P3b Auditory Processing Differences in Adults with Self-Reported Attentional Deficits

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Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is a neurodevelopmental disorder characterized by symptoms such as impulsivity, hyperactivity, and inattention (American Psychological Association, 2013). Manifestations of ADHD are affected by age and this disorder often persists into adolescence and adulthood. Adult ADHD is vastly misunderstood and the mechanisms behind ADHD in adults is understudied (Chi, et al., 2019).

Attention is the process by which individuals selectively orient and focus on discrete pieces of information, like auditory stimuli, while inhibiting responses to other information that is deemed irrelevant (Posner, 2012). Specific cortical neural networks are responsible for attentional processing, which is known to occur in frontal and central regions of the brain (Polich, 2007). Previous research has shown that difficulties in attentional processing, like those seen in patients with attention deficit disorders, are linked to disruption or atypical activation of cortical neuronal networks (Griffiths, et al., 2021).

Electroencephalogram (EEG) recordings of brain activity and event-related potential (ERP) analysis can be used to reflect patterns of early neuronal activity. ERPs are time-locked electrophysiological responses to stimuli resulting from sensory, cognitive, or motor events (Luck, 2014). The electrophysiological characteristics of ERPs can reflect activity related to specific cognitive processes, including attention and working memory (Polich, 2007). The centro-parietally focused P3b ERP has been studied in relation to cognitive processing and is commonly used to study ADHD, as its electrophysiological characteristics can be indicative of cognitive capabilities (Polich, 2007).

The objective of this study is to examine the characteristics, including peak amplitude and latency, of the early attention and deviant stimulus-processing P3b ERP in an oddball auditory processing task in adults with self-reported deficits of attention.

Participants

10 college-aged adults (8 females, 2 males) with self-reported symptoms of attentional deficits.

No history of auditory processing disorders.

Grouping

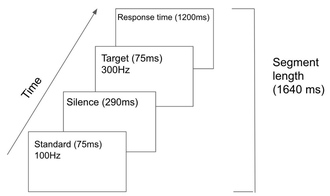
ASRS-v1.1 Adult ADHD Self-Report Scale:
Grouped participants into AD and non-AD groups based on their answers to the first six questions, which apply to six of the most predictive DSM-IV-TR criteria/symptoms consistent with ADHD (Adler et al., 2005).

Methods

EEG Recording: EEG/ERP data was collected using a HydroCel GSN 128 channel sensor net supplied by Electrical Geodesics, inc.

Auditory Stimuli: Stimuli were presented as a pair of tones with differing frequencies, separated by 75 ms. Standard tones were a low-low pair of 100 Hz-100 Hz. Target tones were a low-high pair of 100 Hz-300 Hz. Each pair was separated by 290 ms. 680 standards were presented with 175 targets.

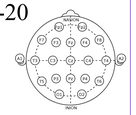
Stimuli Presentation: Stimuli were randomly presented in an oddball paradigm format with a 75:25 ratio of standard to target stimuli. The processing involved in distinguishing between standard and target stimuli elicit the P3b ERP.



Conditions: Participants underwent both passive and active conditions.
Passive condition - paying attention to stimuli
Active condition - pressing a button when target stimulus is presented.

Data Analysis

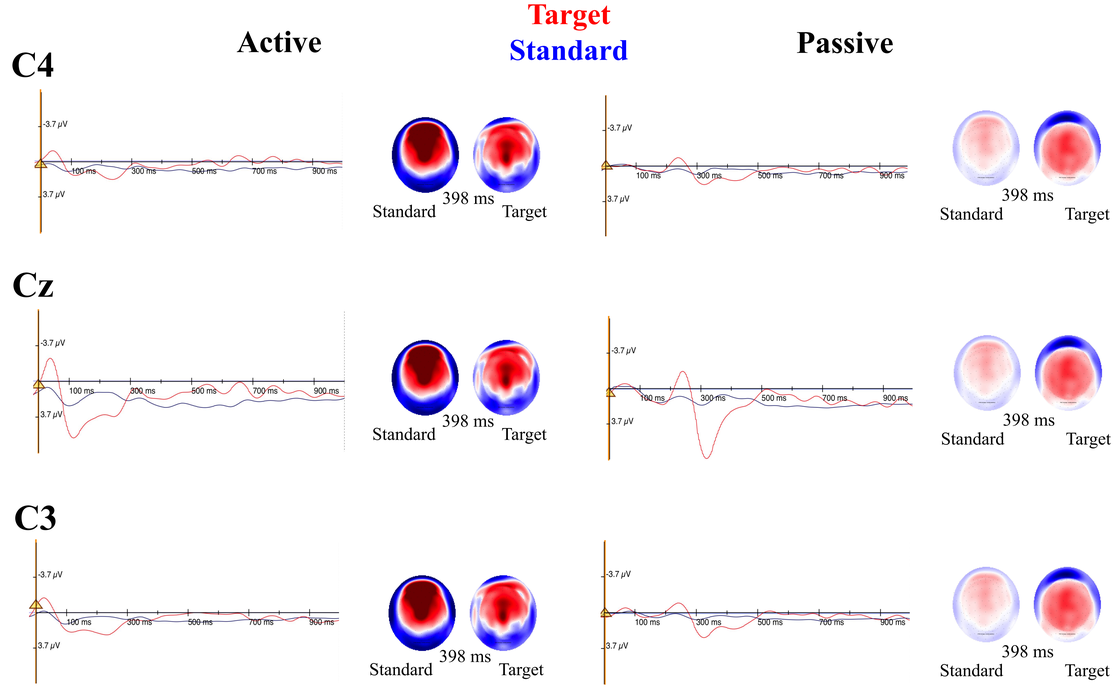
Data Extraction:
Amplitude and latency values for P3b were extracted from all electrodes over a 10-20 channel montage.



Statistical Analysis:
2x2 mixed-factorial ANOVAs of amplitude and latency values across both conditions and stimuli using IBM SPSS Statistics.

Findings

High Attentional Deficit Individuals
n=10



Observations

Auditory processing differences in adults with self-reported attentional deficits are consistent with expected results of oddball paradigm stimuli presentation, with localization to the right-central region of the cortex:

- Processing of the target stimulus elicits a greater response than the standard stimuli across all central areas of the brain ($F_{1,9} = [6.949\text{-}15.094]$, $p < 0.05$).
- The active condition elicits a more robust response in right-localized central regions (C4) ($F_{1,9} = [4.907\text{-}5.620]$, $p < 0.05$).
- Responses to standard stimuli occur later than responses to targets across both conditions in right-localized central regions (C4) ($F_{1,9} = [5.457\text{-}8.807]$, $p < 0.05$).

Preliminary analysis of control individuals (n=24) shows greater amplitudes across all conditions and stimuli when compared to individuals with attentional deficits, indicating a reduction in the amount of neuronal network activation involved in processing.

References

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