

Dissertation

Task Switching and Cognitive Control in Adolescents with Obsessive-Compulsive Disorder, Including Mindfulness: A Multi-Method EEG Approach

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ABSTRACT

Obsessive-compulsive disorder (OCD) in childhood and adolescence is characterized by cognitive rigidity, repetitive behavior patterns and altered executive functioning, particularly in the domain of cognitive flexibility and inhibitory control. While behavioral findings on task switching in OCD have been mixed, neurophysiological approaches provide increasing evidence for more subtle dysfunctions in the underlying control mechanisms. The present dissertation investigated cognitive control in adolescents with OCD from a multi-level perspective, integrating behavioral, neurophysiological and clinical measures. The findings from the three electroencephalography (EEG)-based studies examining switch costs during task switching and N-2 repetition costs in backward inhibition and its modulation through a mindfulness-based intervention in adolescents with OCD within the framework of the Metacontrol State Model (MSM) along the persistence and flexibility continuum.

Study I investigated externally (cue-based) versus internally (memory-based) guided task switching in adolescents with OCD compared to healthy controls. Although behavioral switch costs did not differ between groups, oscillatory EEG analysis showed altered theta- and alpha-band activity dynamics during memory-based switching, indicating impaired endogenous task-set updating. These findings suggest a persistence-dominant metacontrol bias, impairing the coordination of persistence and flexibility while leaving response speed intact, but contributing to lower accuracy.

Building on these neurophysiological differences, *Study II* examined whether an app-based mindfulness meditation training could enhance cognitive flexibility in adolescents with OCD as mindfulness has been linked to improvements in adults with OCD. Using a randomized controlled design and advanced EEG analyses, including multivariate pattern analysis and source localization, the study demonstrated reduced behavioral switch costs following the mindfulness intervention. Neurophysiological improvements were linked to altered response selection processes in the medial frontal gyrus and anterior cingulate cortex suggesting that mindfulness training can modulate frontal control networks and imply a flexible metacontrol state more efficiently. Within the MSM, these effects may reflect a shift toward a more balanced metacontrol state, allowing efficient engagement of flexibility during switch trials while maintaining persistence during repetition trials.

Study III focused on backward inhibition, a specific inhibitory component of cognitive flexibility previously reported to be atypical in adolescent OCD. Contrary to expectations, app-based mindfulness meditation training did not specifically alter the backward inhibition (BI)-effect (N-2 repetition costs) at the behavioral and neurophysiological level with an event related potential (ERP) approach.

Across Studies II and III, OCD symptom severity decreased in both mindfulness and audiobook control groups, suggesting that high-frequency engagement with an auditory task can produce mindful-like benefits even without mindfulness-specific mechanisms. The dissociation between symptom reduction and cognitive control changes underscores the independence of clinical improvement and executive function in adolescent OCD.

Taken together, these studies suggest that cognitive flexibility deficits in adolescent OCD are not uniformly expressed at the behavioral level but are reflected in distinct neurophysiological alterations, particularly in internally guided control and task-set updating processes. Mindfulness-based interventions appear capable of improving certain aspects of flexibility metacontrol states, yet their effects might not be to all inhibitory mechanisms. These findings underscore the importance of distinguishing between different components of cognitive flexibility and provide a foundation for developing targeted, evidence-based approaches to enhance cognitive control in adolescents with OCD.