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RESEARCH ARTICLE

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Cognitive performance of youth with primary generalized anxiety disorder versus primary obsessive–compulsive disorder

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Background: Despite gains made in the study of childhood anxiety, differential diagnosis remains challenging because of indistinct boundaries between disorders and high comorbidity. This is certainly true for generalized anxiety disorder (GAD) and obsessive–compulsive disorder (OCD) as they share multiple cognitive processes (e.g., rumination, intolerance of uncertainty, and increased attention to threat). Disentangling such cognitive characteristics and, subsequently, underlying mechanisms could serve to inform assessment and treatment practices, and improve prognoses.

Methods: The current study sought to compare the cognitive performance (working memory, visuospatial memory, planning ability/efficiency, and cognitive flexibility), indexed by the Cambridge Neuropsychological Automated Battery (CANTAB) among three nonoverlapping groups of youth: (1) those diagnosed with OCD ($n = 28$), (2) those diagnosed with GAD, not OCD ($n = 34$), and (3) typically-developing controls (TDC) ($n = 65$).

Results: Results showed that OCD and GAD youth demonstrated neurocognitive deficits in planning ability/efficiency, cognitive flexibility, and visual processing when compared to TDC, with potential diagnostic specificity such that youth with GAD or OCD had unique deficits compared to TDC and to one another. Specifically, youth with OCD demonstrated significantly impaired planning ability compared to youth in the GAD and TDS groups, whereas youth with GAD demonstrated greater cognitive inflexibility and delayed visual processing compared to youth in the OCD and TDC groups.

Conclusions: Future studies should expand upon these findings with more comprehensive assessment of cognitive functioning by including self- and parent-report forms, and neuroimaging to link behavioral findings with subjective ratings and neurocircuitry. Altogether, data can then inform future assessment and treatment targets.

KEYWORDS
anxiety disorders, child/adolescent, cognition, GAD, OCD

1 | INTRODUCTION

Anxiety disorders are among the most commonly diagnosed psychiatric conditions in childhood (e.g., 2–5% prevalence in population-based studies), with significant associated social, family, and academic impairments (Airaksinen, Larsson, & Forsell, 2005; Beesdo, Knappe, & Pine, 2011; Connolly & Bernstein, 2007; Toren et al., 2000). Despite this high prevalence and gains made in the study, assessment, and understanding of anxiety, these disorders continue to challenge clinicians when it comes to differential diagnosis. Contributing to this challenge are the indistinct boundaries and high rates of comorbidity between the anxiety disorders (Costello, Egger, & Angold, 2005). This is particularly true with generalized anxiety disorder (GAD) and obsessive–compulsive disorder (OCD) as they share common cognitive processes including "persistent and impairing apprehension regarding future events," rumination, intolerance of uncertainty, and increased attention to threat that make them challenging to parse apart (Armstrong, Zald, & Olatunji, 2011; Comer, Kendall, Franklin, Hudson, & Pimentel, 2004; Fergus & Wu, 2010; Holaway, Heimberg, & Coles, 2006). Moreover, despite the best current treatments, both OCD and

GAD remain impairing illnesses for children. Specifically, youth with GAD, with or without comorbid conditions, demonstrate significant difficulties in their family and peer relationships, at school and in their home functioning (Alfano, 2012; Clementi & Alfano, 2014). Youth with OCD are also at high risk for significant peer conflict, academic difficulties, and decreased perceived quality of life (Lack et al., 2009). Disentangling the cognitive processes and underlying mechanisms, noting those that are shared versus unique in children and adolescents with either primary OCD or primary GAD, could serve to inform future assessment and treatment practices, and improve prognoses (Gordon, 2016).

With respect to what is known about patients with OCD, at present, we know far more about the cognitive characteristics of OCD in adults than in children or adolescents. In adults with OCD, findings are mixed with some highlighting deficits in executive function domains (e.g., attention set shifting and response inhibition), whereas others have reported deficits in visual memory and visuospatial ability (Boone, Ananth, Philpott, Kaur, & Djenderedjian, 1991; Christensen, Kim, Dysken, & Maxwell Hoover, 1992; Malloy, 1987; Martinot et al., 1990; Veale, Sahakian, Owen, & Marks, 1996). A recent meta-analysis concluded that OCD in adults is characterized by wide-ranging deficits rather than limited to a specific cognitive domain, albeit with small to medium effects (Shin, Lee, Kim, & Kwon, 2014). Another meta-analysis that had $n = 115$ studies, in which adults with OCD were compared to nonpsychiatric controls, highlighted the potential methodological flaws likely contributing to such inconsistent findings in neuropsychological profiles, and suggested improvements in these may allow for greater replicability of findings (e.g., evaluating the association between OCD severity and/or medication status on task performance, providing details about recruitment methods used, and correcting for multiple comparison; Abramovitch, Mittelman, Tankersley, Abramowitz, & Schweiger, 2015).

In children with OCD, the relatively fewer studies are just as varied in their findings. For example, in comparing the neuropsychological functioning of med-naïve and nondepressed youth with OCD versus controls using tasks of planning ability and set shifting among other cognitive abilities, Beers and colleagues found no significant group differences (Beers et al., 1999). Andrés and colleagues, however, found that youth with OCD were more impaired on tasks of visual memory, velocity, and visual organization than sex- and age-matched healthy controls (Andrés et al., 2007). Shin and colleagues (2008) highlighted executive function deficits (i.e., set shifting) among youth with OCD compared to multiple other psychiatric groups (i.e., those with tic disorder, attention deficit hyperactivity disorder [ADHD], or depression) and healthy controls. Lewin and colleagues (2014) reported significant executive function and memory deficits among their sample of treatment-seeking youth with OCD, and that these deficits were associated with medication status and comorbid conditions and not OCD symptom severity or age as found with post hoc exploratory analyses. Abramovitch and colleagues (2015) conducted a recent meta-analysis of the pediatric OCD-specific literature and, similar to Beers et al., found no noteworthy neuropsychological deficits characteristic of the OCD group, yet they noted a small degree of overall underperformance of youth with OCD versus controls on most subdomains assessed across the $n = 11$ included studies. They hypothesized that this lack of significance may be related to the dearth of controlled studies and urged for future work to continue evaluating the neuropsychological functioning of this population. Moreover, there is a particular paucity of comparative studies of cognitive functioning in children or adults with OCD to those with other primary anxiety disorders.

Similarly, there are relatively few studies of cognitive functioning in children or adolescents with other anxiety disorders like GAD despite being the group of disorders most commonly diagnosed in childhood (Airaksinen et al., 2005; Beesdo et al., 2011; Toren et al., 2000). Similar to the work in OCD, findings from such studies are inconsistent. For example, Airaksinen et al. (2005) found that their adult anxiety disorder group (i.e., panic, social, GAD, OCD, and specific phobia) demonstrated impairments in both episodic memory and executive functioning, whereas Toren and colleagues (2000) found verbal memory deficits among 6–18-year olds with "an anxiety disorder" (i.e., children with separation, overanxious, and/or social anxiety disorders). Vasa et al. (2007) compared the visual and verbal memories of youth at-risk for anxiety based upon parental history of anxiety or depression, such that approximately one-third of the sample met criteria for at least one anxiety diagnosis themselves. They found that youth with social anxiety disorder demonstrated reduced visual memory, whereas youth with GAD did not. In contrast, Jarros et al. (2017) found no differences in attention, verbal episodic memory, working memory, or executive functioning when comparing youth with a mild or severe anxiety disorder (i.e., GAD, social, separation, and panic) to a comparison group of youth with no anxiety disorder (although some were diagnosed with other psychiatric conditions like ADHD, specific phobia, and oppositional defiant disorder), all treatment-naïve and community-recruited. Again, no known studies exist comparing children with primary GAD to those with another primary anxiety disorder, such as OCD.

In the current study, we sought to address the need for studies comparing neurocognitive performance in children with anxiety by harnessing data from two separate research groups and potentially serving as a stepping stone for future multi-group data collection. Specifically, we enrolled three nonoverlapping groups of youth: (1) those diagnosed with current OCD, (2) those diagnosed with GAD but not OCD, and (3) community-recruited, typically-developing controls (TDC). Cognitive performance was indexed using the Cambridge Neuropsychological Automated Battery (CANTAB) to assess particular domains of cognitive functioning, including working memory (spatial span), visuospatial memory, planning ability or efficiency, and cognitive flexibility. We hypothesized that youth with OCD or GAD would demonstrate neurocognitive deficits across multiple domains compared to TDC. Drawing on prior work in GAD and/or OCD, we hypothesized that youth with OCD would demonstrate greater deficits in executive functioning (cognitive flexibility and planning ability) and visuospatial memory compared to youth with GAD, whereas youth would demonstrate greater deficits in working memory compared to the OCD group (Andrés et al., 2007; Ferreri, Lapp, & Peretti, 2011; Jarros et al., 2017; Kashyap, Kumar, Kandavel, & Reddy, 2013; Shin & Liberzon, 2010; Toren et al., 2000).

2 | METHODS

2.1 | Participants and procedure

Participants (ages 7–17 years) were enrolled in one of two institutional review board-approved studies conducted at the same academic-affiliated psychiatric hospital after informed consent and assent were obtained, in compliance with the Code of Ethics of the World Medical Association (Declaration of Helsinki).

2.1.1 | Study #1

GAD and TDC participants were enrolled in an assessment and imaging study. Following a brief telephone interview to ascertain relevant symptoms, youth and at least one parent/guardian were invited for a comprehensive on-site assessment of psychosocial functioning, including the *Kiddie Schedule for Affective Disorders and Schizophrenia*, *Present and Lifetime* (KSADS-PL; i.e., a semi-structured diagnostic interview of lifetime psychiatric symptoms), *Wechsler Abbreviated Scale of Intelligence* (WASI), various parent and self-report forms, and computerized neuropsychological tasks (Kaufman & Rao, 1996; Woerner & Overstreet, 1999).

GAD group inclusion criteria consisted of meeting DSM, 4th Edition Text Revision (DSM-IV-TR) criteria for the disorder as assessed by KSADS-PL administered by graduate level clinicians to children and parents separately, including excessive worry for more than 6 months causing significant functional impairment (American Psychiatric Association, 2000). Participants were excluded from the GAD group if they met criteria for comorbid OCD or posttraumatic stress disorder, given data suggesting varied pathophysiology of these disorders versus other anxiety disorders (further supported by OCD and PTSD being officially moved from the anxiety disorders section in the most recent version of the DSM). They were also excluded if they met criteria for a mood disorder or ADHD, with the intent of keeping the study's psychiatric groups as distinct from one another as possible. Finally, they were excluded if there was reported substance abuse/dependence within 2 months of study enrollment, autism spectrum disorder (ASD), primary psychosis, or WASI Full Scale IQ < 80 in order to minimize participant misunderstanding of study procedures. Of the youth included in the GAD group, four of 34 met criteria for panic disorder and six of 34 for social anxiety disorder.

TDC participant inclusion criteria were not meeting lifetime psychiatric diagnoses in themselves and in first-degree relatives as assessed by KSADS-PL interview. Participants were excluded from the TDC group if WASI IQ < 80, they met criteria for an ASD or for primary psychosis.

2.1.2 | Study #2

OCD participants were seeking standard outpatient services and enrolled in an assessment study prior to starting their care. OCD group inclusion criteria were meeting DSM-IV-TR criteria for OCD as their primary diagnosis as assessed by the KSADS-PL. OCD participant exclusion criteria were meeting criteria for ASD, a psychotic disorder, or depression as these conditions might interfere with the participant's ability to complete study procedures. OCD participants were also excluded for severe cognitive deficit (i.e., mild to severe intellectual disability) based upon parent report and not formally assessed within the current study. Of the $n = 28$ youth included in the OCD group, subsets met criteria for comorbid ADHD ($n = 3$), GAD ($n = 9$), social anxiety disorder ($n = 7$), and Tourette's ($n = 7$).

2.2 | Measures for study #1 and study #2

Both studies administered the KSADS-PL, which has been shown to have adequate concurrent validity supported by strong correlations with rating scales of psychopathology, as well as general test–retest reliability with strong interrater agreement on screening items and diagnoses (Achenbach, 1991; Conners & Barkley, 1985; Kaufman et al., 1997; Kovacs, 1985).

Parents of youth in the GAD and OCD groups also completed the *Child Behavior Checklist* (CBCL), a 117-item parent-report assessment of multiple areas of a child's (ages 4–18 years) emotional and behavioral functioning (Achenbach, 1991). The CBCL has acceptable psychometric properties, including the total problems scale having excellent test–retest reliability ($r = 0.93$) and fair internal consistency (alpha = 0.68; Achenbach, Dumenci, & Rescorla, 2003; Achenbach & Rescorla, 2001). For this study, the internalizing, externalizing, and total *t*-scales were examined for possible group differences based upon parent perception of youth general psychosocial functioning. Youth in the GAD and OCD groups completed the *Multidimensional Anxiety Scale for Children* (MASC), a 39-item self-report assessment of anxiety symptom severity with satisfactory reliability and validity (March, Parker, Sullivan, Stallings, & Conners, 1997). The MASC total *t*-score was used in the current study.

2.2.1 | Neuropsychological tasks of cognition

Participants' cognitive functioning was evaluated in both studies via tasks from the CANTAB (Cambridge Cognition, Cambridge, UK), selected to probe a range of cognitive abilities in line with domains looked at in the existing literature while being mindful of burden placed on participants.

The Spatial Span (SSP) task assesses working memory capacity. SSP is modeled after the Corsi Block Tapping Test and is a visuospatial version of the Digit Span test (Corsi, 1972). Participants are instructed to observe as some squares on the screen in front of them change, one at a time, from white to a different color. The participants then touch the squares on the screen in the order in which they changed color. The number of squares changing colors increases from two to nine across trials and the sequence of color change is varied through the test. Outcome variables include length of memory span, total errors (i.e., number of times the participant selected an incorrect square), and total usage errors (i.e., number of times the participant selected a square not in the sequence being recalled).

The Stockings of Cambridge (SOC) task assesses planning ability or efficiency and is a modified version of the Tower of London task (Shallice, 1982). Participants are presented with two displays on a top-bottom split screen, each containing three colored balls. They must recreate the sequence of moves modeled by the top set of balls using

the bottom set of balls. The task becomes more difficult with each sequence as the minimum number of moves increases from two to three, four, and five. Outcome variables include problem solved in minimum moves, mean number of moves, and initial thinking time for each level.

The Intra–Extra Dimensional Set Shift (IDED) task assesses set shifting and cognitive flexibility and is based upon the Wisconsin Card Sorting Task (WCST) (Grant & Berg, 1948). Participants learn through trial and error which of two shapes is being reinforced. For each of the task's nine stages, participants are required to successfully complete six consecutive trials in order to move on to the subsequent stage. The test is discontinued if the participant is unable to successfully complete six consecutive trials in the total maximum of 50 attempts. In stage 3, lines are added to the shape stimuli as distractors, although reinforcement remains focused on the shape stimuli from stage 1 through 7. Stage 6 is the intradimensional shift because, although all stimuli are changed (i.e., lines and shapes), reinforcement is based upon the participant selecting the correct shape. Stage 8 is the extradimensional shift and participants must learn that reinforcement has changed to selecting the correct line. Stages 2, 5, 7, and 9 are reversal stages, requiring participants continue selecting the same type of stimuli (i.e., either line or shape) reinforced in the previous stage but move to selecting the other exemplar not previously reinforced (i.e., if circle was previously rewarded, the participant learns that the square is now being reinforced). Outcome variables include total errors and total trials by stage.

The Pattern Recognition Memory (PRM) task assesses visual processing and delayed recall. Participants are presented with a series of geometric patterns. In the recognition phase, they are required to choose the pattern they have already seen when presented again alongside a novel pattern. They are then presented with a new series of geometric patterns and undergo a second recognition phase with a new set of comparisons. Outcome variables include number and percent of correct trials and response latency.

2.3 | Analytic plan

First, chi-square and analyses of variance (ANOVA) tested for between-group differences on demographic variables and *t*-tests examined between-group differences (GAD and OCD groups only) on general psychosocial functioning using the CBCL broadband scales. Second, the primary study aim was addressed with ANOVA, to specifically examine the effects of group (GAD, OCD, and TDC) on CANTAB task outcome variables. Finally, to further distinguish the OCD and GAD groups from one another, ANOVA analyses with CANTAB outcomes as the dependent variables were rerun while excluding the $n = 9$ youth from the OCD group who were also diagnosed with comorbid GAD.

3 | RESULTS

There were no between-group differences in age, sex, race, or ethnicity. Regarding symptoms and severity, the OCD and GAD groups did not differ on the clinician-rated *Global Assessment of Functioning* scale ($M\ [SD]_{OCD} = 63.15\ [10.74]$, $M\ [SD]_{GAD} = 65.03\ [9.38]$, $F(1,58) = 0.53$, $P = 0.47$) or on the self-reported MASC ($M\ [SD]_{OCD} = 60.48\ [11.87]$, $M[SD]_{GAD} = 64.39\ [9.70]$, $F(1,56) = 1.90$, $P = 0.17$). The OCD and GAD groups also did not differ on their medication status (i.e., the total number or type of psychotropic medications prescribed). However, OCD and GAD groups did differ on parent-reported CBCL broadband subscales such that the GAD group was rated as significantly more impaired in their overall psychosocial functioning (see Table 1).

With regard to assessment of cognitive functioning on the CANTAB battery, with a Bonferroni correction employed by task to account for multiple comparisons, we found between-group differences emerging on SOC, IDED, and PRM, but not SSP (see Table 2).

On SOC, the OCD group had a greater mean number of moves on level 3 ($F(2,124) = 5.50$, $P = 0.005$), greater mean subsequent thinking time on level 3 ($F(2,124) = 3.87$, $P = 0.02$), and greater mean number of moves on level 5 ($F(2,124) = 3.46$, $P = 0.04$) compared to the TDC group. The OCD group also had a greater mean subsequent thinking time on level 4 ($F(2,124) = 5.10$, $P = 0.007$; $M\ [SD] = 1,475.07\ [1,540.26]$) compared to both the TDC group ($M\ [SD] = 847.09\ [960.70]$, $P = 0.03$; Cohen's $d = 0.49$) and GAD group ($M\ [SD] = 646.36\ [710.88]$, $P = 0.008$; Cohen's $d = 0.69$).

On IDED, the GAD group made a greater number of errors on simple reversal (level 2 only) during which previously nonrewarded stimuli are rewarded ($F(2,124) = 4.77$, $P = 0.01$; $M\ [SD] = 2.29\ [2.11]$) compared to both the TDC group ($M\ [SD] = 1.43\ [1.08]$, $P = 0.01$; Cohen's $d = 0.51$) and OCD group ($M\ [SD] = 1.43\ [0.88]$, $P = 0.049$; Cohen's $d = 0.53$). There were no group differences, however, found on compound reversal learning ($F(2,124) = 1.59$, $P = 0.21$).

Finally, on PRM, GAD participants took longer to select the correct pattern ($F(2,124) = 8.86$, $P = 0.0003$; $M\ [SD] = 2,495.98\ [713.54]$, $P = 0.0003$) when compared to both the OCD ($M\ [SD] = 2,031.59\ [326.93]$, $P = 0.003$, Cohen's $d = 0.84$) and TDC participants ($M\ [SD] = 2,052.04\ [494.70]$, $P = 0.0004$, Cohen's $d = 0.72$), although the groups did not differ on the number of correct responses.

3.1 | Secondary analyses

3.1.1 | Comorbidity

To further distinguish the GAD and OCD groups from one another, analyses were rerun excluding the $n = 9$ youth from the OCD group with comorbid GAD. There were still no between-group differences in age ($F(2,115) = 1.79$, $P = 0.17$) or sex ($\chi^2 = 0.73[2]$, $P = 0.69$). Regarding symptoms and severity, the OCD and GAD groups did not differ on the clinician-rated *Global Assessment of Functioning* scale ($M\ [SD]_{OCD} = 63.88[12.64]$, $M\ [SD]_{GAD} = 65.03\ [9.38]$, $F(1,48) = 0.13$, $p = 0.72$) or on the self-reported MASC ($M\ [SD]_{OCD} = 61.56\ [11.70]$, $M\ [SD]_{GAD} = 64.39\ [9.70]$, $F(1,47) = 0.83$, $P = 0.37$). They continued to differ on the parent-reported CBCL broadband subscales (Internalizing $M\ [SD]_{OCD} = 38.97\ [5.61]$, $M\ [SD]_{GAD} = 65.12\ [9.16]$, $F\ [1,48] = 115.49$, $P < 0.001$; Externalizing $M\ [SD]_{OCD} = 33.26\ [2.50]$, $M\ [SD]_{GAD} = 52.27\ [11.68]$, $F(1,49) = 46.10$, $P = 0.001$; total $M\ [SD]_{OCD} = 33.14\ [3.22]$, $M\ [SD]_{GAD} = 57.82\ [9.56]$, $F\ [1,48] = 106.16$, $P = 0.001$).

TABLE 1 Sample demographics

Characteristic	OCD (*N* = 28)		GAD (*N* = 34)		TDC (*N* = 65)		
Age in years (*M*, *SD*)	12.6	2.5	11.9	2.9	13.0	2.9	$F(2,124) = 1.74$, $P = 0.18$
Full-scale IQ (*M*, *SD*)	–	–	110.2	12.0	111.5	11.0	$F(1,97) = 0.27$, $P = 0.61$
GAF (*M*, *SD*)	63.15	10.74	65.03	9.38	–	–	$F(1,58) = 0.53$, $P = 0.47$
Race (*n*, %)							$\chi^2 = 5.54$, $P = 0.70$
Caucasian	21	91.3	28	87.5	49	79.0	
African American	0	0	2	0.06	3	0.04	
Asian	0	0	0	0	2	0.03	
Multi-racial	2	0.09	2	0.06	6	0.10	
Other	0	0	0	0	2	0.03	
Ethnicity (*n*, %)							$\chi^2 = 0.67$, $P = 0.72$
Hispanic	2	0.09	2	0.06	7	11.7	
Non-Hispanic	21	91.3	29	93.5	53	88.3	
Sex (*n*, %)							$\chi^2 = 1.16$, $P = 0.56$
Male	15	53.6	15	44.1	27	41.5	
Female	13	46.4	19	55.9	38	58.5	
Comorbid conditions (*n*, %)							
ADHD	3	10.7	0	0	–	–	
GAD	9	32.1	–	–	–	–	
OCD	–	–	0	0	–	–	
Panic disorder	0	0	4	11.8	–	–	
Social phobia	7	25.0	6	17.6	–	–	
Tourette's	7	25.0	0	0	–	–	
Chronic motor or vocal tic disorder	0	0	0	0	–	–	
Psychotropic medications (*n*, %)							
Total number							
0	10	35.71	19	55.88	–	–	$\chi^2 = 4.08$, $P = 0.25$
1	12	42.86	9	26.47			
2	5	17.86	4	11.76			
3	1	3.57	0	0			
4	–	–	–	–			
Alpha agonist	1	3.57	0	0	–	–	$\chi^2 = 1.16$, $P = 0.28$
Anti-epileptic	1	3.57	0	0	–	–	$\chi^2 = 1.16$, $P = 0.28$
Anti-psychotic	1	3.57	1	2.94	–	–	$\chi^2 = 0.01$, $P = 0.92$
Sedative	0	0	1	2.94	–	–	$\chi^2 = 0.89$, $P = 0.35$
SSRI	7	25	9	26.47	–	–	$\chi^2 = 0.08$, $P = 0.79$
Other antidepressant	0	0	1	2.94	–	–	$\chi^2 = 0.89$, $P = 0.35$
Stimulant	3	10.71	0	0	–	–	$\chi^2 = 3.61$, $P = 0.06$
MASC (*M*, *SD*)	60.48	11.87	64.39	9.70	–	–	$F(1,56) = 1.90$, $P = 0.17$
CBCL broadband scales (*M*, *SD*)							
Internalizing problems	38.7	5.1	65.1	9.2	–	–	$F(1,56) = 168.91$, $P < 0.001^{**}$
Externalizing problems	33.4	2.4	52.3	11.7	–	–	$F(1,57) = 65.55$, $P < 0.001^{**}$
Total problems	32.9	3.0	57.8	9.6	–	–	$F(1,55) = 151.63$, $P < 0.001^{**}$

ADHD, Attention Deficit Hyperactivity Disorder; CBCL, Child Behavior Checklist; GAD, generalized anxiety disorder; MASC, Multidimensional Anxiety Scale for Children; OCD, obsessive–compulsive disorder; PTSD, Post Traumatic Stress Disorder; TDC, typically-developing controls; GAF, Global Assessment of Functioning; SSRI, Selective Serotonin Reuptake Inhibitor. ADHD diagnoses were not recorded for OCD participants.
$^{*}P < 0.05$ and $^{**}P < 0.01$

TABLE 2 CANTAB performance grouped by OCD (with comorbid GAD) versus GAD versus TDC

	OCD (*N* = 28)	GAD (*N* = 34)	TDC (*N* = 65)	*F*	*P*
SSP (*M*, *SD*)					
Span length	5.93 (1.05)	6.21 (1.41)	6.58 (1.39)	2.61	0.08
Total errors	15.18 (6.77)	14.15 (7.31)	14.75 (6.85)	0.18	0.84
Total usage errors	2.39 (1.83)	2.79 (1.59)	2.46 (1.78)	0.53	0.59
PRM (*M*, *SD*)					
Number correct	21.57 (1.79)	21.47 (2.92)	22.09 (2.17)	0.99	0.37
Percent correct	89.88 (7.47)	89.46 (12.15)	92.05 (9.04)	0.99	0.37
Correct latency	2,031.59 (326.93)	2,495.98 (713.54)	2,052.04 (494.70)	8.86	0.00**
SOC (*M*, *SD*)					
Two moves					
Moves	2.07 (0.38)	2.06 (0.24)	2.05 (0.25)	0.04	0.96
Thinking time	271.06 (790.32)	59.57 (192.80)	114.51 (413.58)	1.58	0.21
Three moves					
Moves	3.61 (0.67)	3.29 (0.48)	3.25 (0.40)	5.50	0.005
Thinking time	1,018.11 (1,725.50)	409.67 (883.22)	278.19 (1,038.38)	3.87	0.02*
Four moves					
Moves	5.67 (1.09)	5.63 (1.05)	5.43 (.96)	0.75	0.48
Thinking time	1,475.07 (1,540.26)	646.36 (710.88)	847.09 (960.70)	5.10	0.007**
Five moves					
Moves	7.83 (1.57)	7.53 (1.48)	7.03 (1.32)	3.46	0.035*
Thinking time	789.15 (1,300.20)	523.17 (468.39)	739.66 (887.51)	0.83	0.44
IDED (*M*, *SD*)					
Stages completed	8.50 (0.84)	8.21 (1.63)	8.48 (1.13)	0.64	0.53
Totals errors	21.07 (11.38)	24.21 (16.75)	19.20 (13.39)	1.43	0.24
Completed stage trials	73.96 (16.03)	76.15 (27.95)	72.34 (21.64)	0.32	0.73
Total trials	88.25 (19.00)	92.32 (28.98)	84.65 (24.04)	1.11	0.33
Pre-ED errors	7.86 (3.04)	9.88 (7.72)	6.75 (4.12)	4.10	0.02*
ED shift errors	10.46 (9.30)	9.26 (10.37)	9.12 (10.11)	0.18	0.83
Simple reversal learning errors	1.43 (0.88)	2.29 (2.11)	1.43 (1.08)	4.77	0.01*
Simple reversal learning trials	8.25 (2.91)	10.15 (4.53)	8.26 (3.55)	3.21	0.04*
Total reversal learning errors	7.11 (6.69)	10.18 (10.94)	7.26 (7.24)	1.59	0.21
Total reversal learning trials	33.96 (12.86)	38.68 (20.27)	34.12 (15.37)	0.99	0.38

GAD, generalized anxiety disorder; IDED, Intra–Extra Dimensional Set Shift; OCD, obsessive–compulsive disorder; PRM, Pattern Recognition Memory; TDC, typically-developing controls; SOC, Stockings of Cambridge; SSP, Spatial Span.
*$P < 0.05$ and **$P < 0.01$.

In terms of analyses with CANTAB task outcomes as the dependent variables (see Table 3), between-group differences on the SOC remained largely the same with the only difference being that the OCD group no longer differed from TDC on subsequent thinking time on level 5. On IDED, while the GAD group made a greater number of errors on simple reversal (level 2 only) compared to TDC, they no longer significantly differed from the OCD group on simple reversals. Results on PRM and SSP were unchanged when excluding youth with OCD and comorbid GAD.

3.1.2 | Age

Given the known association between age and cognitive ability, analyses with CANTAB task outcomes as dependent variables were rerun with age as a covariate (see Table 4). Findings again mirrored those found in the primary analyses such that between-group differences on the SOC remained. The only addition is that the OCD group had a greater mean number of moves on level 3 compared to the GAD and TDC groups instead of the TDC group only. On IDED, the GAD group made a greater number of errors on simple reversal (level 2 only) compared to TDC only, whereas initial analyses also showed a significant difference with the OCD group. PRM and SSP findings were unchanged.

3.1.3 | Anxiety severity

Analyses with CANTAB task outcomes as dependent variables were also rerun with anxiety symptom severity as a covariate (see

TABLE 3 CANTAB performance grouped by OCD (without comorbid GAD) versus GAD versus TDC

	OCD (*N* = 19)	GAD (*N* = 34)	TDC (*N* = 65)	*F*	*P*
SSP (*M*, *SD*)					
Span length	5.84 (0.96)	6.21 (1.41)	6.58 (1.39)	2.56	0.08
Total errors	14.47 (6.85)	14.15 (7.31)	14.75 (6.85)	0.09	0.92
PRM (*M*, *SD*)					
Number correct	21.63 (1.30)	21.47 (2.92)	22.09 (2.17)	0.90	0.41
Percent correct	90.13 (5.42)	89.46 (12.15)	92.05 (9.04)	0.90	0.41
Correct latency	2,017.07 (300.95)	2,495.98 (713.54)	2,052.04 (494.70)	8.36	0.00**
GAD vs. OCD Cohen's *d* = 0.87; GAD vs. TDC Cohen's *d* = 0.72					
SOC (*M*, *SD*)					
Two moves					
Moves	2.11 (0.46)	2.06 (0.24)	2.05 (0.25)	0.24	0.79
Thinking time	368.35 (948.83)	59.57 (192.80)	114.51 (413.58)	2.54	0.08
Three moves					
Moves	3.61 (0.61)	3.29 (0.48)	3.25 (0.40)	4.53	0.01*
OCD vs. TDC Cohen's *d* = 0.70					
Thinking time	1,066.13 (2,021.14)	409.67 (883.22)	278.19 (1,038.38)	3.14	0.047*
OCD vs. TDC Cohen's *d* = 0.49					
Four moves					
Moves	5.67 (1.10)	5.63 (1.05)	5.43 (0.96)	0.67	0.52
Thinking time	1,619.19 (1,807.61)	646.36 (710.88)	847.09 (960.70)	5.20	0.007**
OCD vs. TDC Cohen's *d* = 0.53; OCD vs. GAD Cohen's *d* = 0.71					
Five moves					
Moves	7.79 (1.40)	7.53 (1.48)	7.03 (1.32)	2.85	0.06
Thinking time	828.79 (1,497.87)	523.17 (468.39)	739.66 (887.51)	0.86	0.42
IDED (*M*, *SD*)					
Simple reversal learning errors	1.37 (.60)	2.29 (2.11)	1.43 (1.08)	4.73	0.01*
GAD vs. TDC Cohen's *d* = 0.53					
Total reversal learning errors	6.32 (5.42)	10.18 (10.94)	7.26 (7.24)	1.84	0.16

GAD, generalized anxiety disorder; IDED, Intra–Extra Dimensional Set Shift; OCD, obsessive–compulsive disorder; PRM, Pattern Recognition Memory; TDC, typically-developing controls; SOC, Stockings of Cambridge; SSP, Spatial Span.
*$P < 0.05$ and **$P < 0.01$.

Table 4). While overall findings mirrored those found in the primary analyses, they did not entirely. On the SOC, there was an overall difference between groups on mean subsequent thinking time on level 3 ($F(2,94) = 3.27$, $P = 0.4$), although post hoc pairwise comparisons did not reveal significance. The OCD group no longer differed from TDC on mean subsequent thinking time on level 4. On IDED, the groups no longer differed on the number of errors on simple reversal (level 2 only) during which previously nonrewarded stimuli are rewarded or on compound reversal learning. While PRM findings were unchanged, the groups now differed on SSP mean span length, such that the OCD group had shorter span length versus the TDC group.

3.1.4 | Medications

To further understand potential between-group differences, analyses with CANTAB task outcomes as dependent variables were also rerun with number of psychotropic medications prescribed as a covariate with the OCD and GAD groups only (see Table 4). The OCD group now had a greater mean subsequent thinking time on level 2 compared to the GAD group in addition to thinking time on level 4. There were no longer between-group differences on the IDED or SSP, and PRM results remained the same compared to the primary analyses.

4 | DISCUSSION

The current study is among the first to directly compare the neurocognitive functioning of youth with primary OCD to youth with primary GAD and healthy controls. In line with our hypotheses, OCD and GAD youth demonstrated neurocognitive deficits in planning ability or efficiency, cognitive flexibility, and visual processing when compared to healthy controls and to one another. That is, our findings suggest the potential for diagnostic specificity such that youth with GAD and youth with OCD had unique deficits compared to healthy controls and to one another. However, replication and further evaluation is warranted,

TABLE 4 CANTAB performance with age, anxiety severity and medication as separate covariates

	Age		Anxiety severity		Number of medications	
	F	*P*	*F*	*P*	*F*	*P*
SSP (*M*, *SD*)						
Span length	2.26	0.11	3.60	0.03*	1.76	0.19
			OCD vs. TDC Cohen's $d = 0.47$			
Total errors	0.25	0.78	0.66	0.52	0.08	0.78
PRM (*M*, *SD*)						
Number correct	0.66	0.52	2.49	0.09	0.12	0.73
Percent correct	0.66	0.52	2.49	0.09	0.12	0.73
Correct latency	7.21	0.001**	5.53	0.005**	7.15	0.01*
	GAD vs. OCD Cohen's $d = 0.84$; GAD vs. TDC Cohen's $d = 0.72$		GAD vs. OCD Cohen's $d = 0.79$; GAD vs. TDC Cohen's $d = 0.65$		GAD vs. OCD Cohen's $d = 0.80$	
SOC (*M*, *SD*)						
Two moves						
Moves	0.04	0.97	0.81	0.45	0.009	0.92
Thinking time	1.77	0.17	0.50	0.61	4.23	0.04*
					OCD vs. GAD Cohen's $d = 0.42$	
Three moves						
Moves	5.64	0.005**	2.85	0.06	2.74	0.10
	OCD vs. TDC Cohen's $d = 0.65$; OCD vs. GAD Cohen's $d = 0.55$					
Thinking time	3.86	0.02*	3.27	0.04*	2.64	0.11
	OCD vs. TDC Cohen's $d = 0.52$	No significant post hoc pairwise contrasts				
Four moves						
Moves	0.59	0.56	0.18	0.83	0.009	0.93
Thinking time	5.78	0.004**	3.87	0.03*	7.49	0.008**
	OCD vs. TDC Cohen's $d = 0.49$; OCD vs. GAD Cohen's $d = 0.69$		OCD vs. GAD Cohen's $d = 0.69$		OCD vs. GAD Cohen's $d = 0.73$	
Five moves						
Moves	2.92	0.06	4.41	0.02*	0.27	0.61
			OCD vs. TDC Cohen's $d = 0.67$			
Thinking time	1.23	0.30	0.98	0.38	1.69	0.20
IDED (*M*, *SD*)						
Simple reversal learning errors	4.11	0.02*	1.52	0.23	3.55	0.07
	GAD vs. TDC Cohen's $d = 0.51$					
Total reversal learning errors	0.90	0.41	1.44	0.24	1.09	0.30

GAD, generalized anxiety disorder; IDED, Intra–Extra Dimensional Set Shift; OCD, obsessive–compulsive disorder; PRM, Pattern Recognition Memory; TDC, typically-developing controls; SOC, Stockings of Cambridge; SSP, Spatial Span.
*$P < 0.05$ and **$P < 0.01$.

potentially in larger samples or using alternative tasks tapping into the same cognitive processes.

Our data suggest that youth with OCD have impaired planning ability compared to their healthy and GAD counterparts. These deficits, while generally more widespread versus the former during initial analyses, remained even when controlling for comorbidity, age, anxiety severity, and medication status. Specifically, youth with OCD needed more time and made more moves to solve the SOC stimuli presented on multiple levels compared to controls, whereas this was true on only one of the more difficult levels compared to the GAD group. This finding aligns with (Chamberlain et al., 2007) in that, with a one touch version of the Tower of London task on the harder but not the easier levels, youth with OCD made more moves to reach the correct response compared to TDC and trichotillomania groups. This finding may indicate that the planning efficiency of OCD youth becomes significantly more strained as problems increase in complexity, and may be useful in differentiating them from both TDC and other clinical groups—a distinction less apparent if focused on simpler problem solving or on their accuracy of responding (Veale et al., 1996; Watkins et al., 2005). Moreover, this finding may have treatment implications, such that youth with OCD may need explicit training in structured problem solving, particularly in the context of elevated

distress, which may in turn decrease their use of ritualized behavior to manage distress. Future studies should attempt to replicate this finding with larger groups, with attention toward how the underlying fronto-striatal abnormalities implicated in the pathophysiology of OCD might map onto or are associated with such planning deficits (Van Den Heuvel et al., 2005). Another important avenue of inquiry may be to examine planning ability or efficiency as a potential marker, besides illness severity, of treatment outcomes.

In contrast, the GAD group made more simple reversal errors—an index of cognitive inflexibility and difficulty responding to initial changes in reward contingencies—compared to both their TDC and OCD counterparts during initial analyses, while not having global deficits on other IDED stages involving reversal learning. This finding is consistent with Lee and Orsillo (2014) who conceptualized cognitive inflexibility as a combination of inhibition and shifting deficits. Specifically, they found that GAD youth self-reported significantly more cognitive inflexibility (shifting) compared to healthy controls and required significantly more time to complete an emotional Stroop switching task (inhibition). These studies, however, differ in the measurement of the executive functioning domain and therefore, future work should attempt to assess cognitive flexibility using multiple measures in order to both establish a more comprehensive picture among those with GAD and to clarify how impairment in simple reversal learning correlates with clinically relevant symptoms of worry, perfectionism, bias toward threat, etc.

Secondary analyses from the current study highlight other factors to consider in future works seeking to better understand cognitive flexibility among anxious youth. Specifically, group differences diminished (e.g., GAD differed from TDC but no longer OCD) when controlling for age or were eliminated altogether when controlling for anxiety severity and medication status. For the latter two, likely intricately linked to one another, it may be important to consider anxiety from both a dimensional approach, in line with the National Institute of Mental Health's (NIMH) Research Domain Criteria Initiative (RDoC), as well as a categorical (i.e., diagnoses) approach. That is, future research should attempt to replicate current findings by comparing youth with GAD, with symptom severity factored in, to other nonanxiety diagnostic groups to evaluate diagnostic specificity and therefore, subsequent utility in assessment, diagnosis, and treatment. Similar work has been done among youth with bipolar disorder (BD), and is now being tested as means for a potential mechanism-based intervention (Dickstein, Cushman, Kim, Weissman, & Wegbreit, 2015). Specifically, data suggest that children with BD have impaired behavioral performance with associated brain alterations in cognitive flexibility as indexed by reversal learning compared with both TDC and youth with severe mood dysregulation (Dickstein et al., 2007, 2010). Important steps would be to compare these existing BD neuroimaging findings among a group of youth with GAD to not only understand the general mechanisms underlying cognitive flexibility but also the potential specificity for different diagnoses and symptom severity profiles and to guide the development of mechanism-oriented interventions particularly for youth with GAD.

In the current study, the GAD group also took longer to visually process and select the correct pattern in the PRM task (although they did not differ on the number of correct patterns selected) compared to the OCD and healthy control groups. This finding, remaining even after controlling for age, anxiety severity, and medication status, may reflect the transdiagnostic symptom of perfectionism such that these youth are taking longer to scan and check that the answer chosen is correct. This finding aligns with past research that has shown the positive association between concern over mistakes, personal standards, and clinical perfectionism with pathological worry among a clinical sample of individuals with GAD (Handley, Egan, Kane, & Rees, 2014). Future research should further examine the mechanisms underlying this delayed processing and its link to both perfectionism and worry. Better understanding this connection between brain circuitry and real-world symptoms can then guide the design of targeted interventions useful as self-sufficient or augmentative strategies.

Our study has several limitations, including cross-sectional design, current treatment, and psychiatric comorbidity. First, our data are drawn from two cross-sectional studies and so provide only a snapshot of the cognitive functioning of aforementioned youth. Prospective studies are needed to understand how potential OCD or GAD specific findings might change throughout development. Similarly, given our study design, additional work is required to parse out potential effects of treatment, both psychotherapy and medication. For the latter, we considered the potential effect of number of psychotropic medications prescribed on neurocognitive functioning, noting that, although the overall pattern of findings remained, fewer total between-group differences emerged. Future efforts could focus on better understanding the impact of medications, exploring the impact of both the number of medications with a larger sample size and category of medications on cognitive functioning. Additionally, our clinical groups represent youth with either primary GAD or OCD and yet present with other comorbid psychiatric diagnoses (e.g., Tourette's, ADHD). While certainly representative of psychiatric groups existing in the real-world, such comorbidities complicate interpretation of group findings. Perhaps future studies could consider the cognitive functioning of youth with and without comorbid conditions in order to speak more clearly to diagnostic specificity. One such example would be to assess the cognitive performance of youth with OCD without versus with comorbid tic disorders, the latter a particularly represented subgroup within the current sample, to understand how this pairing might impact outcomes. Further, future efforts—subsequent to the introduction of the NIMH's RDoC—could move beyond categorical views of psychopathology and examine the dimensional and subclinical symptoms impacting cognitive functioning. Finally, our data are based upon behavioral task performance only. To more comprehensively assess and compare the cognitive functioning of youth with OCD to GAD, future studies should include self- and parent-report forms, as well as neuroimaging to link behavioral findings with subjective ratings and neurocircuitry.

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