Theta Inter-Trial Phase Coherence Deficits During Error Processing in Adolescents with ADHD Symptomatology

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Background

Cognitive control deficits and increased neural intrasubject variability (ISV) were both suggested as a fundamental characteristic of ADHD (e.g., Kofler et al., 2013; Nigg et al., 2020). We examined the link between these impairments within the framework of error processing, following the work of Groom et al. (2010) and Aydin et al. (2023). We focused on theta inter-trial-coherence (ITC) as a potential neurophysiological marker of the partially genetic neural dysfunction in ADHD.

Method

Participants

63 male adolescents (*M* = 17.37 yrs., *SD* = 0.41) who have been followed since birth as part of a prospective longitudinal study about ADHD's developmental pathways.

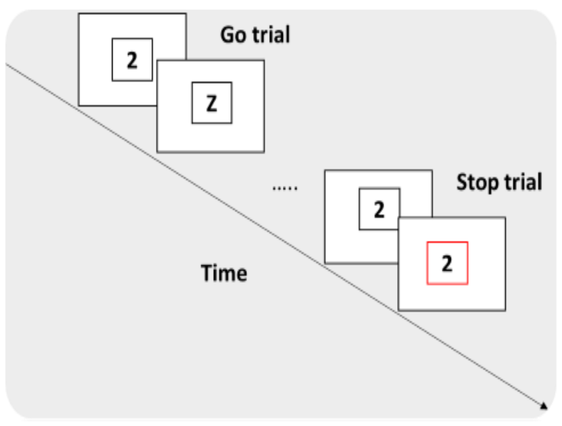
ADHD Symptoms Throughout development

The ADHD Rating Scale-IV (DuPaul et al., 1998)

Mothers completed the questionnaire when their sons were 4.5 years old (Cronbach's alpha = .86).

The Conners' Rating Scales-Revised (CRS-R; Conners, 1997)

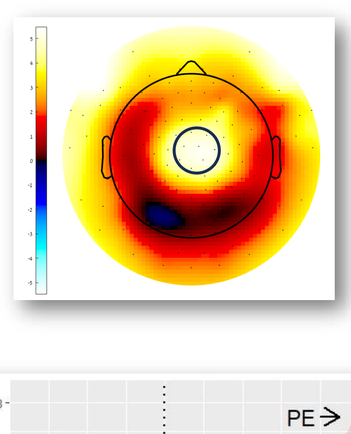
Mothers completed the questionnaire when their sons were 7 and 17 years old (Cronbach's alpha > .86).



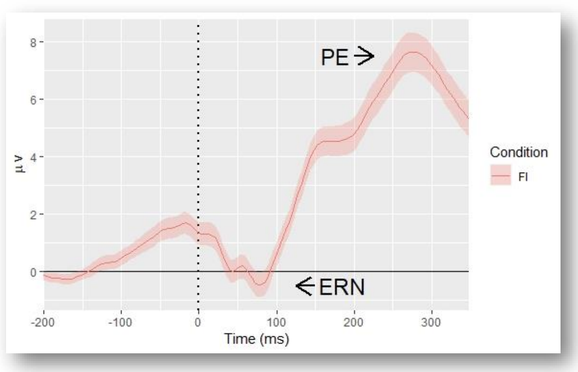
The Stop Signal Task (SST)

(Logan, 1994)

EEG data were recorded during the SST. Failed inhibition (FI) trials were used for all further analyses



Topographic map of theta ERSP (Event-related spectral perturbation) power on the scalp at 300 ms. Chosen electrodes region marked with a circle.



Grand average ERP waveforms across subjects of FI trials in the SST; the vertical dotted line marks motor response onset, and the shaded area indicates the 95% confidence interval.

Error Processing ERP measures

ISV ERP measure

Theta ITC

Mean phase coherence between 200-600 ms

Traditional ERP measures

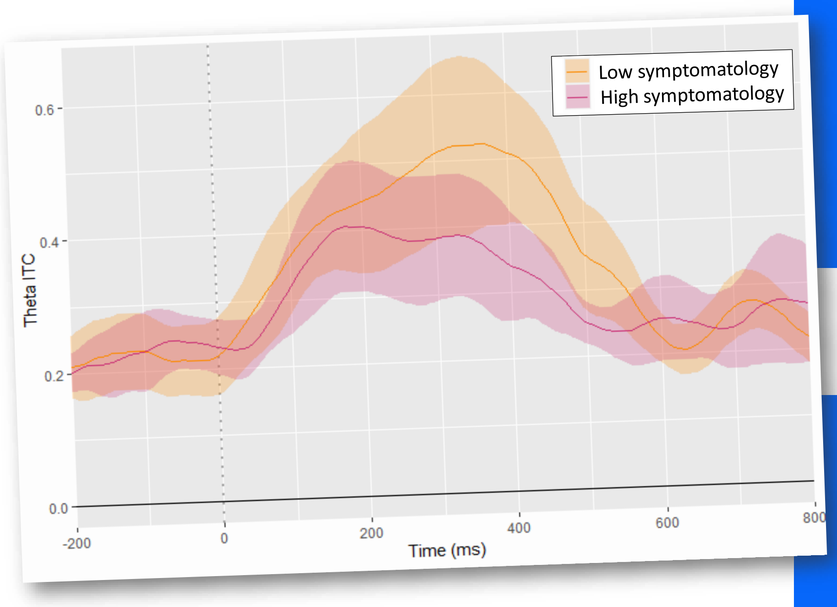
ERN

Peak negative amplitude between 0 to 120 ms

Pe

Peak positive amplitude between 120 to 350 ms

Results



Theta ITC during error processing is a better indicator for neural deficits in ADHD relative to traditional ERP measures.

Model	Predictor	ADHD symptoms – 17 years β	ADHD symptoms – 17 years ΔR^2	R^2 (Adjusted R^2)
1	Number of FI trials	-.07		.00 (.00)
2	Number of FI trials	-.11	.10+	.10 (.04)
	ERN	.07		
	Pe	-.35*		
3	Number of FI trials	-.34*	.15*	.25*(.18)
	ERN	.05		
	Pe	-.14		
	Theta ITC	-.49*		

Model	Predictor	Theta ITC β	Theta ITC ΔR^2	R^2 (Adjusted R^2)
1	Number of FI trials	-.52***		.27*** (.25)
2	Number of FI trials	-.51***	0.21***	.48*** (.45)
	ADHD symptoms throughout childhood	-.25*		
	ADHD symptoms – 17 years	-.30*		

Neural ISV, as measured by theta ITC, was uniquely associated with ADHD symptomatology both during adolescence and throughout childhood.

Conclusion

Our study strengthens the view of theta ITC as a significant neurophysiological marker of a core neural dysfunction in ADHD.

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