The Effect of Music on Recall Ability of Words and Digits

Claire Jameson

Submitted in partial fulfilment of the requirements of the Bachelor of Arts degree (Psychology Specialization) at DBS School of Arts, Dublin.

Supervisor: Dr J. Murphy

Head of Department: Dr S. Eccles

April 2013

Department of Psychology

DBS School of Arts

Contents

Page

Acknowledgements

I would like to thank my supervisor Dr Jonathan Murphy and the lecturers and staff at DBS for their help and guidance throughout the process of writing this thesis. To my fellow classmates and my family and friends for their unwavering encouragement and support throughout the past few months I owe a debt of gratitude. Finally, to the participants who agreed to partake in this research, thank you.

Abstract

The aim of the current study is to investigate the effect of music on recall ability of words and digits. A PowerPoint slideshow of sequences of words and digits was presented to a sample of 84 DBS Undergraduate students. Participants were allocated to one of three conditions; silent, vocal/pop or instrumental. In the two music conditions background music was played for the duration of the experiment. Participants had to recall the presented stimuli onto a recall sheet.

The findings suggest that music has a negative effect on the recall of words but it has no significant effect on the recall of digits. The participants recalled digits better than words, across all music conditions and there was no significant difference in gender recall ability.

Introduction

General Memory

Memory is a process that retains, retrieves and uses information that is no longer present (Goldstein, 2011). There have been many researchers (Atkinson & Shiffrin, 1968; Baddeley, 1986; Cowan, 1988; Ericsson & Kintsch, 1995) that have proposed models and theories in an attempt to explain what memory is and what it does. It is proposed that memory has multiple structures including sensory memory, short-term memory, long-term memory and more recently, working memory. Each of these structures provides different stages in the memory process and has different time-spans for different information. For the purpose of the current study, working memory is of predominant interest but it is also beneficial to be familiar with short-term memory and long-term memory in order to have a better understanding of working memory.

Short Term Memory and Long Term Memory

Immediate recall of stimuli occurs in the working memory (WM), as proposed by many researchers. Much of the research in WM appears to contradict other studies of the same subject with researchers including Baddeley (1986), Cowan (1988) and Ericsson and Kintsch (1995) proposing relatively diverse models and theories. For some time previous to the investigation of the WM many researchers focused on short-term memory (STM) as being responsible for immediate recall as it holds information for a short period of time (Baddeley, Eysenck & Anderson, 2009). The majority of information that is stored in STM is eventually forgotten with a minority managing to access long-term memory (LTM). There is a 15 -20 seconds duration of STM providing there is no rehearsal of information presented (Goldstein, 2011). A popular measure of STM is digit span which attempts to explain how many digits a person is able to recall. Typically, a person can recall between 5 and 9 digits

(Miller, 1956). The digit span approach is a similar approach to that which is used in the current experiment, as will be discussed later. Krueger and Salthouse (2011) examined the serial position effect and they proposed that the recency effect, where last items on a list are bettered recalled, is due to the most recent items being still readily available in the STM at the time of recall. Krueger and Salthouse also discovered that recency recall is less dependent on episodic memory than primacy recall or recall of the middle items on a list because of its availability in STM.

Although the modal model of memory proposed by Atkinson and Shiffrin (1968) included sensory memory, STM and LTM, Baddeley noticed that this model did not account for the ability to perform two simultaneous tasks, for example reading whilst remembering certain numbers (Goldstein, 2011). Consequently, Baddeley (2000) proposed a WM which is a STM storage system as well as having the ability to manipulate the information that is presented.

Working Memory

This WM model consists of a phonological loop, central executive system and a visuospatial sketchpad (Baddeley & Hitch, 1974). According to Baddeley, the phonological loop deals with the storage of verbal and auditory information; the visuospatial sketchpad stores spatial and visual information, thus is particularly relevant to this study; and the central executive acts as a mediator between the LTM and WM and primarily divides attention between the different activities that the person is performing, for example recalling visual stimuli that is presented to a person whilst listening to background music. This is indicative of the central executive's attempt at ignoring "irrelevant" information (e.g. background music) whilst concentrating on "relevant" information (e.g. visual stimuli to be recalled). Hulme and Tordoff (1989) studied acoustic similarity on serial recall and their findings suggest support for Baddeley and Hitch's WM model. Hulme and Tordoff suggested that

development of the articulatory loop, as is present in the WM model of Baddeley and Hitch (1974), is important in explaining the connection between the development of recall accuracy, age and speech rate. Further investigation has since led Baddeley to re-consider WM by adding the episodic buffer to its composition which he believes provides more storage as well as enabling a connection with LTM, however, he admits the full extent of the episodic buffer is not yet known (Baddeley et al., 2009). Furthermore, even though the WM has been extensively studied, there is not much evidence of its function for music (Williamson, Baddeley & Hitch, 2006). There is, however, neuroscientific evidence emerging to suggest that the cortical areas that are typically related to storage and rehearsal of WM are also active when a person is listening to music (Brown, Martinez, Hodges, Fox and Parsons, 2004).

Recall and Recognition

In order to effectively examine recall accuracy it is important to be aware of the difference between recall and recognition. It has been suggested that twice as much information can be recognised as can be recalled (Hollingworth, 1913). In an attempt to differentiate between recall and recognition, the former has been described as a memory process without a focal element, but where a background or setting is evident. When a person attempts to recall something, the desired recollection appears in fragments, for example letters of a word. Recognition, conversely, is almost the same process but in opposite order. That is, the focal element is present but the context from which this element is recognised is not apparent (Hollingworth, 1913). In studies that are investigating recall accuracy there is also a possibility that recognition of the stimuli will influence the participant's scores. Baddeley, Thomson and Buchanan (1975) proposed that temporary representations that participants make when shown the stimuli are lost within 2 seconds unless rehearsal refreshes them. Given that participants are sometimes shown a list or sequence of stimuli it has been

suggested that these representations that last no more than 2 seconds can be lost in the process of recalling the sequence (Hitch, Towse & Hutton, 2001).

Individual Differences in Recall Ability

While WM models aim to solidify the construct and capacity of human beings memory storage universally, there have been numerous studies carried out that are focused on highlighting the many individual concepts that inevitably vary recall ability from person to person. Some people perform better than others at immediate recall tasks and for years researchers have been investigating what it is that makes some people recall more accurately than others. The variations found thus far have been external factors as well as internal factors. There was a study carried out in 1983 by Crawford and Stankov that emphasised individual differences. It focused on primacy and recency effects and the cognitive abilities that are linked to this particular type of recall. The findings suggest that primacy effect is related to processing speed, with higher speed of processing leading to greater recall of the first few items in a list. One limitation of this study, however, is that it did not address the middle segment of items. Hulme and Tordoff (1989) investigated the effects of speech rate, word length and acoustic similarity on serial recall. The results from their study suggest that recall accuracy increases with age, corresponding with increased speech rate.

Krueger and Salthouse (2011) examined the recall ability of words based on different list segments of those words. In this study they dealt with serial position effect which is identified by the first and last segments of a list being better recalled than the middle segments. This is in turn broken into the primacy effect, where the first items on a list are better recalled, and the recency effect, where the last items are better recalled. As will be discussed later, the serial position effect approach may be relevant to the current study because it is based on lists of stimuli and an immediate recall at the end of each list, which is the same approach as that taken by the current study.

Whilst the study of Krueger and Salthouse was a structural approach to explaining recall ability, Unsworth, Spillar and Brewer (2010) focused on associations between WM, reasoning skills (which includes number series) and SAT verbal and quantitative measures of performance on each of the positions of stimuli on a list of words. The findings suggest that recall of items across every position was connected with WM measures of reading and operation span tasks which subsequently implies that recall ability of every item position may be affected by the cognitive abilities of the person (Krueger & Salthouse, 2011).

Furthermore, a greater recency effect is associated with people who have a higher level of crystallised and fluid intelligence (Krueger & Salthouse, 2011).

Individual differences in recall ability are also concerned with any possible gender differences. There has been substantial research examining how cognitive abilities may differ between genders. Larrabee and Crook (1993) found that females outperform males in some cognitive tasks including verbal-learning-remembering tasks, name-face association, and first-last-name associations learning. The findings from the longitudinal study by Maitland, Intrieri, Schaie and Willis (2000) suggest that females outperformed males on verbal recall tasks and perceptual speed tasks and in contrast, males performed better than females on spatial orientation tasks. In other research, Lawton and Hatcher (2005) examined gender differences regarding visuo-spatial short-term memory. Participants were shown images that appeared separately and then had to recognise the resulting image when the two separate images were merged together. Males performed better than females; they were more accurate and quicker at recognizing the image. The varying results from such cognitive tasks as the ones just mentioned are encouraging for the current study to investigate possible gender differences in recall ability of words and digits.

Music and Recall

There is substantial research that considers individual differences in recall ability but another consideration when investigating the effect of music on such tasks is the type or style of music that is played whilst the participants are performing the task (Konz, 1962; Smith, 1961). Research has found that WM is particularly vulnerable to the effects of both vocal and instrumental music with regard to cognitive and linguistic abilities (Armstrong & Sopory, 1997; Iwanaga & Ito, 2002; Rauscher, Shaw & Ky, 1993). Freeburne and Fleischer (1952) suggested that music has no affect, either positive or negative, on difficult mental tasks; there were five groups, each comprising of approximately 40 students, given a piece of material on Russian history. Each group had to read this material and then complete a comprehension test. Four out of the five groups had music playing in the background, comprising of classical, pop, semi-classical and jazz, during the experiment. The remaining group acted as the control group and performed in silence. The findings somewhat support Freeburne and Fleischer's hypothesis because even though the group that performed to jazz music read significantly quicker than the other groups, the comprehension task results did not differ significantly between any of the music groups or the control group.

In a similar study in 1982, Etaugh and Ptasnik had forty students read a passage either in a silent environment or while listening to music. The students had to state whether they normally study in a silent environment or with music in the background. After this, the participants either relaxed or read other material that was not related to the first passage. The students who usually studied whilst listening to background music appeared to have a better grasp of the material when they had read it in the presence of music, while the students who usually studied in silence performed better in this study in silence. The findings of Etaugh and Ptasnik (1982) appear to contradict those of Freeburne and Fleischer (1952). A limitation of the former study, however, is the effect of familiarity of music whilst carrying out cognitive tasks. Participants' familiarity with the music they hear can also influence recall

ability. This limitation was taken into consideration for the current study in the choosing of the music conditions and for that reason 'Price Tag' by Jessie J ft. B.o.B. (Cornish, Gottwald, Kelly & Simmons, 2010) was decided to be the most appropriate song given it was the most played song on Irish radio in 2011. This could help to lessen the effect of familiarity on the results. Smith (1985) addressed background music as being an influential factor in affecting memory. He proposed that in an immediate recall test, it is best to play the same music during the task itself and during the recall period as the music can act as a retrieval cue. This is a similar approach to the one used in the current study.

Since the mid 90's there has been great interest in the effect of music on worker productivity and this led Furnham and Bradley (1997) to conduct their study investigating the distraction of background music on workers performance on cognitive tests. In particular they were interested in 'pop music'. Participants were given a reading comprehension test and an immediate and delayed recall memory test. All tasks were performed either in silence or whilst pop music played in the background. The results found that music had a significant effect on the recall memory tests, with poorer performances evident than when performed in silence, although the study did only examine one particular type of music. Hallam and Price (1998) investigated the effect of background music on the maths test performance of emotionally and behaviourally disturbed children. All pupils performed better on their maths test when the background music was introduced, particularly 'calming' music. The music did not interfere with the children's concentration but it did suppress their 'stimulus hunger' which may have enabled better concentration.

Stimuli to be Recalled

In order to fully understand these cognitive processes the items that are being recalled must also be taken into consideration. The majority of studies in the area of immediate recall deal primarily with reading tasks or recall of words and images, with fewer researchers

employing numbers and/or digits in their studies. The current experiment aims to address this relatively unstudied aspect of recall ability. For example, Williamson et al. (2006) investigated the effect of pitch proximity on recall accuracy of non-musicians but they used words and letters as the stimuli. The study involved two experiments where the melodies that were to be recalled had been manipulated. The effects of this manipulation were compared to the recall of verbal stimuli (of words and letters) that were similar or dissimilar in phonological terms. The researchers examined the theory that acoustically similar sequences of words and/or letters are more difficult to recall than acoustically dissimilar stimuli. A significant effect of pitch proximity was found in both of the experiments. Furthermore, the infamous classic memory span experiments, typically involving recall sequence of stimuli, are made up of words and/or letters (Williamson et al., 2006).

The Current Study

With so much emphasis on words, images and letters on recall tasks and very little dealing with numbers it is difficult to get a complete understanding of immediate recall ability. The aim of the current study is to investigate the relatively unstudied area of recall ability of words and digits. By using Mendelssohn's instrumental music (Mendelsshon, 1836) and Jessie J's pop song 'Price Tag' the study will be examining whether or not 'soothing' music has a similar effect to 'arousing' music, as was proposed by Hallam and Price (1998), as well as controlling for the effect of the presence of lyrics which is also thought to be influential (Cassidy & MacDonald, 2007).

It is hypothesised that music will have a significant effect on the accuracy of recall of numbers (in digit form and word form), across gender. There will be a significant difference in recall ability between the groups that listen to music whilst performing the task and the group that performs in silent condition (SC). There will be a significant difference in recall ability between participants who perform the task in the vocal conditions group (VC) and

those who perform in the instrumental conditions group (IC). There will be a significant difference between the ability to recall numbers in digit format (DF) and word format (WF).

Methodology

Participants:

A convenience sample of 84 full-time and part-time students from DBS was used for this study. There were 57 females and 27 males. Respondents participated in one of three groups: 29 participants in the vocal group; 28 participants in the instrumental group; and 27 participants in the silence (control) group. Some participants were recruited through an advertisement on Facebook about the experiment, on a DBS Facebook page that the researcher had access to. The rest were recruited by the researcher speaking to classes during their lecture time and asking for their participation. Participants did not receive any incentives for participating.

Design:

This is a mixed between-within groups design. The between- groups variables are gender and music condition, while the within-groups variables are digits and words. The independent variables are gender, stimuli (digits and words) and music condition (vocal, instrumental and silence) while the dependent variable is recall accuracy of stimuli. The instrumental group and the vocal group are the experimental groups and the silent group acts as the control. Participants in each of the three conditions were randomly allocated to their group. They responded to an ad on Facebook and were informed of the time and place of the experiment. The researcher also attended lectures of students and verbally informed them of the experiment. The experiments were run in the same room, over a two week period with multiple slots for each condition in order to facilitate participants.

Materials:

The stimuli presented to participants include 52 words (see Appendix A) and 52 digits (see Appendix B). The words are all numbers, ranging from one to nine inclusive. The same range of numbers is used for the digit stimuli. This range was chosen because the numbers

are all single figure and it would be more difficult to control for the use double figure numbers as well as single figure (see table 1 for examples).

Table 1. *Example of Words and Digits used in the first three sequences of words and digits respectively.*

	Words	Digits
Sequence 1	Six, one, two	9,1,7
Sequence 2	Four, nine, eight, three	2,4,9,3
Sequence 3	Five, one, four, eight, seven	6,8,5,1,2

There was no corresponding order in the presentation of the words with that of the digits. The researcher attempted to keep the correspondence different to prevent the chance of participants copying the answers from words to the answers for digits. The researcher picked the numbers from a hat in order to decide the arrangement of each sequence and if any correspondence was occurring a different number would be chosen. There are eight sequences of words followed by eight sequences of digits. The first sequence comprises of 3 stimuli, with each following sequence gaining one extra stimulus with the eighth and final sequence having 10 stimuli. A pilot study on family and friends of the researcher revealed that ten stimuli is an ideal number as people appear to struggle with recall of six or seven stimuli. In terms of the words stimuli, the length of each word was of concern to the researcher. An attempt was made to have a mixture of long and short words in each sequence. A slideshow of the stimuli was made on PowerPoint and presented to participants via a computer and projector. The song for the vocal condition is 'Price Tag' by Jessie J ft B.O.B (see appendix C) and was chosen because it is the most played song on Irish radio stations in 2011, so it was thought that that would help to control for familiarity effect. The song for the instrumental condition, Mendelleshon 'Songs Without Words' Op. 38, No. 4, in A Major,

covered by Barenboim (see Appendix D), was chosen as it was used in a previous study (Fried & Berkowitz, 1979). The music was attached to the PowerPoint slideshow so there was no need for an MP3 player.

Access to YouTube enabled the acquisition of both songs but they had to be edited to lengthen them in order for them to play for the entire duration of the slideshow.

Apparatus:

A recall sheet, as designed by the researcher, was provided to each participant (see Appendix E). There was also a cover sheet accompanying the recall sheet, outlining consent, the aim of the experiment and the instructions to follow to complete the experiment correctly (See appendix F). The computer used was Dell. The software used by the researcher to edit the music is called Pinnacle Studio.

Procedure:

When participants were seated the researcher verbally addressed them outlining the instructions that they had to follow and the ethical issues, including how participants could withdraw at any time but once they hand up their recall sheet it will be irretrievable due to its anonymity. There is a box to tick on the cover sheet if they agree to informed consent to participate. The verbal instructions from the researcher corresponded with the written instructions on the cover sheet of the recall paper. Participants had to state whether or not they suffer from visual or hearing impairments or from dyscalculia as all of these impairments would inhibit their recall accuracy. They also had to state whether they are male or female. The researcher explained that the slideshow would present 8 sequences of words followed by 8 sequences of digits with blank slides appearing at the end of each sequence, which was their cue to write down what stimuli they could recall from that sequence. For each sequence there is a designated space on the recall sheet. Participants were also told that they could write their answers in word or digit format, whichever they preferred. Participants

were informed by the researcher that the experiment is examining recall ability and they were not informed of the effect of music until the debriefing.

Once the slideshow finished, participants were asked if they had any questions regarding the study. Any questions put forward were answered to the best of the researcher's ability. The researcher provided their email address to participants. If they wanted to be informed of the results of the study, they could email the researcher requesting this information. The researcher also explained the true purpose of the experiment, explaining the three different conditions/groups and the reasons for the music.

It took approximately 5 minutes for introductions and instructions and to hand out the recall sheets. The slideshow lasts 8 minutes and the debriefing and collection of recall sheets lasts approximately 5 minutes.

Each slide with a stimulus appears for 3 seconds and the blank slides appear for 10 seconds each. So, the first sequence which consists of 3 stimuli takes 9 seconds while the eighth sequence which consists of 10 stimuli takes 30 seconds to complete.

Results

Normality

Prior to proceeding with the statistical tests, a test for normality was run to identify whether or not the results agree with the assumptions of normality. The test of normality suggests the results do agree with the assumptions of normality. The skewness and kurtosis levels of Words (Skewness= -1.68, Kurtosis= 3.07) and of Digits (Skewness= -1.37, Kurtosis= 1.66) are both below 5 so parametric tests were used.

Descriptive Statistics

Table 2: *Descriptive Statistics of Recall Accuracy*

Variable	Mean	Standard Deviation
Word Recall	40.29	9.30
Digit Recall	45.45	5.54

The overall mean of the Word Recall score was lower than the overall mean of the Digit Recall score (See Table 2). Participants scored higher on Digit recall than on Word recall. A mean score of 40+ suggests that participants scored above average, with more correct answers than errors.

Table 3: *Descriptive Statistics of Recall Errors*

Variable	Mean	Standard Deviation
Word Recall Errors	11.70	9.32
Digit Recall Errors	6.68	5.59

The overall mean of the Word Recall Error score was higher than the overall mean of the Digit Recall Error score (see Table 3). Participants made more errors on recall accuracy of Words than on recall accuracy of Digits.

The number of errors made corresponds with the number of correct scores; as the errors score increases, the accuracy scores decrease.

There are twice as many female participants as male participants.

Inferential Statistics

Recall between Gender

Table 4: *An Independent Samples T-test table displaying the differences of recall of Words and Digits between Gender.*

Variables	**Stimuli**	**Mean**	**SD**	***t***	***df***	***p***
Recall Accuracy-Males	**Words**	40.67	7.36	.257	82	.798
	Digits	43.81	6.48	-1.894	82	.062
Recall Accuracy-Females	**Words**	40.11	10.14	.257	82	.798
	Digits	46.23	4.91	-1.894	82	.062

Note: p significant at .05 level.

Male participants had a higher recall score of words but a lower recall score of digits than females (See Table 4).

The word recall scores of males (M=40.67, SD=7.36) was higher than the word recall score of females (M=40.11, SD= 10.14). The 95% confidence limits showed that the population mean difference of the variables lies somewhere between -3.784 and 4.906. On closer inspection, an independent samples t-test found that there was not a statistically significant difference between word recall accuracy of males and females (t (82) = .257, p =.798). Therefore the null hypothesis can be accepted.

The digit recall scores of males (M=43.81, SD= 6.48) was lower than the digit recall score of females (M= 46.23, SD= 4.91). The 95% confidence limits showed that the population mean difference of the variables lies somewhere between -4.949 and .122. An independent samples t-test found that there was not a statistically significant difference between recall accuracy of

digits of males and females (t (82) = -1.894, p = .062). Therefore the null hypothesis can be accepted.

Recall between Music Conditions

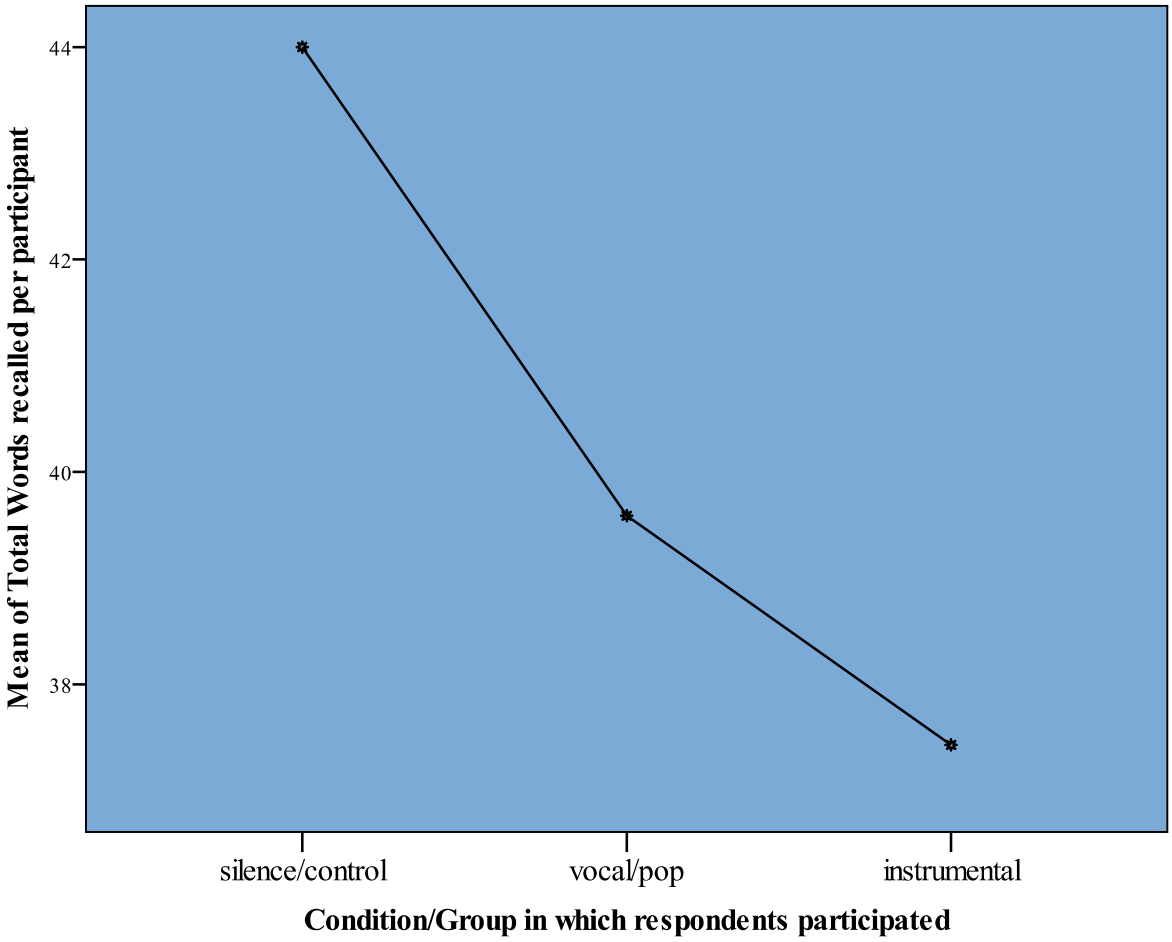

Figure 1: *Graph showing the distribution of Word Recall Scores of the Music Condition*

Figure 1 shows the mean scores for Word Recall in each music condition. It shows that the silent/ control group has a higher mean than the vocal and instrumental groups and that the instrumental group appears to have a lowest mean recall of words out of all three conditions.

A one-way analysis of variance showed that the recall scores of Words differed significantly between the three music conditions (F (2, 81) = 3.80, p= .026). More specifically Tukey HSD post hoc analyses highlighted that the silent/control group (M= 44, SD= 7.81) scored significantly higher on recall accuracy than the instrumental group (M= 37.43, SD= 12.05, p=

.022) but did not score significantly higher than the vocal group (M= 39.59, SD= 6.12, p= .165).

Tukey HSD also highlighted that there was no significant difference in recall accuracy of words between the vocal group and the instrumental group (M= 37.43, SD= 12.05, p=.639).

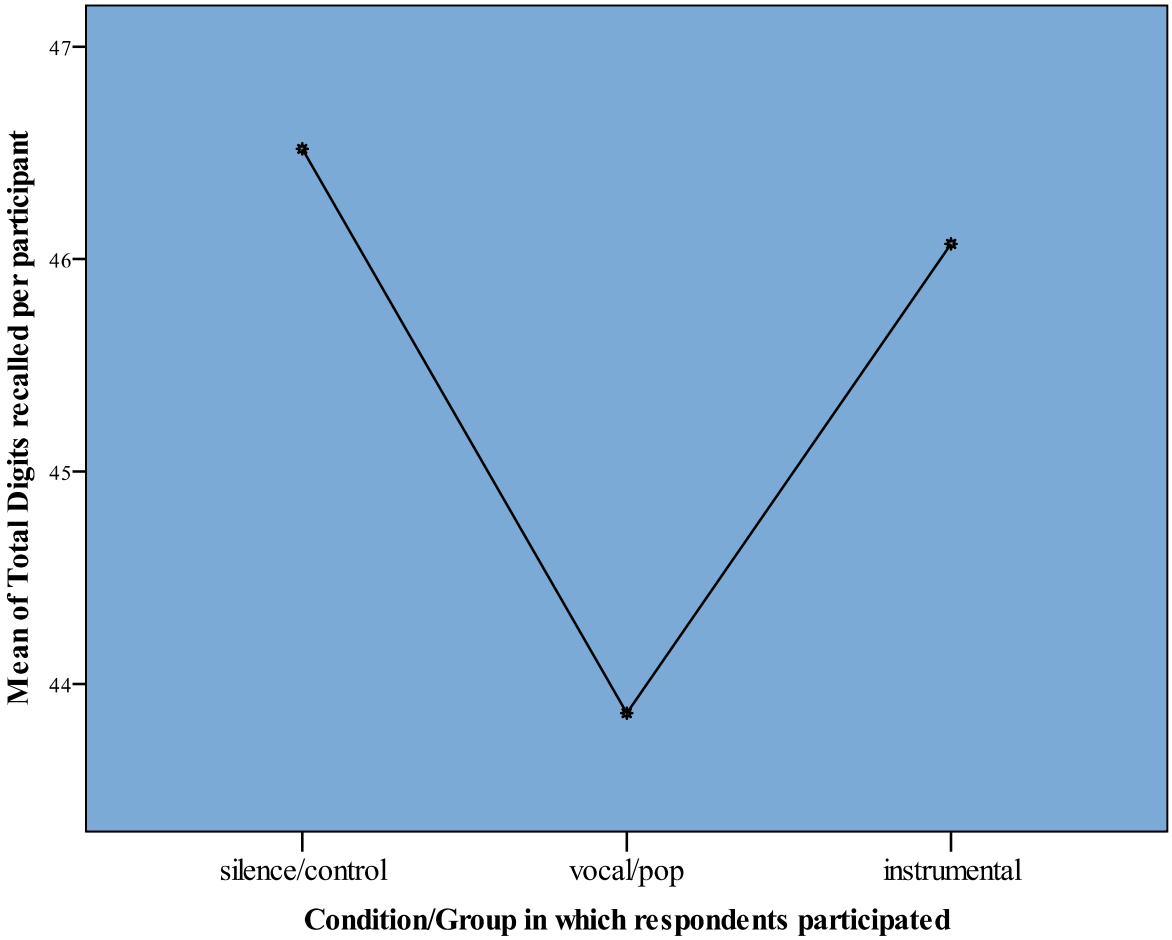

Figure 2: *Graph showing the Digit Recall Scores of the Music Conditions.*

Figure 2 shows a greater mean for the silent/control group (M= 46.52, SD= 4.48) in terms of recall accuracy of Digits between the three conditions. The vocal group (M= 43.86, SD= 7.09) appears to have the lowest Digit recall score compared to the instrumental group (M= 46.07, SD= 4.32) and the silent/control group.

A one-way analysis of variance also showed that there was no significant difference in recall accuracy of digits between the three music conditions (F (2, 81) = 1.91, p= .155).

Recall within Music Conditions

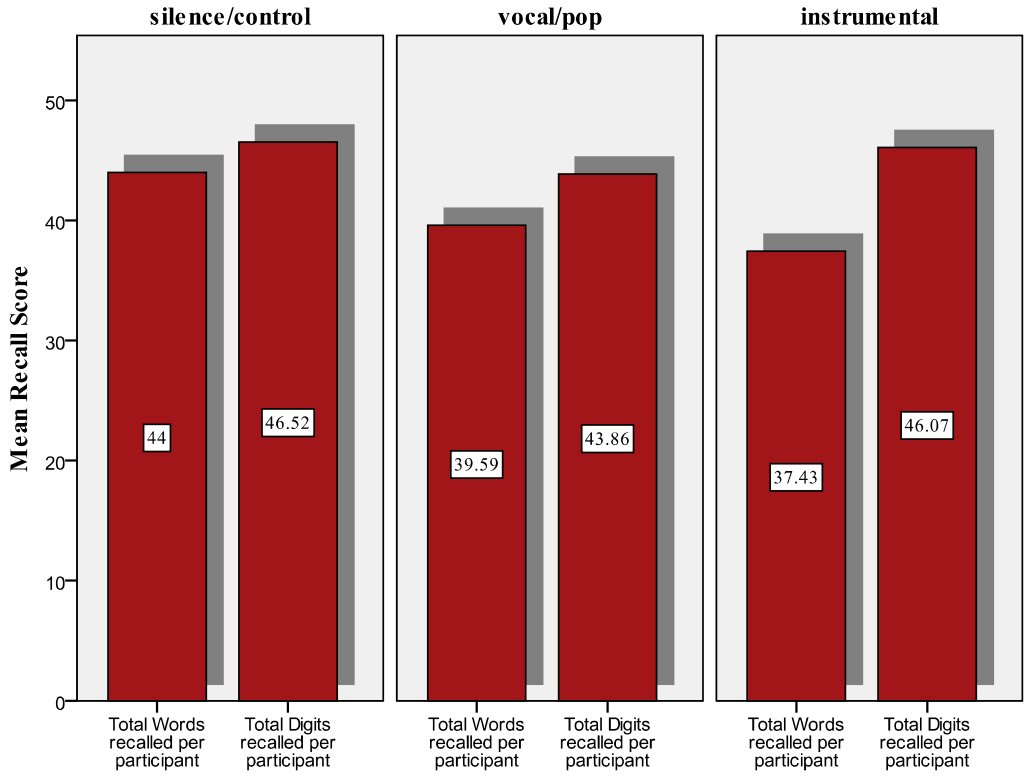

Figure 3: *A Bar Chart showing that digits were better recalled than Words in each of the music conditions.*

Figure 3 shows the mean distribution of Words and Digits within each Music Condition. It shows that in each of the conditions, the mean Digit Score is higher than the mean Word score.

Dependent t-tests found a significant difference in recall accuracy of words and digits, with digits better recalled than words in the vocal group ($t(-4.16) = 28$, $p<.001$), the instrumental group ($t(-3.78) = 27$, $p=.001$) and in the silent/ control group ($t(-2.08) = 26$, $p=.048$).

Discussion

The aim of the current study is to investigate the effect of music on recall ability of words and digits. The results are varied, with some supporting the hypothesis and others rejecting the hypothesis. It was hypothesised that there would be a significant difference in recall accuracy of males and females but the results of the current study do not support this. It was also hypothesised that music would have an effect on recall ability, with the type of music also being influential. The results suggest that there was a significant difference in recall ability of words between the three music conditions, with the silent condition outperforming the two music conditions, but there was no such difference for digits. Within each of the music conditions, it was hypothesised that there would be a difference in recall accuracy of words and digits. The results suggest that there is a significant difference within each group, with digits being better recalled than words overall.

The results of the current study suggest that background music did affect participant's performance on recall. Furthermore, the participants that performed the task in the vocal group had the lowest digit recall scores out of the three groups. This result supports the results of the study carried out by Furnham and Bradley (1997) which found vocal or 'pop' music playing in the background lessened cognitive performance. In that particular case the subjects were employees as oppose to students and there was only two conditions that the experiment was concerned with; 'pop' and silence. The genre of music was similar in both studies but the samples of participants were quite different yet both studies yielded similar results. This may suggest generalisation support for the findings of the current study and that of Furnham and Bradley as the samples are quite diverse but the results are similar. Similarly, Cassidy and MacDonald (2007) studied the effect of lyrics on performance of cognitive tasks and their findings also suggest music has a negative effect on the performance of cognitive tasks. In that particular study, the vocal music negatively affected all five of the cognitive

tasks carried out. Immediate recall was one such task which was impeded as was numerical recall. In the current study vocal music also affected immediate recall but it was the recall or words rather than digits that was affected. The reason behind this contrasting result may be because there were four other tasks involved in the Cassidy and MacDonald study, some of which included symbols and words whereas, in contrast, the current study employed much fewer tests in a shorter length of time with fewer variation of stimuli.

The instrumental condition yielded significant results in relation to the recall of words compared to the silence group. The latter group resulted in higher recall accuracy than the former group but the instrumental group did have higher recall scores for digits than the vocal group, although the scores still suggest a negative effect when compared to the control group scores. This would suggest the negative effect of lyrics is more influential than the negative effects of instrumental, or lyric free, music. Smith (1985) found instrumental music, especially acoustic, helps recall accuracy when dealing with lists of words, although this study did have a 48 hour recall interval as oppose to immediate recall. The findings from the current study would suggest this may not be the case as the instrumental group scored the lowest in word recall out of both of the music conditions and the silent/control group. This finding suggests instrumental music may have a negative effect on word recall performance, more so than vocal music or silent condition. The contrasting results between the current study and the study by Smith (1985) must be taken within context as although both studies were dealing with recall of words and the effect of music on this recall, the study by Smith was concerned with context-dependent memory rather than working memory. Future research may benefit from investigating both the immediate recall and delayed recall of words under the same music conditions. This may help to explain the dynamics of memory and the differing abilities of the various aspects of memory.

The findings of the current study also disagree with those of Hallam and Price (1998). This study was investigating the effect of music on maths performance of behavioural and emotionally disabled children and the results suggest that 'calming' music improved the children's maths performance. The instrumental song chosen for the current experiment (Mendelssohn) was used in previous studies (Fried & Berkowitz, 1979) because of the 'soothing' effect it appears to have. Although the song used in this study appears to be calming and soothing it did not have the same effect on recall accuracy as that used in the Hallam and Price study. There is another factor to be considered, however, when comparing the current results with those of Hallam and Price. The participants 'stimulus hunger' in that study was calmed by the music which enabled better concentration and consequently better recall accuracy than when performing in silence. This effect is not the case for the current study and it may be suggested that the calming effect of the Mendelssohn music inhibited the concentration of the participants as there was no 'stimulus hunger' or substantial level of excitation that would consume this calming effect. Another possibility is that the Mendelssohn song was not perceived as being calming by the participants of this current study. In future research it may be helpful to gain the participants opinion or perception of the music they perform to, this might enable a better understanding of the subsequent results. Furthermore, the current study did not use the same participants in each condition. A possibility for future research in the area of the effect of music on recall ability would be to test the same sample in silent (i.e. control) conditions and then test them in a music condition, as was the case in the Hallam and Price study. This might demonstrate a more reliable varying difference, if any, between a controlled condition performance and a performance in a music condition. The samples from both studies are vastly different (emotionally and behaviourally disabled children and undergraduate students) but the findings from both suggest that instrumental music does effect cognitive performance, but in the case of the

study with the children it is a positive effect and in the case of the students it is a negative effect.

As the findings of the current study suggest that music has a negative effect on recall accuracy there is a contradiction with the results of the Freeburne and Fleischer (1952) study that proposed that music has no effect, positive or negative, on difficult mental tasks. Although this study examined the performance on comprehension tasks rather than words and digits, there was no significant difference between results in any of the four music conditions and the control group. As the Freeburne and Fleischer experiment and the current study used different tasks to examine the effect of recall ability, which may account for the contrasting results, future experiments looking at the area of music and recall may choose to involve both comprehension tests and number recall tests to investigate the difference between recall accuracy of different cognitive tasks. Although not completely relevant to the recall of digits and words a better understanding of such cognitions may lead to explanations for the differing effects that music can have on cognitive tasks. These implications could be important for various fields including studying, worker productivity and competency when performing a cognitive task.

Etaugh and Ptasnik (1982) also investigated reading comprehension ability in silence and in music conditions. The participants who performed in the music condition and who also admitted to usually studying with music in the background performed better than the participants who usually study in silence. Music in the background disrupted the performance of those who usually study in silence and it enhanced the performance of those who usually study with music playing. There appears to be a familiarity effect and the possibility of this type of effect was not considered in the current study. Unlike in the research of Etaugh and Ptasnik, there was no consideration in the current study for distinguishing between participants who usually perform mental tasks in silence or in a music environment. This

might be an important factor to account for in future research as it could mislead the results if the normal condition in which the participant usually carries out these cognitive tasks is not apparent to the researcher. The everyday use of headphones and earphones to listen to music is so common now that it is important to understand the possible implications of this music on cognitive task performance.

In the current study digits were better recalled than words within the vocal, instrumental and control group. Between these three groups there was no significant recall accuracy difference of digits so this may suggest that music did not impair recall (of digits), unlike in the experiment carried out by Williamson et al (2006). In that study the researchers found that recall of words or letters is negatively affected by music when the stimuli sound similar. The recall of words in the current study was also negatively affected by music, with words being better recalled in the silent group than in either of the two music groups. As some of the results from the current study supports the findings of Williamson et al (2006) in terms of music impairing word recall it would be interesting if more research had been carried out on the area of digit recall to examine whether or not the digit recall scores of the current study can be further supported. In the study by Williamson et al each of the sequences of letters were six letters long whereas in the current study the sequence length varied, getting progressively longer as the experiment proceeded. Although there was no statistical examination of the recency effect or serial position effect in the current study, the data does suggest the longer sequences near the end of the experiment are more difficult to recall than the first few shorter sequences. By using varied sequence lengths the results may be more substantial than when a standard sequence length is used because the position effects can be examined and may yield more detailed results. Future experiments investigating recall effect may benefit from employing varied sequence lengths, as the current study did, and also statistically examining the position effect in order to identify the possible effect of the length

or size of stimuli on recall accuracy. Hulme and Tordoff (1989) proposed that word length does have a substantial effect on recall accuracy, particularly serial recall. Their research also suggests that age is an important factor in recall ability. The current study used a sample of students so further research may be necessary on different generations of people in order to identify any possible differences in recall ability between children and adults.

Another possible explanation for the better recall of digits than words could be processing speed of participants. This individual difference was not accounted for in the current study but it appears to have some relevance to the area of word and digit recall. Baddeley et al (1975) proposed that recall ability stems from an individual's ability to recite stimuli in a 2 second time space. As the current study presented each stimulus for 3 seconds the time space for recitation should have been sufficient. In the space of time that the participants in the current study were recalling each sequence (10 seconds) any representations they may have made with each stimuli might have been lost, which may have impacted on recall speed (Hitch et al, 2001).

Another hypothesis that must be rejected is that there would be a significant difference between recall ability of male and female participants. Although there were more than twice as many females than males in the current study there was no significant difference in their performance. Males had a higher score than females in terms of word recall scores but it was not substantial enough to make the difference significant. Had there been a more equal number of males and females maybe the results would have been different. In contrast, females had a higher recall score of digits than males but this difference was not great enough to merit a statistical significance either. Previous research has not placed too much emphasis on gender differences in recall ability as it appears so far that there is no significant difference, particularly in relation to word and digit recall. The findings of the current study do not support the findings of Maitland et al (2000) where females

outperformed males on recall, although it was a verbal recall test rather than written. Future research may benefit from testing both verbal and written recall and investigating the difference between both types of recall as it has been suggested that different types of recall consume different cognitive abilities. This information will help researchers to gain a broader understanding of the area of recall.

The main weaknesses in the current study have been outlined in this discussion already, with suggestions for future research in the area of the effect of music on recall ability. A principal limitation is that participants were tested once and in one condition. In future research it might be beneficial to test participants in a silent condition and a music condition because their baseline performance scores can then be compared to their performance scores in a music condition. The sample used in the current study was predominantly female which was not ideal for examining gender differences of recall accuracy. The mean scores obtained suggest a difference between male and female participants but if there were a more equal number of both genders the study may have yielded significant results as previous research that has been mentioned has found gender differences do exist in some cognitive tasks.

A positive factor of this study is the choice of words used for recall. By using the names of numbers the words are likely to be neutral to participants. When names of objects or places are used participants may have some affiliation to the word which would influence their recall of that stimulus. The current study appears to have controlled for that factor. The main strength of the results of this study is that digits are better recalled than words and that the ideal condition for performing a cognitive recall task is in silence. This knowledge may be beneficial to various fields including students, workers and musically inclined persons. As previous research suggests (Etaugh & Ptasnik, 1982) many students study with background music playing. The results of the current study suggest that music does negatively affect digit

recall which may be important in the area of mathematical studies. As well as possibly impairing studying and learning, the findings may also generalise to the presence of background music inhibiting cognitive abilities of workers. Future research may investigate the most popular music that is played in work environments where cognitive tasks are predominant in that area of work. Results may yield implications for worker productivity and efficiency. The results of the current study suggest that music has a negative effect on immediate cognitive performance. Future research could investigate the effect of music on long-term cognitive performance to identify if the implications are similar or dissimilar to the implications on immediate cognitive performance.

The main findings of the current study are that there is a significant difference in recall ability of words and digits amongst Undergraduate DBS students, with digits being better recalled than words. There was no significant effect of music on the recall of digits, but there was a significant negative effect of music on the recall of words with the silent condition outperforming both the vocal/pop condition and the instrumental condition. The study also yielded results to suggest that there is no significant difference between male and female performance on recall tests. The results support those of some previous research and reject other previous findings.

References

Armstrong, G.B., & Sopory, P. (1997). The Effects of Background Television on Phonological and Visuo-spatial Working Memory. *Communications Research, 24,* 459-480.

Atkinson, R.C., & Shiffrin, R.M. (1968). Human memory: A proposal system and its control processes. In K.W. Spence & J.T. Spence (Eds.). *The Psychology of learning and motivation.* New York: Academic Press

Baddeley, A.D. (1986). *Working Memory.* New York: Oxford University Press

Baddeley, A.D. (2000). Short-term and working memory. In E. Tulving & F.I.M. Craik (Eds.), *The Oxford hand-book of memory* (pp.77-92). New York: Oxford University Press

Baddeley, A.D., & Hitch, G.J. (1974). Working Memory. In G.A. Bower (Ed.), *The Psychology of learning and motivation* (pp. 47-89). New York: Academic Press

Baddeley, A.D., Thomson, N. & Buchanan, M. (1975). Word length and the structure of short-term memory. *Journal of Verbal Learning and Verbal Behaviour, 14,* 575-589.

Brown, S., Martinez, M.J., Hodges, D.A., Fox, P.T., & Parsons, L.M. (2004). The song system of the human brain. *Cognitive Brain Research, 20,* 363-375.

Cassidy, G., & Macdonald, R.A.R. (2007). The effect of background music and background noise on the task performance of introverts and extraverts. *Society for Education, Music and Psychology Research, 35*(3), 517-537.

Cornish, J., Gottwald, L., Kelly, C., & Simmons, B. R. (2010). Price Tag (Recorded by Jessie J and B.o.B). On *Who You Are* (CD). Buffalo, New York City, USA: LAVA, Island. Retrieved from http://www.youtube.com/watch?v=qMxX-QOV9tI

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention and their mutual constraints within the human information processing system. *Psychological Bulletin, 104,* 163-191.

Crawford, J., & Stankov, L. (1983). Fluid and crystallised intelligence and primacy/recency components of short-term memory. *Intelligence, 7,* 227-252. Doi: 10.1016/0160-2896(83)90016-8

Ericsson, K.A., & Kintsch, W. (1995). Long-term working memory. *Psychological Review, 102,* 211-245.

Etaugh, C. & Ptasnik, P. (1982). Effects of studying to music and post-study relaxation or reading comprehension. *Perceptual and Motor Skills, 55,* 141-142.

Freeburne, C.M. & Fleischer, M.S. (1952). The effect of music distraction upon reading rate and comprehension. *Journal of Educational Psychology, 43,* (2), 101-110.

Furnham, A., & Bradley, A. (1997). Music while you work: the differential distraction of background music on the cognitive task performance of introverts and extraverts. *Applied Cognitive Psychology, 11*(5), 445-455.

Goldstein, E.B. (2011). *Cognitive Psychology* (3rd ed.). Wadsworth Cengage Learning

Hallam, S., & Price, J. (1998). 'Can the use of background music improve the behaviour and academic performance of children with emotional and behavioural difficulties?' *British Journal of Special Education, 25*(2), 88-91.

Hitch, G.J., Towse, J.N., & Hutton, U. (2001). What limits children's working memory span? Theoretical accounts and applications for scholastic development. *Journal of Experimental Psychology: General, 130,* 184-198.

Hollingworth, H.L. (1913). Characteristic Differences between recall and recognition. *The American Journal of Psychology, 24*(4), 532-544.

Hulme, C., & Tordoff, V. (1989). Working memory development: The effects of speech rate, word length, and acoustic similarity on serial recall. *Journal of Experimental Psychology, 47,* (1), 72-87.

Iwanaga, M., & Ito, T. (2002). Disturbance effect of music on processing of verbal and spatial memories. *Perceptual and Motor Skills, 94,* 1251-1258.

Konz, S.A. (1962). The effect of background music on productivity of two different monotonous tasks. Paper to Human Factors Society, New York.

Krueger, L. E., & Salthouse, T.A. (2011). Influence of cognitive abilities and age on word recall performance across trials and list segments. *American Journal of Psychology, 124*(3), 291-300

Larrabee, G.J., & Crook, T. (1993). In D.F. Halpern (2000). *Sex Differences in Cognitive Abilities* (3rd ed.). Mahwah, New Jersey: Lawrence Erlbaum Associates Publishers.

Lawton, C.A., & Hatcher, D.W. (2005). Gender differences in integration of images in visuospatial memory. *Sex Roles, 53,* 717-725.

Maitland, S.B., Intrieri, R.C., Schaie, K.W., & Willis, S.L. (2000). Gender Differences and changes in cognitive abilities across the lifespan. *Aging, Neuropsychology, and Cognition, 7* (1), 32-53.

Mendelsshon, F. (1836). Andante in A Major. Vol.3, op.38, No. 4. On *Songs Without Words.* Germany. Retrieved from http://www.youtube.com/watch?v=dAFrRuSaLiI

Miller, G.A. (1956). The magical number seven, plus or minus two: Some limits on or capacity for processing information. *Psychological Review, 63,* 81-97.

Rauscher, F.H., Shaw, G.L., & Ky, K.N. (1993). Music and spatial task-performance, *Nature, 365,* 611.

Smith, S.M. (1985). Background music and context-dependent memory. *American Journal of Psychology, 6,* 591-603.

Smith, W.A. (1961). Effects of industrial music in a work situation requiring complex mental activity. *Psychological Reports, 8,* 159-162.

Unsworth, N., Spiller, G.J., & Brewer, G.A. (2010). The contributions of primary and secondary memory to working memory capacity: An individual differences analysis of immediate free recall. *Journal of Experimental Psychology: Learning, memory and cognition, 36*(1), 240-247. Doi: 10.1037/a0017739

Williamson, V.J., Baddeley, A.D., & Hitch, G.J. (2006). Music in the working memory? Examining the effect of pitch proximity on the recall performance of non-musicians. In M. Baroni, A.R. Adelessi, R. Caterina, M. Costa (Eds.), *Proceedings of the ICMPC9 (Bolognia: Italy),* pp. 1581-1590. Retrieved from http://www.marcocosta.it/icmpc2006/pdfs/50.pdf

Appendices

Appendix A:

Lists of Words Stimuli as they appear in the sequences

Six, one, two

Four, nine, eight, three

Five, one, four, eight, seven

Three, nine, two, seven, four, one

Two, eight, six, three, five, nine, four

Seven, one, five, two, eight, four, three, nine

One, seven, three, five, two, nine, four, eight, six

Nine, two, one, eight, three, five, six, four, seven, one

Appendix B:

List of Digits Stimuli as they appear in the sequences

9, 1, 7

2, 4, 9, 3

6, 8, 5, 1, 2

4, 7, 3, 8, 6, 5

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

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

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

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

Appendix C:

Link to the song used for the Vocal/Pop group

http://www.youtube.com/watch?v=qMxX-QOV9tI

Appendix D:

Link to the Mendelssohn song used in the Instrumental group

http://www.youtube.com/watch?v=dAFrRuSaLiI

Appendix E:

Recall Sheet

Please circle which of the following you are: MALE or FEMALE

Follow the researcher's instructions. At the instructed time, write down the words/digits you can remember from the slideshow on the screen.

STOP WRITING WHEN INSTRUCTED TO BY THE RESEARCHER.

Words

1._____

_____

2._____

_____

3._____

_____

4._____

_____

5._____

_____

6._____

_____

7._____

_____

8._____

_____

Please turn over to continue

Digits

1._____
_____

2._____
_____

3._____
_____

4._____
_____

5._____
_____

6._____
_____

7._____
_____

8._____
_____

Thank you for participating in this experiment.

Appendix F:

Recall Ability

This experiment will be submitted for examination as part of the researcher's Final Year Project.

Please answer the following questions if you are interested in participating

Are you 18+ years of age? yes no

Unfortunately if you are not 18+ years of age you will not be able to participate in this experiment.

Do you suffer from any of the following?

- Hearing impairment yes no
- Visual impairment yes no
- Dyscalculia yes no

Unfortunately if you suffer from any of the above mentioned impairments you will not be able to participate in this experiment.

All information/data received in this experiment will be stored in SPSS in a password protected file. The researcher and their supervisor will have access to this information.

All information in this experiment is anonymous; therefore you will not be able to withdraw your data once it has been given to the researcher.

Please tick the box if you agree to informed consent to participate €