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Predicting ADHD Symptoms in Adolescents Using Error-Related Brain Potentials

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Introduction

- Attention Deficit Hyperactivity Disorder (ADHD) is one of the most prevalent childhood disorders affecting 5-6% of children and adolescents (Michelini et. al, 2016).
- The clinical course of the disorder varies widely, and it is currently unknown why some individuals experience remission of their ADHD symptoms across development, while others have their symptoms persist into adulthood.
- Performance monitoring is one aspect of cognitive control important for self-regulation. It involves the ability to recognize errors and make behavioral adjustments.
- Performance monitoring can be measured using event-related potentials (ERPs), which capture brain activity in response to errors. Error-related ERPs include the earlier error-related negativity (ERN, unconscious error processing) and later error-related positivity (Pe, conscious awareness of errors).
- Performance monitoring may be impaired in some children with ADHD (Meel et. al, 2007), and may contribute to symptom change (Geburek et. al, 2013).

Research Question & Hypothesis

Research Questions:

- Are early or late stages of performance monitoring impaired in ADHD?
- Does performance monitoring predict ADHD symptom improvement?

Hypothesis:

- Later stages of performance monitoring will be impaired in ADHD participants. Greater awareness of errors, measured by higher Pe amplitudes, will be associated with greater symptom improvement.

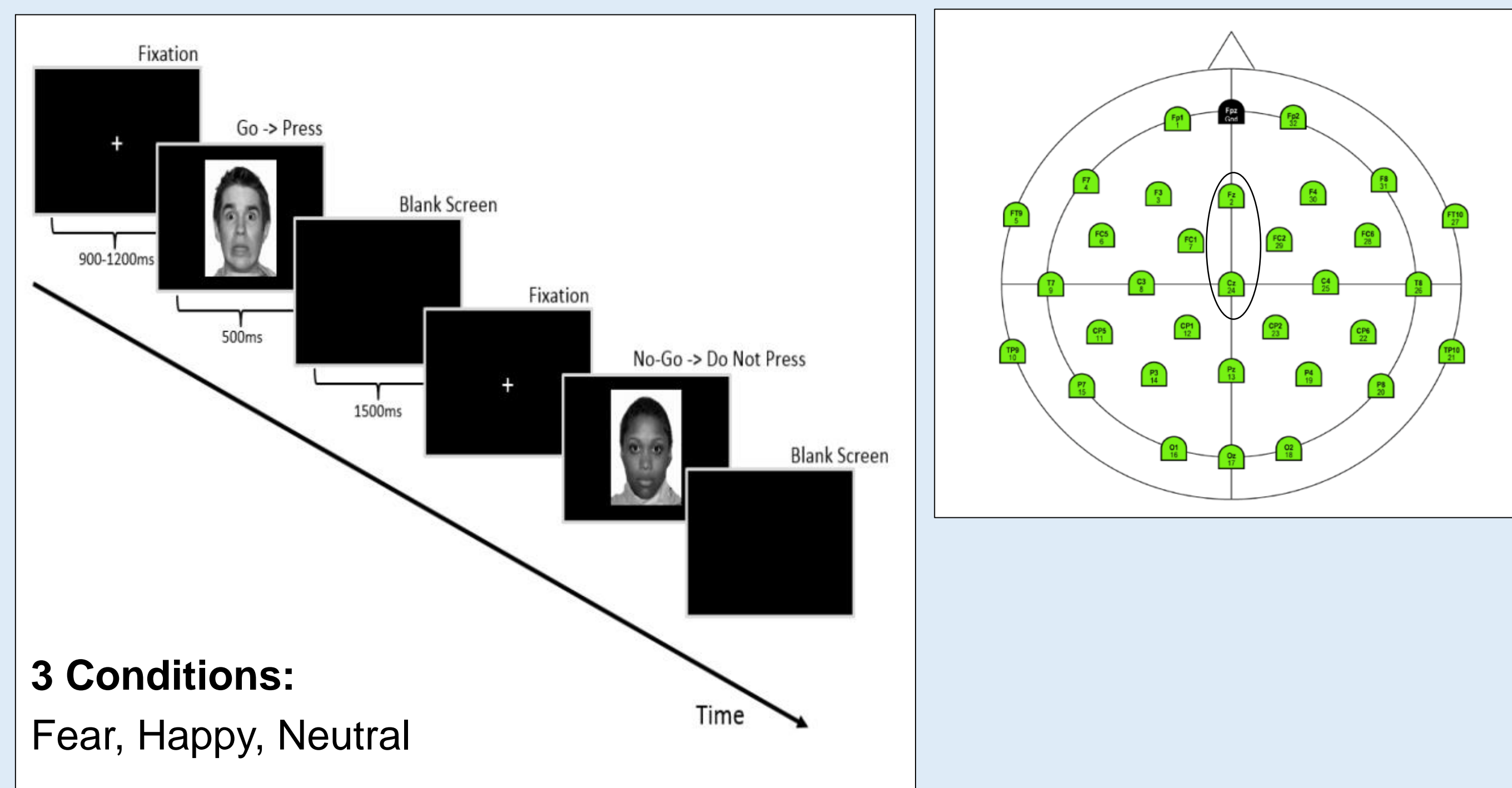
Method

Study Design:

- Data was examined as part of a larger longitudinal study. 75 participants 7-11 years old at start of study (control=35, ADHD= 40).
- Year 1:**
 - Parents and teachers completed behavioral rating forms (ADHD-rs).
 - Parents also completed a semi-structured clinical interview (KSAD). ADHD symptoms combined using "Or" algorithm.
- Annual follow-up visits (3-5 years later):**
 - ADHD assessment repeated.
 - Children completed a computerized emotional go/no-go task while 32-channel electroencephalogram was recorded.
 - Response-locked ERN calculated as mean area amplitude from -100- 100 ms and Pe calculated as mean area amplitude from 200-400ms at Cz and Fz.

Method (cont.)

Figure 1. The computerized go/no-go task:



3 Conditions:
Fear, Happy, Neutral

Variable	Control	ADHD	Stats
Age (years)	14.0 (1.1)	13.7 (1.5)	$p = .232$ (ns)
Sex (male:female)	23:12	35:40	$p = .025$
IQ	116.3 (12.1)	106.9 (13.9)	$p = .003$
Happy No-go Acc	.86 (.12)	.79 (.17)	$p = .006$
Neutral No-go Acc	.85 (.13)	.73 (.19)	$p = .000$
Fear No-go Acc	.84 (.15)	.74 (.20)	$p = .002$
Happy Go RT	503.12 (111.34)	529.01 (117.96)	$p = .21$ (ns)
Gender Go RT	524.66 (106.16)	559.02 (153.73)	$p = .14$ (ns)
Fear Go RT	570.83 (161.07)	586.80 (162.22)	$p = .58$ (ns)

Table 1. Descriptive information and task performance data.

Results

- ERN amplitudes did not differ between groups at Cz, but were significantly larger in ADHD at Fz ($p < .05$).
- During positive emotion conditions, controls had higher Pe amplitudes (Cz: $M=9.34$, $SD=6.49$) than ADHD participants (Cz: $M=5.57$, $SD=5.62$), $F(1,71) = 5.64$, $p = .02$.

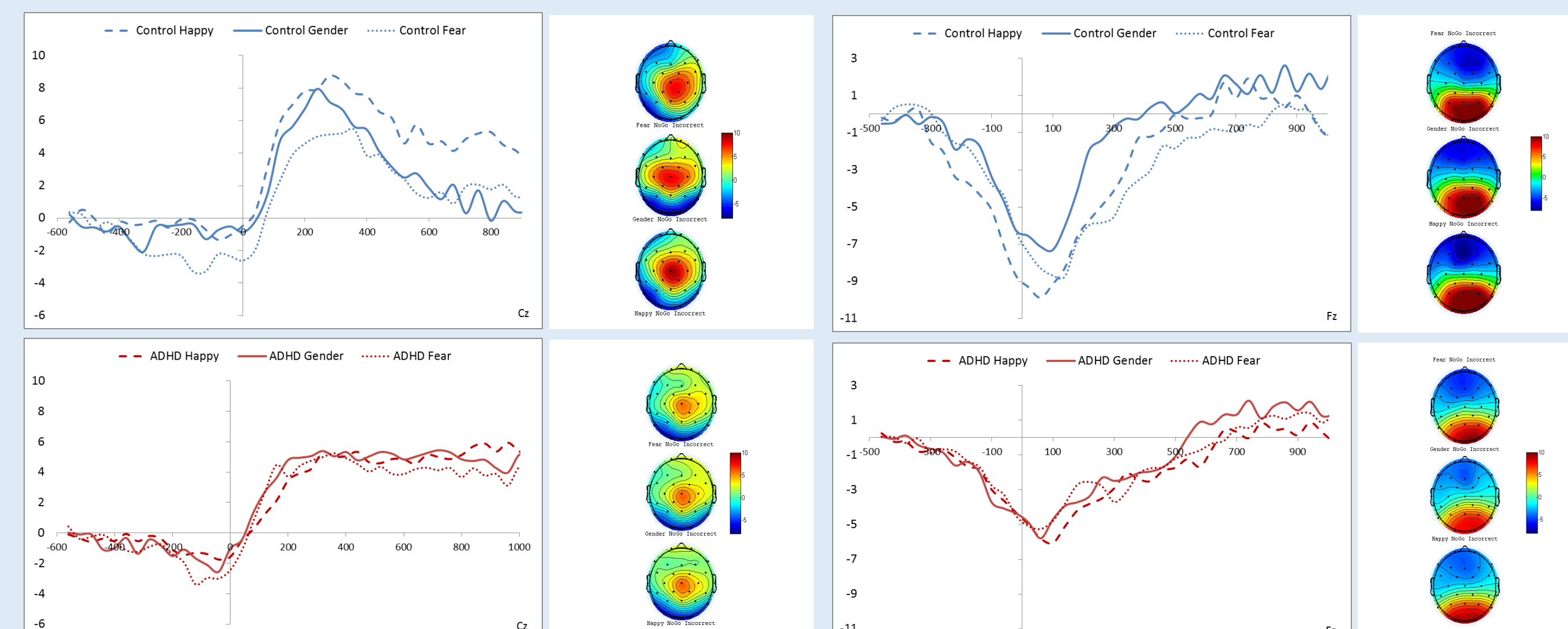


Figure 2. Average response locked event-related potentials of the error-related positivity (Pe, top left) and error-related negativity (ERN, top right) for ADHD and control group on no-go incorrect trials. Topographic maps included.

Results (cont.)

- Among the ADHD group, higher Pe amplitude in positive emotion conditions predicted a greater decrease in ADHD symptoms after controlling for baseline symptom severity, $b = -.40$, $p = .005$.

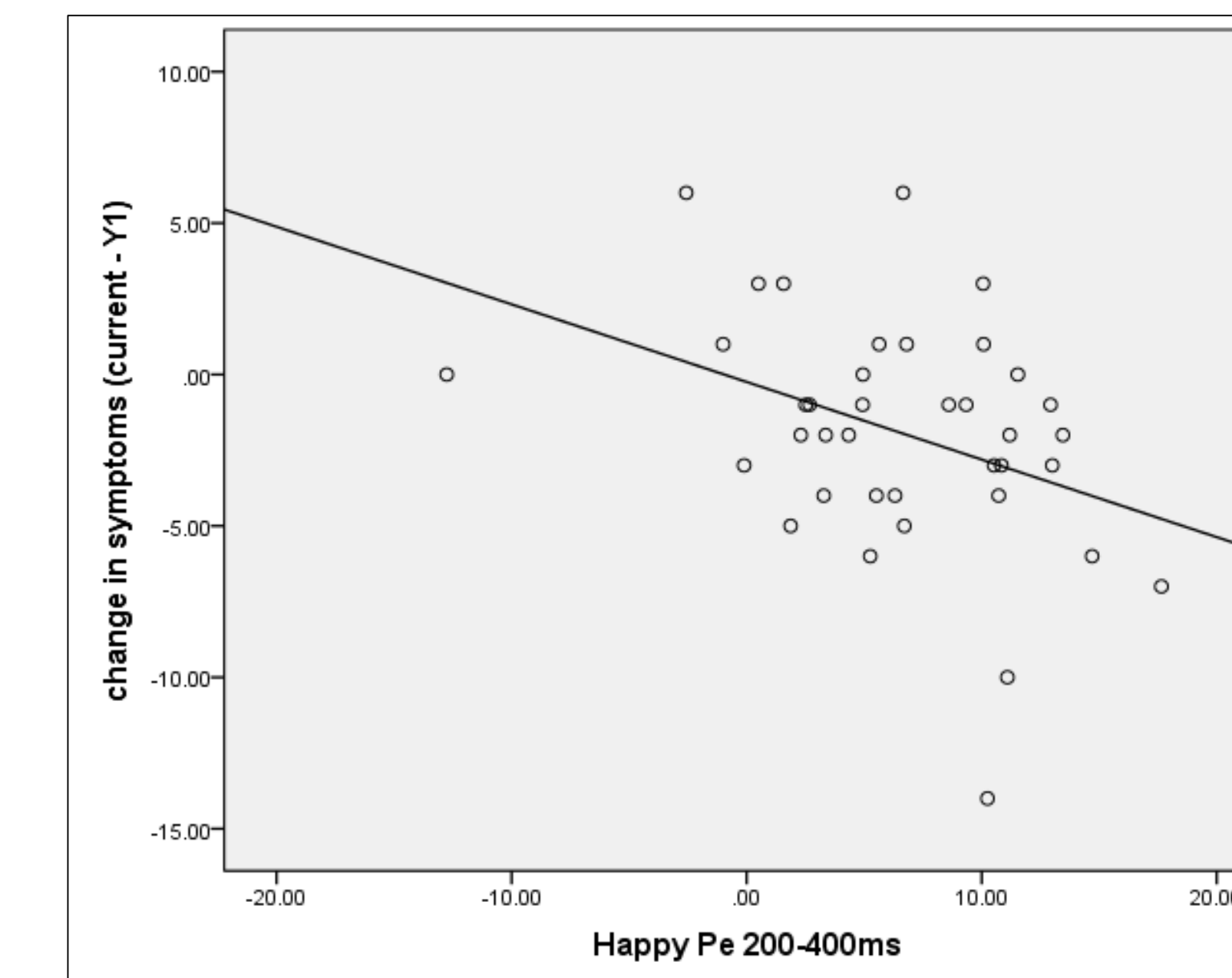
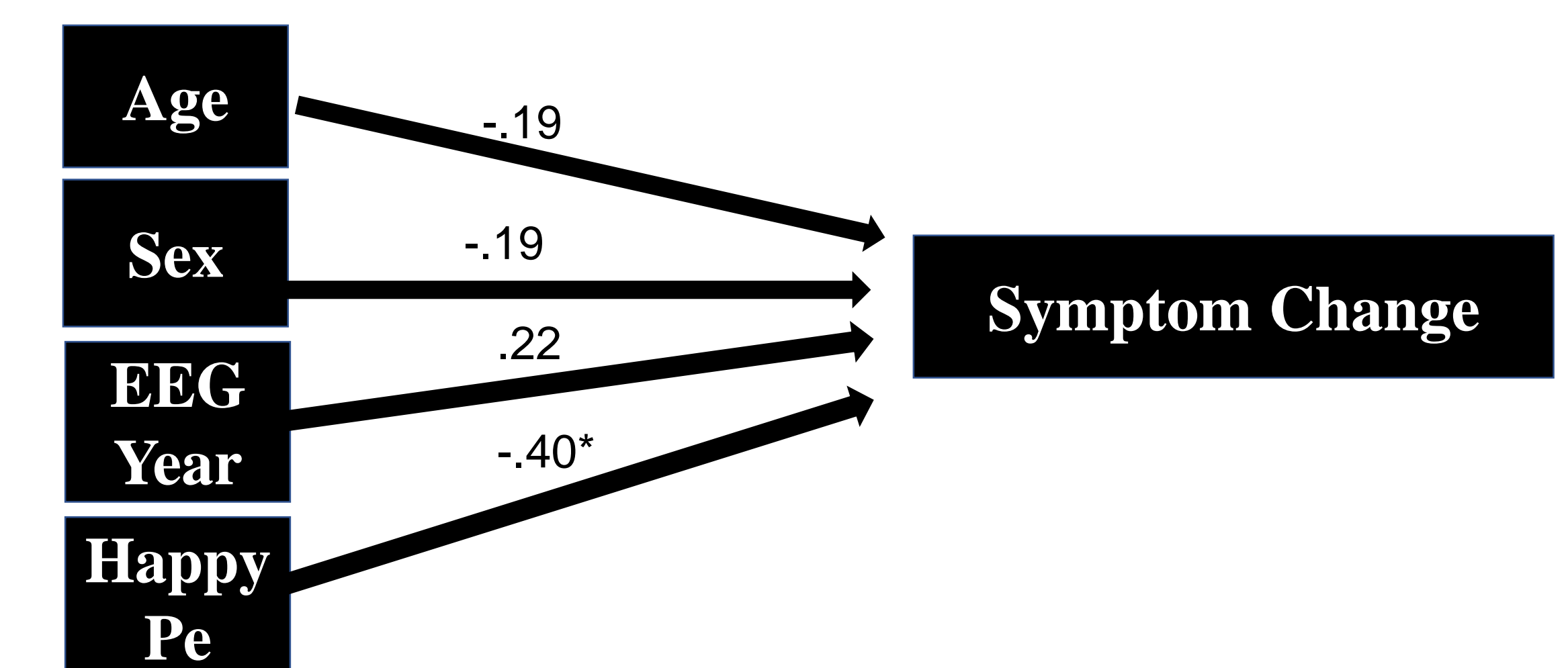


Figure 3. Regression scatterplot for change in ADHD symptoms as a function of Happy Pe amplitude on no-go trials.



Conclusions

- Performance monitoring is a potential cognitive skill associated with the remission of ADHD symptoms.
- Insight into the progression of ADHD symptoms in individuals is essential for improving clinical outcomes through intervention.
- Understanding the clinical course adds to the research currently being conducted on its' heterogeneity.

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