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Disrupted latent decision processes in medication-free pediatric OCD patients

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ABSTRACT

Background: Decision-making in Obsessive Compulsive Disorder has typically been investigated in the adult population. Computational approaches have recently started to get integrated into these studies. However, decision-making research in pediatric OCD populations is scarce.
Methods: We investigated latent decision processes in 21 medication-free pediatric OCD patients and 23 healthy control participants. We hypothesized that OCD patients would be more cautious and less efficient in evidence accumulation than controls in a two alternative forced choice (2AFC) task.
Results: Pediatric OCD patients were less efficient than controls in accumulating perceptual evidence and showed a tendency to be more cautious. In comparison to post-correct decisions, OCD patients increased decision thresholds after erroneous decisions, whereas healthy controls decreased decision thresholds. These changes were coupled with weaker evidence accumulation after errors in both groups.
Limitations: The small sample size limited the power of the study.
Conclusions: Our results demonstrate poorer decision-making performance in pediatric OCD patients at the level of latent processes, specifically in terms of evidence accumulation.

1. Introduction

OCD is a debilitating psychiatric condition with the age of onset spanning a range from early childhood to adulthood (Pauls et al., 2014). OCD affects 1–3% of the pediatric/adolescent population (Apter et al., 1996; Pauls et al., 1995; Valleni-Basile et al.,1994). The condition includes either or both obsessions and compulsions (American Psychiatric Association, 2013), which significantly reduce the quality of the patients' lives.

A number of previous studies have investigated decision-making in adult OCD patients. However, there is less research conducted with pediatric OCD populations. The Iowa Gambling Task (IGT; Bechara et al., 1994) has been used in many studies with adult OCD patients. Some studies revealed that OCD patients made more disadvantageous choices (e.g. Cavedini et al., 2002; Rocha et al., 2011; Starcke et al., 2010), however other studies revealed comparable performance to healthy controls (e.g. Lawrence et al., 2006; Nielen et al., 2002). In the only IGT study conducted with pediatric OCD patients ($n_{OCD}=22$; $n_{Control}=22$), Kodaira et al. (2012) found more disadvantageous responding of participants with OCD on the last block of testing and suggested that pediatric OCD patients had impaired decision-making. It is worthy to note that recruiting medication-free OCD patients is challenging and that some patients in the above mentioned studies were on psychiatric medications at the time of the experiment (e.g. Kodaira et al., 2012; Lawrence et al., 2006; Rocha et al., 2011; Starcke et al., 2010).

Much neuropsychological research has been undertaken in adult OCD groups but with highly divergent outcomes (Abramovitch et al., 2013a). A recent meta-analysis with 115 studies revealed an average moderate effect size across domains denoting worse performance for OCD patients, which the authors conclude might not allude to clinical significance (Abramovitch et al., 2013a). There is much less neuropsychological research conducted with pediatric OCD patients. A recent meta-analysis compiling 11 studies investigating executive function, memory, processing speed, visuospatial abilities, and working memory has concluded that there is no evidence for neuropsychological dysfunction in

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pediatric OCD populations (Abramovitch et al., 2015). This meta-analysis did find a trend for worse performance in neuropsychological tasks for pediatric OCD patients compared to healthy controls, but the effect sizes were neither statistically significant nor clinically meaningful. The authors attributed the lack of statistical significance to the number of available studies and sample sizes across studies, and pointed to a need for further research. Importantly, decision making tasks were not included in the meta-analysis.

In their critical review, Abramovitch and Cooperman (2015) argue that neuropsychological tests, although informative for the psychiatric area, can be improved with some modifications. For instance, because many neuropsychological studies employ commonly used classic experimental procedures and analyses rather than venturing to new methods, the conclusions may become restricted and thereby uninformative. With different approaches in analyses and changes in the established neuropsychological tasks (e.g. adding distractors or manipulating the task load) (Abramovitch and Cooperman, 2015), the area can benefit from more in-depth characterization of behavior.

In the area of computational psychiatry, researchers are also striving to come up with more in depth analyses of psychiatric problems and shift from a symptom-based descriptive understanding of psychiatric disorders to descriptions involving "objective computational multidimensional functional variables" (Wiecki et al., 2015, p. 378). To this end, Wiecki et al. (2015) point to sequential sampling models as important tools for the field of psychiatry. Drift diffusion model (DDM) is a prominent sequential sampling model, which utilizes a combination of accuracy and reaction time data to explain latent decision-making processes (Ratcliff, 1978; Ratcliff and McKoon, 2008; Ratcliff and Rouder, 1998). Through these processes, the model can provide psychological explanations (such as cautious responding, non-decision time, biases in decision-making and evidence accumulation efficiency) to differences in choice behavior (White et al., 2010a).

The DDM assumes that in a decision-making task with two choices, the agent starts at a point (starting point: z; initial belief state) between the two alternatives and accumulates evidence from the noisy signal with some rate (drift rate: v). As the agent gathers enough evidence to reach one of the two thresholds, the corresponding decision is made. The area between the thresholds associated with two alternatives is referred to as the boundary separation (e.g. Ratcliff and McKoon, 2008). The core parameters of DDM are threshold setting (a), drift rate (v), starting point (z), and non-decision time (*Ter*). The more complex version of the model (extended model; Ratcliff and Rouder, 1998) includes variabilities in non-decision time (*St*), drift rate (*eta*), and starting point (*Sz*). Threshold setting indexes speed accuracy tradeoff or the caution with which the decision is made; the higher the threshold setting the more caution the decision maker exercises. Drift rate indexes the rate of evidence accumulation or signal to noise ratio. The starting point indexes the bias towards either of the two choices and the non-decision time indexes the duration of signal detection or motor response (e.g. Ratcliff and McKoon, 2008; White et al., 2010a).

White et al. (2010a) have pointed out the benefits of using DDM in clinical research. In support of this argument, the DDM has indeed been successfully used in studies with populations suffering from ADHD (e.g. Karalunas and Huang-Pollock, 2013; Metin et al., 2013; Mulder et al., 2010), anxiety (White et al., 2010b), depression (Pe et al., 2013), and clinical (Banca et al., 2015) and subclinical (Erhan and Balcı, 2015) OCD.

Banca et al. (2015) used the dot motion discrimination task with three different levels of signal to noise ratios (SNRs) to study decision-making behaviors of mostly medicated adult OCD patients ($n_{OCD}=28$; $n_{Control}=35$). Monetary rewards and punishments indicated the correct and incorrect responses. Performances on low (coherences .025 and .05), medium (coherences .15 and .25), and high (coherences .45 and .7) levels of SNRs were compared using Hierarchical Drift Diffusion Model (HDDM). The findings revealed higher threshold settings for OCD patients than healthy controls at low and medium SNR levels and lower drift rates than healthy controls in medium and high SNR levels. In other words, OCD patients responded in a more cautious manner and gathered more evidence than controls in lower SNR but accumulated evidence less efficiently in higher SNR scenarios.

Erhan and Balcı (2015) also used the dot motion discrimination task but with a single coherence level (12%) and with healthy adult participants ($N=74$) who rank on various levels on OCD scales. Their findings revealed that increases in rumination and checking tendencies as well as an increase in the entire OC score predicted higher threshold settings. Differing from the clinical OCD study (Banca et al., 2015) subclinical OC traits did not predict drift rates. Authors concluded that a low drift rate could be a signature for clinical OCD populations.

In the current study, we seek to understand the latent decision variables of a medication-free pediatric OCD population (ages 9–16). Even though symptom dimensions of OCD are alike across age groups, pediatric and adult OCD populations seem to have abnormal neural activations in similar brain locations but in reversed directions (Gilbert et al., 2009). Abramovitch et al. (2012), in their review on neuroimaging in pediatric OCD, also argued that adult OCD and pediatric OCD can be distinct and that neurodevelopmental factors such as pruning and myelination make it more difficult to pinpoint a common neurobiological basis for OCD across ages.

We sought to fill the empirical gap in the literature regarding the study of decision-making in the pediatric OCD group at the level of latent processes. We hypothesized that pediatric OCD patients, similar to adult OCD patients (Banca et al., 2015) would set higher decision thresholds than control participants due to the checking and doubting nature of the disorder. Based on the argument that sensory-perceptual evidence, which lets most people make rapid decisions, is not sufficient for patients with OCD (Sachdev and Malhi, 2005), we hypothesized that these patients would need higher amounts of evidence before making a decision. We also predicted lower drift rates on the part of OCD patients as an alternative basis for decision-making deficits associated with this group. As an extension of these predictions, we also predicted OCD patients to set higher thresholds after errors compared to after correct responses.

2. Methods

2.1. Participants

Fifty-three participants partook in the study. Participants with OCD diagnosis ($n=21$) were recruited from the pediatric clinic of a public psychiatric hospital, İstanbul Erenköy Psychiatric Training and Research Hospital. The participants in the control group ($n=32$) were volunteers from a public school in a nearby neighborhood. The study was approved by the Koc University and Erenköy Psychiatric Training and Research Hospital Ethical Review Boards and related permissions were obtained from the Istanbul Provincial Directorate of National Education Board. All parents signed informed consent forms and all participants gave assent to partake in the study. Participants were compensated by a fixed amount for participation-related expenses (e.g. travel).

The exclusion criteria for both groups were intellectual disability, major neurological disorders, and use of psychiatric medication within the last 6 months. The inclusion criterion for the