The Arousal-Mood Theory: Current Research and Limitations

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Abstract

The idea that certain types of music can enhance performance on cognitive tasks has fascinated psychologists for decades. One study that has gained heightened attention is the study on the Mozart Effect by Rauscher and others, which demonstrated a positive effect of Mozart's music on performance on a spatial reasoning task. Later research that replicated the study, however, achieved mixed findings, with some supporting the Mozart Effect while others not. One of the most widely cited alternative explanations is the arousal-mood theory developed by Thompson and others in 2001. Yet, though improving on the previous theory, there are also inconsistent findings regarding this model. Consequently, the present review aims to investigate why contradictory results exist by analyzing experiments conducted in the past decade. Studies are discussed in terms of their level of support for the arousal-mood theory and why this might be so, evoking various pre-existing models. It was found that the results largely rely on task type and individual differences. Research gaps and future research directions are also proposed.

Keywords: Arousal-mood theory, cognitive functioning, music, arousal, mood, valence, Eysenck's theory of personality, Mozart Effect.

Introduction

The role of music in cognitive functioning has long been a topic of interest among psychologists. One of the most cited experiments in this field is Rauscher et al's 1993 study on the Mozart Effect (Rauscher et al., 1993). Rauscher was interested in whether Mozart's music could lead to an enhancement in spatial reasoning, meaning the ability to envision and manipulate three-dimensional objects in one's mind, as measured by the spatial-reasoning sub-task of the Stanford-Binet IQ Test. Participants in the experimental group were asked to first listen to Mozart's Sonata for Two Pianos in D Major, K.448 for 10 minutes and then complete a test assessing spatial reasoning skills. Participants from another two groups either received verbal relaxation instructions or sat in silence before completing the same task. Rauscher discovered that the group that listened to Mozart had a temporary (approximately 15-minute) improvement in spatial intelligence compared with the other groups. The study was later published in Nature, and ever since it has intrigued a large number of scientists and even policymakers, one famous example being Georgia's governor Zell Miller, who decided to offer free classical music CDs to every child born in the state in 1998 to make the babies smarter.

As researchers attempted to replicate the results, though, inconsistencies arose. While some studies supported the original findings (Wilson & Brown, 2010), others demonstrated either an absence of effects or short-term effects associated with increased arousal and mood (Bridgett & Cuevas, 2000). Furthermore, studies reveal that the "Mozart Effect" might not be related solely to Mozart, but that other types of music—even non-musical stimuli—can achieve comparable results. For example, in a study conducted by Schellenberg and Hallam (2005), British schoolchildren were assigned to listen to either music by Mozart or Blur, a famous rock band at the time. Results show that kids who listened to Blur performed better than kids who listened to Mozart on spatial tasks. Additionally, in a study by Nantais and Schellenberg, 28 college students either listened to Mozart or heard a short story by Stephen King. Researchers found that participants demonstrated better performance on whichever activity they preferred—in other words, Mozart's music did not necessarily give all of them a boost in visual-spatial ability (Nantais & Schellenberg, 1999)

With the Mozart Effect called into question, researchers started to seek alternative models. One theory proposed is the arousal-mood theory, developed by Thompson et al. in 2001 (Thompson et al., 2001). The arousal-mood theory suggests that it is not Mozart's music that enhances performance on cognitive tasks. Rather, mediators—in this case, arousal and mood—instead of the music itself produce the effect. Arousal refers to the level of psychological and physical activation (which can be interpreted as the intensity of the felt emotion induced by music), and mood refers to the valence of the emotion perceived, which can be either positive or negative (Husain et al., 2002; Schellenberg et al., 2007). Specifically, Thompson hypothesized that high (but not excessively high) arousal and the positive mood of music contribute to a boost in cognitive functioning.

Nevertheless, though effective at explaining a wide range of cases, this model did not put an end to controversies. For example, in a study that investigated music's effects on memory tasks and processing speed in older adults by Bottiroli et al. (2014), although results for the processing speed task did support the arousal-mood theory, free-recall did not necessarily benefit from upbeat music—conversely, performance was also in the condition with the music of more negative mood (Bottiroli et al., 2014). Since the methodologies across different studies vary, and as the arousal-mood theory does not specify the types of cognitive tasks with which it is relevant, the current literature review aims to explore in a more exhaustive approach the cognitive tasks which the hypothesis applies to and gain insight into why results vary across studies. The research question proposed is: under what conditions is the arousal-mood theory applicable? It is hypothesized that the reasons for the discrepancies among experiments include: (1) the differences between the nature of different cognitive tasks (2) the methodological differences across studies and (3) certain studies' failure to control for confounding variables.

Methodology

Regarding population, all studies of healthy adults, defined as all of those aged 18 or above, are included. The exclusion criterion is diagnosis with any type of mental disorder. The type of intervention examined is music-accompanied cognitive tasks. Control conditions include silence groups and opposite mood/arousal groups. Concerning musical material, the present review only incorporated studies that used non-lyrical musical material, as it has already been shown that music with lyrics impairs cognitive performance (Oliver et al., 2021). Another reason why only studies with non-lyrical music are considered is that the original study proposing the arousal-mood theory (Thompson et al., 2001) employed instrumental music.

Concerning the time when music is played during the task, both studies that used music prior-task and those that used music as background were taken into account, as even though the original study used music prior-task, authors of later studies believed that music played before the task and during task has comparable effects on cognition (Bottiroli et al., 2014; Cloutier et al., 2020; Gonzalez & Aiello, 2019; Lemaire et al., 2019; Marti-Marca et al., 2020; Nguyen & Grahn, 2017; Proverbio et al., 2015; Proverbio et al., 2018; Woloszyn & Ewert, 2012), and there is already evidence suggesting such comparability for verbal episodic memory encoding (Cardona et al., 2020). In terms of the publication time range of the included studies, research from the past decade—specifically, research that has a publication date between August 1st, 2011 and August 1st, 2021—is examined. All articles analyzed are journal articles. Regarding search strategy, the researcher searched for relevant literature from three perspectives: arousal-mood theory/hypothesis, arousal's impact on cognitive task performance, and mood's impact on cognitive task performance. The above three dimensions were taken into consideration because while some studies were done to comprehensively explore both aspects of the theory—namely, both arousal and mood—other experiments only focus on either one of the two. To ensure thorough inclusion of pertinent studies, therefore, the researcher conducted her search with three types of search formulae.

Literature from four databases (ProQuest, Web of Science, PsycNet, and PubMed) was thoroughly screened for eligibility, and 19 articles were incorporated. The three types of searches, as illustrated by an example from ProQuest, applied are as follows: (1) ab(music) AND ab(arousal OR intensity OR activation) AND ab(affect cogni*) (2) ab(music) AND ab(mood OR valence) AND ab(affect cogni*) (3) ab(arousal-mood theory) OR ab(arousal and mood hypothesis) OR ab(arousal mood theory) OR ab(arousal-mood hypothesis) OR ab(arousal and mood theory). A table (see Table 1) summarizing key information of the studies is provided on the next page.

Discussion

Arousal and Task Performance

Results regarding arousal's effects on cognitive functioning are relatively consistent across studies. Among the 9 studies that investigated arousal's effects on cognitive task performance, 7 are in line with the arousal-mood theory—that the higher the arousal, the better the performance. This holds for a variety of cognitive tasks, which include tasks on arithmetic calculations, declarative memory, processing speed, visuospatial attentional control, episodic memory, creativity, and (alleviation of) mind-wandering (Bottiroli et al., 2014; Cloutier et al., 2020; Lemaire et al., 2019; Proverbio et al., 2015; Proverbio et al., 2018; Ritter & Ferguson, 2017; Taruffi et al., 2017).

There are differences in ways in which high arousal enhances performance in the above-mentioned tasks depending on the complexity of the tasks. For simple tasks, study results can be explained by the Distraction-Conflict Theory (Baron, 1986). This theory posits that for each task, there is a state of optimal arousal, a state in which an individual is just mentally activated enough to perform a certain task. Both arousal levels below and above the optimum impair performance. When an individual is inadequately aroused, they are prone to boredom and mind-wandering. In this case, if another task that requires a desirable amount of mental effort can be introduced, one can adjust their level of arousal upwards so that the optimum is reached. On the other hand, when an individual is excessively aroused, it would be harmful to introduce a task that necessitates further attentional resources, and this is when the additional task becomes not a bonus, but a "distraction". The "simple tasks" referred to in this review include all of the previously mentioned cognitive tasks except creativity tasks. A common feature among the simple tasks, for which six studies are relevant, is that they are all conducted in the intelligence domain. For such tasks, performance was enhanced because the music served as a desirable "distraction"—that they occupied the superfluous cognitive capacity and prevented mind-wandering.

Conversely, for creativity tasks (on which one study is relevant), which are more complex, performance enhancement could be attributed to the Dual Pathway to Creativity Model (De Dreu et al., 2008). According to De Dreu, optimally high arousal is the "necessary precondition" to more creative thinking, and valence determines the "pathway" through which creativity for a particular task is achieved.

In terms of the two studies that are inconsistent with the arousal-mood theory, the hidden cause might be flaws in the study design. Regarding the study by Nguyen and Grahn, as suggested by the authors, low-arousal music might have been more beneficial than high-arousal music due to the possibility that the high-arousal music is excessively arousing (Nguyen & Grahn, 2017), thereby jeopardizing participants' performance on recognition memory tasks. In the other study by Oliver and others, music arousal was varied with a 10dB difference in sound intensity (Oliver et al., 2021). As a 10dB amplitude difference is not very significant, and increased arousal is more often induced by faster tempo (Carpentier & Potter, 2007) and added instrumental layers (Gonzalez & Aiello, 2019), it could be argued that the experimental and control conditions are not perceptually different. Thus, it can still be concluded that cognitive performance on simple, intelligence-related tasks and creativity tasks can be improved by moderately arousing music.

Valence/Mood and Task Performance

Regarding the mood dimension of the arousal-mood theory, the findings are murkier. Among the 16 relevant studies, 5 indicate that positive valence improves task performance, 1 show that positive valence is detrimental, 5 demonstrate that positive valence has no effects on performance, and another 4 studies investigating the effects of mood congruence (which refers to whether the valence of the musical stimuli matches the valence of the task stimuli) on task performance reveal that task-valence-congruent music is the most effective. Among studies that are consistent with the arousal-mood theory, no particular patterns regarding the type of tasks employed can be perceived: performance enhanced for processing speed, verbal episodic memory, visual attention, (divergent) creativity, and mind-wandering was alleviated (Bottiroli et al., 2014; Cardona et al., 2020; Marti-Marca et al., 2020; Ritter & Ferguson, 2017; Taruffi et al., 2017). For the study showing the detrimental effect of positive mood, the task assessed selective attention (Putkinen et al., 2017). For studies in which positive valence has null effects, again no patterns can be found: more positive mood does not enhance performance on arithmetic calculations, working memory, declarative memory, recall memory, recognition memory, or associative memory (Borella et al., 2014; Bottiroli et al., 2014; Isarida et al., 2017; Nguyen & Grahn, 2017; Proverbio et al., 2018). Patterns appear once more among research investigating the effects of musical congruence: all four studies are done on memory tasks such as working memory tasks (Franco et al., 2014; Tesoriero & Rickard, 2012; Ward et al., 2021; Woloszyn & Ewert, 2012).

Among studies demonstrating a beneficial effect of positive valence, all studies indicate that the effect applies to all participants except one study, which specifies a particular type of participants who tend to benefit more from positive valence (Cardona et al., 2020). According to Cardona (2020) and others, for highly hedonic participants, meaning individuals who are highly sensitive to musical pleasure, the more pleasant the musical stimuli, the more the words they can encode in their memory during/after music listening. On the contrary, for less hedonic participants, higher pleasantness of the music was associated with worse episodic memory encoding.

Concerning the study (Putkinen et al., 2017) showing impaired cognitive performance in the face of positive valence, such a discovery could be ascribed to the nature of the task employed. One possible explanation, similar to the idea of the Distraction-Conflict Theory, is that performance is affected by both the level of the pleasantness of the music and the requirement of the task. In other words, pleasant music might be effective at enhancing performance for certain types of tasks but not others depending on the nature of the task in question. As the author mentions, previous studies indicate that positive valence "broadens the scope of visual attention, which can manifest as heightened distractibility". For a task that necessitates highly focused attention (like the one in this study), positive valence would likely be harmful. In this study, participants were given a fairly complex dichotic listening task: different kinds of auditory stimuli were presented to two ears in an alternate pattern; in one ear, target (which include trumpet and piano sounds that the participants were told to concentrate on), non-target, and cue sounds were presented simultaneously; in the other ear, human novel sounds, non-human novel sounds, and standard tones were simultaneously presented. With a whole mixture of sounds alternating between ears from which to extract target sounds, participants would likely need to exert considerable attentional resources, thereby rendering music a distractor.

It might be confusing, then, as to why positive-mood music facilitated visual attention performance in another study (Marti-Marca et al., 2020). A possible explanation might lie in the difference in nature between visual and auditory attention tasks. According to a study by Chun and others, positive valence does not lead to the reallocation of processing resources from foveal stimuli to peripheral stimuli. Instead, to accommodate the processing of both stimuli, additional attentional resources are employed (Chun et al., 2011). In other words, the processing of the peripheral stimuli does not occur at the expense of the processing of the foveal stimuli (Vanlessen et al., 2016). The current study suggests the opposite—processing of the auditory stimuli occurred at the expense of performance on the dichotic listening task. Judging from the above, it also seems that positive valence does not boost cognitive task performance, as it is only non-distractive in the visual attention task and is distractive in the auditory attention task. Such a postulation might also be supported by the fact that the largest number of studies (6 studies) demonstrate no effect of positive valence on task performance. Rather, it could be that a confounding variable is lurking behind the valence variable. Mood and arousal might not be completely separable. According to a study by Proverbio (2015), participants' heart rates (an indicator of arousal) increased for both emotionally touching and pleasant music. Thus, it could be argued that for studies showing a beneficial effect of the positive valence of music, two possible reasons might account for this phenomenon: (1) for the task (especially with tasks not tapping into attention) employed, broadened attention does not matter and might even be beneficial (2) the induced positive mood caused a concurrent enhancement in arousal, which, at a desirable level, boosts cognitive performance.

Finally, the fourth group of studies, which were the four studies on congruence, yield a uniform conclusion: congruent music enhances memory. In other words, happy music facilitates memory for happy stimuli, and the same mechanism applies to stimuli of other moods. It is shown that mood-mismatching music makes recall error-prone. Therefore, it could be argued that positive-mood music has no significant benefits except when it comes to memory tasks in which valence-congruent music is played.

In all, it appears that when it comes to the valence aspect of the arousal-mood theory, applicability largely depends on the type of tasks considered, with tasks concerning memory for positively/negatively-valenced information being one of the few conditions in which the theory holds. Concerning other types of tasks, it might be that the assumption that music with a positive mood enhances cognitive functioning is simply false.

Differences Across Individuals

Although there are certain general ways (that are common to everyone) in which people benefit from music differing in arousal and valence, as are elaborated on above, there still are slight differences in terms of music's effects on cognitive task performance that are dependent on differences in individual characteristics. Among the studies included in the present review, 3 discuss mechanisms through which different kinds of music influence different kinds of people differently. The three mechanisms concern music-specific hedonia (which has already been discussed), introversion/extraversion, and preference for external stimulation (Cardona et al., 2020; Gonzalez & Aiello, 2019; Proverbio et al., 2018;).

Regarding the effects of an individual's introversion/extraversion on cognitive task performance, it was found that more extroverted participants tend to benefit more from music with high arousal, while those with more introversion often experienced impaired cognitive task performance (Gonzalez & Aiello, 2019; Proverbio et al., 2018;). An explanation concerns Eysenck's Theory of Personality. According to this theory, introverts and extraverts have different amounts of basal cortical arousal levels, with introverts having higher cortical arousal and extraverts having lower cortical arousal. Cortical arousal refers to the "activation of the reticular formation of the brain" (Oxford Reference, 2021), and it is associated with wakefulness and vigilance. The main idea is that there is a point of optimal cortical arousal when performing a particular cognitive task and that both cortical arousal levels that are too low or too high impair performance. Performance as a function of arousal is said to be in an "inverted U" shape (Oxford Reference, 2021). Thus, with already high resting-state cortical arousal, to not jeopardize performance introverts have less capacity for listening to arousing music than extroverts. If high-arousal music is introduced at this time, introverts' arousal will likely exceed the optimum level. This also raises the question of when introverts might be able to best benefit from arousing music (if at all). Possibly, introverts might benefit from arousing music when they are less aroused than usual—for instance when they are drowsy or bored. Additionally, when it comes to general cases, it might be that music with a medium instead of a high level of arousal works best for introverts.

The mechanism concerning the preference for external stimulation builds on the Distraction-Conflict Theory. Specifically, different individuals differ in terms of their "propensity to attend to stimulating elements of their environment" (Gonzalez & Aiello, 2019). Those who have a greater preference for external stimulation are more likely to be distracted by music, especially when it is played in the background.

Research Gaps and Future Directions

One of the most noticeable research gaps is that all studies within discussion were completed on non-musicians. This is possibly due to the consideration that musicians and non-musicians perceive music differently, with musicians preferring different types of music and attending more to artistic minutiae than non-musicians. It would be worthy, therefore, to investigate to what extent the arousal-mood theory applies to musicians and how this particular group of people benefit from music listening cognitively in the future, as the mechanisms would likely be different.

Another possible future research direction is to unravel the common neurological mechanisms among cognitive tasks on which performance benefits from a certain type of arousal or mood (for instance, why "simple tasks" benefit from increased arousal). With such knowledge, it might be possible to then narrow down completely what tasks benefit from what types of music (which the current review is still unable to exhaustively explore) and even predict what kinds of music can facilitate new types of tasks.

Conclusion

In all, this review synthesizes findings among studies conducted in the past decade tapping into the impact of music's arousal and mood on cognitive functioning to explore the causes of the inconsistencies of results of previous studies on the arousal-mood hypothesis. This review provides examples as to how performance on different tasks is enhanced, impaired, or unaffected by music varying in arousal levels and mood. It also examines the effects of individual characteristics on task performance. It was found that: (1) moderately high musical arousal enhances performance on simple intelligence tasks and creativity (divergent thinking) tasks. (2) positive mood does not seem to enhance performance on cognitive tasks except when it comes to memory tasks in which mood congruence is advantageous. (3) different types of individuals benefit from music differently. The reasons for the inconsistencies are as predicted: they are mainly due to the different nature of cognitive tasks, methodological differences, and failure to control for confounding variables. Future research can be conducted to investigate the effects of music with different arousal and mood on cognitive functioning on musicians and to delve into the biological aspects of cognitive tasks on which the performance is enhanced by certain types of music.

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