The Effects of Music Complexity on Memory in Introverts and Extroverts

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The Effects of Music Complexity on Memory in Introverts and Extroverts

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Abstract

Past research has supported the idea that introverts and extroverts differ on cognitive levels under a variety of conditions. The present study was designed to answer the question of whether or not the complexity of background music would affect the performance of both introverts and extroverts on a memory task. Eysenck’s Personality Questionnaire was filled out by participants whose memory was then tested using a paired-associates learning task. No significant main effect was found for either levels of extroversion or music complexity on memory. No interaction was found between levels of extroversion and music complexity. Possible methodological errors are discussed.

Key words: Human, memory, introvert, extrovert, music

Cognitive differences in different personality types have been a topic of interest for decades. Human beings seem to differ a lot in their performance on cognitive tasks, especially memory. Many theories have been generated for these differences from a physiological perspective, but both personality and cognitive psychologists have attributed these differences to psychological phenomena. Memory, in particular, has been a topic of interest due to the vast differences in an individual’s ability to recall information. Some people seem to have an easier time retrieving memories than others. Often, personality theorists question whether different personality traits are what make memory better in certain individuals. For example, individuals who were found to be high in neuroticism reported more memory failures than those who were low on the neuroticism spectrum, which may explain why students often report failing to remember what they studied during an exam (Neupert, Mroczek, & Spiro, 2008). Cognitive
theorists tend to examine memory differences under particular conditions and whether or not these conditions impair, enhance, or have any effect on the ability to recall information. For example, the myth that chewing gum enhances memory was disproved after discovering that participants performed significantly worse on serial recall tasks involving letter lists while they were chewing gum. It was speculated that gum chewing reduced the cognitive capacity needed when processing sequences (Kozlov, Hughes, & Jones, 2012).

A vast amount of cognitive research seems to support that memory is impaired when there is another factor taking away from one's cognitive capacity. A lack of distraction seems to reflect one's entire capacity as a baseline measure, with any subsequent factors impairing memory further. Previous research on the effects of music, a factor that could potentially use up cognitive energy, on tasks have shown a variety of results. This theory seems to hold true when consider tasks that do not require much cognitive energy, such as repetitive tasks like those of factory workers, and also when you consider tasks that do require much cognitive energy like studying for an exam. Listening to music while performing repetitive tasks has been shown to increase productivity in the workplace (Fox & Embrey, 1972; Reynolds, 1943). Repetitive tasks don't require much concentration or cognitive energy. The monotony of doing repetitive tasks for so long may actually take away from cognitive energy as boredom may cause one's mind to wander in an attempt to seek stimulation. Music has also been shown to increase work quality and decrease the amount of time that workers are found to be off-task (Lesiuk, 2005). The data was collected from computer information systems developers in their workplace while they were doing their job, so no new learning was taking place. While previous research seems to support music being favourable in repetitive tasks, other research has shown music to be a deterrent in cognitive tasks, especially those that require learning. In a task involving serial recall of
sequences of 9 digit numbers, both unattended vocal and instrumental music hindered one's ability to retain information compared to a control group with no music. Vocal music negatively affected memory more than instrumental music did (Salamé & Baddeley, 1989).

The fields of cognitive psychology and personality psychology overlapped when some researchers became interested in seeing if there was a difference in cognitive performance between introverts and extroverts when background music was a factor. It was famously proposed in personality psychology that introverts and extroverts differ in terms of cortical arousal, or rather the amount of activity occurring in the reticular formation of the brainstem. Extroverts have lower levels of cortical arousal and therefore tend to seek out external stimulation to reach an optimal level of arousal. Introverts, however, have higher levels of cortical arousal, so too much stimulation can be draining (Eysenck, 1967). Eysenck's hypothesis has been tested on numerous projects and has mostly held true. For example, it was found that when given a monotonous task, extroverts tended to add more variety when given choices and various ways of completing the task (Hill, 1975). Another study found that introverts were more likely to seek quieter environments to study in, such as a library. Extroverts preferred to study in areas where there were more opportunities to socialize and where the noise levels were higher, though extroverts were also not as meticulous as introverts when it came to studying in an area matching their preferred level of arousal (Campbell & Hawley, 1982). The theory has even been supported from a biological perspective. Blood flow distribution of introverts and extroverts was tested and showed that introverts had higher blood flow in the temporal lobes, which may signify an increased connection between the cerebral cortex and the limbic system. The increased connection might account for higher levels of activity in the cerebral cortex for introverts (Stenberg, Risberg, Warkentin, & Rosén, 1990). Therefore, it can be assumed that introverts and
extroverts may perform differently on tasks under different conditions due to their differences in levels of optimal arousal.

The theory that there would be differences in cognitive performance between introverts and extroverts under a variety of stimulating conditions has been supported by research. Introverts were found to perform significantly worse on both memory recall tasks and reading comprehension tasks than extroverts when pop music played in the background (Furnham & Bradley, 1997). The theory expanded with the introduction of different types of music while participants performed memory tasks. Despite outperforming the extroverts under control conditions, the cognitive abilities of introverts continued to decline when music that had high arousal potential and negative affect was played in the background while performing tasks involving immediate, free, numerical, and delayed recall (Cassidy & MacDonald, 2007).

Past research on the subject has supported the theory that there are differences between introverts and extroverts on a cognitive level, but fails to answer the questions of how exactly they differ. Of course, the presence of some sort of background noise seems to deter the cognitive performance of introverts. The world, however, is filled with constant background noise and yet introverts continue to succeed at seemingly the same activities as introverts. Therefore, it can be assumed that there must be some specific property of music or background noise that must have more of an effect of the cognitive abilities of introverts that does not have the same effect on extroverts.

The present study examines differences in memory between introverts and extroverts based on music complexity. It is predicted that, based on Eysenck's theory, introverts will perform best under a condition in which no music is present during the retention of information and will perform worse when complex music is being played. Introverts, having higher levels of
cortical arousal, should find any music to be detrimental to their ability to memorize as they become overstimulated. Extroverts should perform best under a condition where simple music is playing. Extroverts, having lower levels of cortical arousal, should find a lack of music to be under-stimulating when performing a cognitive task and should deter their ability to focus. However, it is possible for an extrovert to become overstimulated and it is therefore predicted that the complex music will be too much stimulation for even an extrovert to handle. On the contrary, it is possible for an introvert to become under-stimulated as well, but this should not be present in the current study as several other factors, such as being out of one's comfort zone, will be stimulating the introvert.

Method

Participants

Forty-nine participants of varying ages and occupation were used with the youngest participant being 18-years-old and the oldest participant being 69-years-old. An approximately even mix of males and females were used. Participants who scored 7/13 or higher on Eysenck's Personality Questionnaire (EPQ; Eysenck, 1963) were considered to be extroverts while participants who scored 6/13 or less on the questionnaire were considered to be introverts. 27 participants scored as extroverts and 22 participants scored as introverts. All participants had normal hearing.

Materials

Music was played using Sony stereo headphones from an iPod at the same volume for each participant. Two different styles of music were used: "simple" and "complex". The two types of music differed in terms of tempo, dynamics, mood, and structure. The 2nd movement from Symphony no. 9 in E Minor by Antonín Dvořák was used as the simple music piece. It has
a tempo of around 40 BPM. The dynamics in this piece stay relatively stable in the piano region with several brief crescendos. Despite the symphony being written in a minor key, the movement used was written in a major key and as such, it had a much happier mood to it. The structure of the piece follows a typical sonata form with a repeating theme being played throughout. The repetition and soft dynamics of the piece make it very easy to listen to. The finale from Symphony no. 6 in A Minor by Gustav Mahler was used as the complex music piece. The tempo in this piece is very inconsistent and often very fast at up to 150 BPM. There are many drastic changes in dynamics and tempo throughout, with the majority of the piece being played above a forte level. The mood of this piece is very dark as it was written to reflect three hardships in the composer's life, each of which is represented by a large hammer blow which punctuates the movement. The piece alternates many times between a major and a minor key, which makes the mood incredibly unstable.

A modified version of the EPQ was used to determine whether a participant was introverted or extroverted. Prior to modification, the questionnaire consisted of 64 questions measuring neuroticism, extroversion, sociability, and impulsiveness, with some questions left unscored. The questionnaire was modified to include only questioned that pertained to levels of extroversion. The resulting questionnaire consisted of 13 yes-or-no questions in which one choice indicates a tendency towards extroversion and the other a tendency towards introversion. Examples of these questions are "Do you often crave excitement?" and "If you want to learn about something, would you rather do it by reading a book on the subject than by discussion?" The results of the EPQ were later hand scored with a score of 0-13 being possible, a higher score meaning that the participant has more of a tendency towards extroversion and a lower score meaning that the participant has more of a tendency towards introversion (Eysenck, 1963).
reliability and validity of the EPQ has been extensively studied. The EPQ always has an internal consistency of .8 or higher. The test-retest reliability consistently scores above .7, giving it satisfactory reliability (Kline, 1993). The validity of the scales on the EPQ is well-supported by extensive experimental work. Rearranging the structure of the EPQ has in the past revealed that each of the items on the test were completely separate from each other (Barrett & Kline, 1980).

The memory test involved a paired-associate learning task consisting of 21 word pairs. The words were generated from an online random word generator to ensure that they could not be connected in any logical way. The words consisted of nouns, adjectives, and verbs of various complexities, though all words were simple enough that all participants would know their definition. The test itself consisted of all 21 word pairings with one word, either the first word or the second word, missing. The word pairs were also presented in a different order than they were on the initial study sheet. The font was the same on both the study sheet and on the memory test. Both used a 12 pt sans-serif font that was clearly legible. All words were written entirely in uppercase letters.

**Procedure**

Participants filled out Eysenck’s Personality Questionnaire and were instructed to take their time reading over each question carefully. They were then randomly divided into one of three groups to perform a memory task regardless of their performance on the Personality Questionnaire: the no music group, the simple music group, or the complex music group. On the memory task, participants were given the list of word pairings which they had 4 minutes to study. Under the no music condition, participants studied these words in silence. Under the simple music condition, participants studied these words while listening to the simple music. Under the complex music condition, participants studied these words while listening to complex music.
After the study time was up, they were given two minutes to complete the memory test where they had to write down the missing word in each pair.

**Results**

Figure 1 shows the progression of both the introverts and extroverts by comparing the percentage of the amount of words they were able to recall to the background noise present. The performance of the extroverted group decreased while the complexity of music increased. The introvert group performed best under the no music condition, but performed poorly under the complex music condition and even worse under the simple music condition.

A 3 X 2, between-subjects analysis of variance on music complexity and memory revealed no significant main effect, $F(2, 30) = 0.44, p > 0.05$. The participants did not differ significantly in their performance when they were under the no music condition ($M=0.45, SD=0.23$), the simple music condition ($M=0.36, SD=0.28$), or in the complex music condition ($M=0.38, SD=0.18$). There was also no significant main effect of level of extroversion on memory, $F(1, 30) = 1.14, p > 0.05$. The introverted group seemed to have performed just as well ($M=0.36, SD=0.21$) as the extroverted group ($M=0.44, SD=0.25$). Finally, there was no significant interaction between music complexity and level of extroversion, $F(2, 30) = 0.71, p > 0.05$.

**Discussion**

The results of this experiment may not have yielded a significant main effect, but they do follow the predicted results to some extent. The extroverts performed identically to how they were predicted to perform. They performed much worse under the complex music condition compared to the other two, and the simple music condition seemed to be favourable. The introverts, however, produced unexpected results. It was predicted that they would perform best
Figure 1. Percentage of words remembered over the no music condition, the simple music condition, and the complex music condition between introverted and extroverted participants.
under the no music condition and the worst under the complex music condition. While they did perform their best under the no music condition, there is a perplexing drop in test scores under the simple music condition. While it remains unclear as to why the introverts performed so poorly under the simple music condition, especially compared to the complex music condition, several factors should be considered.

There have been countless factors that have been shown to affect memory that were not controlled in the present experiment. One of the biggest factors that was not controlled was age. A wide range of ages were used during this study, with the youngest participant being 18 years old and the oldest participant being 69 years old. Previous studies have demonstrated that working memory tends to decrease with advanced age (Chen & Naveh-Benjamin, 2012). Therefore, many of the differences in test scores might not have been attributable to how extroverted a person is, but rather the imbalance of ages under each of the conditions. Another age-related factor that was not controlled was occupation. The majority of the participants under the age of 25 were enrolled in some form of a post-secondary educational facility. It can be assumed that those who spend most of their days studying and trying to retain information will perform much better on a memory task than those who do not. Many adults who are already in a career that does not require studying would likely not have the same ability to retain information after such a short period of time.

Some past research has supported the idea that there are differences between the working memory in introverts and extroverts even without external stimulation, such as the presence of music. One researcher noted that the reticular formation is known to be different in introverts and extroverts and suggested that because the executive component of working memory is found in the dorsolateral prefrontal cortex, which is influenced by the reticular formation, then this may
account for the differences in working memory between introverts and extroverts (Lieberman, 1998). This baseline difference in introverts and extroverts in working memory may explain why the introverts performed so poorly on the task when simple music was played. The no music condition was perhaps ideal for the introverts, yet understimulating for the extroverts. The fact that the extroverts and introverts performed equally as well under this condition could be because of the proposition of extroverts having a better working memory; they were not performing their best, but even then were still exceeding the performance of the introverts. Under the simple music condition, which extroverts perhaps found to be more ideal, the introverts may have suffered due to overstimulation. This cannot, however, explain why the introverts performed better on the complex music condition than on the simple music condition.

The most logical explanation for the poor and seemingly bizarre performance of the introverts is a flaw in the design. The hypothesis of this study was based on the theory that introverts have higher level of cortical arousal, and therefore external stimulation may cause them to surpass their preferred level of arousal. The goal was that the music would overstimulate them, thus resulting in lower test scores under the conditions with music. However, the introverts may have felt overstimulated not because of the music present, but rather other external factors that were not controlled. All participants were being watched while performing the test, which may have affected most participants, but especially the introverts. The environment was inconsistent as well. Participants did the test in different areas, some more crowded than others. The thought-process behind this was that those in the music groups would not be bothered by the sounds of crowds because the music would drown it out, but unfortunately that was not the case. The presence of other people was most likely enough to make the introverts uncomfortable. Being outside of a regular comfort zone may also cause stimulation, as well as meeting and
communicating with new people for the first time. Even though the researcher-participant communication was limited in this study, it was still present. All of these factors may imply that it doesn't matter how complex the music is; the introverts will perform subpar regardless when they are in unfavourable conditions.

Past research has speculated that it isn't the type of music that affects the performance of listeners, but rather that it is the listener's fondness of the type of music that is being played. Workers who either really enjoyed or really did not enjoy the music that was played during a task tended to be affected negatively by its presence (Huang & Shih, 2011). The present study used only classical music, which is not a popular genre of music these days and is often disliked by younger listeners. An instrumental version of popular music may have yielded different results as it might not have been as likely to be disliked by the participants. The introverts especially may have been more sensitive to music that they did not enjoy. It is entirely possible that most participants just preferred the music from the complex condition over the music in the simple condition.

The personality questionnaire itself was a confounding variable in this study. The EPQ was written in 1963 and as such, a lot of the questions were outdated. For example, one question on the questionnaire, "On the whole, do you prefer the company of books to people?" might not actually appeal to all introverts. With the invention of new technology, many introverts may find themselves occupying their time by doing solitary activities other than reading, such as surfing the Internet. Therefore, it's entirely possible that an introvert would rather spend time with other people than read a book if they dislike reading. Other questions were worded in a way that made them difficult to understand, such as "Do you hate being with a crowd who play jokes on one another?" It is odd and uncommon to ask a question about whether or not someone hates
something when it would be much simpler to ask if they enjoyed being with a crowd who play jokes on one another. There were a number of oddly-worded questions on the questionnaire, which seemed to confuse participants as they were often seen erasing and scribbling out their answers. The existence of the Eysenck Personality Questionnaire - Revised (EPQ-R) version was not acknowledged until the process of collecting data had already started. The EPQ-R is a revised version of the EPQ which contains 100 questions in total pertaining to the same traits in the EPQ (Eysenck & Eynsenck, 1973). For future research, the EPQ-R would probably be more accurate and up-to-date. Another issue regarding the questionnaire was that it relied on self-report measures. One study discovered that extroversion was one of the traits on a French personality questionnaire called the Test d'Admission Initial - aspect personalité (Congard, Antoine, & Gilles, 2012) that was most likely to be influenced by social desirability (Congard, Antoine, Ivanchak, & Gilles, 2012). While that test was not used in the present experiment, extroversion is often socialized into people because of how extroverted the world is, and therefore the trait of extroversion may seem more ideal than introversion. Therefore, the accuracy of the "introvert" and "extrovert" labels may have been incorrect.

The past research on this type of study does not entirely match up with the current findings, most likely due to the number of flaws in the design of this experiment. The small sample size might account for the lack of significance. The results from this study look as though they are showing differences in performances, but because of the inequality of group sizes and the lack of participants, significance was not observed. Also, many of the past studies of this nature tended to choose only people who scored on the extreme ends of the spectrum. This study had a lot of "ambiverts", or people who score almost equally on both introversion and extroversion. The modification to 13 questions, an odd number, was to prevent anyone from
falling evenly into both categories, though anyone who scored close to the median is most likely an ambivert.

One interesting phenomenon was noticed over the course of this study that might be worth further research. The extroverts seemed to be more inclined to give up easily compared to the introverts. The majority of the extroverted participants tried to give in their test before the 2 minute time limit was up, stating that they could not remember any more words. Not a single introvert tried to hand their test in early. A correlational study between levels of extroversion and perseverance might yield significant results. This phenomenon was seen especially under the no music condition with the extroverts. Some extroverts reported zoning out after about a minute of studying the word list. Their lack of perseverance might have been the result of them being understimulated and thus bored. Extroverts were also observed talking to themselves often while studying the word list and completing the memory task.

The present study could be expanded further by examining individual characteristics of music that might affect levels of cortical arousal. This could be done either by performing a study similar to the present one in which participants complete a variety of cognitive tasks under music differing in specific characteristics, or also by taking on a biological approach and measuring arousal to certain properties of music. This study also only looked at the effects of music complexity on memory. There are other cognitive tasks that were not examined that would also give a good indication of whether or not cognition is affected by certain properties of music in introverts and extroverts.

While the present experiment did not show any significant results, the results from previous studies and future studies show relevance to the domain of education. The current education system holds a very extroverted perspective where a lot of focus is put on group work
and interaction with peers. If the theory that the memory of introverts is being hindered by overstimulation holds any truth to it, then the educational system may need to reconsider their current methods and allow for more adaptation for introverted students. Also, the findings might make some students want to reconsider their study habits if they are studying with music, as past research seems to support the idea that music is taking cognitive energy away from what they are trying to study.

Overall, no significant main effect was found between music complexity and levels of extroversion on memory tasks. The lack of significance is most likely due to methodological flaws rather than the non-existence of an interaction, based on previous research. Further research needs to be done in the area to answer the question of what specific properties of background noise, or music, are causing extroverts to out-perform introverts.
References


Music, Memory, and Levels of Extroversion

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Appendix 1. Summary table of raw data.
Appendix 2. List of word pairings used in the paired-associates learning task.
ARCH + _______

_______ + KETTLE

PLACE + _______

_______ + LANDING

_______ + LEGAL

NEAR + _______

_______ + REPRESENT

COFFEE + _______

SYMBOL + _______

_______ + CONDUCT

BORROW + _______

_______ + CUSTODY

_______ + PROTEST

PATTERN + _______

_______ + WALNUT

WATER + _______

_______ + VITAMIN

SIGHT + _______

PROCEED + _______

_______ + HALLWAY

_______ + SWORD

Appendix 3. Memory task involving the words used in Appendix 2.