Using EEG Recordings to Examine the Relationships Between Sustained Attention and Types of Background Music in Individuals with ADHD

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ABSTRACT
The purpose of this exploratory study was to use Electroencephalogram (EEG) recordings to examine the relationships between the maintenance of sustained attention across various academic tasks and the presentation of different background music amongst individuals diagnosed with Attention Deficit (Hyperactivity) Disorder (ADHD). Specifically, the present research sought to explore the differences in sustained attention and ease of paying attention and enjoyability across Reading, Reading Comprehension, Reading Comprehension with recall (with working memory load), Numerical Operations, and the presentation of silence, classical music, pop music, and sounds from television programs. Differences in sustained attention were measured using EEG recordings while the participants rated the ease of paying attention and enjoyability across the different sound conditions on the different tasks. Twelve individuals with ADHD participated in this study. Individuals with ADHD were found to be better able to sustain attention and enjoy tasks with pop music in the background in tasks that did not have a working memory load.

Author Keywords
EEG, ADHD, music, sounds.

INTRODUCTION
Attention-Deficit/Hyperactivity Disorder (ADHD) is an enduring mental disorder that characterized by an inability to pay attention and/or hyperactivity (American Psychiatric Association, 2000). The prevalence rates for this disorder range from 7 to 12 percent (Barkley, 2009). Without effective treatment, children with ADHD are at greater risk of developing poor academic, behavioural, social, and mental health outcomes (Antshel, Macias, & Barkley, 2009). It is thus imperative that efforts be directed towards helping students with ADHD achieve academically. Unfortunately, ADHD students typically find it very challenging to focus and filter distractions (both internal and external) long enough to be successful academically.

It is conventional wisdom that silence promotes engagement in academic tasks. However, findings from a few studies suggest that the brains of individuals with ADHD require stimulation in the form of music (Zentall, 2006), to function more effectively on academic tasks. According to Barkley (2009), students with ADHD have a greater than average need for stimulation. Thus, students with ADHD attempt to increase their levels of stimulation, consciously or not, in various settings and tasks, and this need for stimulation extends to academic settings (Zentall, 2005). This belief, nonetheless, has only been examined anecdotally.

With the advent of Electroencephalogram (EEG) devices, a tool that measures electrical activity originating in an area of the brain called the cerebral cortex, anecdotal information regarding the effect of music on engagement in academic tasks can be verified objectively.

ADHD is really a neurological disorder and the symptoms of ADHD reflect an underlying dysfunction of the brain which is related typically to increases in slow waves in the frontal and central cortical and subcortical regions (Mann, Lubar, et al., 1991). Electrical detectors, which, when placed on the scalp, are able to detect small changes in electrical activity allow the relationships between music and task engagement to be examined.

METHOD

Participants
I invited children and youth at a clinic to participate. Twenty-two potential participants who ranged in age from 9 years to 15 years agreed to take part with their parents' permission. All the potential participants' parents rated them on the Conner's Parents Rating Scale-Revised: Long Form (Conners, 1997). The CPRS consists of 80 items which reflect the construct of ADHD as stated in the Diagnostic and Statistical Manual of Mental Disorders

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(DSM-IV-TR, American Psychiatric Association, 2000). To be eligible for participation, the potential participants had to obtain at least a T-score of 65 on the ADHD Index. All participants were assessed by an educational psychologist. None of the participants were taking psychostimulant medication for ADHD at the time the experiment was conducted.

All the potential participants were administered the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV, Wechsler, 2003). Potential participants who scored below 85 (M=100, SD=15) on any of the four subscales of the WISC-IV were excluded in order to exclude children with possible cognitive problems.

Finally, the researcher hooked the potential participants up to an EEG machine and assessed their brain waves for 10 mins. The researcher chose participants who produced slow frontal brain waves at the middle of their heads (Cz).

The ADHD, IQ assessment, and slow wave requirement plus the time commitment to participate in the study reduced the sample from 22 to 12.

Setting

I tested the participants individually in a bare room. I placed the relevant tasks on the desk. I also placed a computer and EEG equipment on the desk.

Procedure

I asked the participants to engage in one of the following tasks: reading, reading comprehension, reading comprehension with recall (with working memory load), and numerical operations.

I modified the questions for use for these tasks from test questions in the Wechsler Individual Achievement Test-Three (WIAT-III), a test none of the participants had taken. The reading comprehension with recall (with working memory load task) was the same as the reading comprehension task except that I did not allow the participants to refer to the passage they had just read and expected them to give the answers by trying to recall the information from the passage.

The year levels of the tasks chosen were 2 years below the participants' chronological ages (if there were enough questions to permit that) so that presumably the tasks were easy enough for the participants. I instructed each participant to engage in these 4 tasks and the tasks were administered in a counter-balanced fashion to the extent possible for 3 min each to the participants. I gave the participants a 2-min break after the 3-min engagement in each task regardless of the number of questions they had answered.

While the participants were completing the tasks, I administered one of 4 sound conditions: silence, classical music, pop music, or sounds from television programs. I played these sounds in the background without the use of headphones.

While the participants were engaged in the tasks with the various sound conditions, I measured their brainwaves at the middle of their heads (Cz) with EEG equipment. Immediately at the end of each task, I asked each participant to rate, on a 10-point scale, how easy it was for them to pay attention while attempting each task under each sound condition, and how enjoyable it was for them to perform each of the tasks under each sound condition.

RESULTS

Test results were analysed using SPSS version 17.0 for Windows. The MANOVA method was employed to compare the means in slow wave activity at the middle of the head, and the responses to the two questions (ease of paying attention and enjoyability) across the different sound conditions. On the reading and reading comprehension tasks, participants were able to lower their slow wave activity in the pop music condition. A significant number of the 12 participants rated the popular music condition as easy to pay attention to and enjoyable.

DISCUSSION

The results show that the pop music condition was rated most highly by the participants for engagement in tasks. It is possible that the pop music condition proved to be more effective as the participants are mostly pre-teens or teens. This study, being exploratory in nature, has a rather small sample size. To be more certain about the findings, the study will have to be replicated with a larger sample which would include adults with a variety of tastes in music.

It has also been claimed that binaural beats (produced by playing 2 slightly different tones into each ear) can help to increase focus (http://www.i-dose.us/dose/en/21/Focus+2/0/). Using EEG technology, this claim can be explored and verified.

CONCLUSION

Understanding the conditions that promote task engagement in ADHD students is highly important as ADHD students, much more than other students, require a high level of stimulation and support. To a parent or a teacher, the ways in which these students seek out stimulation can certainly be very confusing or frustrating. If parents or teachers are able to understand the ways in which students with ADHD seek appropriate stimulation while trying to complete their academic tasks, they would be better able to foster these optimal conditions and thereby help to promote better academic outcomes on the part of the ADHD students.

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