Decreased motor cortex responsiveness during stopping in children with ADHD

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PURPOSE

To investigate neurobiological mechanisms of impaired response inhibition in children with ADHD. We aimed to compare motor cortex activation during a Stop Signal Task in 8-12-year-old children with ADHD vs. typically developing (TD) controls.

BACKGROUND

Children with ADHD more often fail to suppress inappropriate actions. To identify quantitative, brain-based measures linked to this deficit, we previously designed a child-friendly race-car version of the Slater-Hammel Stop Signal Task ideal for measuring concurrent motor cortex excitability with Transcranial Magnetic Stimulation (TMS). Objective: to replicate and extend prior findings, using lower intensity TMS pulses.

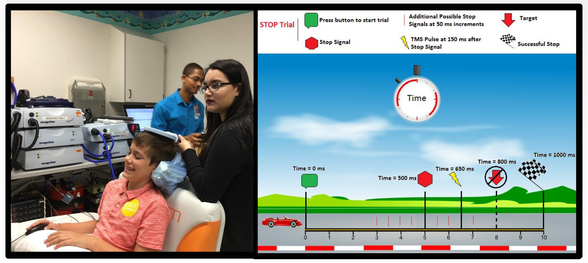

Figure 1: Transcranial Magnetic Stimulation (TMS) left; and Race Car Stop Signal Task, right

MATERIALS AND METHODS

In 8-12-year-old children with ADHD and matched, typically-developing (TD) controls, we assessed behavioral symptoms and validated ADHD diagnoses using standard scales and tests. We used Transcranial Magnetic Stimulation (TMS) pulses at each child's resting motor threshold (RMT) to quantify motor cortex excitation, represented by right first dorsal interosseus (FDI) motor evoked potential amplitudes (MEPs), during 96 Racecar Task (Figure 1) trials: 1) "Start-Go" @250 milliseconds (ms); 2) "Prep-Go" @650 ms; and 3) "Inhibit" (STOP) @150 ms after the dynamic stop cue. GO/Stop ratio is 3:1, in randomized order. We estimated Diagnosis and Task effects using mixed-models, repeated measures regression.

RESULTS

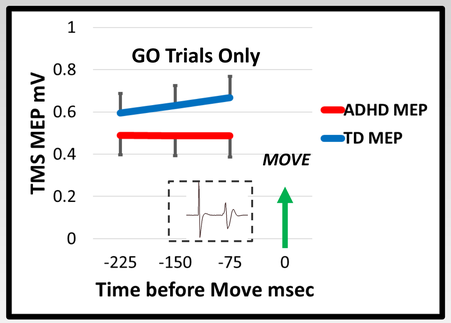

Figure 2: MEP amplitudes prior to movement.
- In TD, MEPs enlarge as TMS → MOVE (expected).
- In ADHD, this is not observed (flat line).
- **Time*Diagnosis p = 0.10**.
- Inset: EMG tracing with TMS and FDI MEP.

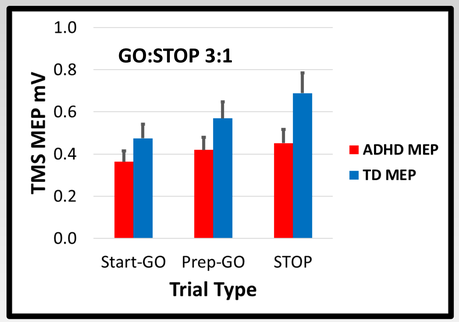

Figure 3: Smaller MEPs in ADHD.
- During Stop-Signal Task, task-related up-modulation (TRUM) is reduced in ADHD.
- **Trialtype*Diagnosis p < 0.001.**
- **Post hoc ADHD vs. TD Stop p = 0.04.**

Table 1. Study Participants

Characteristic	ADHD n = 39	TD n = 40	p-value
	n (%)	n (%)	
Gender			
Female	18 (46%)	18 (45%)	>0.9
Male	21 (54%)	22 (55%)	
Race			
Asian	0 (0%)	3 (7.5%)	
Black/African American	7 (18%)	3 (7.5%)	0.2
> 1 Race	3 (7.7%)	2 (5.0%)	
White	29 (74%)	32 (80%)	
Ethnicity			
Hispanic or Latino	7 (18%)	0 (0%)	0.016
Not Hispanic or Latino	32 (82%)	40 (100%)	
	Mean (SD)	Mean (SD)	
Age (years)	10.2 (1.4)	9.7 (1.3)	0.07
ADHD Scales			
ADHD-RS Inattentive	17 (5)	3 (3)	**<0.001**
ADHD-RS Hyper/Impulsive	13 (6)	2 (3)	**<0.001**
Stop Signal Reaction Time (SSRT) (msec)	313 (66)	284 (48)	**0.029**

CONCLUSIONS

In children with ADHD, there is diminished and less specific activation of motor cortex during a response inhibition task.

CONTACT

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