The Effect of Background Music on Learning

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Bachelor's Thesis
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Word count: 6737
Word count (abstract): 120
Date: June 2011
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Abstract

This review investigated the effect of background music on learning, which led to a number of relevant insights. First, vocal and especially highly arousing music tends to impair performance, whereas instrumental music leaves most individuals unaffected. Second, extraverts seem less influenced by background music and noise compared to introverts. Third, some evidence suggests that the type of cognitive task the individual is performing is relevant to the effect of background music in that music tends to impair performance on verbal tasks while hardly affecting performance on arithmetic or reasoning tasks. All effects are rather small and short-lived; findings are fairly inconsistent, so caution is advised when broad claims are made with respect to the effect of background music on learning.
Introduction

With the advent of small and lightweight multimedia devices, it seems that more and more students choose to encapsulate themselves in the public space, ‘tuning out’ the sound of their environment. This 'sensory gating' as it is sometimes referred to seems especially popular among the younger generation of students (Bull, 2010). Many university students study in study halls, using headphones to increase the level of immersion and to better be able to focus on the material, but there is still a lot of debate about the effects of listening to background music while learning. It is certainly conceivable that increased amount of—or change of variability in—sensory input takes away from the focus the students might seek to gain from this, in which case it could even have deleterious effects.

Several theoretical approaches to this issue have been introduced over the years, and it seems warranted to provide an overview of the multitude of effects that have been found (wanting at times) in the light of these theories. Perhaps the most popularised study related to the topic of music and learning was published by Rauscher, Shaw and Ky (1993) and dealt with what they called the "Mozart Effect", referring to a beneficial effect of Mozart's music on the performance of participants on a spatial task. It is important to note that this study describes a result obtained by having participants listen to music before the learning session. The results of this study have not been consistently replicated and where they have been, the effects turned out to be rather small (Chabris, 1999), so the validity of this finding has been called into question (cf. Steele, Bass, & Crook, 1999). There have been some recent attempts to investigate the effect of music during what one might call the consolidation phase, thus after the content has been learned (Judde, 2010), but the majority of research deals with the effect of music the individual is listening to while learning the material.

There have been numerous approaches to the issue, yet the theoretical foundation most frequently used to predict the effect of sensory input on performance on cognitive tasks is the working memory model of Baddeley (Baddeley & Hitch, 1974; Baddeley, 1986), often in
combination with reference to the irrelevant speech effect (Salamé & Baddeley, 1982, 1989).

In Baddeley's model there are three systems: first of all there is the central executive, responsible for coordination of its slave systems, integration of the sensory input, decision on what cognitive strategies to apply as well as controlling attention focus and inhibition. The other two systems are called the visuo-spatial sketchpad and the phonological loop. The former basically acts as memory for visual input but allows for manipulation thereof. The latter acts as an online storage for short sequences of phonological information presented through the auditory stream. The central assumption of Baddeley's model is that there is a limit to the amount of information that can be processed in working memory. Background music can be considered a source of noise, assuming that the goal of cognitive processing is to utilise all attentional resources and assuming that the music is attended to. It follows that if such a source of noise uses up a given amount of working memory resources, these resources could obviously not be used to tackle a task that is cognitively taxing. The idea that an auditory signal such as human speech conflicts with processing within the phonological loop is here referred to as the hypothesis of structural interference. This presents us with another idea that has been formulated in this context, namely the idea that the more attentional resources are required to effectively complete a task, the more music would be expected to disturb that process, hence we would expect to find bigger effects as music becomes progressively intrusive to the attentional subsystem of cognition. The more complex a task, the more intrusive it will be. Furthermore, humans seem to be sensitive to human language, as indicated by studies investigating the irrelevant speech effect (Salamé & Baddeley, 1982, 1989), where individuals display a tendency to pay attention to human speech even if that distracts from a task they are supposed to complete.

Since it is only sensible to assume that individual characteristics of the listener may change the direction or size of the effect of noise stimuli, it would be prudent to control for these factors. Eysenck's theory of cortical arousal (Eysenck, 1967) has been central to a
number of frameworks modeling the effect of background music on the individual. According to Eysenck, introverts and extraverts differ in degree of cortical arousability; whereas introverts both operate at a generally higher level of arousal and require less stimulation to achieve their optimum level of arousal. This is relevant, because the optimum level of arousal is often understood as an inverted U-shaped function in relation to performance (Berlyne, 1967). When applied to this model, Eysenck’s theory predicts that extraverts require more stimulation to reach their optimum level whereas introverts require less stimulation. In this sense, evidence supporting Eysenck’s theory would by corollary be evidence against Baddeley’s working memory model, because the latter would predict noise to have a detrimental effect on performance. The size of the effect of noise might differ depending on the overlap between modality of the stimulus and modality of the noise; facilitation, however, would never be the predicted outcome if noise processing occupied attentional resources. Putting the proposed working memory and arousal-emotion theories to the test should provide us with clearer answers to our questions.

The central question this review aims to answer is: What are the relevant factors and circumstances that determine whether or not an effect can be observed – and what its direction is? It seems logical to assume that there are at least four variables we need to consider when trying to unravel the complex effect of background music on learning, which I will introduce now. The first variable I will address in this thesis is ‘music type’: the constituents of the sound stimulus such as instrumental or vocal elements. The second variable can be referred to as ‘musical features’ and includes elements such as tempo, instrumental layering, mood and meaningfulness of lyrics. The third variable I will refer to as ‘individual characteristics of the listener’, which includes personality, presence and form of musical preference and studying habits. The last variable I will address is ‘task characteristics’, which is fairly self-explanatory: there might be a differential effect of background music depending on the type or task performed by the listener. There is a wealth of verbal tasks, which is especially
interesting in the light of Baddeley’s working memory model, then there are spatial reasoning and logic problems as well as mental arithmetic. These are the four topics I will seek to illuminate.

The Relevance of Music Type

Crawford and Strapp (1994) investigated the effect of music type in an experiment controlling for the effects of personal study habits. They first assessed level of extraversion and study habits of 61 university students and then presented them with a battery comprising of spatial scanning, logical thinking and visual associative memory tasks. The students were randomly assigned to three music type conditions—vocal music, instrumental music and silence—in a between-subjects design. The authors predicted an interaction between condition and study habit as well as a main effect of condition; students who usually studied with music were expected to perform better in both music conditions than students who did not, vocal music was expected to impair performance on the tasks more than instrumental music. The major finding here was that vocal music disrupted performance for all subjects on all tasks except for the visual associative memory task, where students who usually studied with music performed experienced facilitation in the vocal music condition. Another interesting result was that students who did not usually listen to music while studying performed better in the silence condition than the group of students who reported that they usually listen to music while studying.

The authors concluded that background music impairs performance as a corollary of competition between information being processed and increasingly meaningful noise. They explain the rather anomalous facilitation finding in terms of working memory demands and hypothesise that students typically studying with music might have developed coping strategies that reduce its effect. They explain the differential results in the silence condition in
the Eysenckian terms of under-arousal of extroverted students, drawing on their finding that students who usually listened to music while studying also tended to be more extroverted.

These findings are corroborated and expanded by a recent eye-tracking study conducted by Johansson, Holmqvist, Mossberg and Lindgren (2011), who investigated possible effects of background music and noise on reading comprehension. The within-subjects experiment included 24 university students who were first tested for object span\(^1\) as well as level of extraversion. The experimenters then asked them for samples of both music the students preferred and music they explicitly did not prefer to listen to. Afterwards, the students performed a reading comprehension task in four different conditions, namely preferred music, non-preferred music, café noise and silence. The authors hypothesised, more on the grounds of intuition than on the basis of previous results, that reading comprehension would be improved by preferred music and impaired by both non-preferred music and café noise. They also expected object span to be correlated to performance, arguing that a higher object span would indicate a higher amount of cognitive capacity, which could serve to improve speed and accuracy of processing of the tasks. Finally, they predicted that if a condition were to impair performance, the corresponding eye-tracking data would show a tendency for longer fixation durations, more regressions, more second-pass reading and shorter saccadic amplitudes, based on previous findings in the field.

The results provided two major insights: First, background music was only detrimental to performance if it was non-preferred. No other differences were found between the conditions. Object span was not related to any recorded measure, either. Second, none of their eye-tracking related hypotheses was supported by the data, but for extraverts both eye tracking and performance data seemed to suggest that this group comprised of less skilled readers. Interestingly, the degree of disruptiveness of the background music or noise, as rated by the students during an exit-interview, proved irrelevant to the performance, despite the

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\(^1\) Object span (OSPAN) is a measure of working memory capacity.
fairly expected finding that all types of music and noise led to higher arousal than silence, as measured by the degree of pupil dilation. It might be worth noting that Johansson et al. also found evidence in the eye-tracking data suggesting that extraverts tended to be less skilled readers in general. The fact only non-preferred music caused a drop in performance is remarkable, because it implies that individual listener characteristics may be more relevant to the effect than musical features, a possibility which will be investigated in the third paragraph of this review.

Pool, Koolstra and van der Voort (2003) designed an experiment to assess the effect of background media on reading comprehension and verbal memory tasks. They used a randomised block design to assign 160 grade eight students to one of four background media conditions: a TV soap opera in their native language, foreign language music videos, foreign language radio music and silence. Performance was indicated by scores on the reading comprehension and memory tasks as well as time on task. On the basis of an earlier study, the authors predicted that only the soap opera would produce any significant detrimental effects on performance. Building on the assumption that memory tasks would lead to exhaustion of capacity limits sooner than reading comprehension tasks, they expected the effects of background media to be stronger when memorisation was involved. The results showed that the only condition to lead to poorer performance was the soap opera condition, where students scored significantly lower than students in other conditions. Pool et al. give a number of possible explanations for these findings, among which the possible role of attentional capacity interference. This explanation suggests that soap operas may require more attention than does foreign vocal music, which would be in line with Salamé and Baddeley’s findings related to what they termed the unattended speech effect. On the basis of this idea it is logical to assume that lyrical music is more distracting than instrumental music, because lyrical music contains human speech, which the attentional subsystem is less able to ignore (Salamé & Baddeley, 1989). As the results suggest, an audio stream containing human speech that is
foreign to the listener seems to require less attentional resources despite causing structural interference between the speech signal and phonological working memory dedicated to the task.

If meaningfulness of the audio stream is the reason for the observed difference in performance, as predicted by the structural interference hypothesis, then an audio stream consisting purely of speech should produce the same effects. This was investigated in a recent study authored by Alley and Greene (2008). In this within-subjects experiment, they presented 60 participants with four background conditions: silence, vocal music, equivalent\(^2\) instrumental music and irrelevant speech. Irrelevant speech comprised of an excerpt of a play. The dependent variable in this experiment was digit span. Three significant differences emerged: Digit span was higher in the silence condition than in the speech or vocal music condition and higher with instrumental music compared with vocal music. Familiarity with a song, as reported by the students, was not correlated with performance. Interestingly, vocal music was reported as most distracting, followed by speech and instrumental music. All differences between these ratings were significant.

Alley and Greene interpreted this as support for both a standard model of working memory and the irrelevant-speech effect hypothesis. The above results are relatively heterogeneous and barely conclusive, as indicated by the fact that only two studies found an overall effect of vocal music. There is a trend, however, indicating that background music tends to impair performance rather than facilitate it, as none of above studies has reported any beneficial effects. One may consider this to be consistent with Baddeley’s model of working memory, but the inconsistency of the findings warrants further scrutiny. Maybe there is more to the characteristics of the background music itself which shape its effects. I will now turn to

\(^2\) This means that these pieces of music were simply the instrumental versions of the vocal music used in the second condition.
these musical features and analyse which, if any, result in lesser impairment or perhaps even facilitation of performance.

The Relevance of Musical Features

In a 2010 electro-encephalography (EEG) study, Jäncke and Sandmann manipulated tempo as well as whether the musical piece was in- or out of tune. It is conceivable that out-of-tune music is closer to noise than in-tune music, so we would expect to see out-of-tune music and noise to produce comparable effects with respect to performance on the tasks. Aiming to find out whether background music improves verbal learning they randomly assigned 75 subjects to one of five non-vocal background music conditions: in-tune fast or slow, out-of-tune fast or slow and brown noise\(^3\). Surprisingly, no difference on the relevant measures of verbal learning or EEG activity was found between any of the groups. Despite this null-result, the EEG data suggested that background music increased cortical activation, which could be taken as circumstantial evidence in support of the idea that music affects learner's performance by means of raising their level of cortical arousal.

Similarly, Cassidy and MacDonald (2007) assessed the arousal potential of musical excerpts. In their study, 40 university students first completed tests for degree of extraversion, music preference and study habits, followed by the Stroop Neuropsychological Screening Test—where they had to read aloud colour names printed on a screen in a non-concurrent colour—and three verbal memory tasks in one of four musical conditions: relaxing or aggressive music, background noise or silence. Cassidy and MacDonald used Eysenck’s theory of cortical arousal to predict that music influences task performance by affecting arousal and mood. In particular, they predicted performance would be lowest in the noise condition, followed by music and silence. Second, they expected introverts to perform worse than extraverts in the music and noise conditions. Third, they expected introverts to report a

\(^3\) White, hence evenly distributed, noise filtered with a low-pass filter.
lower preference for studying with music. The results were not as clear-cut as expected: there was a task-dependent main effect of extraversion indicating that extraverts performed better on the Stroop task than introverts, whereas introverts performed better on all verbal memory tasks. In addition, there was a significant main effect of background music, suggesting that background music generally impaired performance. Relaxing music had no detrimental effect on performance on any test, in contrast to both noise and aggressive music. The latter affected the performance of introverts more than the performance of extraverts. The negative main effect of background music led Cassidy and MacDonald to conclude that listening to music requires dedication of cognitive capacity which would otherwise be dedicated to the task. Accordingly, this is evidence in support of Baddeley’s working memory model. Extraversion only affected results on one task, so the authors deemed it to be partial support for Eysenck’s theory. They proposed that the task-dependency of the effect could be a result of task complexity – claiming that the Stroop task could be considered as more cognitively taxing than the other tasks.

A slightly more spectacular finding was reported by Hallam, Price and Katsarou (2002) who, in their first experiment, compared school pupils' performance on a set of arithmetic problems. Thirty-one children were randomly assigned to either a background music condition or a no-music control condition. In the former, pupils listened to calming children's music. The results revealed that there was no significant difference in the percentage of accurately solved problems between the groups, but children in the music condition exerted what one might call increased perseverance as they tried to solve significantly more problems than did children in the control condition. An interesting result was that scores in the music condition exhibited much more variance than did scores in the control condition, hinting at the possibility that pupils in that group differed on a relevant dimension related to background music, which in turn moderated performance.
In their second study, Hallam et al. randomly assigned 30 elementary school pupils to one of three groups: the first group listened to calming music, the second group listened to aggressive music and the third group listened to no music. This time, the authors gave the pupils a verbal memory task as well as a task to assess level of altruism in order to find out whether music would affect the pupils’ pro-social behaviour. Analysis of the data showed positive effects of calming background music on both the verbal memory as well as the altruism task; aggressive music led to the lowest scores on both tasks. This suggests that the effect of music might be related to motivation. It is also conceivable that certain kinds of music induce a beneficial mood. The following study might shed some light on the mood elevation—or, more practically speaking—physiological-arousal-alteration qualities background music might offer.

In a somewhat unique study, Savan (1999) looked for evidence of an effect of background music on behaviour and a number of physiological measures including blood pressure, body temperature and pulse rate during successive science lessons. She observed behavioural variables such as coordination, task completion as well as noise level and took physiological measurements of 10 boys between the ages of 11 and 12 with special educational needs. Disabilities included poor vision or hearing, asthma or epilepsy. The main manipulation consisted of alteration of the audio tape, which, in its original form, was a recording of some of Mozart's orchestral compositions. Six variations were made, each changing a single feature of the music pertaining to tempo, pitch, played direction⁴ or audible frequencies. The results showed a decrease in all physiological measurements 20 minutes into the lessons and one hour after the end of a lesson. Additionally, Savan observed improvements in behaviour, suggesting that concentration span and coordination were enhanced by the music. These effects were only significant for the tapes containing either the original composition, variations with slightly altered tempo and altered playing direction.

⁴ One of the tapes was the original composition played in reverse.
Considering these results, it seems likely that background music can indeed influence not only perceived relaxation but also physiological and behavioural correlates thereof. Altogether, these results seem to suggest that musical features such as tempo and whether it is lyrical or not, are quite relevant to the nature of the effect, but again the occurrence of null-effects warrants further inquiry. Since the null-effects might have been the result of lack of control for individual listener characteristics, I will now turn to a more complete overview of the results attributed to said characteristics.

The Influence of Individual Listener Characteristics

Anderson and Fuller (2010) focused on student's study habits in relation to task performance. The sample population comprised of 334 7th- and 8th-grade students, the only task was a reading comprehension task taken from the fourth edition of the Gates-MacGinitie Reading Test. Random allocation determined whether the students performed the task in silence or with lyrical pop music played in the background. The results were fairly inconclusive, as background music led to lower scores on the task irrespective of preference, but total music preference score was correlated, albeit weakly, with reading comprehension scores in the silent condition only. There was no such correlation between music preference and performance in the music condition. The authors found a significant difference in performance between girls and boys however. Either the experimental design allowed for a third variable to cloud the results, or the effect of background music on reading comprehension was too small to detect. It remains a subject of speculation, but it seems reasonable to hypothesise that the gender difference might have been a result of girls being more extraverted than boys (cf. Lynn and Martin, 1997). If this was also true of the sample population and if Eysenck’s theory holds, we would expect girls to be less affected by background music, which is exactly what the authors found. Therefore, we could tentatively
consider this as evidence supporting Eysenck’s theory or cortical arousal until extraversion is included in the experimental design.

Indeed, as suggested in previous research (cf. Crawford & Strapp, 1993; Cassidy & MacDonald, 2007), extraversion might be a major factor of interest here. Luckily, a series of studies has been conducted by Furnham and his colleagues to elucidate the influence of extraversion on the effect of background music on performance, the first of which being Furnham and Bradley (1997). They collected data of 88 students, 20 of which were selected based on the fact that their extraversion scores were among the highest or lowest within the entire group. The students were given a reading comprehension test as well as immediate- and delayed-recall visual memory tests; one test type was performed in silence, the other with vocal background music in the form of a radio programme. Recall, according to Baddeley’s model, the more complex a task, the more cognitive resources are required to process it. As a consequence, any condition that lowers the amount of available resources would negatively affect processing of the task. Since the authors deemed the tasks in this experiment rather complex, they predicted an overall negative impact of background music on performance.

The results showed a significant interaction between personality and music on the reading comprehension test; extraverts' performance suffered less from the music than did performance of the introverts. On the immediate-recall memory test, there was only a small detrimental main effect of background music. On delayed recall, the main effect disappeared but an interaction between personality and music emerged: extraverts' performance decreased less with background music. Results of a post-test questionnaire showed that introverts differed from extraverts in their study habits in that they generally seemed to avoid background music and considered it to be more distracting than did extraverts.

In a later study, Furnham and Allass (1999) essentially repeated the previous study, with the addition of the Raven's Advanced Progressive Matrices task as a test of abstract reasoning. The 48 students participating in the study listened to simple or complex
background music or no music at all for the duration of the tasks. The authors hypothesised that complexity of the music would affect arousal, which in turn would differentially affect introverts and extraverts, ultimately resulting in an interaction between music condition and personality. The results were similar to those reported in the previous study, but this time no difference in scores on the reading comprehension test emerged. No main effect of background music was found on the test of logical reasoning, either. This null-effect was qualified by an interaction between personality and condition. Whereas the performance of extraverts was not influenced by background music, the performance of introverts showed a linear decline as complexity of background music increased. Data taken from post-test questionnaires revealed that extraverts rated complex music as less distracting when compared with introverts' ratings. Extraverts did not report the complex music to be any more distracting than simple music, while introverts found them to differ.

In an attempt to explain the unsystematic performance patterns found in the simple music condition, Furnham and Allass speculated that perhaps preference might act as a third variable. This would be in agreement with Johansson et al.'s (2011) finding that the effect of background music depended on the participants' musical preference. Overall, main effects of personality suggested that introverts achieved significantly higher scores on the reading comprehension test, while extraverts achieved higher scores on the memory tests. Considering the (personality x condition) interaction was significant for the logical reasoning task, Eysenck’s theory receives partial support here. The fact that extraverts found complex music to be equally distracting to simple music, whereas introverts found complex music to be more distracting than simple music could be considered problematic for Baddeley’s model, as extraverts’ performance benefitted from the complex background music. Recall, the core assumption of Baddeley’s model is that facilitation should not occur if attentional resources are being dedicated to something other than the task. In order to account for this without
discarding the model, one would have to assume that the background music somehow increases extraverts’ cognitive capacity – which is exactly what Eysenck’s theory predicts.

This outcome was put into perspective by Furnham and Strbac (2002). Aiming to ascertain whether background noise has a similar effect on the performance of introverts and extraverts as background music does, they set up yet another experiment similar in design to the previous studies, replacing the 'simple music' condition with an 'office noise' condition and exchanging the Raven's Advanced Progressive Matrices test with a mental arithmetic task. This time they found no main effects of personality, but detrimental main effects of background music and noise on the reading comprehension and verbal memory tasks. The results revealed significant interactions between personality and the music as well as noise condition on the reading comprehension task, again showing that introverts performed worse with background music or noise, whereas the performance of extraverts was less compromised. Introverts and extraverts did not differ with respect to performance on the mental arithmetic task.

Another source of confusing results is the study conducted by Dobbs, Furnham and McClelland (2011), which was supposed to extend previous research mainly by using what the author referred to as "purer measure of extraversion" (p. 308) and including IQ test data in the analysis. Dobbs et al. randomly assigned 118 female secondary school students to one of three groups and let them complete a verbal reasoning task, the Raven's Progressive Matrices test of logical reasoning and the Wonderlic Personnel Test, a test of general cognitive abilities. During each of the tasks, the participants listened to either no music at all, pop music, or a recording of general classroom noise. Analysis of the results showed significant main effects of extraversion across all tasks, significant main effects of music on the verbal reasoning task and significant interactions between extraversion and music condition across all tasks. Dobbs et al. report that extraverts performed better on all tasks, in

\[\text{sic}\]
all conditions with the exception of the verbal reasoning task combined with background music. Most notably, in the noise condition, extraversion was a strong, significant predictor of performance on all three tasks with an $R^2$ between 44% and 58%. This would seem to support Eysenck’s theory of cortical arousal: despite the fact that no facilitation is observed for extraverts in the music condition, extraverts display remarkable resilience towards external stimuli, whereas introverts show the opposite pattern.

Once again the evidence is far from being unequivocal, even within studies. Where interactions are found, they do not always apply to all tasks. This result was somewhat expected, but it is unsatisfactory nonetheless. We do see a tendency for Eysenck’s theory to hold, but the effect seems to be mediated by both musical features as well as task complexity. It becomes clear that neither Eysenck’s theory nor Baddeley’s model can predict the results of these experiments in isolation, they must be combined to make sense of the data. The following paragraph, as previously indicated, addresses the question of how task characteristics affect the listeners’ performance on tasks while music is playing in the background.

The Role of Task Characteristics

According to a recent study (Kotsopoulou et al., 2010), students report that for certain tasks, they choose to not listen to background music, namely memorisation tasks, among which foreign language vocabulary learning. It is therefore conceivable that the students are aware of differential effects of background music depending on the kind of task they are performing. To see whether the students’ perceptions are correct and such an interaction exists, I will discuss four additional studies as they provide results for tasks that have not yet been reported, after which I will review the relevant results for all articles, addressing the results for each category of tasks performed by the participants in the respective studies.
In what seems to be the only study investigating the effect of background music on creative writing, Ransdell and Gilroy (2001) tried to answer the question whether background music influences writing\textsuperscript{6} fluency and quality. Writing fluency was operationalised as the number of words written per minute\textsuperscript{7}, whereas quality was assessed by independent student peers. Forty-five students first completed tests so their degree of musical training and typing speed to dictation could be determined. The students were then instructed to write two essays on certain topics (e.g. “best possible college instructor” and “best possible vacation”); one of these essays in silence, the other while listening to music. The main effect of music on the average number of words written per minute was ever so slight, but reached statistical significance: 17.8 words in the music condition compared to the 18.8 words in the silent control condition. Quality was not affected. The impact of this result is further mitigated by the fact that the effect vanished for musically trained students.

Contrary to these findings, a recent study conducted by Angel, Polzella and Elvers (2010) provides some evidence suggesting that spatial and linguistic processing might benefit from background music. In order to investigate whether background music differentially affects performance on high- and low-difficulty tasks, the authors recruited 56 students, half of which completed a task related to either linguistic or spatial processing. The linguistic processing task required a judgement on the similarity of letter pairs, whereas the spatial processing task required judgement on the similarity of two successively flashed histograms. Response time and accuracy were measured. Contrary to most previously reviewed studies, this time there was evidence of facilitation. Background music significantly increased the speed of spatial processing and the accuracy of linguistic processing; notably, task difficulty did not seem to make much of a difference, as there was no interaction between task difficulty and music condition. This is interesting because it provides evidence against Furnham and

\textsuperscript{6} Word-processed writing: the writing of texts on a computer, using a word processor, also referred to as text editor.

\textsuperscript{7} Including words which were ultimately deleted.
Strbac's (2002) idea that task complexity detrimentally affects performance by usurping working memory resources, provided that the linguistic and spatial reasoning tasks used in this study were sufficiently complex. Furnham and Strbac also suggested that music might facilitate performance on mundane tasks only, which might be corroborated by results of the following study.

Furnham, Trew and Sneade (1999) had 142 sixth form students participate in their study and predicted a significant interaction between personality and condition for a test of reading comprehension, but none for a coding task, which they deemed less mentally taxing. The Law School Admission Test, a test of logical reasoning, concluded their battery of tests. There were three conditions: silence, instrumental music and vocal music. After completing the tasks, the students were asked to rate how distracting they found the music and how often they studied with music. The results were fairly straightforward in that the only main effect found for the reading comprehension task was linked to extraversion: extraverts performed better than introverts. On the logic task, the only result that reached significance was a main effect of condition, where music facilitated performance of both groups. There was no difference in scores on the coding task: neither between groups based on personality, nor between groups based on condition. At the beginning of this paragraph, it was mentioned that students preferred not to listen to music while studying foreign language vocabulary, for instance, but there are very few scientific studies investigating whether it is indeed detrimental to retrieval.

In order to find out whether and how stimulus characteristics such as typicality, concreteness and frequency influence short-term and long-term retrieval of foreign language words, de Groot (2006) set up an experiment where 36 participants completed vocabulary

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8 Hand-eye coordination.

9 It also seems that Furnham, Trew & Sneade (1999) incorrectly labelled Table 1, as they claim that introverts performed slightly worse with music, while extraverts performed slightly better. A quick look at the table reveals the opposite to be the case. Also, the numbers do not add up: the authors claim that n=71 introverts and n=71 extraverts, but the N for extraverts adds up to 72.
learning tasks in one of two conditions: in silence or with classical instrumental background music. The participants learned nonsense words that varied in concreteness, typicality and frequency. Typicality referred to the degree to which a nonword resembled actual words in the student’s native language. The experiment consisted of three sessions with two presentations of all vocabulary pairs each, interspersed with tests following each session. One week after the third test had been completed, participants were tested again in order to test for possible long-term effects.

The results were not spectacular, but in the light of the previously reviewed literature still unusual in that some evidence was found that background music facilitated performance. Stimulus characteristics effects were found to be largest during the early stages of the experiment, while the effect of music was smallest. With time, however, the effect of music increased in size. Still, initially beneficial effects, especially with respect to learning of infrequent words, dissipated when delayed recall was assessed. Unfortunately, extraversion was not measured, but the peculiar finding that the main effect of music only generalised over items and not over participants led the author to suggest that only a subgroup of the participants benefitted from background music. On the one hand, it is not difficult to imagine this subgroup to be extraverts, considering the results of previously reviewed studies addressing the role of extraversion. On the other hand, only instrumental music was used in this study and while it is not surprising that this kind of background music had no negative effects on the performance of the participants, one would rather expect a null-effect as instrumental music has relatively consistently been found to be less arousing than vocal music. In Eysenckian terms: if the music was not arousing enough to negatively affect the hypothetical group of introverts in the sample, it should hardly be enough to facilitate the performance of extraverts. It is also possible that the task was not complex enough for any detrimental effect to manifest for any introverts who may have been part of the sample, but that would just mean that either way, the effect of background music on performance is
negligible. All in all, the evidence is mixed yet again concerning the question whether music affects the learner. Nonetheless, there is a slight trend suggesting that both reading comprehension and verbal memory tasks are less affected by background music compared with visual memory and logical reasoning tasks.

Conclusion

Overall, the effect of background music on learning tends to be small yet often detrimental, but there are many caveats we have to take into consideration. First, the evidence provided in the paragraph about the relevance of music type suggests that instrumental music tends to have even smaller an effect on individuals than does vocal music. Johansson et al. (2011) however provided evidence that even vocal music need not necessarily have a negative impact on performance, as participants in their study suffered no performance losses while listening to music, as long as the music was preferred by the listener.

In the second paragraph, I reviewed articles aiming to find a pattern pertaining to the relevance of musical features such as tempo, complexity and whether it was in- or out-of-tune. The general conclusion is that musical features can play an important role: aggressiveness for instance seem to have a fairly negative impact on performance. According to Eysenck’s theory, this should only affect introverts, but several studies report a detrimental effect of aggressive music on extraverts as well (Cassidy & MacDonald, 2007; Furnham, Trew, & Sneade, 1999). Interestingly, both Dobbs, Furnham and McClelland (2011, p.312) as well as Furnham, Trew and Sneade (1999) claim that music was most distracting when it is "fast, familiar, vocal music that is most often known by, chosen and liked by the user". Despite being in line with Eysenck's theory of cortical arousal, it not supported by what Johansson et al. (2011) found. On balance, the evidence seems to be slightly in favour of Eysenck's theory, as there were numerous studies which reported a difference between introverts and extraverts with respect to their studying behaviour and the effect background
music has on their performance (Crawford, 1994; Dobbs et al., 2011; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002). Studies where null-effects were observed (Cassidy & MacDonald, 2007; Furnham, Trew & Sneade, 1999) usually reported some significant effects as well, so the effect is sometimes task-dependent.

When we look at the influence of the task type on the effect of background music, a marginally clearer picture emerges. Performance on reading comprehension tasks was largely unaffected by background music but where it made a difference, the effect was detrimental. Performance on visual memory tasks was almost universally negatively affected at immediate as well as delayed recall, except for two studies where extraverts and participants who reported to regularly study with music performed better with music (Crawford, 1993; Furnham & Allass, 1999). The effect was more pronounced for vocal music. Performance on verbal memory tasks shows a pattern of results that is consistent with the notion that calm, relaxing instrumental music tends to produce more positive effects, while aggressive, highly arousing music tends to have detrimental effects. Results of studies investigating the effect of background music on performance on reasoning tasks offer no additional insights, except for a marginal tendency of background music and noise to impair introverts' performance, but not that of extraverts. Two studies used arithmetic tests, one of which reported positive results with respect to perseverance; schoolchildren attempted to solve more arithmetic problems while listening to background music than they did in silence (Hallam et al., 2002). This might indicate that music can help to alleviate boredom, but for now this is only speculation, as the learners' levels of boredom would have to be properly assessed before that inference can be considered a likely explanation.

In conclusion, there are few hard facts to be found in the wealth of literature on the subject and if one wishes to further illuminate this field of research, it would be advisable to take into consideration how arousing the music is, personality traits such as extraversion and music preference as well as complexity of the tasks. Judging by available results, however,
one may doubt whether further study of the subject should prove fruitful. The consensus of
the studies discussed here seems to be that both Eysenck’s theory of cortical arousal and
Baddeley’s model of working memory are helpful in predicting effects of background music
on learning, as is a thorough understanding of the complexity of the task. The effects of
background music on learning seem to be short-lived, however, so if one wants to derive
practical advice to students based from the research discussed in this paper, it would probably
suffice to say that they should learn in an environment they consider most suitable for
studying.

References
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