Using EEG To Test Working Memory Speed with Positive or Negative Arousal Background Music While Studying

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Listening to music is something done often in day-to-day experiences. From walking around the mall, driving in one's car, to sitting in a café, there is usually always some kind of music playing based on season, what is popular on the radio, or what type of music an individual is into. On average adults listen to 18 hours a week of music, whether that is passively or actively (Sanfilippo et al., 2020). Music is such a crucial part of people's lives because of the emotional responses it causes (Sanfilippo et al., 2020). There has been an increase in interest in studying music which has branched into many sectors like psychology, education, and health. (Blasco-Magraner et al., 2023). Overall, many studies have found that music has been identified as important in the lives of many, fulfilling social, emotional, and cognitive needs from childhood to late adulthood (North et al., 2000; Blasco-Magraner et al., 2023). However, music has also been in the spotlight of research in terms of the ability to multitask. The Merriam-Webster (n.d.) dictionary defines multitasking as as "the performance of multiple tasks at one time." However, the definition used by psychologists is when an individual attempts to perform two or more tasks simultaneously and switch from one task to another in rapid succession (American Psychological Association [APA], 2006). The overlap of either definition relies on the fact that multiple tasks, objectives, or goals are trying to be completed at the same time. Research involving multitasking is inconclusive as to whether the brain has the capacity or ability to multitask. The question of the brains capacity to multitask is why many researchers have added working memory to explain different factors.

Working memory is explained as the small amount of information that can be held in the mind. Working memory can be used in cognitive tasks and has been related to intelligence, problem-solving, comprehension, information processing, and learning (Cowan, 2014). Working memory itself has had an ongoing debate about how exactly it is structured. The two most prominent models of working memory have been done by Baddeley (1986) and Cowan (1999) (Lehmann & Seufert, 2017). Baddeley's work assumes that there is a central executive, or the core, that is responsible for coordinating information from the two subsidiary systems of speech and perception. Within Baddeley's model, speech is classified as the articulatory loop, and perception is classified as the visuo-spatial scratch pad (Baddeley, 1992; Lehmann & Seufert, 2017). Cowan (1999) took a different approach and proposed that working memory could be explained by the embedded-processes model. Cowan's model assumes that working memory is part of long-term memory and has a more hierarchically organized component. In the embedded-processes model, the similarity of information can influence how much information can be processed simultaneously (Cowan, 1999; Slana, 2020; Lehmann & Seufert, 2017).

Music is processed through the primary auditory cortex which lies within the Sylvian fissure (Warren, 2008). Many higher cortical areas surround the auditory cortex like the temporal, parietal, and frontal lobes, which are included in the processing of complex sounds (Warren, 2008). Furthermore, Sluming and colleagues (2007) found that when musicians are compared to non-musicians, musicians have more grey matter in the frontal cortex which is known to assist neural networks that are involved in working memory processes. Working memory has been identified to be within the prefrontal cortex and the hippocampus although it can involve many areas of the brain (Funahashi, 2017; Borders et al., 2022). These specific structures have a high overlap when processing music, verbal stimuli, and working memory (Jäncke, 2008).

Through a close analysis of the literature on multitasking with music, it is clear that there exists a gap in understanding the neurological reaction to multitasking and comprehension of multitasking. An interesting addition to any of these multitasking studies would be an electroencephalogram (EEG). EEG is a relatively cheap and easy method to test the electrical activity of the brain. EEG uses several electrodes attached to the head to record electrical currents. With an EEG there is very little amount of movement that is allowed, as even eye blinks create noise on the output of EEG, which can distract from the data. However, EEG has a high temporal speed, which can be crucial when wanting to understand how fast something is being processed at the time of occurring information (APA, 2018). In 2019, Keune and colleagues used EEG to test processing speeds when comparing slow frontal theta waves (4-8hz) to fast beta waves (13-30hz) in participants with Multiple Sclerosis. The researchers found that frontal EEG theta activity was an inverse marker of processing speed (Keune et al., 2019). Overall, Keune and their colleagues' findings mean that participants with slowed processing speeds show an increase in theta waves creating a larger theta beta wave ratio (Keune et al., 2019). By using an EEG to assess processing speed after multitasking it would further our understanding of the effect of comprehension (Newman, 2019).

Overall, in research it is important to replicate studies to further support or disprove findings as time passes and research evolves. Additionally, as technology has improved it is made more accessible, creating room for greater clarity and new perspectives into past studies. A study that could be replicated and adjusted could be the study done by Lehmann and Seufert (2017) where participants studied a reading comprehension about different time zones across the world while either listening to an instrumental version of a popular German song or had no music playing (Lehmann & Seufert, 2017). The study found that the group that had music playing while studying had lower comprehension scores overall compared to the control group (Lehman, & Seufert, 2017). To elaborate on Lehmann and Seufert study an addition of using an EEG to test processing speed during the reading comprehension. It would be interesting to see if with the addition of processing speed would produce the same interaction effect that when a person's working memory capacity is within the average range, background music assists with comprehension. With the changes to Lehmann and Seufert's study it is hypothesized that having instrumental music while studying will produce a slower processing speed with a higher theta wave to beta wave ratio and with a lower understanding of the reading comprehension due to a higher capacity intake on working memory. These results would be conclusive with the original study as the control condition with no music which has a lower capacity intake on working memory, leading to a higher understanding.

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