually presented sequences of verbal material, such as digits, are also phonologically encoded and remembered via the articulatory loop system, with the items being recoded through subvocalization, which enables them to be stored within the short-term phonological store. As such, the phonological loop serves to store verbally communicated information, as well as written information, which may be internally articulated, or subvocalized. Memory traces can be refreshed by being retrieved and re-articulated (Baddeley, 2003), although Hanley (1997) has suggested that articulatory suppression may serve to remove the irrelevant speech effect.

It is assumed that the phonological loop evolved to facilitate the acquisition of language. It is further theorised that immediate memory has a limited span because the process of verbal articulation takes place in real time — as the number of items rehearsed increases, it reaches a point at which the first item will have faded before it can be rehearsed (Baddeley, 2003).

Visuospatial sketchpad.

Providing a non-verbal presentation of working memory, it is theorised that the visuospatial sketchpad is the subsystem responsible for visual and spatial information processing, storage and manipulation, as well as facilitating semantic acquisition regarding objects and stimuli within the environment (Baddeley, 1996, 2003; Baddeley & Hitch, 1974). Whilst the visual component considers object characteristics such as shape or color, the spatial component deals with relational information and the control of movements, for example, arm or eye movements (Lawrence et al. 2001; Logie 1995; Logie and Marchetti 1991 cited in Schuler et al., 2011).

The visuospatial sketchpad is assumed to be responsible for picture processing, (Schuler et al., 2011), and visuospatial information storage is said to contribute to recall, making short word recall in particular, easier (Cowan, Baddeley, Elliott, & Norris, 2003).

Baddeley (2003) further suggested that when individuals perform a visuospatial task, they also recruit the phonological store to code information while simultaneously manipulating the same information visuospatially. Dindar and Akbulut (2016) found that, relating to instances of multitasking such as listening to music whilst studying, sequential multitasking was linked to the visuospatial sketchpad capacity whereas concurrent multitasking was related to the phonological loop.

It is important to note that working memory performance appears to operate independently from socioeconomic status, as indicated by studies measuring both phonological loop and central executive performance. This then indicates that working memory measures reflect fluid cognitive abilities that are independent of acquired knowledge and skills (Engel, Santos, & Glathercole, 2008). As such, studies measuring working memory performance should be able to be replicated in various environments, with similar findings produced. However, this is not the case, with the various studies considering various aspects of working memory providing contradictory results. These will now be discussed in further detail.

Individual differences and working memory.

It has been shown that working memory differs between individuals and some individuals are able to retain more information and manipulate the information more effectively than others (Baddeley, 2003). This section will discuss some of the areas that affect, or are affected, by individual working memory capacity.

Attention.

Two studies in 2004 (Feldman Barrett, Tugade, & Engle; Schweizer & Moosbrugger), explored the relationship between attention and working memory. The results indicated that there is indeed a substantial link between attention and working memory, and that the ability to control one's attention significantly contributes to individual differences in working memory capacity. These results further imply that measures of working memory thus inadvertently include a component that is also represented by measures of attention. Practically, this is seen when conducting working memory assessments. For participants to successfully complete such an assessment, they need to pay attention to the task at hand. However, there are environmental conditions such as background noise or music, lighting changes and interpersonal interaction, as well as intrapersonal factors such as mood and motivation discussed above which all may affect how well one can attend to the task. Another individual difference that may affect one's ability to pay attention, and thus one's working memory capacity, is one's arousal.

Introversion/extraversion arousal.

Hallam and MacDonald (2009) used the Yerkes-Dodson law to explain that the level of arousal experienced by the individual may increase their performance up to an optimal level, however, arousal beyond this point leads to deterioration in performance. This deterioration is also more likely to occur quicker when the task being performed is complex or under-learned. According to this law, simple tasks require higher levels of arousal for concentration to be maintained, whilst more complex tasks require lower arousal levels. Slow, soft, repetitive (low information load) music was shown to be the most optimally arousing form of music (Doyle & Furnham, 2012). It then follows that listening to complex, arousal-evoking music would likely reduce the attentional space available for task performance.

Personality factors are also implicated in optimal arousal levels (Hallam & MacDonald, 2009), with findings suggesting that introverts have higher resting levels of arousal than extroverts and are therefore naturally more sensitive towards becoming overly aroused. Supporting the arousal hypothesis for introversion and extroversion, Furnham and Bradley (1997) found that introverts were more negatively, whilst extroverts more positively affected, in their study which introduced extra stimulation to participant's work environments. These results are further supported by Schellenberg and Weiss (2013), who found that when completing delayed-recall and reading-comprehension tasks, introverts listening to pop music performed worse than both introverts tested in silence and extroverts tested with music. It was further shown that both music and noise could impair reading comprehension for both groups, however introverts are more negatively affected than extroverts (Doyle & Furnham, 2012). Similarly, on a Stroop task, the negative effects of highly arousing background music is exaggerated for introverts (Schellenberg & Weiss, 2013). As such, the effects of music may be seen as less detrimental, or even beneficial, to extroverts, compared to the same music effects on introverts.

It was also recently shown that when music evokes a pleasant mood, thus increasing the arousal level, there is also a concurrent increase in creative problem-solving and task performance (Geethanjali, Adalarasu, Jagannath, & Rajesekaran, 2016). This is similar to the findings of Doyle and Furnham (2012), who reported that creative participants were less likely to note distractibility and more likely to listen to music.

Emotional states.

A study done by Dosseville, Laborder and Scelles (2011) indicated that music played a role in maintaining positive affect during lectures. These researchers further theorised that music likely induced a change in students' perception of learning environments thus making it more attractive, which could have resulted in increased motivation and in turn increased academic performance.

On a parallel note, more recent research conducted by Storbeck and Maswood (2016) found that positive mood consistently produced the largest (best) working memory capacity score, regardless of the working memory domain (verbal or spatial). However, the study also found that small cognitive costs may arise when maintaining spatial information for individuals in positive moods. There was no significant difference in working memory capacity between individuals experiencing neutral or negative moods. The researchers concluded that the findings support the idea that positive affect may enhance executive control, therefore maintaining verbal and spatial information in working memory while preventing interference from the processing task (Storbeck & Maswood, 2016).

The literature has also indicated fairly distinctly that anxiety has adverse effects on working memory intensive tasks and tasks that require attentional control, as Johnson & Gronlund (2009) indicated in their review. The processing efficiency theory (PET) has postulated that anxiety disrupts phonological rehearsal and therefore the phonological loop (Lee et al., 2013). Due to this disruption, the central executive will also be affected when the phonological loop is overloaded, as indicated in the earlier section. According to the attentional control theory, by disrupting the central executive, the inhibition and switching functions malfunction (Johnson & Gronlund, 2009).

High working memory capacity individuals owe their superior attentional control capacity to their ability to actively maintain task goals in memory, as well as retrieve task-relevant information from memory amidst interference (Baddeley, 2012). Highly anxious individuals are therefore forced to expend additional effort when completing tasks to be able to perform as well as less anxious individuals, in their attempt to control the effects of worry and self-preoccupation. It then follows, according to Owens, Stevenson and Hadwin (2012), that if students are able to effectively reduce their feelings and symptoms of anxiety, their academic performance should also improve.

Intelligence.

One of the most recent studies in the field, by Jastrzebski, Ciechanowska, and Chuderski (2018) investigated the relationship between intelligence and working memory. This study yielded no evidence suggesting that individual differences in strategy use could significantly weaken the relationship between working memory capacity and fluid intelligence (gf). Rather, regardless of strategy mediation attempts, the working memory – fluid intelligence relationship remained robust and strong. An implication of this study is that fluid intelligence test scores relate to the efficiency of working memory, and that both abilities are underpinned by the efficiency of shared brain networks. This is supported by Colom, et al (2004) whose study found that working memory is almost perfectly predicted by intelligence (g), with approximately 92% of variance explained, and the conclusion that working memory and intelligence should be considered as isomorphic entities (Chuderski, 2014).

However, Ackerman, Beier, and Boyle (2005) inferred that working memory and intelligence, although related, are not isomorphic. Furthermore, it was demonstrated that strategy use can account for performance variance on working memory tasks. According to the strategy-as-cause hypothesis, “individuals who are more strategic merely obtain higher span scores.” Alternatively the strategy-as-effect hypothesis proposes that it is one’s higher working memory capacity that allows them to be more strategic, which, in turn, contributes to span scores (Bailey, Dunlosky, & Kane, 2008).

Nevertheless, over the years working memory has been found to correlate significantly with measures of intelligence, such as comprehension (Daneman & Carpenter, 1980), reasoning ability (Kyllonen & Christal, 1990), mathematical achievement (Lee et al., 2013), second language vocabulary retention (Varol & Gulcan, 2016) and broader academic achievement (Blankenship, O'Neill, Ross, & Bell, 2015). Furthermore, Chuderski (2014) identified working memory and intelligence as separable variables, concluding that increasing fluid intelligence moderated the impact of anxiety on working memory. The study by Alloway and Alloway (2010) also suggests that intelligence and working memory both constitute unique cognitive contributions to academic development.

It therefore follows that how students perform academically may, in part, depend on their working memory capacity, given the various studies indicating that the ability to store and manipulate information in working memory may be an important aspect of intelligence. This review has also shown how individual differences in personality, arousal, anxiety and intelligence may converge and improve (or worsen) one's working memory capacity – thus making differences even more individualistic. However, although working memory capacity was once thought to be a stable construct, recent research has demonstrated that the neural systems underlying working memory is somewhat plastic (Sprague et al., 2016).

Working memory capacity and music.

As mentioned earlier, various brain structures are activated when engaging in activities making use of working memory. When a sound enters the eardrum, multiple events occur in the cochlea, brain stem, midbrain nuclei, and cortex to rapidly result in a percept (Peretz & Zatorre, 2005). When listening to music, which structures are activated is said to be dependent on whether or not the individual is a musician (Burunat, Alluri, Toiviainen, Numminen, & Brattico, 2014), as well as how familiar the individual is with the song being listened to (Chew, Yu, Chua, & Gan, 2016). Electroencephalography (EEG) and magnetoencephalography (MEG) recordings display the auditory cortex responding to pitch relations even in the absence of attention, with evidence pointing to the existence of neural networks specialised for the processing of scale structure in melodies (Peretz & Zatorre, 2005). It is also agreed that there is an overlap in the areas used for lyrical music processing and language processing used in conversation (Burunat et al., 2014).

As indicated earlier, students spend a lot of time simultaneously listening to music whilst studying (Dobbs, Furnham, & McClelland, 2010). Some researchers (Doyle & Furnham, 2012; Eiras & McNeil, 2010; Schlittmeier & Hellbruck, 2009) suggest that all music processing takes up cognitive resources since music is a stimulus, and as such, any music is potentially distracting and detrimental to performance and therefore some tasks would be best performed in silence. Others (Daoussis & Mc Kelvie, 1986; Schellenberg & Weiss, 2013) however, propose that individual differences (such as the those discussed above) influence whether background music facilitates or impairs cognitive processing, since these differences help determine working memory capacity. It follows that students with larger capacities are more capable of multitasking (i.e. listening to music and studying). It is further suggested that students who can realistically gauge their multitasking skill will perform better across different multitasking activities (Pollard & Courage, 2017).

A possible explanation for these conflicting findings is the different ways in which the nature of background music was operationalised in the various studies. On the one hand, because "background" implies that listeners are doing two things concurrently with the music not being the focus of attention, cognitive limitations are likely to play a role, which could lead to decrements in performance on the primary task (Schellenberg & Weiss, 2013).
Concurrent multitasking is known to interfere with the retention of information, and sometimes affective outcomes, even when the secondary task requires less processing time, or is an automated activity (Dindar & Akbulut, 2016). Yet, on the other hand music has been shown to improve listeners' emotional states, which can lead to better performance on cognitive ability assessments. For example, examinations are a common cause for both anxiety and cognitive dissonance. Music is a mechanism used to overcome cognitive dissonance and modulate stress tolerance, as well as calm anxiety (Perlovsky et al., 2013). The variety of outcomes is consistent with the notion that music engages multiple processes, some of which facilitate memory and others that compete with it.

Another possible explanation could be that the type of music listened to was not properly considered. Overall, it has been accepted in the literature that it is the specific sound that is present which is the main factor in whether the noise has a positive or negative effect on learning and recall. For example, background noise from aircraft, road traffic, and trains have all been shown to impair learning, while continuous speech or verbal noise that is irrelevant has at times been shown to have no significant effect (Eiras & McNeil, 2010).

The following section will briefly differentiate between sound conditions and examine the impact of these different conditions on working memory.

Different sound condition effects on working memory.

Silence and white noise.

Some researchers have found that tasks are best performed in silence and have demonstrated that both vocal and instrumental background music impair working memory performance when compared with silence, with vocal music having a stronger negative impact, and instrumental music impairing performance more than "modulated" noises, like white noise (Salame & Baddeley, 1989). Doyle and Furnham (2012) for example, indicated that individuals who memorised in silence had better immediate recall.

Others (Cauchard, Cane, & Weger, 2012; Schlittmeier & Hellbruck, 2009) found that there is little difference in task performance, whether or not the task was completed in silence or with music, even though noise may be subjectively rated as more disturbing than silence.

Mozart and other instrumentals.

Research initially found that listening to Mozart improved spatial abilities – this later became known as the (in)famous Mozart effect, where it was speculated that better task performance could be attributed to participants being more aroused after listening to Mozart (Schellenberg & Weiss, 2013). However, further replications of the study demonstrated that although listening to music did improve some cognitive abilities, the music did not have to be Mozart's (Dosseville, Laborde, & Scelles, 2011).

In fact, in 2016, Geethanjali, Adalarasu, Jagannath,and Rajesekaran conducted a study in India using classical Indian instruments and ragas, and concluded that classical music and instrumental tracks can improve cognitive and task performance without distraction, and further, that listening to classical music improves learning, when compared to other types of music.

The study by Dobbs et al. (2010) also indicated that instrumental music improved performance, although in their study it was only in one task. This study did indicate however, that regardless of the music listened to, the more people listened to music whilst completing the task, the more positive their mood, and generally, there were almost no significant impact on their quality of work.

Other varied forms of music.

Jancke and Sandmann (2010) used different background music of various tempos and consonance and concluded that background music had no influence on verbal learning, and therefore phonological loop and working memory functioning, with "only changes in cortical activation in a fronto-parietal network." Oldham et al. (1995) deduced that personal choice of music may be an important factor for how much benefit can be gained from the music. Music that the participants dislike may be found to have more of a negative effect on task performance (Doyle & Furnham, 2012). Chew and colleagues (2016) found that familiarity with the song being played had a larger effect on working memory than the volume at which the song was being played at. Perlovsky et al. (2013) also indicated that the usefulness of music was only present with agreeable music. Background music was also thought to best improve cognitive performance, compared to no music and white noise (Geethanjali et al., 2016).

However, some researchers (Schellenberg & Weiss, 2013) still caution against listening to music with vocals. For example, Pring and Walker (1994) found that working with vocal music lead to activation of the phonological loop, causing more disruptive effects on memory than purely instrumental music. Music with vocals, compared to instrumental music or white noise, also provides the opportunity for irrelevant speech effects to impact on one's working memory capacity.

The irrelevant speech effect.

The reality that "much studying undertaken at home is accompanied by music or the TV playing" (Kotsopoulou & Hallam, 2010) has brought the topic of the Irrelevant Speech Effect to the fore (Alley & Greene, 2008; Kantner, 2009; Perham & Vizard, 2011). The irrelevant speech effect (ISE) is a phenomenon referring to the finding that certain background sounds significantly reduce verbal working memory performance in comparison to silence, thus having a significant impact in the information processing course. This even applies when the sounds are irrelevant to task performance and participants are told to ignore them (Schlittmeier & Hellbruck, 2009). Even Baddeley discussed the irrelevant speech effect, saying that "spoken material disrupted performance on the visually presented digits, an effect that was independent of the loudness of the irrelevant sound sources" (Baddeley, 2012). Kang and Lakshmanan (2017) indicated however, that this effect is prevalent in predominantly those with lower working memory capacities.

This effect suggests that speech (or lyrics) interfere with the process of information encoding even if the speech is in a foreign, incomprehensible language. Findings by Jones and Macken (1993) suggest that both speech and (musical) tones have a disrupting effect on memory for serial order information. To this end, Salame and Baddeley's 1989 study reports that "background music can certainly disrupt immediate verbal memory, particularly in the case of vocal music", indicating that listening to music, especially that with vocals, does have a negative impact on working memory.

Linking Working Memory and Long-Term Memory Retention

Because working memory functioning is essential for the successful implementation of these complex cognitive activities in everyday situations, it has been argued that working memory represents an important cognitive resource for the mastering of everyday life (Zeintl & Kliegel, 2007). According to Dosher (2003) in Sternberg and Sternberg (2012), working memory holds the most recently activated, or conscious, portion of long-term memory, and it moves these activated elements into and out of brief, temporary memory storage (Sternberg, Sternberg, & Mio, 2012), with how information gets encoded, held, and used in working memory impacting how this information is stored and recalled in long term memory stores.

According to Jonides, Lacey, & Nee (2005), biologically speaking, information enters one's working memory from the external world, and is processed by perceptual processing structures situated in the parietal and temporal lobes, which remain active when the stimulus is briefly removed. Working memory storage therefore uses the same mechanisms that underlie perception, and as such, information entering working memory from long-term memory is also stored by the structures that mediated its initial perception. Therefore, if while information is being processed in working memory individuals get distracted, this would affect whether the information would be correctly retrieved and recalled from long-term memory.

This body of empirical evidence represents a variety of contradictory findings, highlighting various extraneous variables which contribute to working memory performance. However, the findings discussed in this literature review support the linkage of various cognitive skills, and therefore overall academic performance to a large degree, to working memory.

This review further indicates that whether one decides to study in silence or with music, the decision is clearly more complex than just choosing instrumental over vocal songs, and individual differences and preferences should also be considered. Given all the contradiction however, the current study will compare South African undergraduate students' working memory performance on alternative forms of a working memory measure, using different forms of sound conditions (White Noise, Beethoven and participants' own choice of music) to investigate whether differences do exist on working memory performance.

Research Rationale

As discussed above, there are many factors that play a role in successful academic performance, and as such, academic performance cannot solely refer to the final percentage on a student's report card after their examinations. Generally, classes and examinations are conducted under fairly standard conditions: topic related discussions are held between lecturers and students in class, and test/examination sessions are held in silence.

However, most of the preparation for tests and examinations are done outside the lecture hall, in a variety of settings – either at home (in quiet bedrooms, in the busy living room area, in the lounge with the television on – as indicated above) or in public (campus or community libraries, transport), with varying levels of noise or distraction. But what impact does this have on their memory, information retention, and therefore academic performance?

The above is an indication that academic performance and working memory are multi-faceted concepts and it is beyond the scope or intention of this study to measure the role of each factor in the academic performance of South African students. However, by studying their music usage behaviours and recreating situations under which their working memory capacity can be observed, under various sound conditions, aspects of their study habits were examined, which may clarify the impact listening to music has on information retention and academic performance.

Research Aim and Questions

The aim of this study was to contribute to the larger body of research by determining whether working memory ability differs significantly amongst undergraduate university students when listening to different sounds or music conditions. This aim was operationalised to be able to answer the following research questions:

1. Describe the current music usage behaviours of undergraduate university students, particularly in relation to their study habits.
2. Determine whether there is a significant difference in working memory performance under different sound conditions.

Chapter Three: Methodology

The research design, sampling strategy and consequent sample, data collection tools, research procedure, and ethical considerations pertaining to this study will be discussed in this chapter. Statistical analyses that were carried out will also be briefly discussed.

This study was conducted from a post-positivist paradigm, which postulates that although reality does exist independent of the researcher, it can but only be imperfectly known because of the researcher's human limitations – as such, reality is discovered within a realm of probability. According to post-positivism, research cannot be done independently of the researcher's own knowledge and paradigmatic views, since this knowledge and views influence what is observed, how it is observed and the outcome of what is observed (Chilisa & Kawulich, 2012). For this current study, the researcher has developed measures that intend to 'capture' aspects of the target populations' music usage behaviours and its impacts on working memory, and thus academic performance. Due to researcher limitations, exactly which behaviours are observed, how these behaviours are observed, and the resultant outcomes and conclusions reached from what was observed, are representative of a reality, although the researcher notes that the sample size is too small to be able to make general statements applicable to the diverse group of undergraduate students nationally.

Research design

The study was designed as a cross-sectional, within-subject experiment, with participants completing three equivalent-form working memory assessments under 3 sound conditions – White Noise, Classical "study" music, and participants' own choice of music. Given the vast literature available on the effects of Mozart and the suggestion to use other composers to see if the results will vary, this study used Beethoven, rather than Mozart, for the classical music condition. "Within-subjects experiments have the advantage of controlling extraneous participant variables, which generally reduces noise in the data and makes it easier to detect a relationship between the independent and dependent variables" (Price, Jhangiani, & Chiang, 2015a). Although the within-subject design meant a more tedious, prolonged process for participants – since they had to complete three assessments instead of one – and further limited the number of additional variables that could be included in the study, it did allow for differences under different conditions in the same participants to be considered, without being confounded by individual differences in working memory between participants.

Sampling strategy and sample

This study utilised a non-probabilistic method of convenience sampling (Laher & Botha, 2012) for both the survey and experiment.

For the survey, the total sample size consisted of 224 participants, of which all indicated they were completing Undergraduate degrees at universities in South Africa at the time of the study. At the end of the survey, participants were asked to provide their contact details should they be interested in participating in the experiment. 82 candidates showed interest in the experiment.

After the researcher contacted interested candidates and arranged for a time to meet and assess them, a total of 37 candidates completed the experiment – 29 of which are undergraduate students at the University of the Witwatersrand, the remaining 8 were studying at the University of South Africa.

As mentioned above, 224 individuals had accessed the link which was made available via the University of the Witwatersrand's student portal and student email addresses, as well as the social media website Facebook, and were assigned respondent identification codes. However, individuals who only answered 19 or fewer questions (completed under 50% of the survey) were excluded from further analysis. From the 37 individuals who completed the experiment, due to system error, the responses of 2 participants were not saved for 2 of the 3 assessments, and therefore they were excluded from being analysed further. From the 35 remaining participants, 30 had also completed the survey. 30 of the 35 participants were students of the University of the Witwatersrand.

The most represented age group for both the survey and experiment was late adolescence (18-20 years old), which is representative of the typical undergraduate student. The mean age of participants who completed the survey was 20.33 (SD = 2.99), whilst the mean age for participants for the experiment was 21.28 (SD = 5.08). Given that most participants were from the University of the Witwatersrand, females appear to be slightly over-represented, given that the most recent University reports' indicate a student population consisting of approximately

54.7% females and 45.3% males (University of the Witwatersrand, 2016, pg 62). However, it is also noted that many participants were undergraduate Psychology students, so the inflated female participant sample may be more representative of the average Psychology class at the University. Participants whose home language is English may have been over-represented in this study since they may have been attracted to the study due to all communication, the survey and experiment being presented in English, and English being the medium of instruction in the University. As expected, first year Humanities students from the University of the Witwatersrand made up the majority of the sample for both the survey and experiment, due to First Year Psychology students being made aware that they would receive 1% participation credit for each part of the study they partook in. The researcher is aware of literature questioning the role of participation incentivisation (Grant & Sugarman, 2010; Singer & Couper, 2008); however, since the University does allow for first year Psychology students to be awarded course credits for their participation in research studies, the awarding of said credit was not regarded as an unusual, or unethical approach to attract participants. No other participant group received any form of incentive. Most participants did not have any hearing impairments, but it is assumed that those who do may engage in different music usage behaviours. The two participants with hearing difficulties/impairments who completed the experiment did not mention it at the time of testing.

Measures

This section will discuss the measures that were developed for this study. To understand the technical process of developing a psychometric measure, the books *Introduction to Psychological Assessment in the South African Context* (Foxcroft & Roodt, 2013) and *Research Methods in Psychology* (Price, Jhangiani, and Chiang, 2015) in particular were consulted.

The development of the Music Usage Survey was largely guided by the seminal works of Alley & Greene (2008); Baddeley & Hitch (1974); Chew et al. (2016); Jones & Macken (1993); Kotsopoulou & Hallam (2010); Salame & Baddeley (1989); Silverman (2007); Swanson (1999); Turner & Engle (1989); Williamson, Baddeley, & Hitch (2006) in particular. These authors' works were discussed in the above literature review and determined the underlying theories and the items to be used to operationalise those theories and determine students' music usage behaviours, particularly in relation to their study habits.

The development of the memory span tasks, which aimed to measure working memory capacity under the various music conditions, were guided by the above-mentioned authors, as well as from consultation with existing working memory assessments such as the Automated Working Memory Assessment (AWMA) (Alloway, 2007), Lucid Recall (St. Clair-Thompson, 2015), and Wechsler Adult Intelligence Scale (WAIS) (III and IV versions) (Wechsler, 1997, 2008). It should be mentioned here that the reason for not using any of these existing assessments is because they have been standardised to be administered in a particular setting, and the current study would have violated those standardisation procedures, given that the assessments had to be completed whilst listening to various sound/music conditions. When measuring working memory performance, generally it is required that the ability to retain recently presented information and at the same time manipulate current information, be assessed – to be considered a working memory span task, the task must contain both storing and processing components (Yang, Shintani, Li, & Zhang, 2017; Zeintl & Kliegel, 2007). Given that the digit span task is the most commonly used span task to measure phonological loop capacity (Schuler, Scheiter, & van Genuchten, 2011), adaptions of this task were developed for this study, so that alongside digits, letters and words were also used as stimulus for participants to recall.

Historically, studies evaluating working memory have included a variety of self-paced, experiment-paced, and computer-paced span tasks (Bailey, 2012). This study combined aspects of each of these techniques to develop computer-paced span tasks, which were administered and controlled by the experimenter, with the recall of stimuli occurring at the pace of the participant. What this translates to is that all participants are given a set amount of time to review and memorise the stimulus, as programmed into the assessment. After this time has elapsed, the experimenter proceeds to the following section allowing participants the chance to recall the stimulus, at their own pace. Once they are satisfied with their response, the experimenter moves onto the next stimulus, which again, can only be viewed for a set amount of time, as regulated by the computer program. It is noted that experimenter-paced span tasks must traditionally be administered individually with an experimenter (Bailey, 2012), and as such, for this study, all span tasks were administered so.

All five measures discussed below have been developed to be administered on a computer, online with a stable network connection. They were all hosted by SurveyMonkey, an online software programme that allows for survey development. All measures were only available in English.

Music usage survey.

Each participant who clicked on the available URL link was redirected to this survey and a respondent Identification Code was automatically generated for them. The survey contained a demographic section, which provided the information available in Table 2. This was followed by 28 questions regarding student's studying and music usage behaviours – for analysis purposes, these questions were later grouped into a) student study behaviours (Table 3), b) Music Usage Behaviours (Figures 1, 2 and 3, Table 4), c) Music Usage and Academic Activities (Table 5) and d) Music Usage Whilst Studying (Table 6), to better describe students' music-study habits. The survey ended by asking participants whether or not they would be interested in participating in the experiment, and if so, to leave their contact details in the available space, and create a Unique ID code. This code would later allow for the linking of survey responses to experiment performance, as well as uphold confidentiality and anonymity of participants for analysis purposes. The full survey as presented to the students is shown in Appendix A. This was the only measure that could be completed on a cell-phone as well as on a computer/laptop/tablet, and the only measure that was completed without any researcher supervision.

Memory span assessments.

These assessments were made up of 10 items each, and consisted of words, letters and numbers (hereafter referred to as stimulus) which participants had to recall in different orders –forward recall, backward recall, and alphabetical/ascending arrangement recall. Refer to Appendix B to see what each item looked like for each memory span assessment. No recognition questions were asked, since recognition tasks are less likely to require manipulation of information (Sternberg et al., 2012), and may also unintentionally measure impulsivity. Sequences remembered in the order asked, would be marked as correct and receive 1 point. Given that participants were typing their responses into short comment boxes under each video, spelling errors would be ignored as long as the word was still recognisable. Sequences in the incorrect order, or sequences with any missing items, however, would be marked as incorrect and receive 0 points, therefore making the possible mark range 0 – 10 per assessment.

Whilst the videos were timed, participants could take as long they needed in typing their responses. These assessments were completed under close researcher supervision.

Designing the Memory Span Assessments – The Process.

The three assessments were designed to be alternate (also known as equivalent) forms of each other, so that the assessments would be of equal difficulty and length. The aim of the study was to test working memory under different sound conditions, and as such, the test difficulty and length had to be equal across the assessments. The assessments were formatted as follows:

Table 1 - Working Memory Span Task Formatting

Question Number	Stimulus	Recall	Exposure Time (s)
1	5 words	Backward	10
2	5 numbers	Ascending	10
3	6 letters	Alphabetical	12
4	6 numbers	Forward	12
5	7 letter/number mix	Alphabetical then Ascending	14
6	7 words	Alphabetical	14
7	8 numbers	Ascending	16
8	8 letters	Forward	16
9	9 numbers	Backward	18
10	9 letter/number mix	Alphabetical then Ascending	18

According to Baddeley (2012), the average individuals' memory span is around six or seven digits. Considering this, and that the consulted assessments (WAIS, AWMA and Lucid) are commonly started with three digits, and often used to test general intelligence more broadly as well as working memory more specifically, it was decided that the starting count for these assessment span tasks be five items – given that the participants are undergraduates, and they were exposed to a demonstration video prior to the assessment. Also, in view of the popular concept of the "magic number 7" (Baddeley, 1994; Mathy & Feldman, 2012) which suggests that short-term memory capacity is limited to around seven ‘chunks’, plus or minus two, items from 5 digits (minus 2) to 9 digits (plus 2) were developed. The exposure times per stimuli slide were chosen after considering the average times taken to respond to items from the WAIS, AWMA and Lucid, and accounting for computer-screen exposure rather than verbal reiteration of the stimuli sequences.

All the words used for Question 1 for each of the assessments were the names of fruits, whilst the words used for Question 6 for each of the assessments were the names of animals, since these are well-known categories, and most of these words are commonly used in daily life.

In developing the strings of stimuli, it was also ensured that two words did not start with the same letter in the same question, so as to not over-complicate the recall process, especially Questions 6 which asked for alphabetical recall. Lastly, the words in Questions 1 and 6 were of all of equal length and were presented as 6 letter word, 5 letter word, 4 letter word, 5 letter word, 6 letter word for Question 1, and 4 letter word, 5 letter word, 6 letter word, 7 letter word, 6 letter word, 5 letter word, 4 letter word for Question 6.

The strings of stimuli involving numbers (ie. Questions 2, 4, 5, 7, 9 and 10) only used single digit numbers (ie. 1-9). Furthermore, for each assessment, the first number question (Question 2) contained 5 numbers, and the following questions then added on to this base set of 5 numbers – in other words, for each assessment, the 5 numbers that were in Question 2, were then used in Questions 4, 7, and 9 alongside the additional added numbers, but ordered differently.

For the letter and number mix (Questions 5 and 10), the format was alternating one letter, one number, and for the Question 5s, this pattern was followed until sequences of 4 letters and 3 numbers were created, whilst for the Question 10s, sequences of 5 letters and 4 numbers. Unlike the number strings, it was ensured that the letters and numbers were not repeated between Question 5 and 10, per assessment.

These strings of stimuli were created on individual slides on PowerPoint and can be seen in Appendix B. Literature indicates that depending on working memory capacity, some computer text formats or styles may be processed more easily by readers (Budd, Whitney, & Turley, 1995; Dee-Lucas & Larkin, 1995; Lorch, 1989; Schroeder, 1994 as cited in Lee & Tedder, 2003). Considering this, all the slides were formatted in the same way – font Century Gothic, font size 54, font colour black, with all content centred, without bold, italics or underlining.

Each slide was then converted into a video; to reduce the chance of human error in time-keeping for each slide, it was easier to electronically determine how long each slide should play for during the experiment – these times are indicated in Table 1 under the Exposure Time column.

These timed videos were then uploaded onto social media website, YouTube, to enable the videos to be embedded on SurveyMonkey. The Music Usage Survey, the 3 memory span assessments, and the End of Study Survey were hosted on SurveyMonkey. When uploading the videos onto YouTube, it was discovered that the video duration was not working optimally, as when the videos were embedded, one could see the strings of stimulus before the video started playing. This technical error was solved by including thumbnails (also made on PowerPoint – example of which can be seen in Appendix B) on each YouTube video – the thumbnail indicated the question number, thus when experiment participants were completing the assessments online on SurveyMonkey, they could not view the stimulus beyond the allocated time.

The University's Psychology Department provided access to the researcher to host the assessments on their SurveyMonkey account. The 3 assessments were created as 3 separate surveys, and the stimuli videos were uploaded and embedded in the relevant surveys, followed by the instructions for recall.

The instructions for recall were as follows:

Question 1 – recall the words in the reverse order from which they were presented (backward recall)

Question 2 – recall the numbers in ascending order

Question 3 – recall the letters in alphabetical order

Question 4 - recall the numbers as they were presented (forward recall)

Question 5 – recall the sequence in alphabetical and ascending order (Letters then numbers).

Question 6 – recall the words in alphabetical order

Question 7 – recall the numbers in ascending order

Question 8 – recall the letters as they were presented (forward recall)

Question 9 – recall the numbers in the reverse order from which they were presented (backward recall)

Question 10 – recall the sequence in alphabetical and ascending order (Letters then numbers)

The complete sets of stimuli for all 3 memory span assessments, as they were presented to the candidates in video form can be seen as screenshots in Appendix B.

Once all 3 memory span assessments were completed, candidates were asked to complete the End of Study Survey.

End of study survey.

This was a short, 10 question survey, which was guided by the purpose of the study, and included 4 demographic questions (Age, Gender, Home Language, Year of Study), 5 memory span feedback questions (which setting was least distracting, which setting was most distracting, which setting was most representative of their typical study setting, did they find any set of questions more difficult than the others, and the name and genre of the piece of music they brought with them), and the last question allowed them to share any comments they had regarding the assessments, the testing process, or anything else they wanted to share. This survey can be seen in Appendix C. This survey was completed under researcher supervision, and the instruction of including one's unique ID to the last answer was verbally communicated.

Research procedure

Upon ethical approval, permission was requested from the Registrar of the University of the Witwatersrand, as well as 7 other tertiary education institutions, to send out an email (see Appendix D) containing the link to the Music Usage Survey to all undergraduate students, along with the researchers' contact details. Only the University of the Witwatersrand and Varsity College Sandton responded positively to this request. The purpose of this email was two-fold: mainly for participants to complete the survey, but also as an advertisement for the experiment. The researcher also contacted course coordinators, lecturers and tutors of the First Year Psychology students, given their incentive to participate, to post an electronic notice on the online student platform SAKAI (see Appendix E). The researcher also asked for permission from these lecturers to approach their students during a lecture and verbally advertise the study and the associated course credits. It was stressed that participation in the survey did not indicate intent to participate in the experiment.

On a weekly basis, the researcher checked the response rate to the Music Usage Survey and followed up with students who had completed it and indicated that they were interested in the experiment, and left contact details. See Appendix I for the email sent out to these individuals, Appendix H for the Information Sheet, which briefly indicated the study aims, duration of testing, the voluntary and confidential nature of the research, the right to refuse to participate or to withdraw at any point in the study, as well as the researcher's and supervisor's contact details, and an electronic consent form (see Appendix J) for the study, which was attached to the email.

Students who wanted to participate then responded to this email, and time and date suitable to both the student and researcher was then allocated for the completion of the memory span assessments and end of study survey.

On the day prior to testing, each participant was sent a reminder email about the time and venue of testing. Testing was conducted by the researcher in the Research Statistics Lab, in the Umthombo building, at the University of the Witwatersrand on an individual, face-to-face basis.

On the day of testing, the researcher set up the testing venue by loading the demonstration video, the 3 memory span assessments, and end of study survey onto a single desktop – this was done before participants arrived, so that the researcher could check that the Internet connection was stable and change stations if necessary. The White Noise (generated by an electric moving-fan sound clip) and Beethoven's Für Elise music files were also loaded onto the computer and a pair of earphones was set up for use (however, participants had the choice of using their own pair if it made them more comfortable). Lastly, the researcher placed the instructions to replicate the Unique ID's participants created had they completed the survey (see Appendix K) next to the computer, at eye-level, for easy reference for participants.

On the day of testing, prior to assessment administration, each participant was required to sign a physical copy of the consent form, had they not already sent back the completed electronic version. Once consent had been affirmed, participants were shown a demonstration video (which had also been created on PowerPoint and hosted on YouTube). This video indicated the forms of recall tasks they would be asked to perform and provided them with an opportunity to practice each type of recall and ask the researcher for any assistance or clarification of unclear aspects. Participants were allowed to watch this video more than once if they needed to; however, only one participant asked to do so. The slides making up this video can be seen in Appendix F. This video also provided the participants the opportunity to test the volume of the computer, which was set at 70 (out of 100), since the demonstration video was accompanied by an embedded ambient sounds' clip, of birds chirping in nature.

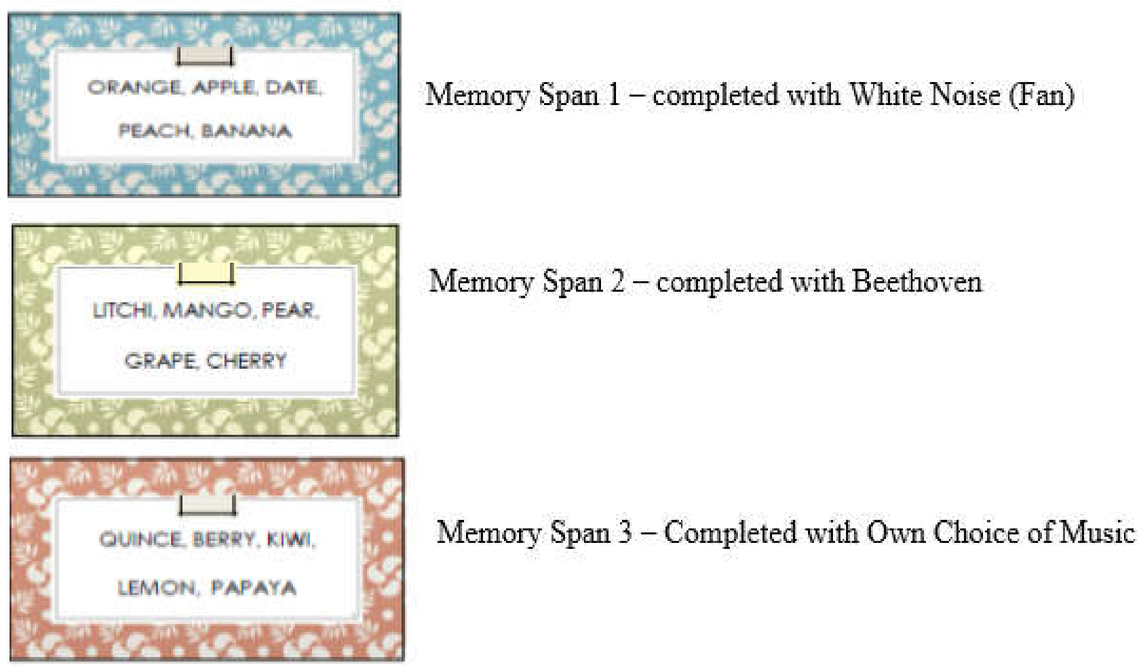


Figure 1- Memory Span Assessment and Sound Condition Association

Once participants were comfortable with the activities they needed to complete, the researcher allowed them to insert their CD/USB in the computer or get their music file ready on their cellphone. Once this was done, the researcher opened the tab to one of the memory span assessments, which was randomly chosen by the researcher. The relevant music file was then opened and the associated memory span assessment completed. As indicated by Figure 1, each memory span assessment was associated with a sound condition. In other words, only the order in which the three memory span assessments were administered changed between participants; all participants completed Memory Span 1 with White Noise, but not participants completed Memory Span 1 first.

Each memory span assessment had the following layout: first, participants had to provide their unique ID, which they created when they indicated that they were interested in participating in the experiment. They then watched Question 1's video, which was followed by the instruction for recall for Question 1. They then had to type in their answers in the provided space on-screen – this was untimed, since participants had varied exposure to computers, keyboards, and computer-based experiments and had different typing rates. The process of watching the stimulus video, being shown instructions for recall, and typing responses was repeated until Question 10, after which the researcher would then move onto the next assessment and change to the corresponding music file, until all 3 memory span assessments were completed. To ensure that each video was watched only once, no questions were accidently skipped, and that the recall instructions were not viewed prior to watching the video, the assessments were closely supervised, with the researcher controlling the cursor and mouse, and instructing participants to focus only on the screen and keyboard. This also reduced the anxiety of participants who were uncomfortable with the computer. By randomly assigning the order in which the assessments were to be completed, the consequences of possible practice-effects, as well as the possible fatigue and boredom experienced by participants in completing three similar assessments were also managed. Once all 3 assessments were completed, the researcher moved onto the End of Study Survey, and allowed the participant to complete it (with or without music, depending on their preference), informing them to include their Unique ID to the last comment box. Once this survey was completed, participants could leave. During the assessment process, the researcher made notes regarding testing order and any interesting behaviours of the participant (such as dancing, or excessive sighing at certain questions/assessments, for example), for possible later analysis if necessary. The average testing session was 40 minutes from the time participants signed the consent form and watched the demonstration video, to them leaving.

The scoring of the memory span assessments was done on Microsoft Excel, using the ‘filter’ function. Since there was no identifying information collected during the assessment process, the researcher asked two assistants for help in marking the responses accordingly – as such, the responses were marked independently thrice, and any differences in allocated marks were given further attention, to ensure that responses were accurately marked, and all three markers agreed on the score.

To ensure that course credit was allocated, a list of student numbers of First Year Psychology students who participated in the survey (which was collected as questions in the survey), devoid of any other survey answers, was generated. The researcher was able to trace through Unique ID’s which students had also completed the experiment, and this was indicated on the list, that those 29 students should receive an additional 1% for their participation efforts.

Ethical considerations

It is essential to ensure the well-being of any individual participating in one's research study and as such, ethical standards were upheld during the course of this study. Ethical clearance was obtained from the Human Research Ethics Committee (HREC Non-Medical) from the University of the Witwatersrand before any research was conducted: protocol number MPSYC/17/006 IH; however, the measures had been developed beforehand, for the Committee to make an informed decision.

Prior to answering any study-related questions for the survey, participants who volunteered to complete it had to read and agree to an information form briefing them on the key aims and rationale of the study, the data collection procedure, the voluntary and confidential nature of participation, as well as the researcher and supervisor's contact information. Additionally, each participant was made aware of their right to refuse to participate in this study or to withdraw at any point without any negative academic or social consequences. Prior to completing the experiment, they had to read and agree to a similar information sheet, modified slightly from the survey, to suit the context of the experiment.

Participants were all undergraduates, and as such, above the age of 18 years. As such, they were legally allowed to consent to participate without additional approval required from a parent or guardian (National Health Act, 2004).

The voluntary and confidential nature of the study was further indicated in the consent form. The consent form also stated that there would be no risks or benefits arising from participation in this study, apart from the 1% course credit obtainable by First Year Psychology students. Any concerns or questions that were raised by the participants before, during or after the assessment, were addressed as comprehensively as possible.

Due to the personal, individualised nature of the testing procedure, as well as the awarding of course credit, complete anonymity could not be guaranteed in the experiment. However, because participants created Unique ID's which linked to their responses, there is no way to trace any assessment result or survey response back to an individual.

Anonymity in the stored data, as well as resulting data analyses, reports, theses, conference presentations and/or publications arising from the study was guaranteed to participants in the consent forms. Confidentiality of results is ensured as only the researcher and their supervisor have access to the data, which is stored electronically on password-protected computers, on the software which is also password-protected, and the physical copies of the completed consent forms are kept locked, with the researcher.

Overview of data analysis

The purpose of this study was to firstly, describe undergraduate students' music usage behaviours, especially in conjunction with their study habits, and secondly, to determine whether different types of music had an impact on working memory.

In light of the research questions posed and the research design followed, the most appropriate statistical procedures were descriptive statistics, frequencies, cross-tabulations and Analysis of Variance (ANOVA). All data was analysed using IBM SPSS, version 24. The results for each memory span were totalled, to give three scores out of 10, from which average performance could be calculated. Since the scores could range from 0 to 10, they could be treated as ratio, or at least interval, scores.

Descriptive statistics were used to describe features of the sample, with means and standard deviations being reported for demographic interval variables such as age, while frequencies assisted in comprising a summary of how often conditions occurred within the data set. Cross-tabulations were conducted to explore and identify relationships between variables. A within-subjects analysis of variance (ANOVA) was run in order to assess whether any differences existed on the performance on the working memory measures when listening to different music conditions. Alpha was set at 0.05 in order to establish significance of results.

Chapter Four: Data Analysis

This study aimed to, firstly, assess music usage behaviours, especially while studying, amongst South African undergraduate university students, and secondly, determine whether differences exist in these students' working memory performance when listening to different sound/music conditions – White Noise, Beethoven and students' own choice of music.

The first component of the study could be seen as mostly descriptive, since it aimed to identify and describe undergraduate students' music usage behaviours using descriptive techniques such as frequency tables and charts, measures of central tendency and variability (means and standard deviations), and explore whether there were any correlations between the various measured attributes of music usage and study behaviours (Price et al., 2015b; Williams, 2007). The second component of the study aimed to determine whether working memory performance (dependent variable), assessed using three alternate forms of a working memory span assessment designed for this study (the data of which was at least interval in nature) was impacted by the music condition (independent variable) under which each assessment was completed. This section will discuss the various descriptive and inferential statistical analyses that were performed, as well as the results emerging from these analyses.

Descriptive Statistics on Music Usage Survey

In this section, data obtained from the survey has been analysed, resulting in frequency tables to indicate the responses produced. Following a report highlighting the most frequent/least common responses, the results of cross-tabulations between various groupings of variables will also be indicated. As mentioned above, from the 35 participants whose complete response set could be accessed, 30 had also completed the survey. These participants are represented twice in the below analyses – first as survey participants, and second as experiment participants – to allow for easy comparison between students who only completed the survey, and those who completed the experiment. This side-by-side comparison also allows the reader to easily see where the experiment sample did not accurately represent the larger survey sample. In other words, the 197 participants that made up the analysed survey participants is inclusive of the 30 experiment participants.

Table 2 indicates key demographic information for both the survey and experiment samples.

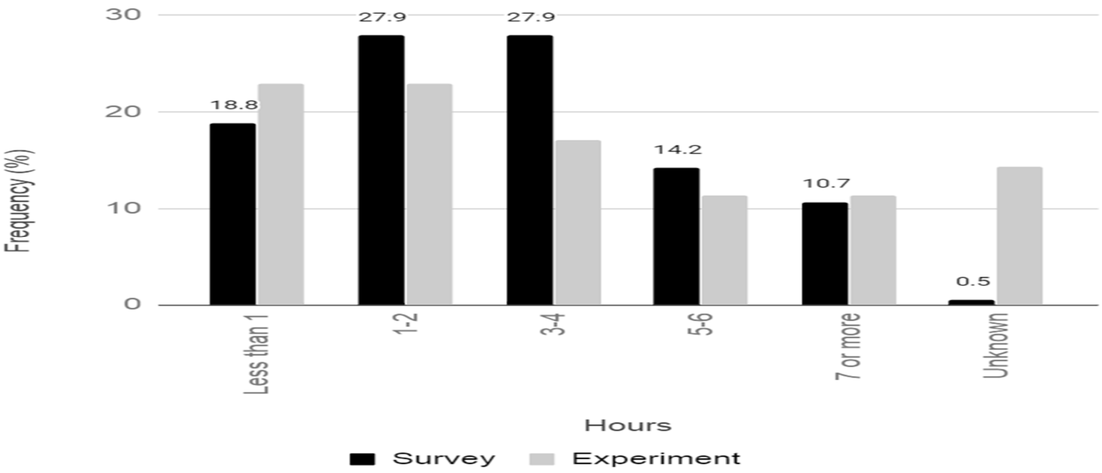
Table 2 - Sample demographics for both survey and experiment participants

	Survey participants (*N* = 197)	Experiment participants (*N* = 35)
	n (%)	n (%)
Gender		
Female	138 (70.1)	21 (60.0)
Male	57 (28.9)	14 (40.0)
Other	2 (1.0)	
Home Language		
Afrikaans	5 (2.5)	1 (2.9)
English	120 (60.9)	20 (57.1)
Ndebele	2 (1.0)	
Northern Sotho	10 (5.1)	3 (8.6)
Southern Sotho	6 (3.0)	
Swati	3 (1.5)	1 (2.9)
Tsonga	6 (3.0)	2 (5.7)
Tswana	12 (6.1)	3 (8.6)
Venda	3 (1.5)	1 (2.9)
Xhosa	7 (3.6)	
Zulu	19 (9.6)	3 (8.6)
Other	4 (2.0)	1 (2.9)
Year of Undergraduate Study		
1st	149 (75.6)	27 (77.1)
2nd	9 (4.6)	
3rd	24 (12.2)	1 (2.9)
4th	5 (2.5)	
Other	10 (5.1)	7 (20.0)
Faculty		
CLM	2 (1.0)	
EBE	1 (0.5)	1 (2.9)
HSc	1 (0.5)	
Hum	168 (85.3)	26 (74.3)
Sci	8 (4.1)	3 (8.6)
Unknown	17 (8.6)	5 (14.3)
Do you have, or have you had a hearing difficulty/impairment?		
Yes	18 (9.1)	2 (5.7)
No	179 (90.9)	28 (80.0)
Unknown		5 (14.3)

Note: CLM = Commerce, Law and Management, EBE = Engineering and the Built Environment, HSc = Health Sciences, Hum = Humanities, Sci = Science

One of the research questions for this study was to describe the music usage behaviours in undergraduates. The following descriptive statistics aim to provide an indication of this usage.

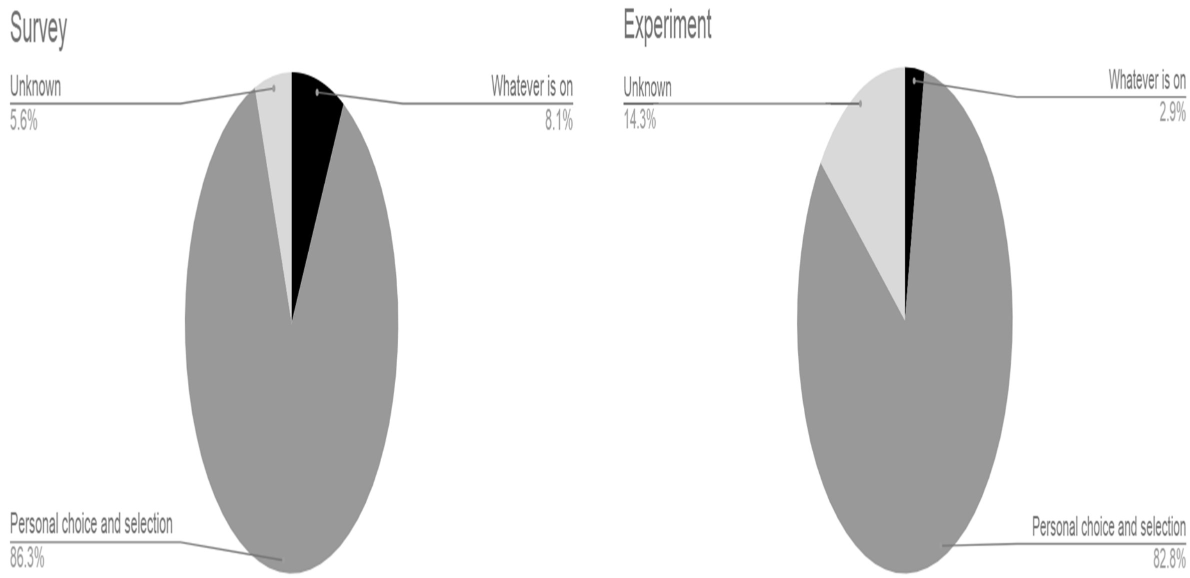
As can be seen from Figure 2, music can be said to be an integral part of most student's daily lives, with 55.8% of students listening to between 1 and 4 hours of music a day, and 24.9% listening for 5 or more hours per day.



Note: Percentages for survey indicated on figure

Responses to music usage survey question "On average, I listen to music ____ hour(s) a day."

Figure 2 - Percentages indicating average daily music consumption by participants



Note: Percentages for response frequency indicated on figure

Responses to music usage survey question "Most of the music I listen to is ___"

Figure 3- Percentages indicating participant's choice of music

Having access to portable devices such as iPads, MP3 players and cellphones have also made it easier for students to listen to their own selection of songs when they choose to, rather than have to listen to what the environment is offering them, as indicated by Figure 3.

According to Table 3, student's music consumption also appears to be affected by task difficulty, with the majority of participants in both the survey and experiment samples indicating that they agree that the difficulty of the task determines whether they will listen to music or not.

Table 3 - Percentages indicating whether participants chose to listen to music based on task difficulty

	Survey participants (*N* = 197)	Experiment participants (*N* = 35)
	n (%)	n (%)
Whether or not I listen to music depends on the difficulty of the task I am completing		
1 star - Strongly Agree	65 (33.0)	7 (20)
2 stars	27 (13.7)	6 (17.1)
3 stars	36 (18.3)	6 (17.1)
4 stars	21 (10.7)	1 (2.9)
5 stars – Strongly Disagree	44 (22.3)	9 (25.7)
Unknown	4 (2)	6 (17.1)

The music usage survey attempted to explore the relationship between music and study habits. Considering this, Table 4 shows that the majority of students complete most of their studying at home and appear to be set in their study styles – given that 56.9% of survey participants and 54.3% of experiment students have been studying the way they have for 3 or more years. The majority of students stated that they get distracted easily, which may also explain why many (survey: 68.0%, experiment: 71.4%) indicated that they experience difficulty in reading or remembering long passages of text. In the survey sample, there were an equal number (23.4%) of students who preferred studying in silence, and with direct music, respectively. In the experiment sample however, the majority preferred studying in silence.

Table 4 - Describing Student Study Behaviours

	Survey participants (*N* = 197)	Experiment participants (*N* = 35)
	n (%)	n (%)
Where is most of your studying done?		
On campus	61 (31.0)	14 (40.0)
At home	132 (67.0)	16 (45.7)
Other	4 (2.0)	
Unknown		5 (14.3)
Do you get distracted easily?		
Yes	145 (73.6)	23 (65.7)
No	52 (26.4)	7 (20.0)
Unknown		5 (14.3)
Since when have you studied the way you do?		
Silence for 3 or more years	63 (32.0)	12 (34.3)
Recently (1-2 years) in silence	11 (5.6)	1 (2.9)
Adapt style to situation/subject	60 (30.5)	7 (20.0)
Recently (1-2 years) with music	13 (6.6)	3 (8.6)
Music for 3 or more years	49 (24.9)	7 (20.0)
Other	1 (0.5)	
Unknown		5 (14.3)
The ideal study situation is		
Long periods of silence	46 (23.4)	13 (37.1)
Background music	34 (19.3)	4 (11.4)
Direct music (through head/earphones)	46 (23.4)	8 (22.9)
Short bursts of silence, followed by interaction	35 (17.8)	2 (5.7)
Short bursts of silence, followed by listening/singing to a song	26 (13.2)	3 (8.6)
Unknown	10 (5.1)	5 (14.3)

Do you sometimes experience difficulty in reading or remembering long passages of text?		
Yes	134 (68.0)	25 (71.4)
No	53 (26.9)	5 (14.3)
Unknown	10 (5.1)	4 (14.3)

Students engage in various academic activities before they write their final examinations –for some of these activities the immediate working environment only affects the current activity (reading, problem solving, developing ideas, thinking) and thus performance can be linked to working and short-term memory given that these activities by their nature do not necessarily rely on the retrieval of previously learnt material (although it can be argued that for reading, one has to recall the alphabet to recognise words, interpreting what has been read as a combination of sentences is rather a short-term memory task). Other activities, however, such as revising for exams, memorising text, doing assignments and studying, aim to accurately encode this information for longer periods of time, into long-term memory storage.

Table 5 indicates that for students who do listen to music whilst completing academic activities, the most common activity to be accompanied by music is assignment completion. Music is then also used for thinking (survey) and problem solving (experiment). Most students do not change their music when changing the subject to be studied, however, they do indicate that vocal music distracts them whilst reading. In contrast, most students indicate that they can write without being distracted. The majority of students appear to associate the songs they study to with the material being studied, since many indicate that they sometimes/always remember the song whilst recalling the learning material. However, most students also stated that actively engaging with the song, by humming or singing along, is too distracting, with many indicating that they refrain from singing along to the music whilst revising or writing the examination.

Table 5 - Music Usage and Academic Activities

	Survey participants (*N* = 197)	Experiment participants (*N* = 35)
	n (%)	n (%)
I prefer to listen to music when completing the following tasks		
Revising for exams	10 (5.1)	1 (2.9)
Memorising text	5 (2.5)	1 (2.9)
Reading	7 (3.6)	2 (5.7)
Doing assignments	74 (37.6)	8 (22.9)
Problem Solving	9 (4.6)	3 (8.6)
Developing Ideas	12 (6.1)	2 (5.7)
Thinking	23 (11.7)	2 (5.7)
Studying my favourite subject	3 (1.5)	1 (2.9)
Studying my least favourite subject	3 (1.5)	
None of the above – do not listen to music	51 (25.9)	10 (28.6)
Unknown		5 (14.3)
Different subjects require different types of music		
Yes	61 (31.0)	13 (37.1)
No	130 (66.0)	17 (48.6)
Unknown	6 (3.0)	5 (14.3)
I can read and listen to vocal music at the same time without getting distracted		
True	73 (37.1)	10 (28.6)
False	112 (56.9)	19 (54.3)
Unknown	12 (6.1)	6 (17.1)

I can listen to music and write at the same time without getting distracted		
True	120 (60.9)	19 (54.3)
False	67 (34.0)	11(31.4)
Unknown	10 (5.1)	5 (14.3)
How often do you recall the song you listened to whilst studying, while recalling the studied information (in exams, while revising)?		
Always	19 (9.6)	2 (5.7)
Sometimes	85 (43.1)	15 (42.9)
Never	88 (44.7)	13 (37.1)
Unknown	5 (2.5)	5 (14.3)
I ____ start humming a song that played when I studied while writing my exam		
Almost always	10 (5.1)	1 (2.9)
Often	14 (7.1)	1 (2.9)
Sometimes	39 (19.8)	4 (11.4)
Rarely	43 (21.8)	11 (31.4)
Never	86 (43.7)	13 (37.1)
Unknown	5 (2.5)	5 (14.3)
I hum/sing along to the music whilst revising familiar study material		
No – too distracting	91 (46.2)	19 (54.3)
Depends on the subject	76 (38.6)	9 (25.7)
Yes – counters boredom	19 (9.6)	1 (2.9)
Unknown	11 (5.6)	6 (17.1)

Table 6 indicates that over 30% of participants in both the survey (N = 62) and the experiment (N = 12) indicated that they do not study with music, with 54 of these 62 survey participants, and 11 of these 12 experiment participants stating that music distracts them. In comparison, only 13.2% (N = 26) of survey and 14.3% (N = 5) of experiment participants stated that they always studied with music, with 13 of these 26 survey, and 4 of the experiment participants indicating that music helps them concentrate. Very few (3.6%) participants listen to music of a different language from what they are studying. "Blocking out other noise" was the main indicated reason as to why participants study with music, with 18.8% of survey, and 22.9% of experiment participants choosing that option. Although most students indicated that they listened predominantly to their own personal selection of music rather than what was chosen by others, this personal selection did not always mean that students had playlists specifically for studying – only 30.5% of survey participants, and 20.0% of experiment participants had specific playlists they listened to whilst studying. From the larger survey sample the majority of participants (58.4%) indicated that whether or not they studied with music depended on their mood, in contrast however, only 37.1% of participants from the experiment indicated that their mood had a role in whether they used music that day whilst studying.

Across participants however, the most common response was that listening to music whilst studying affects their mood (31.0% of survey, and 48.6% of experiment participants). Although the modal response to "studying and music should not be mixed" was the middle star, more students indicated that studying and music should not be mixed, than students indicating that they should. Over 50% of students from both the survey and experiment samples did not use music to help them keep awake when studying at night.

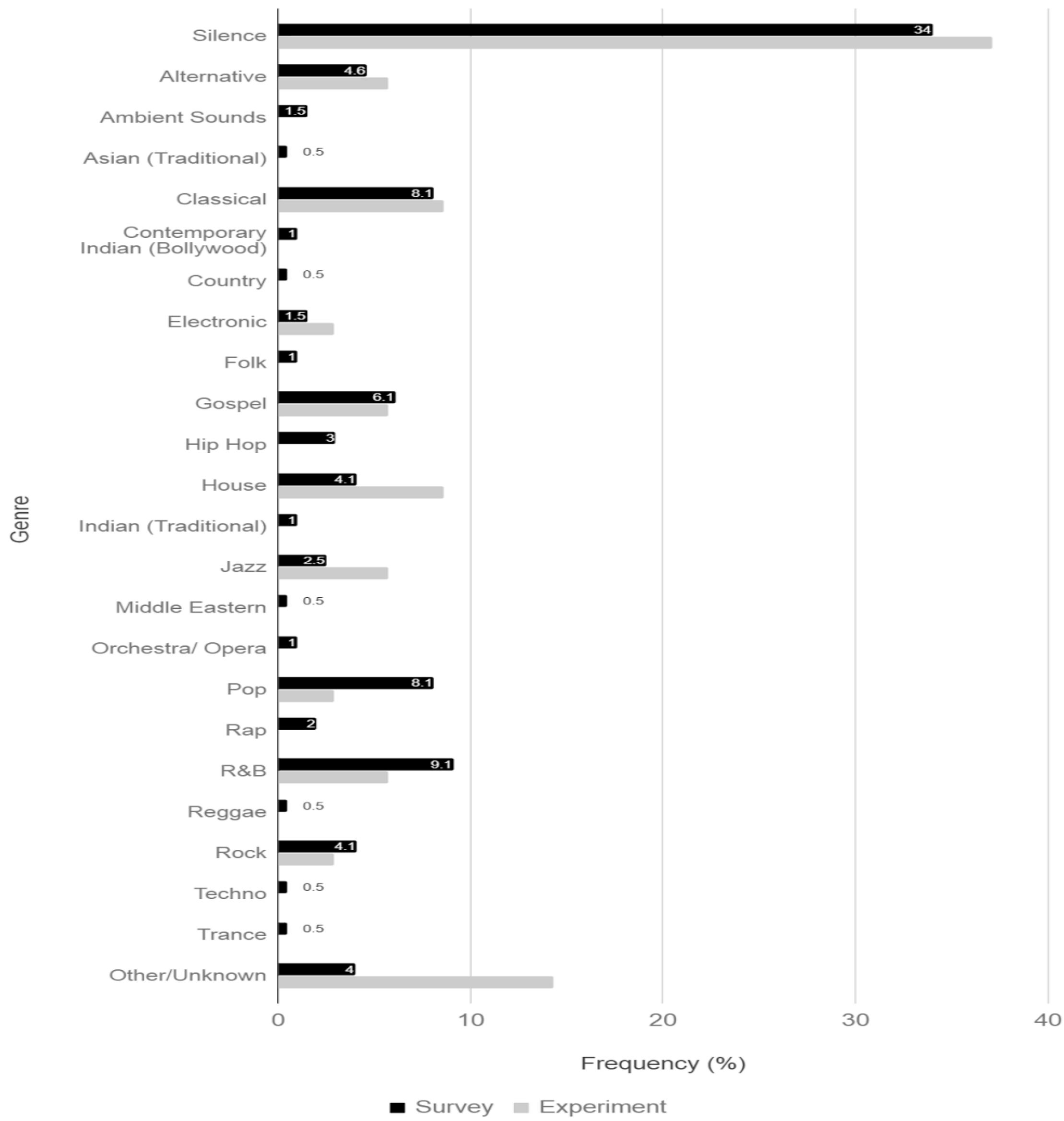
Table 6 - Music Usage Whilst Studying

	Survey participants (*N* = 197)	Experiment participants (*N* = 35)
	n (%)	n (%)
I study with music		
1 star – Never	62 (31.5)	12 (34.3)
2 stars	36 (18.3)	4 (11.4)
3 stars	39 (19.8)	4 (11.4)
4 stars	32 (16.2)	5 (14.3)
5 stars – Always	26 (13.2)	5 (14.3)
Unknown	2 (1.0)	5 (14.3)

Studying with music ____		
Is distracting	65 (33.0)	13 (37.1)
Is calming	17 (8.6)	3 (8.6)
Helps me concentrate	35 (17.8)	8 (22.9)
Keeps me energised	27 (13.7)	1 (2.9)
Makes it less boring	28 (14.2)	3 (8.6)
Makes time go faster	5 (2.5)	
Makes learning easier	5 (2.5)	1 (2.9)
Makes me sing along	15 (7.6)	1 (2.9)
Unknown		5 (14.3)
My reading/study material is in a different language to the music I listen to		
All the time	7 (3.6)	
Often	10 (5.1)	2 (5.7)
Sometimes	40 (20.3)	11 (31.4)
Rarely	63 (32.0)	5 (14.3)
Never	77 (39.1)	12 (34.3)
Unknown		5 (14.3)
I listen to music whilst studying		
I don't	70 (35.5)	12 (34.3)
To make me happy	15 (7.6)	3 (8.6)
To keep me awake	20 (10.2)	1 (2.9)
When I don't like the subject	3 (1.5)	
When the subject is boring	9 (4.6)	
When it is too quiet to concentrate	27 (13.7)	3 (8.6)
To block out other noise	37 (18.8)	8 (22.9)
When I am nervous/anxious	11 (5.6)	2 (5.7)

If someone else has music on	5 (2.5)	1 (2.9)
Unknown		5 (14.3)
If you listen to music whilst studying, do you have specific study playlists?		
I don't listen to music when studying	73 (37.1)	13 (37.1)
Yes – I have study playlists	60 (30.5)	7 (20.0)
No – I listen to anything that plays	63 (32.0)	10 (28.6)
Unknown	1 (0.5)	5 (14.3)
How often do you get distracted by the song playing while studying?		
Never	19 (9.6)	1 (2.9)
Rarely	51 (25.9)	9 (25.7)
Sometimes	80 (40.6)	12 (34.3)
All the time	44 (22.3)	8 (22.9)
Unknown	3 (1.5)	5 (14.3)
My mood determines whether or not I listen to music whilst studying on any given day		
True	115 (58.4)	13 (37.1)
False	78 (39.6)	17 (48.6)
Unknown	4 (2.0)	5 (14.3)
Listening to music whilst studying affects my mood whilst studying		
1 star - Strongly Agree	61 (31.0)	17 (48.6)
2 stars	33 (16.8)	6 (17.1)
3 stars	56 (28.4)	3 (8.6)
4 stars	16 (8.1)	1 (2.9)
5 stars - Strongly Disagree	36 (13.2)	3 (8.6)
Unknown	5 (2.5)	5 (14.3)

Studying and music should not be mixed		
1 star - Strongly Agree	42 (21.3)	10 (28.6)
2 stars	20 (10.2)	
3 stars	66 (33.5)	13 (37.1)
4 stars	36 (18.3)	4 (11.4)
5 stars - Strongly Disagree	30 (15.2)	3 (8.6)
Unknown	3 (1.5)	5 (14.3)
I listen to music _____ studying		
Before	27 (13.7)	6 (17.1)
While	43 (21.8)	9 (25.7)
After	57 (28.9)	8 (22.9)
All of the above	58 (29.4)	7 (20.0)
Unknown	12 (6.1)	5 (14.3)
I am more likely to listen to music while studying at night, to keep awake		
True	84 (42.6)	12 (34.3)
False	102 (51.8)	18 (51.4)
Unknown	11 (5.6)	5 (14.3)



Note: Percentages for survey indicated on figure.

Responses to question “What genres of music do you typically listen to when studying?”

Figure 4 - Percentages indicating most listened to genre of music by participants

Referring to music usage whilst studying, Figure 4 indicates that silence was the most frequently chosen response to “What genres of music do you typically listen to when studying?” from both survey and experiment participants. From musical genres however, R&B (9.1%), Classical (8.1%), and Pop (8.1%) were the most commonly listened to genres by survey participants, compared to Classical (8.6%) and House (8.6%) being the preferred genres by participants who completed the experiment.

Cross-tabulations – survey.

Chi-square tests of independence were conducted to test the associations between participants' various music usage behaviours and study habits. For ease of interpretation, the cross-tabulations of significant associations can be referred to in Appendix L.

A cross-tabulation (Table i) was run to determine whether participants who were easily distracted also got distracted by the song playing whilst studying. The result was significant - $\chi 2^2_{(3)} = 19.498$, $p = 0.000$, indicating an association between easily distractible participants and participants who got distracted by songs playing while studying.

Following this, a cross-tabulation was run to determine whether participants who indicated that they are easily distracted studied with music or not. The result was not significant - $\chi 2(4) = 1.417$, $p = 0.841$; there is no association between whether students chose to study with music (or study in silence) and whether or not they get distracted easily. The cross-tabulation to determine associations between participants who were easily distracted and whether or not they thought studying and music should be mixed also provided a non-significant result – $\chi 2^2_{(4)} = 3.605$, $p = 0.462$ – indicating that whether or not participants listen to music whilst studying is not associated with their accounts of how easily they get distracted.

A cross-tabulation (Table ii) was also run to identify whether there was an association between participants who thought studying and music should or should not be mixed and whether or not they tend to study with music. Although the result was significant - $\chi 2(16) = 146.193$, $p = 0.000$, there were cells with counts less than 5, so this result should be treated with caution. A further cross-tabulation (Table iii) was then run to determine whether there was an association between participants who thought music and studying should not be mixed got distracted by songs playing whilst they studied. Again, the result was significant - $\chi 2(12) = 56.978$, $p = 0.000$; however, there were cells that had an expected count less than 5, and therefore this result should be treated with caution.

These results could suggest that students do not necessarily perceive listening to music as a distractor or of music reducing distraction in and of itself, with the act of listening to music perhaps being attributable to other factors, such as current mood, the nature of the task, especially task difficulty, for example. This was further explored with the experiment sample.

Analysis of Variance – Memory Span Assessments

The other research question was to determine whether a significant difference exists in working memory performance under different sound conditions. The following analyses aimed to answer this question.

The experiment produced usable data for 35 participants, of which 30 also completed the survey. Using their unique IDs that they created at the end of the survey, as well as included at the beginning of each Memory Span assessment, these participants' survey and experiment responses were merged, so that analysis between memory span performance and music usage and study behaviours could be conducted, to enable exploration of possible relationships.

The design of the study did consider how the order in which the assessments were completed may impact on the results generated. Therefore, the order of completion of the three memory span measures were randomised, as a counterbalancing procedure (Price et al., 2015b). Nevertheless, carry-over effects, "an effect of being tested in one condition on participants' behaviour in later conditions" (Price, Jhangiani, & Chiang, 2015a, pg. 106) were tested for. An one-way repeated measures analysis of variance (ANOVA) was run to determine whether or not there were differences in performance on alternate forms of a measure of working memory due to the order in which they were completed. This was done to check that any differences that may be seen on the different assessments can be attributed to the different sound conditions under which they were completed, and not the order in which the participants completed it. Since it is a within-subjects study, and participants did have to complete three assessments one after the other, this analysis was run as an internal check. Table 7 indicates the various orders in which the assessments could be completed, as well as the number of participants who completed each order.

Table 7- Order in which memory span assessments were completed and frequencies per sequence

Order of Assessments	Number of Participants
1, 2, 3	7
2, 3, 1	5
3, 1, 2	5

1, 3, 2	6
2, 1, 3	7
3, 2, 1	5

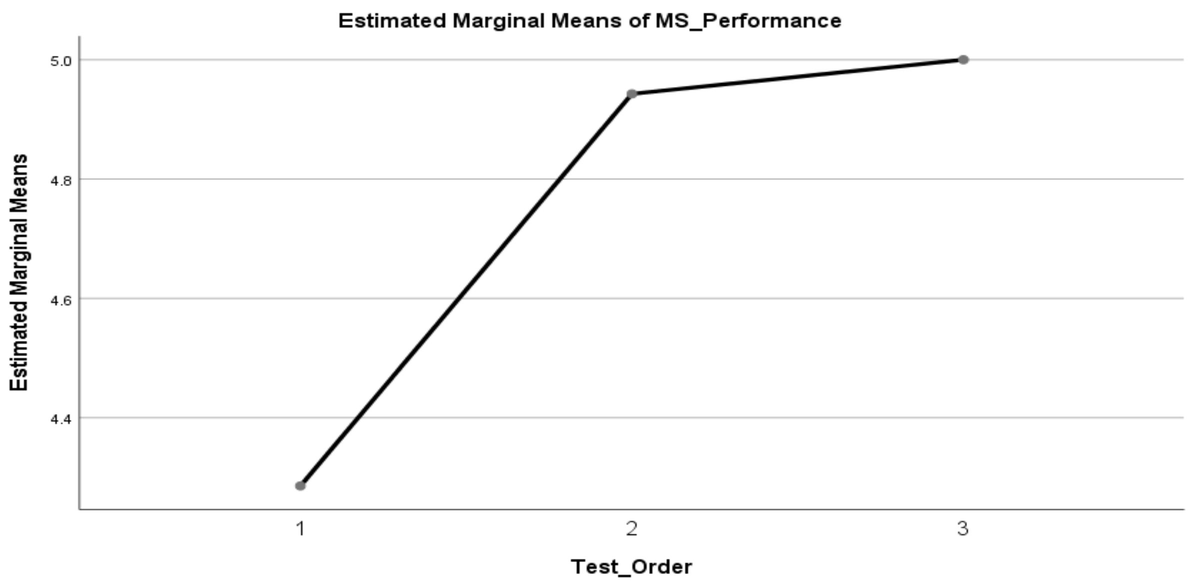
Table 8 - ANOVA determining significance of carry-over effects

	Memory Span 1	Memory Span 2	Memory Span 3
Mean	4.29	4.94	5.00
SD	2.37	1.92	2.06
N	35	35	35

Table 9 - ANOVA Summary Table for carry-over effects

Source	SS	df	MS	F	p-level	Partial Eta Squared
Memory Span Number	11.03	2	5.514	1.930	.153	.054
Error	194.305	68	2.857			

Figure 5 - Estimated Margin Means for Performance according to Test Order



From Tables 8 and 9 as well as Figure 5, it is demonstrated that there was not a significant effect of the order of assessment, Wilks' lambda = 0. 90, F (2, 33) = 1.860, p = 0.172, which is expected and indicates the effectiveness of random assignment of test order. Therefore, it can be deduced that participant performance on the three memory span assessments were not influenced by the order in which they were completed. Thus, the effects of practice and fatigue will be disregarded for the remainder of this paper.

Subsequently, a one-way within-subjects ANOVA was conducted to compare the effect of different music conditions on working memory performance when completing the assessments with white noise (Memory Span 1), Beethoven's Für Elise (Memory Span 2), and participant's own choice of music (Memory Span 3), on the three alternative forms of the Memory Span assessment.

Table 10 - ANOVA determining effects of music conditions on working memory

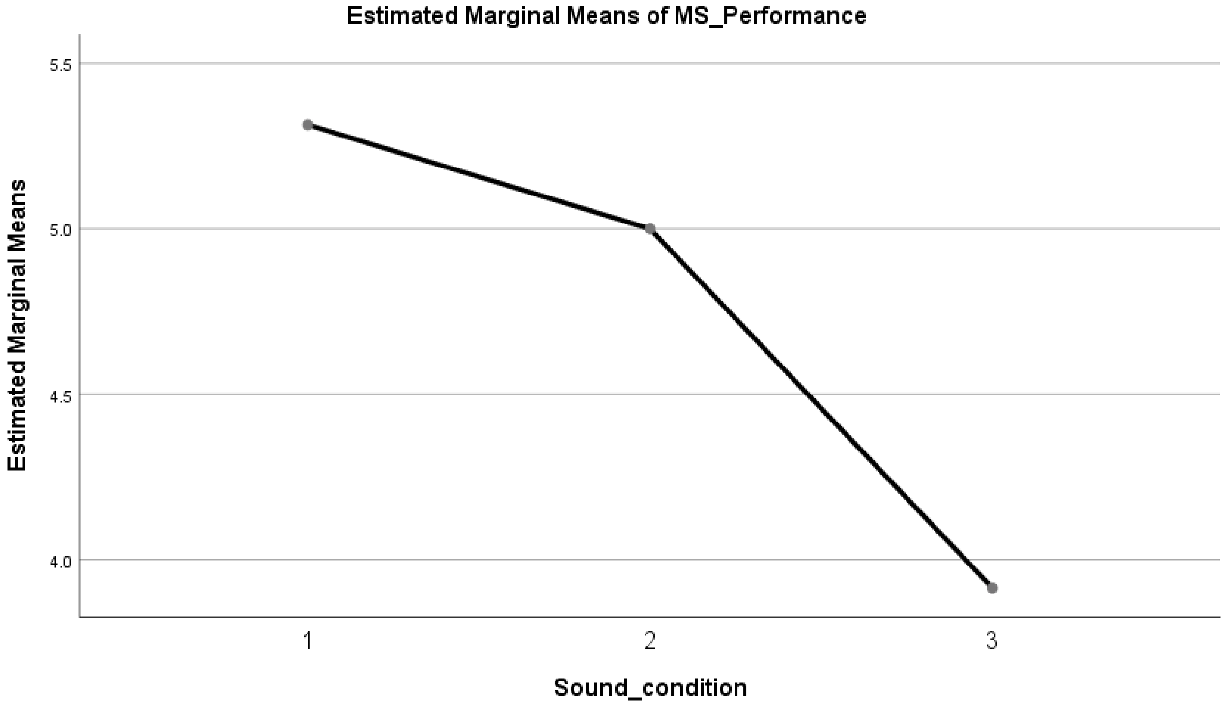
	Memory Span 1	Memory Span 2	Memory Span 3
Mean	5.31	5.00	3.91
SD	2.15	2.36	1.60
N	35	35	35

Table 11 - ANOVA Summary Table with a Greenhouse-Geisser correction

Source	SS	Df	MS	F	p-level	Partial Eta Squared
Music Condition	37.77	1.67	22.64	7.66	0.002	0.184
Error	167.56	56.71	2.96			

There was a significant effect of the music condition, Wilks' lambda = 0.56, F (2, 33) = 13.10, p = 0.000. Tables 10 and 11 provide further descriptive information, with Figure 6 providing a visual representation of the differences in mean across the different sound conditions.

Figure 6 - Estimated Margin Means for Performance according to Sound Condition



Whilst the ANOVA indicated that performance on the working memory span assessments did differ significantly between the different music conditions, Least Significant Difference (LSD) post-hoc tests revealed that whether or not the participant completed the assessments with White Noise, there was no significant difference when compared to their performance with Für Elise ($p=0.467$). However, there was a significant difference in performance between White Noise and participant's own choice of music ($p = 0.000$), with a large effect size $d_{\text{repeated measures}} = 0.87$, and Für Elise and participants' own choice of music ($p=0.010$), with a medium effect size $d_{\text{repeated measures}} = 0.47$. Thus, the results indicate that working memory is most negatively impacted when listening to one's own choice of music, rather than white noise or Beethoven. It is also shown that there are no significant differences in working memory when working with white noise or with "study" instrumental music, such as Beethoven.

Perceptions of Working Memory Assessments

End of study survey – descriptive statistics.

Table 12- Music listened to for Own Choice setting

Genre	n (%)
Alternative	2 (5.6)
Bollywood	3 (8.3)
Classical	2 (5.6)
Country	1 (2.8)
EDM	1 (2.8)
Folk	1 (2.8)
Gospel	5 (14)
Hip Hop	4 (11.1)
House	3 (8.3)
Indie	1 (2.8)
Jazz	1 (2.8)
Lofi	1 (2.8)
Pop	3 (8.3)
RnB	3 (8.3)
Soft Rock	2 (5.6)
Trap	1 (2.8)
Unknown	1 (2.8)

From the 35 participants that completed the assessments, 31.4% indicated that white noise, and 17.1% that instrumental music was most representative of their typical study setting. 51.4% indicated that the own music setting was most representative of their typical study situation. Overall, this is consistent with what was indicated by these participants in the Memory Usage Survey. As can be seen from Table 12 which indicates the music genres listened to by the individuals for the Own Choice assessment, only 2 participants listened to classical music for this assessment. Gospel and Hip Hop were the most common music choices for participants whilst completing the assessment – in contrast from their preferences mentioned in the Music Usage Survey.

The White Noise setting was experienced as the least distracting setting, with 57.1% of participants rating it as such. 25.7% of participants found the instrumental setting as least distracting, whilst 17.1% experienced the own music setting as least distracting. This is in accordance with the findings of above – even though students study with music does not mean that they do not get distracted with it.

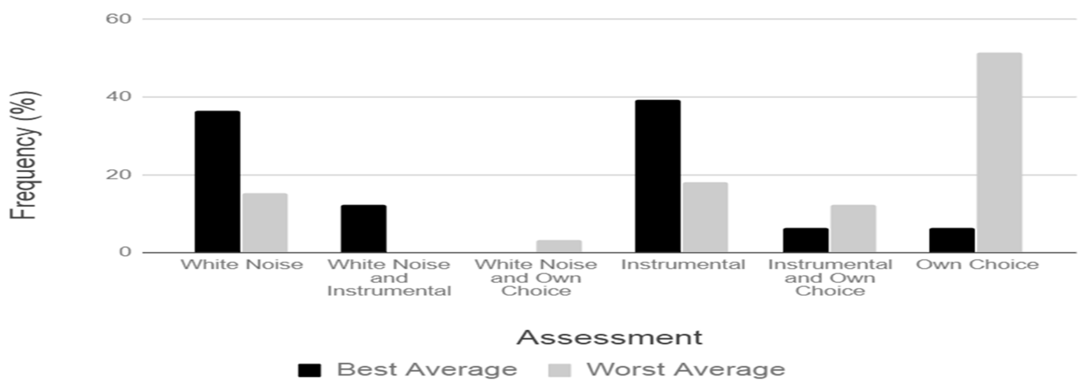
45.7% of participants found the own music setting to cause the most distraction, whilst 28.6% and 25.7% of participants found the instrumental, and white noise setting to be most distracting, respectively. This perception too, is in accordance with above findings – again, the truth that whilst students may be used to studying with music, cannot infer that they do not get distracted with it.

Cross-tabulations – experiment.

A chi-square test of independence was run to see whether there was an association between participants' representative typical study setting and the setting they found least distracting. The result was significant, $\chi2$ (4) = 12.453, p = 0.014. The cross-tabulation (Table iv) can be seen in Appendix L.

A chi-square test of independence was then run to see whether there was also an association between participants' representative typical study setting and the setting they found most distracting. This result was also significant, $\chi2$ (4) = 15.246, p = 0.004, and the cross-tabulation (Table v) is in Appendix L.

The assessments completed were of equal difficulty, given that they were created as alternative forms, and the development of them ensured they were of equal difficulty, and the sequences to be remembered were of equal length. However, out of 35 participants, only 22.9% found all sets of questions to be of equal difficulty. 11.4% found the White Noise set of questions to be more difficult, whilst 25.7% found the Instrumental set to be more difficult. The majority (40.0%) found the Own Music set of questions to be most difficult, as can be seen in Figure 7.



Note: Two candidates performed equally on all 3 assessments, and therefore were not included in the above graph

Figure 7 - Percentages indicating best and worst performance on the White Noise, Beethoven, and own choice working memory span assessments

Table 13 - Memory Span Average Performance Ranges

Average Score	Range	Minimum	Maximum
MS1	8	1	9
MS2	9	0	9
MS3	7	0	7

Note: MS1 – Memory Span 1 (White Noise), MS2 – Memory Span 2 (Beethoven), MS3 – Memory Span 3 (Own Choice)

Table 13 indicates that, although the assessments were alternate forms of each other, participants did not perform equally well on all. This was also shown by the ANOVA results. A cross-tabulation (Table vi, Appendix L) between whether or not participants found any set of questions more difficult than the others and worst average was run to see whether there was an association. The result was $\chi2(12) = 28.215$, $p = 0.005$, however, too many cells had counts less than 5, and therefore although significant, this result should be treated with caution.

Cross-tabulations – connecting the survey and experiment.

Cross-tabulations between whether participants study with music, and since when have they been studying in the way that they do (asked in Music Usage survey – Part 1), and their most representative typical study setting (asked in End of Study survey – Part 2) were run. No discrepancies were noted.

The cross-tabulation (Table vii, Appendix L) between whether or not the participant studies with music and which experimental setting they found most distracting had a result of $\chi2(8) = 19.676$, $p = 0.012$; however, many cells had counts less than 5, and therefore although significant, this association should be treated with caution.

The cross-tabulation between whether or not participants study with music and which set of questions they found most difficult was found to be non-significant, with too many cells with a count less than 5; $\chi2(12) = 12.586$, $p = 0.400$.

Cross-tabulations between how long participants have been studying the way they do and a) whether they found any question set more difficult, b) their worst average, and c) their most distracting setting, were run. All results were non-significant – a) $\chi2(12) = 8.637$, $p = 0.734$, b) $\chi2(16) = 9.569$, $p = 0.888$ and c) $\chi2(8) = 9.709$, $p = 0.286$.

Cross-tabulations determining whether there were associations between listening to music and a) worst performance, and b) did they find any set of questions more difficult, were also non-significant - $\chi2(24) = 21.495$, $p = 0.609$ and $\chi2(18) = 15.104$, $p = 0.655$ respectively.

The results of the cross-tabulations run to determine if there were associations between listening to music and writing at the same time without getting distracted and a) worst performance, and b) did they find any set of questions more difficult, were non-significant – a) $\chi2(4) = 0.769$, $p = 0.943$ and b) $\chi2(3) = 3.240$, $p = 0.356$ respectively.

Cross-tabulations run to determine if there were associations between listening to music and writing at the same time without getting distracted and a) worst performance, and b) did they find any set of questions more difficult, also produced non-significant results - $\chi2(4) = 0.769$, $p = 0.943$ and $\chi2(3) = 3.240$, $p = 0.356$ respectively. Lastly, cross-tabulations run to determine if there was an association between studying with music and whether participants' performance on the music conditions questions sets (Beethoven and Own Choice, mean = 8.91, SD = 3.27) was above or below average. The result was non-significant - $\chi2(1) = 0.362$, $p = 0.547$.

Chapter Five: Discussion

This study aimed to firstly, explore and describe the music usage behaviours of undergraduate students in relation to their study habits, and secondly, determine whether performance on working memory assessments differed when students completed these assessments under different sound conditions. Together, the findings resulting from these two questions could be used to indicate whether or not listening to music impacts on working memory capacity. Given that working memory capacity, and the processes of encoding, storing and retrieving, have been shown to play a significant role in how information is retained and later recalled from long term memory, which may be a determining factor with regards to student's academic performance, this study suggested that by measuring working memory performance under different sound conditions, the effects these different sound conditions would have on academic performance could be inferred.

This chapter presents a discussion of the key findings from the descriptive analyses conducted on both the Music Usage Survey, Memory Span assessments and End of Study Survey, as well as the results of the ANOVA. The results are discussed in relation to the research questions mentioned above, followed by an integration of the debates and contradictions presented in the literature review. The chapter concludes with a summary of the limitations of the study, as well as implications of the results in light of music usage behaviours and academic performance in the context of undergraduate students in South Africa.

Descriptive statistics conducted on the responses of undergraduate students who completed the Music Usage Survey indicated that 80.7% of students listen to music for more than an hour a day. However, the majority of students also indicated that task difficulty determines whether or not they will listen to music whilst completing that task. 73.6% of students stated that they get distracted easily, which may negatively impact how they encode, and therefore later recall, their study material. This may also explain why many (survey: 68.0%, experiment: 71.4%) students indicated that they experience difficulty in reading or remembering long passages of text, possibly due to them being easily distractible and thus having recall difficulties.

For the 74.1% of students who indicated that they do listen to music whilst completing some form of academic activity, the most common activity to be accompanied by music is assignment completion – which is often one of the main activities used by lecturers and tutors

at undergraduate level to create familiarity with learning material and is commonly one of the first times students actively engage with this material, and where most learning is done.
Music is also often used for thinking (survey) and problem solving (experiment) activities, perhaps because music allows the listener to distance themselves from their reality, thus allowing for clearer thoughts or different perspectives to be developed. The majority of students do not change their music when changing the subject to be studied. A lot of students also indicated that they listened to classical music whilst studying. Could this perhaps be indicative of some students' awareness of the Mozart effect? How many students in the South African context are aware of this phenomenon?

56.9% of students also indicated that vocal music distracts them whilst reading – which could be suggestive of the Irrelevant Speech effect. In contrast however, when writing, this effect appears to be less prevalent, since only 34% of students indicated that writing whilst listening to music is distracting. Students do appear to associate the songs they study to with the material being studied, since over half of the respondents (52.7%) indicated that they sometimes/always remember the song whilst recalling the learning material – suggesting that, along with the learning material, the song is often also being encoded. However, most students found that actively engaging with the song, by humming or singing along, is too distracting and many indicated that they refrain from singing along to the music when revising or writing examinations – in this sense, it may be suggested that remembering the learning material is not necessarily associated with specific words or tunes of the songs listened to.

Over 30% of students indicated in the survey that they do not study with music, with 54 of these 62 survey participants (and 11 of these 12 experiment participants) stating that music distracts them. Only 13.2% of survey participants and 14.3% of experiment participants stated that they always studied with music, with the most common reason being that music helps them concentrate (50% of survey participants, 80% of experiment participants who endorsed "Always" study with music). "Blocking out other noise" was the main indicated reason as to why students study with music – in a South African context, considering that many students may be studying in overcrowded homes, or busy townships, could this be linked with them being distracted easily by their external environments? Future studies could investigate the relationship between music usage behaviours and individuals' home/work environments in more detail.

From the sampled group of undergraduates, students generally believed that they get distracted easily. It then should follow that listening to music would provide them with more stimuli to get distracted by. However, non-significant cross-tabulations indicated that, even though students indicated that they were easily distracted, they did not keep away from listening to music to stay focused, nor did they always listen to music to prevent getting distracted from other factors in the environment. Furthermore, a subsequent non-significant cross-tabulation also indicated that whether or not participants listen to music is not determined by their accounts of how easily they get distracted. However, a significant cross-tabulation suggested that students who perceived music to be a distracting stimulus whilst studying were less likely to listen to music whilst studying. These results could suggest that students do not necessarily perceive listening to music as a distractor or of music reducing distraction in and of itself.

The results from the ANOVA showed that students performed significantly worse on the Memory Span Assessment completed whilst listening to their own choice of music. The ANOVA also did not indicate any significant differences in working memory performance between the White Noise and Beethoven conditions. It can be argued that the White Noise is the most representative of usual examination conditions, and as such, being university students, the participants can be said to be most practised to completing tests and examinations in such a setting. Whilst many students did indicate that they study whilst listening to classical music, only 2 participants chose to listen to classical music whilst completing the corresponding Memory Span assessment. It must be noted here that students were not told beforehand what types of music would be part of the experiment, or given any form of indication of what type of music that they should bring – it was completely up to them to bring what they wanted to listen to. Gospel and Hip Hop were the most common music choices brought by these participants – in contrast from their preferences mentioned in the Music Usage Survey.

Regarding levels of distraction whilst completing the assessments, of the 11 participants who indicated that they typically study with White Noise, 9 (81.8%) indicated that White Noise was the least distracting experiment setting, with the remaining 2 (18.2%) stating that the Instrumental was the least distracting. From the 6 participants who communicated that they typically studied with Instrumental music, 4 (66.7%) of them felt that the Instrumental setting was the least distracting, whilst the remaining 2 (33.3%) said that the own music setting was the least distracting. From the 18 participants who typically studied with their own choice of music, only 4 (22.2%) felt that the own choice music setting was least distracting. 11 (61.1%) felt that the White Noise setting was least distracting, and the remaining 3 (16.7%) thought the Instrumental setting was least distracting.

Even though all 3 Memory Span assessments were of equal difficulty, only 8 participants thought this. All 8 of these students performed worst on the own choice music question set. 2 from the 4 participants that thought the White Noise setting was the most difficult performed worst on its' question set. From the 9 participants who believed the instrumental setting was the most difficult, 5 performed worst on it. Lastly, from the 14 participants who stated that the own choice question set was the most difficult, 10 actually performed worst on it. Thus, from 35 participants, 17 (49%) correctly identified which assessment they performed worst on.

From the 12 participants who stated that they never study with music, 10 (83.3%) said that the own music condition was most distracting. From the 5 participants that said that they always study with music, 2 found it to be the most distracting setting, whilst 3 thought White Noise was the most distracting setting. This result therefore suggests that participants who were more familiar with studying with music, indicated that they were less distracted by the music during the experiment, because they had become accustomed to completing academic activities with music.

Many students view studying distastefully; which cannot necessarily be blamed on the difficulty level of the subject matter, but rather finding or creating an environment conducive to learning can at times seem like a tedious activity in and of itself. Students often find themselves either distracted by irrelevant noises or complete silence which allows their mind to wander, making focusing on the task at hand quite exasperating. For this reason, many students attempt to enhance their learning by listening to music while studying, although some may say that music distracts them more, as indicated in this study and further supported by Eiras and McNeil (2010). The survey results from this study indicated that most students feel they get distracted easily, even though the majority study at home, where it is assumed that they would be in a more comfortable environment.

Whilst the survey results indicated that many students studied in silence, it also indicated that classical music was also a common choice amongst participants, which could perhaps be indicative of their knowledge of the Mozart effect, or some form of it. Or perhaps they subconsciously feel more relaxed when listening to this genre. Students may also choose to listen to classical music due to its typically vocal-less tunes, which could again be linked the Irrelevant Speech Effect.

Interestingly, there were students who made the comment during the assessments, or in their feedback, that classical music does not help them study any better – which is supported by the ANOVA results of this study, given that there was no significant difference in performance on the working memory span tasks between the White Noise and Beethoven conditions. For their own choice of music, however, participants performed significantly worse, which could perhaps be explained as a consequence of the Irrelevant Speech Effect. This result further suggests that listening to vocal music, compared to an instrumental tune such as Beethoven, may cause one to try and function beyond what one's working memory capacity allows, with the result of the brain being caught between focusing on the music or the task at hand – in this case, studying, or similar academic activity. As indicated by Baddeley (1994, 2003, 2007, 2012), this may cause problems during the encoding of information into memory, which results in the subsequent faulty recalling of said information. Simply put, if students are distracted, or their working memory capacity is inefficient whilst studying, they may have difficulties remembering that studied information later on, which would negatively impact on their academic performance. Even students who have been studying with music for years and do not claim to find themselves distracted by their music, performed significantly worse on the own choice music working memory assessment.

The majority of students indicated that they do not listen to different types of music depending on the task completed, suggesting that they are most likely to listen to the same type of music (genre, tempo, volume) when completing all types of activities. However, researchers have found that there is a significant relation between certain types of music and learning (Geethanjali, Adalarasu, Jagannath, & Rajesekaran, 2016), and that listening to the right type of music may enhance task performance. Hallam and MacDonald (2009) suggest that the genre, the perceived potential of the song to stimulate or relax, being vocal or instrumental, all affected the relationship between the music listened to and task performance. However, the current survey study also indicated that, if they are going to listen to music, students tend to listen to their choice of music, which may or may not be classical – however, it is the condition most representative of over half of the participants' reported typical study situation, and the condition under which they indicated they were the most distracted, and subsequently perceived as the most difficult and in which they performed the worst. As such, it might not be a bad idea for students to actively resist listening to music whilst studying.

Research has indicated that, even if students turn the music on or off based on their perception of its degree of distraction, they cannot always predict its effects (Alley & Greene, 2008; Kotsopoulou & Hallam, 2010). The current study pointed out that only 49% of students were able to correctly identify which assessment they performed worst on. It was also identified that students who generally feel that they get distracted easily felt that listening to music provides them further stimuli to get distracted by. However, this perception did not prevent them from listening to music whilst studying.

As mentioned by Hallam and MacDonald (2009), the structural features (tempo, modality, instrumentation, genre), cultural and environmental factors (such as how musical associations are culturally shaped and learned) as well as the personal and subjective meanings and associations we place on a particular piece of music, all play a part in our responses to music. Individuals have been found to respond to the same music in very different ways, depending on their musical preferences and their individual characteristics. This is further evidenced in the current study, where participants did have different reactions, and therefore varied performances, in the different music conditions, even though two of the three conditions were the same across all participants.

Participants in the current study who were more familiar with studying with music indicated that they were less distracted by the music during the experiment, because they had become accustomed to completing academic activities with music. Previous research too found that participants who seldom study with music work best in silence, while those who tended to study with music usually worked better with music playing. For those who prefer to work with music, the music had significant effects on performance (Doyle & Furnham, 2012).

Strengths and Limitations of the Study

It has been noted that the provision of incentives improved cognitive performance irrespective of working memory capacity (Lee, Ning, & Chin Goh, 2013). This study did not consider the effects of this in interpretation, mostly because no participant scored full marks on any of the assessments. The nature of the study was also that it was a within-subjects experiment, so the effects of the participants having received an incentive is likely to be insignificant.

Furthermore, not all participants were eligible for the incentive, and only a small percentage of the students eligible for the incentive participated in the experimental, working memory component of the study.

This study was directed at undergraduate students more broadly, rather than imposing an age limit on the participants to make only certain students eligible. The result was that, although the majority of students were in the young adult bracket (18-21), there were older participants, with participants as old as 53. Due to the size of the overall group tested, the researcher did not want to exclude these participants from further analysis. Fandakova, Sander, Werkle-Bergner, & Shing, (2014) demonstrated that, although working memory does peak in young adulthood and declines at an accelerated rate with advancing age, due to an overload of working memory with irrelevant materials (Oberauer, 2005) "the general structure of short-term recognition memory is similar in children, teenagers, and older adults, and is comparable with the factor structure observed in younger adults", suggesting that the ability to hold and retrieve information over a brief period of time may be relatively preserved in older adults, and as such, age was not treated as a concern in this study. Given that the nature of the comparisons were also within-subject, the impact of the variation in ages is likely to be limited. Furthermore, because of the smaller sample size for the experiment, analyses such as regressions could not be run to determine whether certain music usage behaviours could predict performance on the working memory span assessments; future research could consider this. This study also investigated music usage by undergraduates more broadly, and did not consider differences in arousal and performance between musicians and non-musicians, which could be considered in a future study.

Although experimenter-paced and computer-paced span tasks both measure working memory, how the span task is administered influences which additional processes it captures, intentionally or otherwise (Bailey, 2012). This study benefitted greatly from using computerised cognitive testing, given the ease at which relatively large amounts of information was obtained over the three-month data collection period, the significantly cheaper cost of administering surveys and assessments electronically rather than on printed materials, and the ability to precisely measure several time-sensitive tasks. Despite these and other advantages however, a common methodological concern regarding computerised neuropsychological testing is the degree to which the research participant is familiar with computers. This factor can affect individuals' performance on the measure, which will affect the results generated from the assessment and how these are interpreted. Even though Iverson and colleagues (2009) found no significant differences on several measures, including tests of memory, based on computer familiarity by the participant, and the memory span assessments were proctored in this study with the researcher controlling mouse movements, participants' confidence with a computer was not considered or controlled for. Given that Noyes, Garland, & Robbins (2004) found that lower performing individuals will be disadvantaged when carrying out computer-based assessment, future research should consider this when administering computer-based assessments, even when participants indicate that they are computer-literate. However, once again, because this study was designed to be a within-subject study, such effects have likely been minimised.

The literature has also indicated the broad range of factors that affect each working memory, perception and arousal by music, and academic performance, as well as pointing out how individual differences such as extraversion, anxiety and intelligence can further cause changes in how music affects students. This study did not at all consider personality and possible underlying psychopathology in any of the participants. Furthermore, as part of the design of the study, participants were allowed to listen to their "Own Choice" of music for one of the tests - no restrictions were placed on participants to listen to vocal or non-vocal music specifically. The result was that some students listened to music with vocals, and others listened to instrumental music similar to that of the Beethoven condition. In hindsight, this led to some participants experiencing the irrelevant speech effect and others not. Future studies could better control for this confound variable, either by clearly requesting participants to bring with vocal music, or by providing participants with a set of songs chosen by the researcher (all either non-vocal, or all producing the Irrelevant Speech Effect).

This study also did not consider long-term memory recall of the various stimuli after the assessments, since the focus of this study was on working memory specifically. However, literature does show that how working memory functions, and how information gets encoded, manipulated and stored as it moves from working memory to long-term memory, affects how this information will be later retrieved from long-term memory. Further studies could ask participants to recall the same sets of stimuli after longer periods of time have passed, whilst making them complete other tasks to fill those time gaps. These studies could also perhaps investigate how listening to different sound conditions affect different academic activity performance – with it being suggested by literature that the performance of activities such as reading and thinking (considered as short- and working memory recall activities) with music would differ from the performance of long-term working memory activities (such as revising for exams and memorising texts).

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Appendix A: Music Usage Survey

*The format of the below survey is compatible for the online survey development software SurveyMonkey and is how the participants viewed it when completing it.

Music Usage Survey

Good day,

Thank you for showing interest in the study 'The Impact of Music on the Academic Performance of Undergraduate Students'!

As part of my postgraduate Master's degree in Social and Psychological Research at the University of the Witwatersrand, I am conducting a study on the impact music has on academic performance – with a particular focus on working memory. This research study will be supervised by Dr Pitman. I would like to invite you to participate in this study.

Your participation is entirely voluntary and you are under absolutely no obligation to participate in the research – there are no direct advantages or disadvantages to participating. Even if you do indicate that you would like to participate in the study, you still have the right to withdraw, should you change your mind, and this will not be held against you in any way.

This survey is online, therefore please ensure that you have a stable Internet connection whilst completing it. It should take no longer than 10-15 minutes to complete. On the next page, you will be asked to complete a consent form, adding your name and student number – however, this is to assist in allocating participation marks, and this will not be linked to the actual survey.

Your responses will be treated confidentially, and the resulting report will not have any identifying information. Thus, anonymity in reports/theses/publications can be guaranteed, as well as confidentiality of data.

If you choose to participate, and complete the consent form, it indicates that you understand and agree to the above. You are also giving me permission to use all data collected for analyses, reporting and possible publication or presentation. You are more than welcome to ask for general feedback on the outcomes of the study, after analyses have been completed; however, keep in mind that no individual feedback would be possible, since no identifying information would be linked to the data to ensure confidentiality.

Please see the contact details below and if you have any questions or concerns or want to follow up on the research results, please do not hesitate to contact me. Thank you again for your interest.

Ms Pakeezah Rajab - Pakeezah93@gmail.com

Dr Michael Pitman (supervisor) - Michael.Pitman@wits.ac.za

Continue

Leave Survey

I consent to participate in the research study assessing the impact of music on academic performance of undergraduate students, conducted by Pakeezah Rajab and supervised by Dr. Michael Pitman.

I have been informed of the following:

- The general purpose of the study,
- That my participation is voluntary and that I may withdraw at any time without any consequences, positive or negative,
- There are no risks or benefits associated with participating,
- I shall not be harmed or injured during the assessment process,
- My personal details and assessment results will be kept confidential,
- No identifying information will be traced back to my results, and therefore no identifying information will be included in the resulting research report,
- I am aware that the results of the study will be reported in the form of a research report as a requirement for the partial completion of the postgraduate Master's in Social and Psychological Research degree,
- This research report may also be published in a journal, be made available online and may be presented in conferences,
- I may request general feedback from the study.
- Contact details have been made available to me.

Yes

No

I have read the provided information about the study and consent to have my responses used for research purposes.

Agree

Disagree

Age

Gender

Female

Male

Other (list self-identification)

Home Language

Afrikaans

English

Ndebele

Northern Sotho

Southern Sotho

Swati

Tsonga

Tswana

Venda

Xhosa

Zulu

Other

Current Year of Study

1st

2nd

3rd

4th

Other

In which faculty are you currently registered?

Commerce, Law and Management (CLM)

Engineering and the Built Environment (EBE)

Health Sciences (HSc)

Humanities (Hum)

Science (Sci)

Where is most of your studying done?

On campus

At home

In transport- while travelling

Other (please specify)

Do you get distracted easily?

Yes

No

Do you have, or have you had a hearing difficulty/impairment?

Yes

No

On average, I listen to music ____ hour(s) a day.

Less than 1

1-2

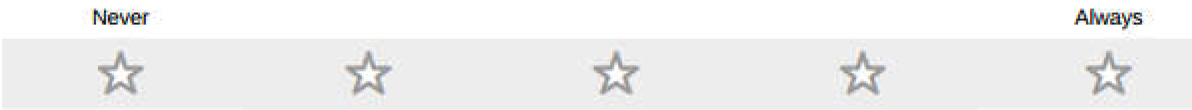
3-4

5-6

7 or more

Never Always

I study with music.



Studying with music ___________ (select which applies best)

Is distracting

Is calming

Helps me concentrate

Keeps me energised

Makes it less boring

Makes time go faster

Makes learning easier

Makes me sing along

I prefer listening to music when completing the following tasks: ________ (select which applies best)

Revising for exams

Memorising text

Reading

Doing assignments

Problem solving

Developing ideas

Thinking

Studying my favourite subject

Studying my least favourite subject

I do not listen to music whilst completing any of these tasks

My reading/study material is in a different language to the music I listen to.

All the time

Often

Sometimes

Rarely

Never

I listen to music while studying _______ (select which applies best)

I don't listen to music while studying

To make me happy

To keep me awake

When it's my favourite subject

When I don't like the subject

When the subject is boring

When it is too quiet to concentrate

To block out other noise

When I am nervous/anxious

If someone else has music on

Since when have you studied the way you do?

I have studied in silence for many years (3 or more)

I have recently started studying in silence (in the past 1-2 years)

I adapt my study style to the situation/subject

I have recently started studying with music (in the past 1-2 years)

I have studied with music for many years (3 or more)

Other (please specify)

If you listen to music whilst studying, do you have specific "study" playlists?

I do not listen to music whilst studying

Yes – I have study playlists

No – I listen to anything that plays

What genres of music do you typically listen to when studying? (select which applies best)

I don't listen to music while studying

African (Traditional)

Alternative

Ambient Sounds

Asian (Traditional)

Classical

Contemporary Indian (Bollywood)

Country

Electronic

Folk

Gospel

Hip Hop

House

Indian (Traditional)

Jazz

Middle Eastern (Traditional)

Orchestra and/or Opera

Oriental (Traditional)

Pop

Rapping

R&B

Reggae

Rock

South American (Traditional)

Techno

Trance

Other (please specify)

How often do you get distracted by the song playing while studying?

Never

Rarely

Sometimes

All the time

How often do you recall the song you listened to while studying, while recalling the studied information (in exams, while revising)?

Always

Sometimes

Never

My mood determines whether or not I listen to music whilst studying on any given day

True

False

Different subjects require different types of music.

Yes

No

I ____ start humming a song that played when I studied while writing my exam.

Almost always

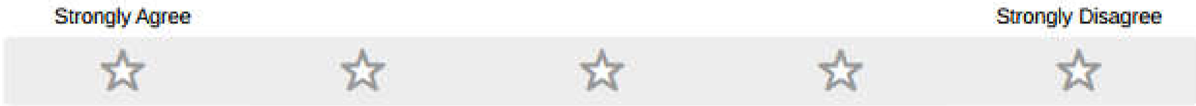
Often

Sometimes

Rarely

Never

Listening to music whilst studying affects my mood whilst studying



Whether or not I listen to music depends on the difficulty of the task I am completing

Studying and music should not be mixed

The ideal study situation is

Long periods of silence

Music playing in the background (in a different room, or on a low volume)

Music playing through my headset/earphones

Short bursts of studying in silence, followed by interaction with others

Short bursts of studying in silence, followed by listening to/singing a song

I listen to music _______ studying

Before

While

After

All of the above

Most of the music I listen to is

Whatever is on radio/television/chosen by others

Personal choice and selection of songs

I am more likely to listen to music while studying at night, to keep awake

True

False

I can read and listen to vocal music at the same time without getting distracted

True

False

I can listen to music and write at the same time without getting distracted

True

False

I hum/sing along to the music while revising familiar study material

No - too distracting

Depends on the subject

Yes – counters boredom

Do you sometimes experience difficulty in reading or remembering long passages of text?

Yes

No

Thank you for taking the time to answer these questions.

Would you be interested and willing to participate in Part 2 of this study?

Yes

No

Participation in Part 2

Cellphone number:

Email address:

Thank you for expressing an interest in Part 2 of the study. Participants selected to take part in Part 2 will be contacted in order to invite them to complete a computer-based task, to be arranged at a mutually suitable time. In order to facilitate this process, you are requested to provide a cellphone number and/or an email address that can be used to contact you during term time.

Please note that the contact information requested of you below is provided ONLY in order to make contact with potential participants for Part 2. No attempt will be made to identify any participants in this survey, nor to link any responses you have provided in the survey to your identity. Once the contact details have been extracted, this information willbe permanently deleted from this survey. Your anonymity of responses is thus ensured.

If you do participate in Part 2 of the study, it will be useful to be able to anonymously connect the information you have provided in this survey (Part 1) with the responses provided in Part 2. In order to do this, you are requested to please follow the instructions below to construct a unique, anonymous identifying code.

In the box provided below, please use the following information to construct your identification code (as in the example we have provided):

1. The first letter of your NAME
2. The first letter of your SURNAME
3. The last FOUR numbers of your student number

Example:

Name - Grace

Surname - Nkomo

Student Number - 546897

Unique Identifying Code - GN6897

Your unique identifying code:

Psychology I

Are you currently registered for Psychology I (PSYC1009 or PSYC1010)?

Yes

No

Research Participation Student Number:

Students currently registered for Psychology I can claim course credit for research participation by entering their student number in the space provided below, as required by the Psychology I Student Research Participation Programme.

Please note that this information is provided ONLY in order to claim course credit. No attempt will be made to identify any participants, nor to link any responses you have provided in the other survey to your identity.

Once the list of names and student numbers has been extracted, it will be deleted from this survey. Your anonymity of responses is thus ensured.

Thank you for taking the time to participate in and complete this survey.

To complete and submit the survey, please click 'Done' below.

Thank you!

Appendix B: The Memory Span Items

All three Memory Span assessments had the same format – the only difference was the sound conditions under which the participants completed them.

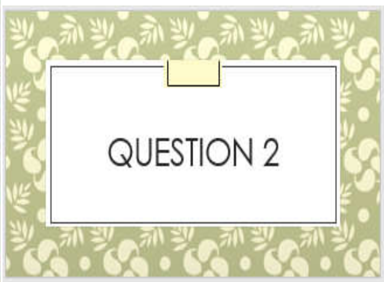
Question Number	Item Composition	Memory Span Recall Task
Question 1	5 words	Backward Recall
Question 2	5 numbers	Ascending Order
Question 3	6 letters	Alphabetical Order
Question 4	6 numbers	Forward Recall
Question 5	7 letter/number mix	Alphabetical then Ascending
Question 6	7 words	Alphabetical Order
Question 7	8 numbers	Ascending Recall
Question 8	8 letters	Forward Recall
Question 9	9 numbers	Backward Recall
Question 10	9 letter/number mix	Alphabetical then Ascending

All of the items below were converted into video format. They are all available for viewing on https://www.youtube.com/channel/UCoglNnh2LX3cqPDsXNMQDhw .

The reason for conversion into video format was for standardisation purposes – to ensure that each participant is only exposed to each item for exactly the same time. Further precaution was also taken, to change the thumbnail of the video on YouTube, so that participants could not see the stimulus before pressing Play.

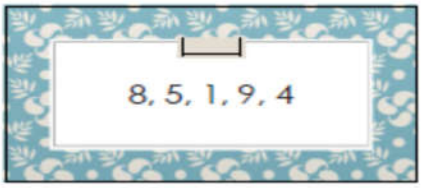
Once the proposal was approved and given Ethical clearance, these videos formed part of the Memory Span assessments that were developed on SurveyMonkey.

To ensure that participants only saw the stimulus for the set time, thumbnails were used for the videos. These thumbnails looked like the below images:

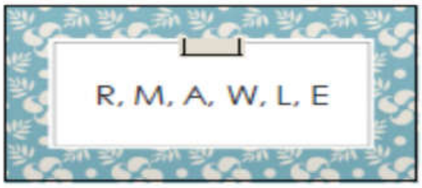


Memory Span Assessment 1 Items

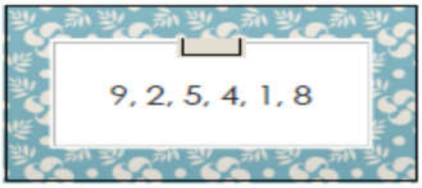
Item 1



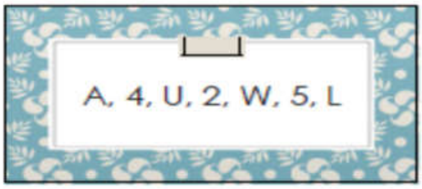
Item 2



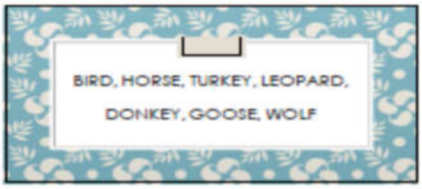
Item 3



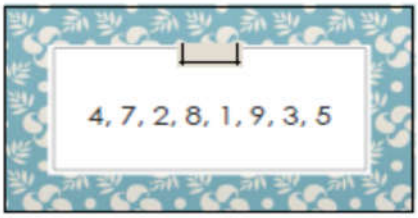
Item 4



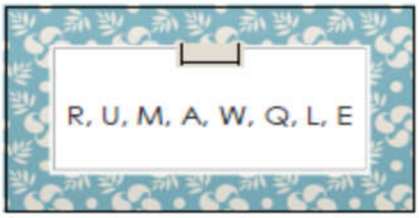
Item 5



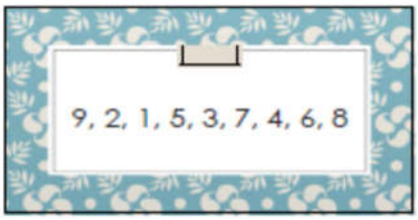
Item 6



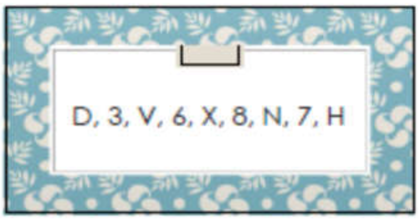
Item 7



Item 8



Item 9



Item 10

Memory Span Assessment 2 Items

LITCHI, MANGO, PEAR, GRAPE, CHERRY

Item 1

5, 2, 6, 9, 3

Item 2

T, P, F, U, O, L

Item 3

9, 6, 5, 3, 2, 8

Item 4

E, 5, V, 3, P, 9, M

Item 5

LION, TIGER, BABOON, GIRAFFE, KITTEN, HIPPO, DEER

Item 6

1, 6, 3, 2, 5, 8, 7, 9

Item 7

T, M, P, F, U, O, L, Z

Item 8

1, 6, 3, 2, 5, 8, 7, 4, 9

Item 9

A, 2, U, 8, F, 7, C, 6, L

Item 10

Memory Span Assessment 3 Items

QUINCE, BERRY, KIWI,
LEMON, PAPAYA

Item 1

7, 4, 2, 8, 3

Item 2

B, D, Y, Q, S, V

Item 3

3, 7, 4, 8, 2, 5

Item 4

B, 6, N, 7, F, 4, Y

Item 5

BEAR, SNAKE, LIZARD, PENGUIN,
TURTLE, RHINO, GOAT

Item 6

6, 3, 7, 9, 8, 2, 5, 4

Item 7

S, B, D, R, Y, Q, L, V

Item 8

6, 3, 7, 9, 1, 8, 2, 5, 4

Item 9

C, 8, L, 2, R, 5, T, 3, J

Item 10

Appendix C: The End of Study Survey

*The format of the below survey is compatible for the online survey development software SurveyMonkey.

1. Age
2. Gender
   Female
   Male
   Other
3. My home language is:
   Afrikaans
   English
   Ndebele
   Northern Sotho
   Southern Sotho
   Swati
   Tsonga
   Tswana
   Venda
   Xhosa
   Zulu
   Other (please specify)
4. Current Year of Study
   1^{st}
   2^{nd}
   3^{rd}
   4^{th}
   Other (please specify)
5. The least distracting setting was the
   White Noise
   Instrumental
   Own Music
6. The most distracting setting was the
   White Noise
   Instrumental
   Own Music
7. Which setting was most representative of your typical study setting?
   White Noise
   Instrumental
   Own Music
8. Did you find any set of questions more difficult than the others?
   No
   Yes - White Noise
   Yes – Instrumental
   Yes – Own Music
9. Name and genre of piece of own music brought with
10. Any other comments

Appendix D: Email Requesting Completion of Music Usage Survey

Dear Student,

I am currently conducting a study on the impact of music on the academic performance of undergraduate students, as part of my postgraduate Master's degree in Social and Psychological Research at the University of the Witwatersrand. I would greatly appreciate it if you could complete a 10 minute survey that asks about your music usage and studying behaviours on https://www.surveymonkey.com/r/MusicUsage

If anything is unclear or you would like more information, please do not hesitate to contact me on the email address below.

I will be collecting data until the **31st of October 2017**.

Many thanks for your time!

Warmest regards

Pakeezah Rajab (1363620)

Pakeezah93@gmail.com

Appendix E: SAKAI notification

SAKAI invitation

Call for Participants

Dear Student,

For my Masters research project, I am conducting a study on the impact music listening has on academic performance, under the supervision of Dr Michael Pitman. I would like to invite you to participate in my study by completing a survey on music usage behaviours at:
https://www.surveymonkey.com/r/MusicUsage

If you are currently registered for Psychology I (PSYC1009 or PSYC1010), you will be able to claim 1% towards your research participation mark for the year.

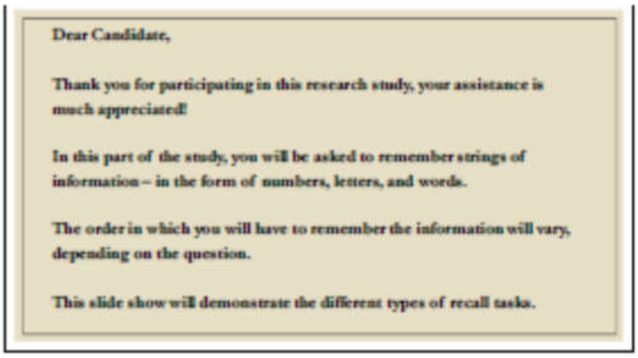
A full participant information sheet is included on the first page of the online survey. If you would like more information regarding the study, please do not hesitate to contact me on pakeezah93@gmail.com

Many thanks for your time!
Warmest regards
Pakeezah Rajab (1363620)

Appendix F: The Memory Span Task Demonstration

*The below slides are available for viewing in video format on Youtube on https://youtu.be/LNXbXFwoz44

1



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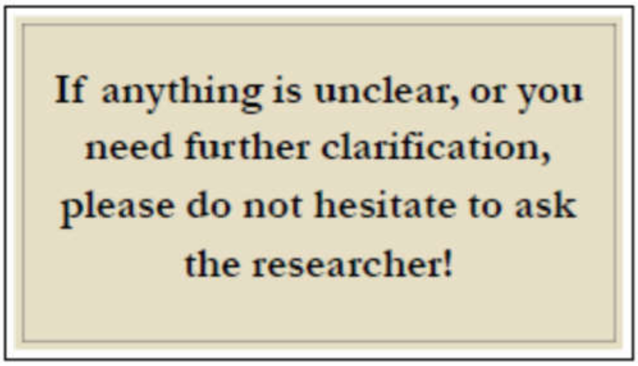

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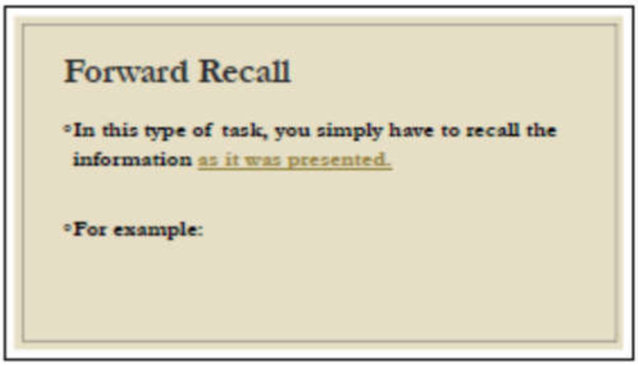


4

CAT, DOG, SNAKE, RABBIT, ELEPHANT

Type what you remember in the order it was presented:

You would type:

CAT, DOG, SNAKE, RABBIT, ELEPHANT

5

Backward Recall

- For this type of task, you have to recall the information in the reverse order from which it was presented.
- For example:

6

9, 1, 7, 3, 8

Type what you remember in reverse order from what was presented:

You would type:

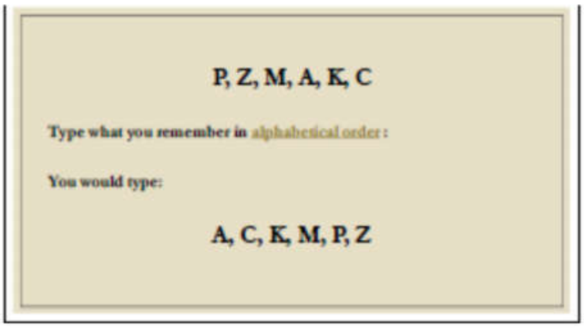
8, 3, 7, 1, 9

7

Ascending Recall

- In this type of task, you have to recall the information in alphabetical or ascending order. You may also be asked to do both.
- For example:

8



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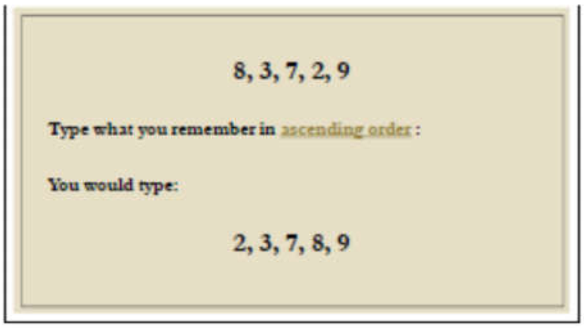

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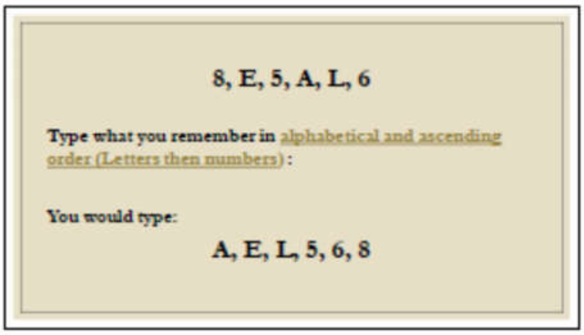

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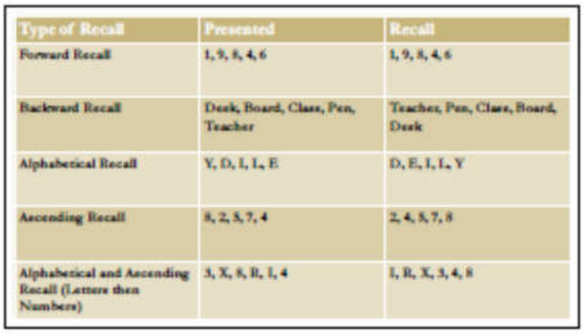

Type of Recall	Presented	Recall
Forward Recall	1, 9, 8, 4, 6	1, 9, 8, 4, 6
Backward Recall	Desk, Board, Class, Pen, Teacher	Teacher, Pen, Class, Board, Desk
Alphabetical Recall	Y, D, I, L, E	D, E, I, L, Y
Ascending Recall	8, 2, 5, 7, 4	2, 4, 5, 7, 8
Alphabetical and Ascending Recall (Letters then Numbers)	3, X, 8, R, I, 4	I, R, X, 3, 4, 8

12

13

Appendix G: Information Sheet for Survey

Dear Participant,

Thank you for showing interest in the study 'The Impact of Music on the Academic Performance of Undergraduate Students'!

As part of my postgraduate Master's degree in Social and Psychological Research at the University of the Witwatersrand, I am conducting a study on the impact music has on academic performance – with a particular focus on working memory. This research study will be supervised by Dr Pitman.

Your participation is entirely voluntary and you are under absolutely no obligation to participate in the research – there are no direct advantages or disadvantages to participating. Even if you do indicate that you would like to participate in the study, you still have the right to withdraw, should you change your mind, and this will not be held against you in any way.

This survey is online, therefore please ensure that you have a stable Internet connection whilst completing it. It should take no longer than 10-15 minutes to complete.

On the next page, you will be asked to complete a consent form, adding your name and student number – however, this is to assist in allocating participation marks, and this will not be linked to the actual survey. Your responses will be treated confidentially, and that the resulting report will not have any identifying information. Thus, anonymity in reports/theses/publications can be guaranteed, as well as confidentiality of data.

If you choose to participate, and complete the consent form, it indicates that you understand and agree to the above. You are also giving me permission to use all data collected for analyses, reporting and possible publication or presentation.

You are more than welcome to ask for general feedback on the outcomes of the study, after analyses have been completed; however, keep in mind that no individual feedback would be possible, since no identifying information would be linked to the data to ensure confidentiality.

Please see the contact details below and if you have any questions or concerns or want to follow up on the research results, please do not hesitate to contact me. Thank you again for your interest.

Ms Pakeezah Rajab

Pakeezah93@gmail.com

Dr Michael Pitman (supervisor)

Michael.Pitman@wits.ac.za

Appendix H: Information Sheet for Experiment

Dear Participant,

Thank you for showing interest in the study 'The Impact of Music on the Academic Performance of Undergraduate Students'!

As part of my postgraduate Master's degree in Social and Psychological Research at the University of the Witwatersrand, I am conducting a study on the impact music has on academic performance – with a particular focus on working memory. This research study will be supervised by Dr Pitman.

You have received this letter because you have expressed interest in the study, and therefore, I take this opportunity to invite you to participate in this research. Participation is entirely voluntary and you are under absolutely no obligation to participate in the research – there are no direct advantages or disadvantages to participating. Even if you do indicate that you would like to participate in the study, you still have the right to withdraw, should you change your mind, and this will not be held against you in any way.

The assessments will be conducted individually, at a time that suits you, on the East Campus (Umthombo Building). Before we start with the assessments, I will require you to sign an informed consent form – meaning, if anything in this letter is not clear, please let me know as soon as possible so I can clear up any confusion and you can make an informed decision. After gaining your consent, I will show you a 5 minute video that will explain the tasks, so please do not be nervous about what to expect. I will also be there throughout the process, so if something in the video did not make sense, I will gladly explain it by other means. However, please do not stress about these tasks; you have likely been exposed to similar types of tasks many times before. After the video, I will then ask you to complete 3 assessments for me, whilst listening to different types of music. These assessments should not take more than 10 minutes each to complete. Once those have been done, you will be asked to complete a quick, 10-question survey for me, where you will be able to provide feedback on the previous 3 assessments. The total time therefore should be, maximum 45 minutes. This investment of your time would be highly appreciated!

For the assessments, I do request that you please bring a PIECE OF YOUR FAVOURITE MUSIC ON A USB/FLASH DRIVE/CD. We will need it during the assessment time, and you can take it back when you leave. The procedure also requires the use of headphones – a pair will be available, but should you want to bring your own pair with for your own comfort, this is fine with me.

Due to the fact that I will be conducting the assessments with you individually, I cannot promise anonymity. However, I can promise that your responses will be treated confidentially, and that the resulting report will not have any identifying information. Thus, anonymity in reports/theses/publications can be guaranteed, as well as confidentiality of data.

If you choose to participate, and sign the consent form, it indicates that you understand and agree to the above. You are also giving me permission to use all data collected for analyses, reporting and possible publication or presentation.

You are more than welcome to ask for general feedback on the outcomes of the study, after analyses have been completed; however, keep in mind that no individual feedback would be possible, since no identifying information would be linked to the data to ensure confidentiality.

Please see the contact details below and if you have any questions or concerns or want to follow up on the research results, please do not hesitate to contact me. Thank you again for your interest.

Ms Pakeezah Rajab

Pakeezah93@gmail.com

Dr Michael Pitman (supervisor)

Michael.Pitman@wits.ac.za

Appendix I: Emailed Invitation to Part Two – Experiment

Dear Student,

Thank you IMMENSELY for participating in Part One (the Survey) of my study "The Impact of Music on the Academic Performance of Undergraduate Students".

As per your indication of being interested in Part Two (the Experiment), please find attached the Information Sheet with all relevant details concerning the experiment. Please do not hesitate to contact me if something in this Information Sheet does not make sense, or if you have concerns around participation marks (for 1st year students), or general queries.

Please also find attached the Consent Form that you will need to fill out. (You can fill this out yourself electronically and send it back to me via email, or you can print it out and give me a hard copy on the day that you choose to do the experiment. I will also have copies with me on the day).

Furthermore, to confirm receipt of this email, could you kindly reply with:

1. Which days would be most convenient for YOU to be tested?
2. What times would best suit YOU to be tested?

I will then try to slot you in at that day and time or at least as close to that time as possible, I will also send you a reminder the day before :)

For this last block of 2017, I am unfortunately only available after 13:30 on Tuesdays, and between 9:30 and 16:00 on Wednesdays and Thursdays. I am unavailable on Mondays and Fridays. Apologies for this inconvenience.

THANK YOU once again for your interest and time. It really means a lot!

Have a wonderful week ahead! :)

If you want, you may forward this email to any friends or peers (undergraduates) you think might be interested in participating.

Kind regards

Pakeezah Rajab

Contact Number: 083 608 4090

Appendix J: Consent Form

I ________________ (*name and surname*) ______________ (*student number*) consent to participate in the research study assessing the impact of music on academic performance of undergraduate students, conducted by Pakeezah Rajab and supervised by Dr. Michael Pitman.

I have been informed of the following:

- The general purpose of the study
- That my participation is voluntary and that I may withdraw at any time without any consequences, positive or negative
- There are no risks or benefits associated with participating
- I shall not be harmed or injured during the assessment process
- My personal details and assessment results will be kept confidential
- No identifying information will be traced back to my results, and therefore no identifying information will be included in the resulting research report
- I am aware that the results of the study will be reported in the form of a research report as a requirement for the partial completion of the postgraduate Master's in Social and Psychological Research degree.
- This research report may also be published in a journal, be made available online and may be presented in conferences
- I may request general feedback from the study. Contact details have been made available to me.

Participant

Date ______________

Appendix K: Unique ID instructions

Constructing your identification code

1. The first letter of your NAME

2. The first letter of your SURNAME

3. The last FOUR numbers of your student number

Example:

Name - Grace

Surname - Nkomo

Student Number – 546897

Unique Identifying Code - GN6897

Appendix L: Significant Cross-tabulation Tables

Table i - Cross-tabulation for association between ease of distraction and distraction by song

			How often do you get distracted by the song playing while studying?				
			Never	Rarely	Sometimes	All the time	Total
Do you get distracted easily?	Yes	Count (n)	7	35	64	38	144
		% within Do you get distracted easily?	4.9	24.3	44.4	26.4	100.0
	No	Count (n)	12	16	16	6	50
		% within Do you get distracted easily?	24.0	32.0	32.0	12.0	100.0
Total		Count (n)	19	51	80	44	194
		% within Do you get distracted easily?	9.8	26.3	41.2	22.7	100.0

Table ii – Cross-tabulation for association between studying with music and whether or not they should be mixed

			I study with music.					
			Never	2	3	4	Always	Total
Studying and music should not be mixed	Strongly Agree - never mix	Count (n)	34	6	1	0	1	42
		% within Studying and music should not be mixed	81.0	14.3	2.4	0.0	2.4	100.0
	2	Count (n)	9	6	4	1	0	20
		% within Studying and music should not be mixed	45.0	30.0	20.0	5.0	0.0	100.0
	3	Count (n)	11	20	23	9	2	65
		% within Studying and music should not be mixed	16.9	30.8	35.4	13.8	3.1	100.0
	4	Count (n)	6	1	9	12	7	35
		% within Studying and music should not be mixed	17.1	2.9	25.7	34.3	20.0	100.0
	Strongly Disagree - always mixed	Count	1	2	2	9	16	30
		% within Studying and music should not be mixed	3.3	6.7	6.7	30.0	53.3	100.0
Total		Count (n)	61	35	39	31	26	192
		% within Studying and music should not be mixed	31.8%	18.2%	20.3%	16.1%	13.5%	100.0%

Table iii – Cross-tabulation for association between distraction by song while studying and whether or not studying and music should be mixed

			How often do you get distracted by the song playing while studying?				
			Never	Rarely	Sometimes	All the time	Total
Studying and music should not be mixed	Strongly Agree - never mix	Count (n)	8	2	9	23	42
		% within Studying and music should not be mixed	19.0	4.8	21.4	54.8	100.0
	2	Count (n)	2	3	9	6	20
		% within Studying and music should not be mixed	10.0	15.0	45.0	30.0	100.0
	3	Count (n)	6	17	34	9	66
		% within Studying and music should not be mixed	9.1	25.8	51.5	13.6	100.0
	4	Count (n)	0	17	15	4	36
		% within Studying and music should not be mixed	0.0	47.2	41.7	11.1	100.0
	Strongly Disagree - always be mixed	Count (n)	3	12	13	2	30
		% within Studying and music should not be mixed	10.0	40.0	43.3	6.7	100.0
Total		Count (n)	19	51	80	44	194
		% within Studying and music should not be mixed	9.8	26.3	41.2	22.7	100.0

Table iv – Cross-tabulation of association between representative study setting and least distracting experimental setting

			The least distracting setting was the...			
			White Noise	Instrumental	Own Music	Total
Which setting was most representative of your typical study setting?	White Noise	Count (n)	9	2	0	11
		% within Which setting was most representative of your typical study setting?	81.8	18.2	0.0	100.0
	Instrumental	Count (n)	0	4	2	6
		% within Which setting was most representative of your typical study setting?	0.0	66.7	33.3	100.0
	Own Music	Count (n)	11	3	4	18
		% within Which setting was most representative of your typical study setting?	61.1	16.7	22.2	100.0
Total		Count (n)	20	9	6	35
		% within Which setting was most representative of your typical study setting?	57.1	25.7	17.1	100.0

Table v – Cross-tabulation of association between representative study setting and most distracting experimental setting

			The most distracting setting was the...			
			White Noise	Instrumental	Own Music	Total
Which setting was most representative of your typical study setting?	White Noise	Count (n)	0	1	10	11
		% within Which setting was most representative of your typical study setting?	0.0	9.1	90.9	100.0
	Instrumental	Count (n)	3	1	2	6
		% within Which setting was most representative of your typical study setting?	50.0	16.7	33.3	100.0
	Own Music	Count (n)	6	8	4	18
		% within Which setting was most representative of your typical study setting?	33.3	44.4	22.2	100.0
Total		Count (n)	9	10	16	35
		% within Which setting was most representative of your typical study setting?	25.7	28.6	45.7	100.0

Table vi– Cross-tabulation of association between worst memory span assessment performance and supposed question set difficulty

			Worst performance					
			1.0	1.3	2.0	2.3	3.0	Total
Did you find any set of questions more difficult than the others?	No	Count (n)	0	0	0	0	7	7
		% within Did you find any set of questions more difficult than the others?	0.0	0.0	0.0	0.0	100.0	100.0
	Yes - White Noise	Count (n)	2	1	1	0	0	4
		% within Did you find any set of questions more difficult than the others?	50.0	25.0	25.0	0.0	0.0	100.0
	Yes – Instrumental	Count (n)	2	0	2	3	1	8
		% within Did you find any set of questions more difficult than the others?	25.0	0.0	25.0	37.5	12.5	100.0
	Yes - Own Music	Count (n)	1	0	3	1	9	14
		% within Did you find any set of questions more difficult than the others?	7.1	0.0	21.4	7.1	64.3	100.0
Total		Count (n)	5	1	6	4	17	33
		% within Did you find any set of questions more difficult than the others?	15.2	3.0	18.2	12.1	51.5	100.0

Table vii – Cross-tabulation of association between most distracting experiment setting and whether or not participant studies with music

			The most distracting setting was the…			
			White Noise	Instrumental	Own Music	Total
I study with music.	Never	Count (n)	2	0	10	12
		% within I study with music.	16.7	0.0	83.3	100.0
	2	Count (n)	0	3	1	4
		% within I study with music.	0.0	75.0	25.0	100.0
	3	Count (n)	1	2	1	4
		% within I study with music.	25.0	50.0	25.0	100.0
	4	Count (n)	1	3	1	5
		% within I study with music.	20.0	60.0	20.0	100.0
	Always	Count (n)	3	0	2	5
		% within I study with music.	60.0	0.0	40.0	100.0
Total		Count (n)	7	8	15	30
		% within I study with music.	23.3	26.7	50.0	100.0