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The effects of music playing on cognitive task performance

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ABSTRACT

Background

Many music cognition studies have demonstrated the cognitive benefits of both long- and short-term musical training. Whereas most of these studies deal with the short-term benefits for the music listener or the longer term benefits for the novice or accomplished musician, our study examines the short-term effects of music playing for the advanced performer.

The musical styles in which a musician may undertake can be—for the sake of simplification here—broadly categorized into two genres: improvisation (generally associated with jazz, baroque or experimental performance practice) or the performance of previously-practiced musical sequences that are normally learned (and frequently reiterated) with reference to a musical score (as generally occurs with classical music).

Since, for the current study, we are looking at the effects of music playing on cognitive task performance, we wanted to ensure that the cognitive results would not be confounded by mixing these two different kinds of performance—since they involve different kinds of neural activity. That different musical training and playing can activate different parts of the brain is supported by neuroimaging evidence. Functional magnetic resonance imaging studies have shown that when a musician is taking part in score-based musical sequences versus spontaneous musical improvisation, distinct patterns of neural activation are produced (Limb & Braun, 2008; Berkowitz & Ansari, 2008). As such, we restricted the category of performers to score-based / classically trained musicians in order to control for the effects of neural priming on task performance.

Aims

Our study examines the influences of musical playing on the non-musical aspects of cognition; as such, an example of influence on task performance can be found in an experiment showing that the colour of a computer desktop can affect cognition in several different ways, depending on the specific colour. Whereas red backgrounds improve accuracy in task performance and attention, blue backgrounds stimulate greater creativity in problem solving (Mehta & Zhu, 2009).

Furthermore, distinct neural activations have also been found to occur as a result of differing cognitive tasks. For instance, during problem solving exercises in which participants worked on anagrams (which can be solved deliberately or with sudden insight), an electroencephalography study demonstrated that different cortical activity occurs between creative problem solving and analytical problem solving (Kounios & Beeman, 2009).

As indicated by the studies mentioned above, the neural effects of creative versus over-learned or detail-oriented actions are evident; however, the cognitive consequences of these different activities have not, to our knowledge, been experimentally examined musically thus far.

Method

For our pretest-posttest design, a total of 46 participants took part in the study based on a self-report during recruitment of advanced piano playing experience. The study took place in the Sound Studio of the Institute for Computing, Information and Cognitive Systems at the University of British Columbia. Participants received $10 in exchange for taking part in the study. All procedures and protocols were approved by the Behavioral Research Ethics Board at UBC, and all participants gave their informed consent.

The participants began by completing a creative exercise (alternative uses task) or detail-oriented exercise (proofreading task). They then performed a piano piece for ten minutes. The performances were followed by completion of a second cognitive task (whichever task they were not given in the pretest condition).

Results

No significant pretest-posttest differences in creativity were reported. However, we found that participants performed significantly worse in the posttest detail-oriented task. Our results suggest that performance in a proofreading task involving the visual detection of errors may be hindered immediately following a short period of music playing when the piece is already familiar to the performer.

One of the reasons may be that once a piece of music is learned to a certain degree, the performance is no longer entirely score-based. At this stage, score reading involves recognition and not the full cognitive process of reading something unfamiliar—there is no longer a need to continuously check the musical page for errors. Hence, the participants in this study were not primed for visual accuracy. They are still monitoring their performance continuously however—only now, instead of scrutinizing their scores and correcting errors in the visual domain, they are noticing and correcting errors in the aural and tactile domains. For our study, the idea that participants were not dependent on their scores is supported by their subjective reports.

It is also possible that the neural underpinnings for error monitoring are minimally activated during higher-level motor performance. Here, the idea is that as the level of playing

expertise increases, the recruitment of motor areas becomes increasingly efficient, allowing the performer's cognitive functions to focus on higher-order aspects of aural tracking and tactile response in connection with the performer's aural image and conception of the music.

Furthermore, we can also interpret our findings through the lens of ego depletion (Baumeister, 2003), where focused cognitive effort such as that associated with score-based playing may impact one's ability to garner cognitive control for a period of time after performance.

Conclusions

Several studies have shown that involvement in musical activities translates to higher musical intelligence. This can be seen in the quality of children's drawings and invented symbols for musical sound as their musical perception and intelligence increasingly develops (e.g. Bamberger, 1982, 1991; Davidson & Scripp, 1988, 1989; Domer & Gromko, 1996; Gromko, 1994; Poorman, 1996).

Furthermore, there have been numerous studies examining the neural responses elicited by musical engagement, and these studies seem to show that music training can generate instant plasticity in the cortex (e.g. Bangert & Altenmuller, 2003).

But what about the extramusical effects of music performance? In the case of our experiment, we found that participants' error detection rates significantly suffered immediately following a familiar score-based musical performance. This finding seems to contrast with the results of many studies that demonstrate the cognitive benefits of musical listening or participation. For example, in addition to several other cognitive skills, studies have detailed the benefits of music training on non-musical abilities such as literacy (e.g. Barwick et al, 1989; Douglas & Willatts, 1994). As such, the question of whether long-term or short-term music exposure can uniquely and reliably produce effects on nonmusical aspects of cognition remains to be settled.

Keywords

Music, Piano, Classical, Score-based, Cognitive task performance, Proofreading task, Alternative uses task

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