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Executive function predicts cognitive-behavioral therapy response in childhood obsessive-compulsive disorder

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ABSTRACT

Cognitive-behavioral therapy (CBT) is considered first-line treatment for childhood obsessive-compulsive disorder (OCD). Despite CBT's efficacy, too many children and adolescents do not fully respond to treatment, making the identification of predictors of treatment response highly relevant. Executive functions (EF) have been suggested to constitute such predictors, but studies with pediatric samples are scarce. In the present study, we investigated latent level EF test performance and ratings of daily life EF behavior as predictors of CBT response in pediatric OCD. We further examined the stability of EF from pre-to post-treatment and the association of EF changes with OCD severity change. EF test performance significantly predicted exposure-based CBT outcome. Patients with better EF test performance had significantly elevated risk of non-response relative to patients with poorer performance. Daily life EF behavior in OCD probands improved after treatment relative to controls. The findings suggest that EF performance impacts CBT outcome, and that exposure-based CBT is well-suited for children and adolescents with OCD and poorer EF test performance. This study supports the relevance of EF in CBT for childhood OCD and denotes a possible need for development of enhanced treatments for children and adolescents with OCD and superior EF performance.

1. Introduction

Obsessive-compulsive disorder (OCD) often starts in childhood and can cause significant impairment in daily life (Canals, Hernandez-Martinez, Cosi, & Voltas, 2012; Piacentini, Bergman, Keller, & McCracken, 2003). Cognitive-behavioral therapy (CBT) is considered first-line treatment in pediatric OCD (Geller & March 2012; Ivarsson et al., 2015); however, programs may vary in content. The most widely investigated and recommended CBT programs for pediatric OCD emphasize exposure and response prevention as a core treatment component (Franklin et al., 2013; Geller & March 2012) and commonly also include components such as psychoeducation, creation of a symptom hierarchy, cognitive restructuring, and contingency management (Kircanski, Peris, & Piacentini, 2011; Rosa-Alcázar et al., 2015). Despite the well documented efficacy of CBT, 30–50% of children and adolescents with OCD only respond partially or not at all to standard CBT (Franklin et al., 2015; Torp et al., 2015). Consequently, identifying those in need of adapted, enhanced, or augmented treatment strategies is of great importance, and requires identification of predictors of treatment response.

A range of factors have been suggested to predict treatment response in pediatric OCD, including executive functions (EF; Ginsburg, Kingery, Drake, & Grados, 2008). Executive functions are a set of general-purpose control processes that regulate thought and behavior reflecting both an underlying general ability (common EF) as well as specific functions (e.g., working memory, inhibition, and set shifting; Miyake et al., 2000). Executive functions can be assessed through the use of neuropsychological tasks (i.e., performance-based measures) or behavior ratings (i.e., rating-based measures). The two types of measures have been suggested to reflect different underlying constructs; that is, EF task performance is thought to reflect “processing efficiency” in a structured

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situation, whereas EF behavior ratings reflect "success in goal pursuit" in a daily life context (Toplak, West, & Stanovich, 2013).

Neurobiological OCD models suggest that dysfunction in fronto-striatal brain circuits associated with EF underlies OCD phenomenology (Brem et al., 2012; Menzies et al., 2008) making the case for EF as a potential endophenotype in OCD (Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005; Olley, Malhi, & Sachdev, 2007; Taylor, 2012; Zhang et al., 2015). But whereas EF task underperformance has been documented in adult OCD samples (Abramovitch, Abramowitz, & Mittelman, 2013; Shin, Lee, Kim, & Kwon, 2014; Snyder, Kaiser, Warren, & Heller, 2014), the OCD EF endophenotype hypothesis has generally not been supported in children and adolescents (Abramovitch et al., 2015; Geller et al., 2017; Hybel, Mortensen, Lambek, Thastum, & Thomsen, 2016). By comparison, studies suggest that pediatric OCD patients might be significantly impaired in daily life EF-related behavior compared to typically developing children and adolescents (Hybel, Mortensen, Højgaard, Lambek, & Thomsen, 2017; McNamara et al., 2014; Zandt, Prior, & Kyrios, 2009).

Though deficits in EF task performance do not seem to constitute core markers in the development of OCD in childhood, EFs might play a significant role as a predictor of response to CBT. Cognitive-behavioral therapy requires the child to carry out homework exercises, restructure thoughts, monitor reactions and emotions, and log progress (Kircanski et al., 2011; Piacentini, Langley, & Roblek, 2007). All of these activities rely on the recruitment of EFs such as the ability to plan, hold and manipulate materials in working memory, and inhibit automatized responses. Well-functioning EFs could therefore be a prerequisite for effective treatment (Mohlman & Gorman, 2005). Indeed, such an association has been suggested with respect to the impact of EFs on cognitive restructuring processes in CBT (Johnco, Wuthrich, & Rapee, 2014). However, as CBT for childhood OCD is largely based on exposure and response prevention, with relatively minor emphasis on cognitive restructuring compared to CBT for adults and CBT for other psychiatric conditions (such as generalized anxiety or depression), and as CBT is a highly structured treatment approach which has been said to promote or hone EF skills (Goodkind et al., 2016), a relationship where CBT is most effective in individuals with less optimally functioning EF might also be proposed. The role of EF in OCD treatment response has been examined in adults and, to a lesser extent, in children and adolescents, but with mixed findings. Seven studies have examined neuropsychological functions as predictors of CBT outcome in adult OCD, using performance-based measures. Three of these reported an association between EF and treatment outcome (D'Alcante et al., 2012; Moritz, 1999; Sieg, Leplow, & Hand, 1999), whereas the remaining studies reported no such association (Braga et al., 2016; Moritz et al., 2005; Vandborg, Hartmann, Bennedsen, Pedersen, & Thomsen, 2016; Voderholzer et al., 2013). In one of the studies, rating-based measures of neurocognitive functions (but not EF) were also applied (Moritz et al., 2005), but no association between self-reported neurocognitive function and treatment response was found.

To date, only two studies have investigated EFs as predictors of treatment response in pediatric OCD. Flessner et al. (2010) explored the impact of different aspects of neuropsychological functioning on treatment outcome after CBT, pharmacotherapy, or a combination of the two in a sample of children and adolescents with OCD. They found that impaired visuo-perceptual memory and organization strategy, as measured by the Rey-Osterrieth Complex Figure Test (RCFT; Lezak, Howieson, Bigler, & Tranel, 2012), predicted poorer treatment outcome, and most significantly so in the CBT condition. As the study was exploratory and the validity of the RCFT as an EF measure has been questioned (Weber, Riccio, & Cohen, 2013), replication of the findings is warranted. McNamara et al. (2014) investigated the association between rating-based EFs and response to CBT plus medication or placebo. Executive function was measured with the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). They reported that only one EF aspect, emotional control, predicted outcome; that is, patients with poorer emotional control generally had poorer outcome across treatment conditions.

Whether based on adult or pediatric samples, nearly all of the above-mentioned studies included patients treated with psychotropic medication, making it difficult to single out the unique contribution of CBT. Also, the majority of studies did not exclude neuropsychiatric comorbidity (e.g., ADHD) associated with EF impairments (Snyder, Miyake, & Hankin, 2015), and such factors might confound OCD treatment effects (Olatunji, Davis, Powers, & Smits, 2013).

A further question is whether EF performance is state dependent and influenced by OCD symptoms or should be considered trait-like. Several studies investigating the stability of neuropsychological functions from pre- to post-treatment in adult OCD have been conducted, albeit with mixed results (Vandborg, Hartmann, Bennedsen, Pedersen, & Thomsen, 2015; Vandborg et al., 2012; Voderholzer et al., 2013). In adult OCD, no studies have investigated rating-based EF stability. The stability of EFs in children and adolescents with OCD has been investigated in three samples. In the study by McNamara et al. (2014), rating-based EF aspects were evaluated and it was reported that high scores on the BRIEF subdomains (shift, inhibit, planning/organizing, monitoring and initiating; indicating poorer EF behavior), were associated with higher degree of symptom severity during treatment. However, this study did not evaluate the EF changes in OCD compared to EF changes in typically developing children and adolescents by inclusion of a control group. Such a design was applied by Andres et al. (2008) who investigated neuropsychological test performance before and after six months of naturalistic treatment in children and adolescents with OCD and compared them with a typically developing control group. Neuropsychological performance, including performance on inhibition and set shifting tasks, generally improved and normalized relative to the control group after treatment, suggesting EFs in children and adolescents to be state-dependent. Likewise, in a functional magnetic resonance (fMRI) study, Huyser, Veltman, Wolters, de Haan, and Boer (2010) found performance on a planning task to improve after CBT. In a concurrent fMRI study with the same sample, however, the authors found no change relative to controls after CBT on a task measuring response inhibition (Huyser, Veltman, Wolters, de Haan, & Boer, 2011). In sum, though somewhat inconsistent, previous findings suggest that EFs in pediatric OCD are state-dependent. However, due to the limited sample sizes of the studies, and the restricted number of EF tasks applied, findings are in need of replication.

The primary aim of the present study was to investigate EF as a predictor of response to CBT in children and adolescents with OCD. A performance-based common EF latent variable measure and a rating-based general EF measure were applied. Based on the limited child and adolescent literature, we hypothesized that poorer EF performance, albeit not daily life EF behavior, would predict poorer treatment outcome. Secondary aims were to examine the stability of EFs from pre- to post-CBT treatment and to investigate whether possible changes in EFs were associated with OCD severity change. We hypothesized that both types of EFs would improve after treatment, and that changes in EFs would be associated with changes in OCD severity.

2. Methods

The present study was an add-on to the Nordic Long-term OCD

Treatment Study (NordLOTS; Thomsen et al., 2013). A detailed description of the methods can be found in Hybel et al. (2016) and Torp et al. (2015). A brief summary is provided below.

2.1. Participants

The study included 100 participants: 50 OCD clinic-referred patients aged 7–17 years, and 50 typically developing children and adolescents recruited from local schools. Control participants were pairwise gender and age (±50 days) matched with OCD patients. The inclusion criteria for the OCD group were an OCD diagnosis according to DSM-IV (American Psychiatric Association Task Force on DSM-IV, 2009) and a Children's Yale-Brown Obsessive-Compulsive Scale (CY-BOCS Scahill et al., 1997) total score ≥ 16 (sample CY-BOCS total: $M = 25.34$, $SD = 5.26$, *range* = 16–36). Co-occurring conditions with a lower treatment priority were included. Patients were excluded if they: (i) fulfilled the criteria for a neurodevelopmental disorder and/or a depressive disorder (i.e., disorders that have been associated with impaired EFs; for reviews see, e.g.: Antshel, Hier, & Barkley, 2014; Castaneda, Tuulio-Henriksson, Marttunen, Suvisaari, & Lonnqvist, 2008; Geurts, de Vries, & van den Berg, 2014; Remijnse et al., 2013; Schwam, King, & Greenberg, 2015; Snyder, 2013), (ii) had an IQ < 85 (one standard deviation below the normative mean was chosen to ensure that EF effects were not attributable to general cognitive performance deficits), (iii) were in treatment with psychotropic medication (in order to ensure that CBT effects were not attributable to effects of medication), and/or (iv) had received CBT within less than six months prior to inclusion (in order to ensure that CBT effects were not attributable to spill-over effects from previous treatment). Exclusion criteria for the control group were: psychiatric diagnosis, family history of OCD, referral to community mental health services within one year of participation in the study, IQ < 85, and/or inadequate Danish language proficiency. Demographic and clinical descriptives are presented in Online Appendix A, Table 1.

2.2. Procedures

The study was approved by the Danish regional ethics committee and informed consent was obtained from all participants. Children and adolescents with OCD were diagnosed according to the Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime version for DSM-IV (Kaufman et al., 1997) and assessed with the CY-BOCS before and after a manualized 14-week individually delivered exposure-based CBT program (Torp et al., 2015). Controls were screened according to exclusion criteria via telephone interviews. Parents of the participants completed a brief background questionnaire. Neuropsychological assessments were conducted in the morning in a 2½-3-h session with a fixed test sequence. Examiners were balanced between groups and repeated assessments were performed by the same examiner (time between assessments in days: $M = 113$, $SD = 13.89$). Days between assessments were matched within previously matched OCD control pairs corresponding to the time-span from baseline assessment to treatment termination for individual OCD patients. Mean time between repeated assessments for the OCD group was 114 days (*range* 91–150) and for the control group 113 days (*range* 54–154). Daily life neuropsychological functioning of participants in the two weeks leading up to the assessment was rated by parents and administered as an on-line questionnaire. The enrollment, in-/exclusion criteria, and drop-out study flow are presented in Online Appendix B, Fig. 1.

2.3. Measures

2.3.1. Interviews and questionnaires

The Children's Yale-Brown Obsessive-Compulsive Scale is a clinician-rated interview used to assess current and past OCD symptoms as well as present OCD severity in children and adolescents aged 6–17 years. The total severity scale which was used in the present study ranges between zero and 40 with higher scores indicating higher symptom levels. *The background questionnaire* assessed length of parental education in years calculated as an average for both parents. *The Behavior Rating Inventory of Executive Function* (Gioia et al., 2000) is used to assess daily life EF behavior. The questionnaire is rated by parents, and is validated for children and adolescents aged 5–18 years. An overall score, the Global Executive Composite, where lower scores indicated better functioning, was used in the present study.

2.3.2. Executive function and IQ tasks

The battery included six basic EF tasks with two tasks for each of

Table 1
Demographic and clinical descriptive statistics and mean change difference effect sizes of groups defined by level of executive functioning above or below the sample mean.

	Performance-based EF		Rating-based EF	
	High performers (Baseline $n = 28$) (Post-CBT $n = 26$) n (%) or M (SD) [*range*]	Low performers (Baseline $n = 22$) (Post-CBT $n = 20$) n (%) or M (SD) [*range*]	High performers (Baseline $n = 26$) (Post-CBT $n = 24$) n (%) or M (SD) [*range*]	Low performers (Baseline $n = 24$) (Post-CBT $n = 22$) n (%) or M (SD) [*range*]
Gender (girls)	21 (75)	14 (64)	21 (81)	14 (58)
Age (years)	14.63 (1.51) [11–17]*	12.25 (2.57) [7–17]*	13.73 (2.40) [7–17]	13.43 (2.33) [7–17]
Parental education (years)	13.81 (2.53) [8–17.5]	12.60 (2.40) [8–17.5]	13.59 (2.51) [8–17.5]	12.95 (2.55) [8–17.5]
IQ estimate (RIST)	101.18 (5.35) [91–110]	99.41 (7.48) [88–116]	101.50 (6.40) [88–114]	99.21 (6.24) [88–116]
Baseline EF task performance (LEFV factor scores) ↑	0.20 (0.16) [−0.04–0.50]*	−0.32 (0.25) [−0.85–0.02]*	0.01 (0.34) [−0.83–0.50]	−0.07 (0.32) [−0.85–0.35]
Post-CBT EF task performance (LEFV factor scores) ↑	−0.29 (0.23) [−0.47–0.49]*	0.18 (0.23) [−0.82–0.20]*	0.04 (0.34) [−0.82–0.49]	−0.09 (0.30) [−0.60–0.40]
Baseline EF behavior ratings (BRIEF GEC raw scores) ↓	120.82 (24.20) [85–170]	129.23 (28.89) [76–175]	103.15 (14.36) [76–124]*	147.67 (13.71) [125–175]*
Post-CBT EF behavior ratings (BRIEF GEC raw scores) ↓	117.55 (22.10) [83–159]	108.15 (22.91) [73–147]	97.95(16.91) [73–146]*	128.19 (17.07) [95–159]*
Baseline CY-BOCS Total	25.93 (5.68) [16–36]	24.59 (4.71) [17–35]	24.42 (5.38) [17–34]	26.33 (5.05) [16–36]
Post-CBT CY-BOCS Total	15.15 (7.26) [0–31]*	8.95 (7.43) [0–33]*	11.38 (6.43) [0–25]	13.64 (9.24) [0–33]
Effect sizes** for mean baseline to post-CBT CY-BOCS change differences between groups	0.93		0.07	

RIST = The Reynolds Intellectual Screening Test; LEFV = Latent executive function variable; BRIEF GEC = The Behavior Rating Inventory of Executive Function – Global Executive Composite; CY-BOCS = The Children's Yale-Brown Obsessive-Compulsive Scale. Upwards and downwards arrows designate that higher scores indicate better functioning (↑) or that lower scores indicate better functioning (↓).
*Wilcoxon Rank-Sum Test difference between high and low EF performing groups with $p < 0.001$ (no p-values were in the 0.05–0.001 range).
**Effect sizes (Cohen's d_{ppc2}) were calculated by subtracting the individual CY-BOCS change effect sizes for the high and the low EF groups with the pooled pretest standard deviation used for weighting the differences of the pre-post-means (Morris, 2008).

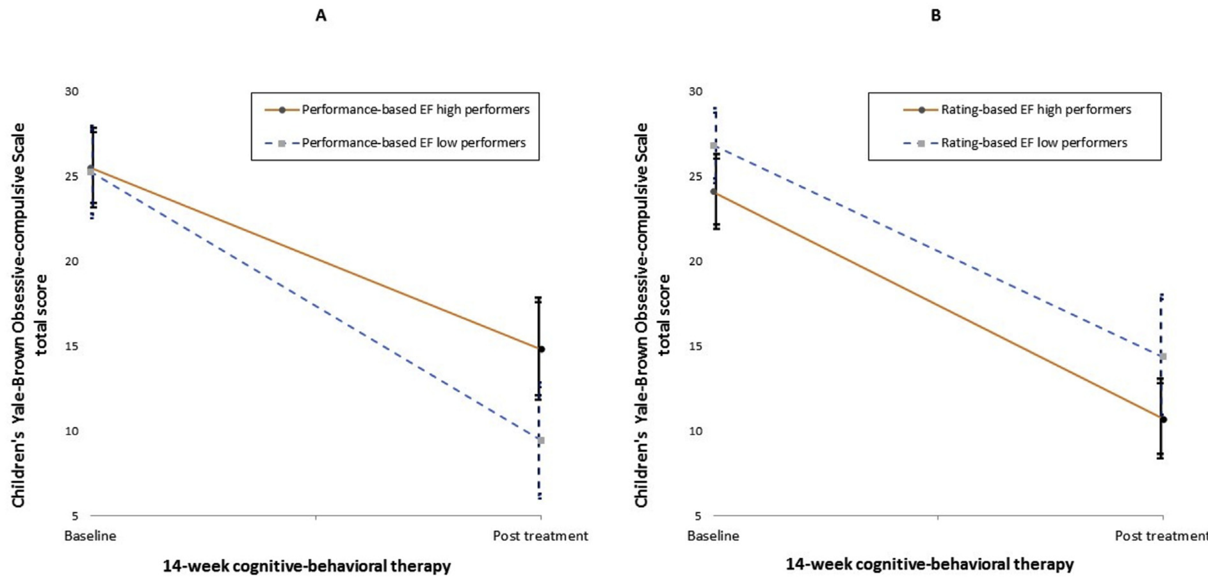

Fig. 1. Multilevel mixed-effects linear regression estimated mean CY-BOCS change from baseline to post-treatment in performance-based EF high and low performers (Figure A) and rating-based EF high and low performers (Figure B) with adjustment for age, gender, and parental education.

the subdomains: working memory, set shifting, and response inhibition. Four tasks were from the Cambridge Automated Neuropsychological Battery (CANTABeclipse, 2006) as indicated by an asterisk (*) below (for a more detailed presentation of tasks see Hybel et al., 2016):

i) *Spatial Working Memory**, outcome measure: number of errors.
ii) *Spatial Span**, outcome measure: span length.
iii) *Intra/Extra Dimensional Set Shift**, outcome measure: total errors adjusted for number of completed stages.
iv) *Trail Making Test – part B* (Reitan, 1971), outcome measure: time to complete.
v) *Stop Signal Task** (Logan & Cowan, 1984; Verbruggen & Logan, 2008), outcome measure: stop signal reaction time.
vi) *Flanker Task* (Eriksen & Eriksen, 1974; Huyser et al., 2011), outcome measure: accuracy on incongruent trials.

A latent variable reflecting common EF (LEFV) based on the above-mentioned tasks was used. Latent EF variable scores were derived from a previous confirmatory factor analysis (CFA) study (see Hybel et al., 2016). Scores in the present sample ranged between −1.31 and 1.11 with higher scores indicating better functioning. The CFA model is presented in Online Appendix C, Fig. 1. *Reynolds Intellectual Screening Test* was applied to measure general cognitive ability (Reynolds, Kamphaus, & Raines, 2012).

2.4. Data analysis

Statistical analyses were conducted with Stata version 14 (StataCorp, 2015). Four patients dropped out of treatment and were not assessed at follow-up. Additionally, four parents did not complete the BRIEF at re-assessment. Data were inspected and tested for normality. Consequently, BRIEF data were transformed through ranking and subsequently z-transformation.

Multilevel mixed-effects linear regression analyses (MME) were used to evaluate baseline EFs as predictors of CY-BOCS change from baseline to post-treatment. Fixed effects were time (baseline; post-treatment), LEFV, BRIEF, age, gender, parental education, and the interaction of time with EFs (time x LEFV; time x BRIEF). Secondary analyses further included IQ in the model. Drop-outs and completers were compared with respect to baseline age, gender, parental education, IQ, LEFV, and BRIEF using the Wilcoxon Rank-Sum Test. No statistically significant differences emerged. Furthermore, the results were not altered when re-running the analyses without the drop-outs, and therefore analyses were conducted with all available data, since MME is able to handle randomly missing data appropriately.

In order to supplement the MME results with a clearer illustration of magnitude of effects, logistic regression analyses with age, gender, and parental education included as covariates were used to evaluate low versus high EF performers' risk of being non-responders to CBT. In the interest of complying with intention-to-treat principles, drop-outs from CBT were considered non-responders in these analyses.

CBT response was defined according to the double criterion introduced by Jacobson and Truax (1991) including: (i) the Clinically Significant Change Index designating a return to normal level of functioning (≥2 SD from the dysfunctional population mean [CY-BOCS < 14.43]), and (ii) the Statistically Reliable Change Index designating whether the change is statistically significant at the 95% level (CY-BOCS change divided by the standard error of the difference for the instrument [≥ 6.48]). The calculations were based on observed sample means in the total NordLOTS sample ($n = 269$; Torp et al., 2015) and a 0.79 test-retest reliability (Storch et al., 2004). Twenty-nine patients were categorized as responders, and 21 as non-responders.

Two types of high and low EF performers were defined based on their LEFV or BRIEF score: Performance-based EF high performers ($n = 28$), rating-based EF high performers ($n = 26$), performance-based EF low performers ($n = 22$), rating-based EF low performers ($n = 24$). High respectively low EF performers had scores indicating an EF level above or below the sample mean (LEFV high performance was indicated by a positive z-score, BRIEF high performance was indicated by a negative z-score and vice versa for low performance).

The stability of EFs (LEFV and BRIEF) across repeated assessment in OCD patients and controls were analyzed using MME with all available data. Fixed effects were time (baseline, post-treatment), group (OCD, control), parental education, days between repeated assessments, and the interaction of time with group (time x group). In secondary analyses, IQ was also included. The models included random intercept and linear-slope by matched pairs (OCD control). For clarity of presentation, EF data were z-transformed.

Second-order partial correlation analysis with adjustment for age, gender, and parental education was used to evaluate associations between baseline to post-treatment change for CY-BOCS and LEFV, as well as CY-BOCS and BRIEF. To test if baseline OCD symptom level significantly affected results, secondary analyses also included adjustment for baseline CY-BOCS. Change scores were generated by subtracting baseline CY-BOCS and BRIEF from post-treatment ditto, and vice versa for LEFV (negative change scores denoted improvement). Analyses were conducted with inclusion of patients with complete data only (CY-BOCS/LEFV: $n = 46$; CY-BOCS/BRIEF: $n = 42$). All secondary MME, logistic regression and partial correlation analyses including IQ or baseline CY-BOCS will be described to the extent that the adjustments significantly influenced the results.

3. Results

3.1. Executive functions as predictors of CBT outcome

Baseline EF test performance, but not daily life EF behavior, significantly predicted CY-BOCS change during treatment (LEFV: $B = 2.76$, $SE = 0.96$, $p = 0.004$; BRIEF: $B = 0.820$, $SE = 1.07$, $p = 0.444$). This was also reflected in the categorical analyses where OCD patients were dichotomized into high and low EF performers on the two types of EF measures. Basic demographic and clinical descriptive statistics for the EF dichotomized groups are presented in Table 1.

Performance-based EF high performers had significantly elevated risk of non-response to CBT relative to low performers (*OR [CI]* = 6.75 [1.31–34.91], $p = 0.023$, *Pseudo* $R^2 = 0.12$). Estimated CY-BOCS change from baseline to post-treatment in the two types of high and low EF performers is presented in Fig. 1A and B.

3.2. Executive function changes across CBT and associations with OCD severity change

The estimated mean change in rating-based EF from baseline to post-treatment was significant in the OCD group as well as in the control group (OCD: $M = -0.44$, 95% CI [−0.64–−0.25], $p = 0.000$; Control: $M = 0.29$, 95% CI [0.14–0.43], $p = 0.000$). Furthermore, slopes were significantly different between the groups ($M = 0.73$, 95% CI [0.54–0.92], $p = 0.000$), with the OCD group improving and the control group deteriorating slightly (control group test-retest $r = 0.81$). No significant differences emerged for performance-based EF. Fig. 2 illustrates the change for the two types of EFs in the two groups.

No significant correlations emerged between CY-BOCS baseline to post-treatment change and change in the two EFs. Partial correlations between and within pre-treatment, post-treatment, and baseline to post-treatment CY-BOCS, performance-based EF and rating-based EF are presented in Online Appendix D, Table 1.

4. Discussion

The aim of the present study was to investigate EF as a predictor of CBT outcome in children and adolescents with OCD, to evaluate the stability of EF from pre-to post-CBT, and to examine possible associations between EF changes and OCD severity change.

Executive Function test performance significantly predicted CBT response. Contrary to our initial hypothesis, results indicated that children and adolescents with poorer EF test performance gained more from CBT, in terms of OCD severity reduction, than did children and adolescents with superior EF test performance. Risk of non-response to therapy was almost seven times higher for children and adolescents in the high performing group. Due to lack of research with children and adolescents, our initial hypothesis was based on results from one previous study where EF was measured based on the RCFT (Flessner et al., 2010). As the validity of the RCFT as an EF measure has been questioned (Weber et al., 2013), it is possible that EF per se was not examined in the Flessner et al. study, which could explain the discrepancy between our hypothesis and findings. One interpretation of the results from the present study might be that children and adolescents with poorer EF abilities have additional treatment gains due to the highly-structured approach CBT offers (e.g., clear in-session agenda-setting, well-planned homework assignments, etc.). Previous studies of adults with OCD have suggested that well-functioning EFs might facilitate the effective application of CBT techniques (Falconer, Allen, Felmingham, Williams, & Bryant, 2013; Johnco et al., 2014; Mohlman & Gorman, 2005), but the results from the present study do not support this conclusion for childhood OCD. On the contrary, the present results could suggest that exposure-based CBT (i.e., with less emphasis on cognitive restructuring techniques) offers a highly scaffolded intervention for children and adolescents with OCD and poorer EF abilities, thereby enhancing treatment for this group specifically. These results partially corroborate findings from a recent study which found that inferior EF task performance (i.e., set shifting ability) predicted better outcome of CBT in elderly depressed patients (Goodkind et al., 2016). Although the Goodkind study addressed a different clinical group (and one at the other end of the age-spectrum), together these results do suggest that level of executive functioning could be modifying effects in CBT more generally. With respect to the present findings and CBT for childhood OCD specifically, aspects such as clear agenda setting, role modeling by the therapist, offering of concrete examples, in-session exercises on how to endure and resist OCD symptoms, and development of individually tailored, clearly written alternative behavior programs for the family to bring home, etc. may enable children and adolescents with inferior EF abilities (as well as their parents) to compensate for these deficient abilities which previously hindered them from tackling OCD symptoms effectively. However, presently the mechanisms by which EFs and CBT interact can only be speculative as the role of EF in CBT outcome, as well as the role of EF in specific CBT mechanisms, is under-investigated (Treworgy, Casale, Giancola, & Roth, 2014). More research is definitely needed before firm conclusions can be made.

As expected, daily life EF behavior was not predictive of outcome. This finding was in line with the McNamara et al. study (2014) and underscored the dissociation between the two types of EF measures as suggested in previous research (Ten Eycke & Dewey, 2016; Toplak et al., 2013).

In line with the hypotheses and previous literature (McNamara et al., 2014), daily life EF behavior improved after treatment. It is possible that this EF aspect is more state-dependent, that is, to a greater extent influenced by OCD symptoms and/or general life conditions than are performance-based EF. Notably, a significant opposite-directed change in rating-based EF was found in the control group. This could be ascribed to measurement uncertainty of the instrument within normal range (i.e., $r = 0.81$, $p < 0.001$; cf. previously reported BRIEF test-retest correlations; Gioia et al., 2000). Contrary to the hypotheses (albeit, in line with one previous study; (Huyser et al., 2011), the present study found no difference in EF task performance before and after CBT. Thus, our findings did not corroborate previous results by Andres et al. (2008) and Huyser et al. (2010), which indicated improvement in EF test performance after treatment. These studies, however, differed from

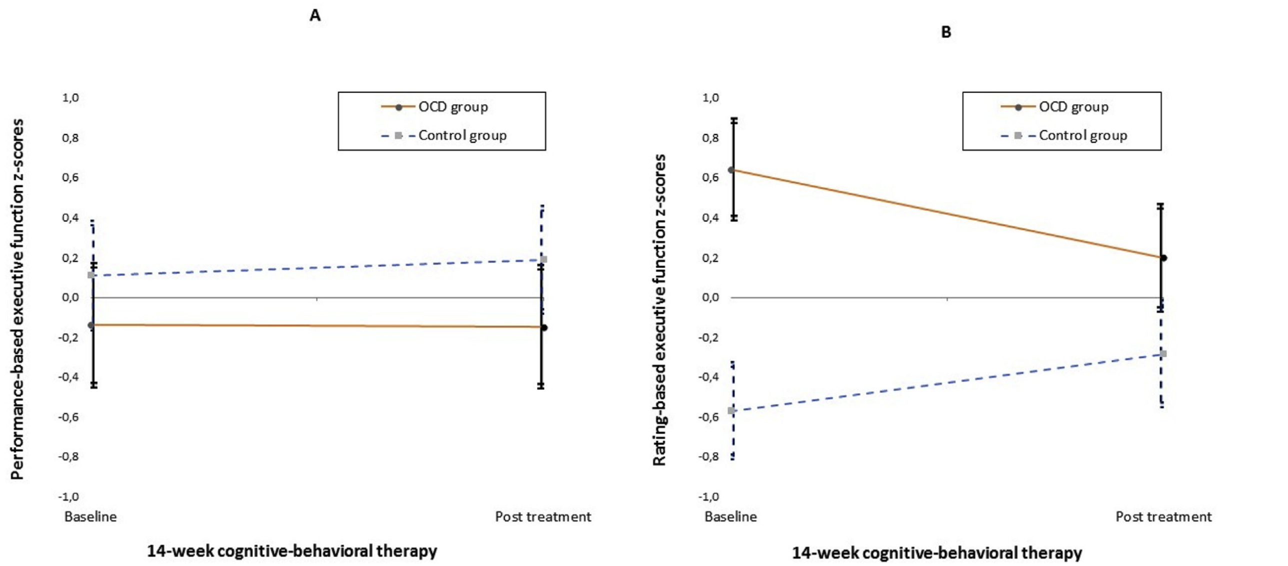

Fig. 2. Multilevel mixed-effects linear regression estimated mean performance-based executive function change (Figure A) and rating-based executive function change (Figure B) in OCD patients and typically developing children and adolescents.

the present study in several methodological aspects, for instance, both studies had considerably smaller sample sizes (OCD, $n = 25$ and 29 respectively), and both investigated observed level EF variables, as opposed to latent ones. Finally, results indicated that change in EF from pre- to post-CBT was not associated with symptom severity change; that is, CBT response was not related to change in daily life EF behavior or EF test performance, and vice versa.

The present study had several strengths. First, it was the first to investigate EF as a predictor of CBT outcome in medication-free children and adolescents with OCD, and to apply a latent EF variable approach in this context. The use of latent variables is generally recommended in EF research because they are suggested to be "purer" measures of EF, less influenced by lower level cognitive functions (Miyake, Emerson, & Friedman, 2000; Snyder et al., 2015). Second, the study was well-controlled with respect to diagnostic status, background variables, and intervention. Third, it included a large sample as well as a well-matched control group. The study also has limitations. The performance-based EF measure did not have norms. Consequently, the cutoff demarking high and low EF performing groups was not indicative of impairment level. From previous research, we know that the OCD patients included in the present study were generally not impaired relative to controls (Hybel et al., 2016), and therefore the dichotomization by EF performance was an indication of high and low performance within the normal range. Since the present study was part of an open CBT trial, we were not able to conclude whether the findings are specific to exposure-based CBT or generalize to other types of treatment. Also, as EFs were not assessed during treatment, the potential mediating effect of EF was not explored, and such aspects should be investigated in future research. Finally, as this was the first study of its kind with pediatric OCD patients, findings would be strengthened by replication.

In conclusion, EF test performance predicted CBT response in childhood OCD. Better performing patients had significantly elevated risk of non-response to CBT. Contrary to EF test performance, daily life EF behavior improved after CBT, indicating that this EF aspect might be state-dependent in childhood OCD. The study has two important implications. First, clinicians should not hesitate to offer CBT to children and adolescents with OCD and poorer EF performance. Second, better EF performing patients might need adjusted, enhanced, or augmented treatment.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.brat.2017.08.009.

References

Abramovitch, A., Abramowitz, J. S., & Mittelman, A. (2013). The neuropsychology of adult obsessive–compulsive disorder: A meta-analysis. *Clinical Psychology Review, 33*(8), 1163–1171. http://dx.doi.org/10.1016/j.cpr.2013.09.004.

Abramovitch, A., Abramowitz, J. S., Mittelman, A., Stark, A., Ramsey, K., & Geller, D. A. (2015). Research review: Neuropsychological test performance in pediatric obsessive-compulsive disorder–a meta-analysis. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 56*(8), 837–847. http://dx.doi.org/10.1111/jcpp.12414.

American Psychiatric Association Task Force on DSM-IV. (2009). *Diagnostic and statistical manual of mental disorders*. In text rev (Ed.) (4. ed.). Washington, DC: American Psychiatric Association.

Andres, S., Lazaro, L., Salamero, M., Boget, T., Penades, R., & Castro-Fornieles, J. (2008). Changes in cognitive dysfunction in children and adolescents with obsessive-compulsive disorder after treatment. *Journal of Psychiatric Research, 42*(0022–3956; 6), 507–514.

Antshel, K. M., Hier, B. O., & Barkley, R. A. (2014). Executive functioning theory and ADHD. In S. Goldstein, & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 107–120). New York: Springer.

Braga, D. T., Abramovitch, A., Fontenelle, L. F., Ferrao, Y. A., Gomes, J. B., Vivan, A. S., … Cordioli, A. V. (2016). Neuropsychological predictors of treatment response to cognitive behavioral group therapy in obsessive-compulsive disorder. *Depression and Anxiety*. http://dx.doi.org/10.1002/da.22509.

Brem, S., Hauser, T. U., Iannaccone, R., Brandeis, D., Drechsler, R., & Walitza, S. (2012). Neuroimaging of cognitive brain function in paediatric obsessive compulsive disorder: A review of literature and preliminary meta-analysis. *Journal of Neural Transmission (Vienna, Austria : 1996), 119*(11), 1425–1448. http://dx.doi.org/10.1007/s00702-012-0813-z.

Canals, J., Hernandez-Martinez, C., Cosi, S., & Voltas, N. (2012). The epidemiology of obsessive–compulsive disorder in Spanish school children. *Journal of Anxiety Disorders, 26*(7), 746–752. http://dx.doi.org/10.1016/j.janxdis.2012.06.003.

CANTABeclipse. (2006). In CANTAB Research Suite v.3 (Ed.), *Cambridge neuropsychological test automated battery*. Cambridge, UK: Cambridge Cognition.

Castaneda, A. E., Tuulio-Henriksson, A., Marttunen, M., Suvisaari, J., & Lonnqvist, J. (2008). A review on cognitive impairments in depressive and anxiety disorders with a focus on young adults. *Journal of Affective Disorders, 106*(0165–0327; 1–2), 1–27.

Chamberlain, S. R., Blackwell, A. D., Fineberg, N. A., Robbins, T. W., & Sahakian, B. J. (2005). The neuropsychology of obsessive compulsive disorder: The importance of failures in cognitive and behavioural inhibition as candidate endophenotypic markers. *Neuroscience & Biobehavioral Reviews, 29*(3), 399–419.

D'Alcante, C. C., Diniz, J. B., Fossaluza, V., Batistuzzo, M. C., Lopes, A. C., Shavitt, R. G., … Hoexter, M. Q. (2012). Neuropsychological predictors of response to randomized treatment in obsessive-compulsive disorder. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 39*(2), 310–317. http://dx.doi.org/10.1016/j.pnpbp.2012.07.002.

Eriksen, B. A., & Eriksen, C. W. (1974). Effects of noise letters upon the identification of a target letter in a nonsearch task. *Perception & Psychophysics, 16*(1), 143–149.

Ten Eycke, K. D., & Dewey, D. (2016). Parent-report and performance-based measures of executive function assess different constructs. *Child Neuropsychology, 22*(8), 889–906. http://dx.doi.org/10.1080/09297049.2015.1065961.

Falconer, E., Allen, A., Felmingham, K. L., Williams, L. M., & Bryant, R. A. (2013). Inhibitory neural activity predicts response to cognitive-behavioral therapy for posttraumatic stress disorder. *The Journal of Clinical Psychiatry, 74*(9), 895–901. http://dx.doi.org.ez.statsbiblioteket.dk:2048/10.4088/JCP.12m08020.

Flessner, C. A., Allgair, A., Garcia, A., Freeman, J., Sapyta, J., Franklin, M. E., … March, J. (2010). The impact of neuropsychological functioning on treatment outcome in pediatric obsessive-compulsive disorder. *Depression and Anxiety, 27*(4), 365–371. http://dx.doi.org/10.1002/da.20626.

Franklin, M. E., Dingfelder, H. E., Coogan, C. G., Garcia, A. M., Sapyta, J. J., & Freeman, J. L. (2013). Cognitive behavioral therapy for pediatric obsessive-compulsive disorder: Development of expert-level competence and implications for dissemination. *Journal of Anxiety Disorders, 27*(8), 745–753. http://dx.doi.org/10.1016/j.janxdis.2013.09.007.

Franklin, M. E., Kratz, H. E., Freeman, J., Ivarsson, T., Heyman, I., Sookman, D., … March, J. (2015). Cognitive-behavioral therapy for pediatric obsessive-compulsive disorder: Empirical review and clinical recommendations. *Psychiatry Research, 227*(1), 78–92. http://dx.doi.org.ez.statsbiblioteket.dk:2048/10.1016/j.psychres.2015.02.009.

Geller, D. A., Abramovitch, A., Mittelman, A., Stark, A., Ramsey, K., Cooperman, A., … Stewart, S. E. (2017). Neurocognitive function in pediatric obsessive-compulsive disorder. *The World Journal of Biological Psychiatry*, 1–26. http://dx.doi.org/10.1080/15622975.2017.1282173.

Geller, D. A., & March, J. (2012). Practice parameter for the assessment and treatment of children and adolescents with obsessive-compulsive disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 51*(1), 98–113. http://dx.doi.org/10.1016/j.jaac.2011.09.019.

Geurts, H. M., de Vries, M., & van den Berg, F. W. M. (2014). Executive functioning theory and autism. In S. Goldstein, & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 121–141). new York: Springer.

Ginsburg, G. S., Kingery, J. N., Drake, K. L., & Grados, M. A. (2008). Predictors of treatment response in pediatric obsessive-compulsive disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 47*(8), 868–878. http://dx.doi.org/10.1097/CHI.0b013e3181799ebd.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). TEST REVIEW behavior rating inventory of executive function. *Child Neuropsychology, 6*(3), 235–238. http://dx.doi.org/10.1076/chin.6.3.235.3152.

Goodkind, M. S., Gallagher-Thompson, D., Thompson, L. W., Kesler, S. R., Anker, L., Flournoy, J., … O'Hara, R. M. (2016). The impact of executive function on response to cognitive behavioral therapy in late?life depression. *International Journal of Geriatric Psychiatry, 31*(4), 334–339. http://dx.doi.org/10.1002/gps.4325.

Huyser, C., Veltman, D. J., Wolters, L. H., de Haan, E., & Boer, F. (2010). Functional magnetic resonance imaging during planning before and after cognitive-behavioral therapy in pediatric obsessive-compulsive disorder. *Journal of the American Academy of Child and Adolescent Psychiatry, 49*(12), 1238–1248. http://dx.doi.org/10.1016/j.jaac.2010.08.007, 1248.e1-5.

Huyser, C., Veltman, D. J., Wolters, L. H., de Haan, E., & Boer, F. (2011). Developmental aspects of error and high-conflict-related brain activity in pediatric obsessive-compulsive disorder: A fMRI study with a flanker task before and after CBT. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 52*(12), 1251–1260. http://dx.doi.org/10.1111/j.1469-7610.2011.02439.x.

Hybel, K. A., Mortensen, E. L., Højgaard, D. R. M. A., Lambek, R., & Thomsen, P. H. (2017). Symptom profiles and executive function in obsessive-compulsive disorder. *Journal of Obsessive-Compulsive and Related Disorders, 14*, 36–46.

Hybel, K. A., Mortensen, E. L., Lambek, R., Thastum, M., & Thomsen, P. H. (2016). Cool and hot aspects of executive function in childhood obsessive-compulsive disorder. *Journal of Abnormal Child Psychology*. http://dx.doi.org/10.1007/s10802-016-0229-6.

Ivarsson, T., Skarphedinsson, G., Kornør, H., Axelsdottir, B., Biedilæ, S., Heyman, I., … March, J. (2015). The place of and evidence for serotonin reuptake inhibitors (SRIs) for obsessive compulsive disorder (OCD) in children and adolescents: Views based on a systematic review and meta-analysis. *Psychiatry Research, 227*(1), 93–103. http://dx.doi.org.ez.statsbiblioteket.dk:2048/10.1016/j.psychres.2015.01.015.

Jacobson, N. S., & Truax, P. (1991). Clinical significance : A statistical approach to defining meaningful change in psychotherapy research. *Journal of Consulting and Clinical Psychology, 59*(1), 12–19. http://dx.doi.org/10.1037/0022-006X.59.1.12.

Johnco, C., Wuthrich, V. M., & Rapee, R. M. (2014). The influence of cognitive flexibility on treatment outcome and cognitive restructuring skill acquisition during cognitive behavioural treatment for anxiety and depression in older adults: Results of a pilot study. *Behaviour Research and Therapy, 57*(1), 55–64. http://dx.doi.org/10.1016/j.brat.2014.04.005.

Kaufman, J., Birmaher, B., Brent, D., Rao, U., Flynn, C., Moreci, P., … Ryan, N. (1997). Schedule for affective disorders and schizophrenia for school-age children-present and lifetime version (K-SADS-PL): Initial reliability and validity data. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(7), 980–988. http://dx.doi.org/10.1097/00004583-199707000-00021.

Kircanski, K., Peris, T. S., & Piacentini, J. C. (2011). Cognitive-behavioral therapy for obsessive-compulsive disorder in children and adolescents. *Child and Adolescent Psychiatric Clinics of North America, 20*(2), 239–254. http://dx.doi.org/10.1016/j.chc.2011.01.014.

Lezak, M. D., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). *Neuropsychological assessment* ((5. ed.). New York: Oxford University Press.

Logan, G. D., & Cowan, W. B. (1984). On the ability to inhibit thought and action: A theory of an act of control. *Psychological Review, 91*(3), 295–327. http://dx.doi.org/10.1037/0033-295X.91.3.295.

McNamara, J. P. H., Reid, A. M., Balkhi, A. M., Bussing, R., Storch, E. A., Murphy, T. K., … Geffken, G. R. (2014). Self-regulation and other executive functions relationship to pediatric OCD severity and treatment outcome. *Journal of Psychopathology and Behavioral Assessment, 36*(3), 432–442.

Menzies, L., Chamberlain, S. R., Laird, A. R., Thelen, S. M., Sahakian, B. J., & Bullmore, E. T. (2008). Integrating evidence from neuroimaging and neuropsychological studies of obsessive-compulsive disorder: The orbitofronto-striatal model revisited. *Neuroscience and Biobehavioral Reviews, 32*(0149–7634; 3), 525–549.

Miyake, A., Emerson, M. J., & Friedman, N. P. (2000). Assessment of executive functions in clinical settings: Problems and recommendations. *Seminars in Speech and Language, 21*(2), 169–183.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49–100. http://dx.doi.org/10.1006/cogp.1999.0734.

Mohlman, J., & Gorman, J. M. (2005). The role of executive functioning in CBT: A pilot study with anxious older adults. *Behaviour Research and Therapy, 43*(4), 447–465. http://dx.doi.org/10.1016/j.brat.2004.03.007.

Moritz, S. (1999). Neurocognitive functioning in OCD before and after treatment. *CNS Spectrums, 4*(21), 21–22, 22.

Moritz, S., Kloss, M., Jacobsen, D., Fricke, S., Carrie, C., Brassen, S., et al. (2005). Neurocognitive impairment does not predict treatment outcome in obsessive-compulsive disorder. *Behaviour Research and Therapy, 43*(6), 811–819.

Morris, S. B. (2008). Estimating effect sizes from pretest-posttest-control group designs. *Organizational Research Methods, 11*(2), 364–386. http://dx.doi.org/10.1177/1094428106291059.

Olatunji, B. O., Davis, M. L., Powers, M. B., & Smits, J. A. J. (2013). Cognitive-behavioral therapy for obsessive-compulsive disorder: A meta-analysis of treatment outcome and moderators. *Journal of Psychiatric Research, 47*(1), 33–41. http://dx.doi.org.ez.statsbiblioteket.dk:2048/10.1016/j.jpsychires.2012.08.020.

Olley, A., Malhi, G., & Sachdev, P. (2007). Memory and executive functioning in obsessive-compulsive disorder: A selective review. *Journal of Affective Disorders, 104*(1–3), 15–23. http://dx.doi.org/10.1016/j.jad.2007.02.023.

Piacentini, J., Bergman, R. L., Keller, M., & McCracken, J. (2003). Functional impairment in children and adolescents with obsessive-compulsive disorder. *Journal of Child and Adolescent Psychopharmacology, 13*(Suppl 1), S61–S69. http://dx.doi.org/10.1089/104454603322126359.

Piacentini, J., Langley, A., & Roblek, T. (2007). *Cognitive-behavioral treatment of childhood OCD. it's only a false alarm. A therapist guide*. New York, NY: Oxford university Press.

Reitan, R. M. (1971). Trail making test results for normal and brain-damaged children. *Perceptual and Motor Skills, 33*(2), 575–581.

Remijnse, P. L., van den Heuvel, O. A., Nielen, M. M., Vriend, C., Hendriks, G. J., Hoogendijk, W. J., … Veltman, D. J. (2013). Cognitive inflexibility in obsessive-compulsive disorder and major depression is associated with distinct neural correlates. *PLoS One, 8*(4), e59600. http://dx.doi.org/10.1371/journal.pone.0059600.

Reynolds, C. R., Kamphaus, R. W., & Raines, T. C. (2012). *The reynolds intellectual assessment scales and the reynolds intellectual screening test*. New York, NY, US:

Guilford Press, New York, NY.
Rosa-Alcázar, A. I., Sánchez-Meca, J., Rosa-Alcázar, Á., Iniesta-Sepúlveda, M., Olivares-Rodríguez, J., & Parada-Navas, J. L. (2015). Psychological treatment of obsessive-compulsive disorder in children and adolescents: A meta-analysis. *The Spanish Journal of Psychology, 18*. http://dx.doi.org/10.1017/sjp.2015.22.
Scahill, L., Riddle, M. A., McSwiggin-Hardin, M., Ort, S. I., King, R. A., Goodman, W. K., … Leckman, J. F. (1997). Children's yale-brown obsessive compulsive scale: Reliability and validity. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*(6), 844–852. http://dx.doi.org/10.1097/00004583-199706000-00023.
Schwam, D. M., King, T. Z., & Greenberg, D. (2015). Characteristics of executive functioning in a small sample of children with tourette syndrome. *Applied Neuropsychology Child, 4*(4), 297–308, 297; 308.
Shin, N. Y., Lee, T. Y., Kim, E., & Kwon, J. S. (2014). Cognitive functioning in obsessive-compulsive disorder: A meta-analysis. *Psychological Medicine, 44*(6), 1121–1130. http://dx.doi.org/10.1017/S0033291713001803.
Sieg, J., Leplow, B., & Hand, I. (1999). Neuropsychological deficits and treatment response in obsessive- compulsive disorder. *Verhaltenstherapie, 9*(1), 7–14.
Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: A meta-analysis and review. *Psychological Bulletin, 139*(1), 81–132. http://dx.doi.org/10.1037/a0028727.
Snyder, H. R., Kaiser, R. H., Warren, S. L., & Heller, W. (2014). Obsessive-compulsive disorder is associated with broad impairments in executive function: A meta-analysis. *Clinical Psychological Science*. http://dx.doi.org/10.1177/2167702614534210.
Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology, 6*, 328. http://dx.doi.org/10.3389/fpsyg.2015.00328.
StataCorp. (2015). *Stata statistical software: Release 14* (14th ed.). College Station, Texas: Statacorp LP.
Storch, E. A., Murphy, T. K., Geffken, G. R., Soto, O., Sajid, M., Allen, P., … Goodman, W. K. (2004). Psychometric evaluation of the children's yale-brown obsessive-compulsive scale. *Psychiatry Research, 129*(1), 91–98. http://dx.doi.org/10.1016/j.psychres.2004.06.009.
Taylor, S. (2012). Endophenotypes of obsessive-compulsive disorder: Current status and future directions. *Journal of Obsessive-Compulsive and Related Disorders, 1*(4), 258–262. http://dx.doi.org/10.1016/j.jocrd.2012.06.004.
Thomsen, P. H., Torp, N. C., Dahl, K., Christensen, K., Englyst, I., Melin, K. H., … Ivarsson, T. (2013). The nordic long-term OCD treatment study (NordLOTS): Rationale, design, and methods. *Child and Adolescent Psychiatry and Mental Health, 7*(1), 41. http://dx.doi.org/10.1186/1753-2000-7-41.
Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 54*(2), 131–143. http://dx.doi.org/10.1111/jcpp.12001.
Torp, N. C., Dahl, K., Skarphedinsson, G., Thomsen, P. H., Valderhaug, R., Weidle, B., … Ivarsson, T. (2015). Effectiveness of cognitive behavior treatment for pediatric obsessive-compulsive disorder: Acute outcomes from the nordic long-term OCD treatment study (NordLOTS). *Behaviour Research and Therapy, 64*, 15–23. http://dx.doi.org/10.1016/j.brat.2014.11.005.
Treworgy, S., Casale, K., Giancola, P. R., & Roth, R. M. (2014). Cognitive behavioral therapy for executive dysfunction in adult psychiatric disorders. In K. P. Bennett (Ed.), *Executive functioning : Role in early learning processes, impairments in neurological disorders and impact of cognitive behavior therapy (CBT)* (pp. 115–137). New York: Nova Science Publishers, Inc.
Vandborg, S. K., Hartmann, T. B., Bennedsen, B. E., Pedersen, A. D., Eskildsen, A., Videbech, P. B., et al. (2012). Do cognitive functions in obsessive-compulsive disorder change after treatment? A systematic review and a double case report. *Nordic Journal of Psychiatry, 66*(1), 60–67. http://dx.doi.org/10.3109/08039488.2011.626869.
Vandborg, S. K., Hartmann, T. B., Bennedsen, B. E., Pedersen, A. D., & Thomsen, P. H. (2015). Are there reliable changes in memory and executive functions after cognitive behavioural therapy in patients with obsessive-compulsive disorder? *Cognitive Neuropsychiatry, 20*(2), 128–143. http://dx.doi.org/10.1080/13546805.2014.981649.
Vandborg, S. K., Hartmann, T. B., Bennedsen, B. E., Pedersen, A. D., & Thomsen, P. H. (2016). Can memory and executive functions in patients with obsessive-compulsive disorder predict outcome of cognitive behavioural therapy? *Nordic Journal of Psychiatry, 70*(3), 183.
Verbruggen, F., & Logan, G. D. (2008). Response inhibition in the stop-signal paradigm. *Trends in Cognitive Sciences, 12*(11), 418–424. http://dx.doi.org/10.1016/j.tics.2008.07.005.
Voderholzer, U., Schwartz, C., Freyer, T., Zurowski, B., Thiel, N., Herbst, N., … Kuelz, A. K. (2013). Cognitive functioning in medication-free obsessive-compulsive patients treated with cognitive-behavioural therapy. *Journal of Obsessive-Compulsive and Related Disorders, 2*(3), 241–248.
Weber, R. C., Riccio, C. A., & Cohen, M. J. (2013). Does rey complex figure copy performance measure executive function in children? *Applied Neuropsychology Child, 2*(1), 6.
Zandt, F., Prior, M., & Kyrios, M. (2009). Similarities and differences between children and adolescents with autism spectrum disorder and those with obsessive compulsive disorder: Executive functioning and repetitive behaviour. *Autism, 13*(1362–3613; 1), 43–57.
Zhang, L., Dong, Y., Ji, Y., Zhu, C., Yu, F., Ma, H., … Wang, K. (2015). Dissociation of decision making under ambiguity and decision making under risk: A neurocognitive endophenotype candidate for obsessive-compulsive disorder. *Progress in Neuro-Psychopharmacology & Biological Psychiatry, 57*, 60–68. http://dx.doi.org/10.1016/j.pnpbp.2014.09.005.