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ORIGINAL ARTICLE

The Overcontrol in Youth Checklist (OCYC): Behavioral and Neural Validation of a Parent-Report of Child Overcontrol in Early Childhood

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Abstract
Self-control is protective against psychopathology in childhood. However, too much self-control, namely overcontrol, potentiates risk. Overcontrol is a constellation of child characteristics related to high need for control, perfectionism, inflexibility, social comparison, and performance monitoring and is a transdiagnostic risk factor associated with psychiatric disorders across the lifespan. However, there are no quick and developmentally appropriate screeners to identify overcontrol in early childhood, when overcontrol purportedly becomes stable. The current study validated the Overcontrol in Youth Checklist (OCYC) in 4–7 year old children and examined relationships with cognitive, social, and psychiatric, neural and behavioral indicators. The OCYC demonstrated good psychometrics and was associated with deficits in cognitive shifting, social functioning, and preschool psychopathology. Higher OCYC scores were associated with a blunted ΔERN, an indicator of performance monitoring in preschoolers. Findings demonstrate the OCYC to be a developmentally valid measure of overcontrol that identifies this transdiagnostic risk factor early in development.

Keywords Overcontrol · Early childhood · Transdiagnostic · Behavioral inhibition · Error-related negativity

Introduction

Self-control develops rapidly in early childhood, is adaptive, and is protective against onset of psychopathology [1]. A lack of self-control, or undercontrol, is widely studied in children and contributes to externalizing presentations [2]. Conversely, excessive self-control, (or, given self-control may not fully be developed in early childhood, excessive *need* for control), or 'overcontrol,' is also implicated across internalizing presentations of child psychopathology [3, 4], but has received much less research attention. Overcontrol is associated with multiple psychiatric disorders across the lifespan, including social anxiety disorder, obsessive–compulsive disorder (OCD), anorexia nervosa and depression [5–7], and thus appears to be a transdiagnostically relevant construct.

Overcontrol taps a desire for control, structure, perfection, and aversion to making mistakes. It appears to most commonly occur in the context of behavioral inhibition (BI), or the hesitancy to approach new and unfamiliar people [e.g., shyness; 8]. However, overcontrol is conceptually distinguishable from BI, demonstrating an independent developmental trajectory, as BI is identifiable in infants and toddlers, while overcontrol does not become stable until age 5 [3, 9]. BI has been extensively studied in young children [e.g., 10, 11], yet only a subset of these children will develop a psychiatric disorder [12]. Thus, characterizing the subset of children with BI who display elevated risk, potentially those exhibiting overcontrol, may be most clinically relevant. The purpose of the current study was to validate a short, easy to administer, parent-reported measure of overcontrol in young children to efficiently identify this transdiagnostic risk marker in early childhood.

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Past work on overcontrol in youth comes from several independent lines of research, with the personality literature first to coin the term [4, 13]. From this perspective, overcontrolled children are introverted and tense, emotionally sensitive, but also agreeable and prosocial [14, 15]. This personality style has been replicated across cultures and ages, demonstrating stability across the lifespan [16, 17]. Overcontrol can also be identified using the Five Factor Model of personality [FFM; 18]; overcontrolled youth demonstrate low extraversion and high neuroticism, with some work indicating low openness and elevated conscientiousness and agreeableness [4, 17, 19].

The temperament literature conceptualizes overcontrol as a form of 'reactive overcontrol,' or rigid, inflexible, behavioral inhibition [3]. This literature characterizes overcontrolled children as shy and inhibited, exhibiting high concern with making mistakes (and as a result are often young perfectionists), displaying high inhibitory control but poor cognitive flexibility and shifting, and exhibiting anxious apprehension [3, 20]. When exhibiting high negative emotionality, these children are emotionally expressive at young ages. However, over time, overcontrolled children learn to inhibit emotion expression and are prone to reactive withdrawal [20].

Overcontrol has recently been examined in the context of BI. In the context of elevated BI, overcontrol is studied as a moderating risk factor [11, 21]. Although many overcontrolled children exhibit a behaviorally inhibited temperament, not all children with elevated BI are overcontrolled. In the BI literature, overcontrol is indexed using task-based inhibitory control [21] or a neural marker, the error-related negativity (ERN), an event-related potential (ERP). The ERN is associated with anxious apprehension, error and performance monitoring, and reactive control processing [see below for more on this indicator; 22–24].

Outcomes Related to Overcontrol in Children

The constellation of characteristics that make up overcontrol in early childhood often result in poor social functioning, including social withdrawal, peer rejection, high conflict in parent–child relationships, and loneliness, which persist through adolescence and adulthood [17, 20, 25, 26]. However, overcontrolled children are often prosocial and desire social interactions, so poor social functioning can manifest as high social concern combined with a lack of age appropriate social skills [15, 20].

Additionally, overcontrol is associated with high internalizing symptoms in youth [27]. In children with elevated BI, overcontrol potentiates risk for social anxiety [21, 28, 29]. Characteristics of overcontrol (e.g., high concern for errors, perfectionism, cognitive inflexibility) have been theorized to be an endophenotype conferring risk for OCD and anorexia nervosa [6, 30].

Neural and Behavioral Indicators of Performance Monitoring and Overcontrol

Although most research examines overcontrol as a constellation of temperamental/personality characteristics, the BI literature has utilized neural (ERN) and behavioral indicators of overcontrol that overlap with performance monitoring (NIMH Research Domain Criteria (RDoC) Cognitive control: Performance monitoring). Specifically, the ERN is a negative deflection occurring within 50 ms of making a behavioral error and indexes non-conscious responding to errors [24]. A larger (more negative) ERN is evident in anxiety disorders, particularly OCD, a disorder characterized by heightened concern over errors [31], and a larger ERN predicts onset of anxiety disorders in school-aged children [32]. The ERN is associated with checking behaviors and self-monitoring [33] and has been equated with overcontrol [11].

There is some evidence the ERN shows developmental specificity in its relationship with fear and anxiety. Most literature demonstrates a larger ERN in relation to overcontrol and anxiety outcomes in older children and adults, however an emerging literature indicates the opposite relationship in young children. In 6-year-old children, temperamental fear, anxiety symptoms and children with maternal history of anxiety disorders are associated with a *blunted* ERN [34, 35]. Age 3 fear predicted a blunted ERN at age 6 [23]. Although it is unclear why the relationship between the ERN and anxiety flips developmentally, it has been theorized to be due to changing phenomenology of anxiety from external to internal sources and/or the differential development of the rostral versus dorsal ACC, from where the ERN is thought to emerge [23, 35].

Behavioral adaptations following errors also index performance monitoring and may be tapping into overcontrol. These include slowing down after making a mistake (post-error slowing), which could adaptively improve later performance (post-error accuracy) [36]. However, post-error slowing may also index behavioral interference due to focusing on the error [37, 38], leading to worse subsequent performance. Although no work has examined how these behavioral indicators are associated with overcontrol in youth, they may provide meaningful information regarding cognitive patterns associated with overcontrol.

The Current Study

Overcontrol is a purported early-emerging transdiagnostic risk factor contributing to psychopathology. Identifying this characteristic early in childhood could lead to targeted early interventions that prevent onset of psychopathology and promote adaptive psychological functioning across the lifespan. Moreover, mapping a quick behavioral measure onto neural functioning could help link dimensional behavioral constructs implicated in mental disorders with neurobiological systems. However, currently there are no quick, feasible, and developmentally appropriate screening tools to identify overcontrol in early childhood. Past research has either used clustering or modeling analytical techniques of multiple characteristics, task-based measures that only capture aspects of the characteristic, or neural markers, each of which has limitations as measurement approaches (long or resource intensive).

The current study had three aims, with the overarching goal of validating a developmentally appropriate screening measure of overcontrol for early childhood, when these characteristics first become stable around age 5 [3]. First, we developed a brief parent-report questionnaire assessing early childhood overcontrol and tested its psychometric properties. Second, we examined how this measure related to psychological functioning, including cognitive and social functioning, behavioral inhibition and activation, and psychopathology. Third, we investigated whether this measure mapped onto neurobiological (EEG) and behavioral functioning that indexes heightened performance monitoring and overcontrol, including the ERN, post-error slowing and post-error accuracy. We hypothesized that children exhibiting higher overcontrol would display deficits in cognitive shifting (but not other measures of executive functioning) and social functioning, and elevated BI and internalizing presentations. We did not expect relationships between the OCYC and behavioral activation (BAS) or externalizing presentations. We also hypothesized that overcontrol would be associated with a blunted ERN, increased post error slowing due to perseverative attention towards the error, and increased post-error accuracy as a compensatory behavior to decrease subsequent errors.

Methods

Participants

95 depressed preschoolers and 52 healthy children aged 3–7 years (N = 147; M = 5.29, SD = 1.02) and their caregivers participated. Preschool depression prevalence rates of 1–2% are comparable to school-age depression [39], and depressed preschoolers were from a randomized clinical trial [PCIT-ED; Parent–Child Interaction Therapy Emotion Development; 40]. The majority completed assessments at baseline (42.2%), a subset (4.8%) attended a separate session soon after baseline and some completed measures following therapy (22.4%). Treatment targeted emotional development and did not address overcontrol. A comparison sample of community healthy preschoolers completed a one-time session, confirming mental health status with below clinical *T*-scores on the Child Behavior Checklist [41, 42] and matched on gender, age, ethnicity and SES. A subset of children completed the neural ERP assessment (n = 64); showing no demographic differences (*p*'s > .05) compared to the larger sample. A separate subset of parents (n = 55) completed a second assessment of overcontrol to examine test–retest reliability. The current sample was part of an exploratory study to identify overcontrol in early childhood. All preschoolers in ongoing studies were invited to participate. Given overcontrol exists on a continuum across clinical and healthy samples, it was ideal to include both clinically depressed and healthy preschoolers.

Measures

Overcontrol in Youth Checklist

The overcontrol in youth checklist (OCYC) was designed to assess behavioral manifestations of overcontrol in young children. The OCYC began as a 25-item parent-reported measure including original items and items developmentally adapted from currently validated questionnaires [including the Behavioral Inhibition Questionnaire; Child Retrospective Perfectionism Questionnaire, Iowa-Netherlands Comparison Orientation Measure, Child Yale-Brown Obsessive Compulsive Scale, and Child and Adolescent Perfectionism Scale; 43–46]. The OCYC assesses early childhood inflexibility, perfectionism, anxious apprehension, checking and social comparison that contribute to overcontrol. Parents are asked Yes/No questions about how their child acts most of the time, using the previous year as a time anchor. Dichotomous responses (yes/no) were chosen to create a screening checklist that is highly feasible in clinical and research settings and only takes 2 to 4 min to complete. Full-scale validation below and full questionnaire in supplementary materials.

The Behavior Rating Inventory for Executive Function-Preschool Version [BRIEF-P; 47] and the Behavior Rating Inventory for Executive Function BRIEF; Gioia et al. [48])

The BRIEF-P (n = 86) was completed by parents with children < 6 years and the BRIEF (n = 58) was completed by parents with children > 6 years. The BRIEF/-P measure behavioral manifestations of executive function, scored on a 3-point scale from *never*, *sometimes*, and *often*. Scores are summed, age-normed *T*-scores are used, and higher scores indicate greater impairment. Overlapping subscales for the BRIEF-P and BRIEF include inhibitory control (Inhibition), cognitive and behavioral flexibility (Shifting), emotional regulation (Emotional control), working memory (Working memory) and ability to plan and organize cognition and problem-solving (Plan/organize).

The Behavioral Inhibition and Activation Scales-Revised

The Behavioral Inhibition and Activation Scales (BIS/BAS) assess child's behavioral inhibition (hesitancy to approach novelty) and behavioral activation (appetitive and approach motives). The revised validated version for younger children includes BAS Drive, BAS Reward Responsiveness and BIS subscales [49]. Internal consistency was adequate in the current sample (BIS $\alpha = .72$, BAS-drive $\alpha = .82$, BAS-reward $\alpha = .82$).

Income-to-Needs Ratio

This ratio was a measure of socioeconomic status computed by dividing total family income by the federal poverty level, based on family size.

Kiddie Schedule for Affective Disorders, Early Childhood

Preschool-onset major depression (PO-MDD) and anxiety (separation anxiety disorder, generalized anxiety disorder, social anxiety disorder) and externalizing (oppositional defiant disorder, conduct disorder, ADHD) disorders were determined using the Kiddie Schedule for Affective Disorders, Early Childhood Version (K-SADS-EC; [50]). Interviews were administered by masters level clinicians to the primary caregiver of children in the clinical trial. To have PO-MDD, caregivers reported their child experienced ≥ 4 DSM criteria for major depression in the past month. All diagnoses underwent case consultation and reliability across diagnoses was good ($\kappa = .88$).

MacArthur Health Behavior Questionnaire

Parents of depressed preschoolers completed the Peer Relations subscale of the MacArthur Health and Behavior Questionnaire-Parent 1.0 for children aged 4–8 [51]. This subscale consists of the 8-item peer acceptance/rejection and the 3-item bullied by peers subscales. Parents report on their child's experiences from 1 (*not at all like*) to 4 (*very much like*). Internal consistency for peer relations, peer acceptance, and bullied were good (α's = .89, .87, .77, respectively).

Child Behavior Checklist

All parents completed the Child Behavior Checklist (CBCL) [41, 42] appropriate for their child's age, a well-validated measure assessing internalizing and externalizing problems. Age-based and normed *T*-scores for symptom-based subscales were used.

Go/No-Go ERN Task

Children played The Zoo Game, a child-friendly go/no-go task [52]. Children were instructed to 'round up' escaped zoo animals by hitting a button (go-trials; 75% of trials), and told the orangutans were friends helping and should not be round up (no-go trials, 25% of trials). Children pressed a button as quickly as possible when they saw an animal on the screen (except orangutans). Animal stimuli were presented for 500 ms, followed by a blank screen for 900 ms until the child responded; the intertrial interval was jittered 200–300 ms. Children completed four blocks of 70 trials each with breaks between blocks. The task was presented on a 20-inch monitor using E-prime Software (Psychology Software Tools, Inc., Pittsburgh, PA; [53]) and using a Logitech Gamepad F310 game controller. Prior to the task children were shown three boxes of prizes with increasingly attractive toys linked to differing points. Children were told every time they 'caught' an animal (except orangutans) they would accrue points to win a prize and with more points, they could pick a better prize.

Behavioral measures included reaction time (RT) and accuracy for error and correct trials. To measure behavioral slowing and accuracy on trials immediately following errors, post-error slowing (PES) and post-error accuracy (PEA) percentage change variables were created, which take into account individual differences in reaction time [37]. Reaction time or accuracy following a correct go-trial is subtracted from an incorrect no-go response, then divided by reaction time or accuracy following a correct go-trial [PES: (RT when prior trial was incorrect no-go—RT when prior trial was correct go)/RT when prior trial was correct go-trial] and [PEA: (Accuracy when prior trial was incorrect no-go—accuracy when prior trial was correct go)/accuracy when prior trial was correct go-trial].

Procedure

As part of the larger study, parents and children completed a series of behavioral, EEG, and therapy sessions. In the current study, parents completed measures about their child while the child completed the EEG. All study materials received IRB approval from Washington University in St. Louis, School of Medicine and consent and assent was obtained from all study participants prior to data collection.

After the study was described, children were seated in a chair 60 cm from the computer screen and EEG sensors were attached. Children first completed 24 total practice trials to ensure comprehension. The task took children approximately 15 min and parents were paid for their time and children received prizes. To examine stability of the OCYC, a subset of parents completed a second OCYC over 149.15 (SD = 19.98; range 92–198) days apart. Although a long duration, given the stability of this characteristic we felt it could be interpreted as test re-test marker of stability.

Psychophysiological Recording, Processing, and Analysis

EEG was recorded using a BainVision ActiCHamp 32-channel electrode system (Brain Products, Germany), using a subset of the International 10/20 system sites and a ground electrode at FPz. Additional electrodes for electrooculogram (EOG) included two electrodes placed laterally to the eyes to record horizontal EOG and two electrodes placed above and below the left eye to detect blinks and eye movements to record vertical EOG. Continuously recorded EEG was digitized at 500 Hz with 24 bits of resolution and referenced to Cz. Offline processing was performed using Brain Vision Analyzer software (Brain Products, Germany), including re-referencing to the average of TP9 and TP10 (adjacent to mastoids), and band-pass filtering from .1 to 30 Hz. Eye blinks and movements were corrected using Gratton et al. [54] procdures. Physiological artifacts were rejected using a semi-automated procedure allowing maximum voltage steps of 50 μV, maximum absolute voltage difference of 175 μV within 400 ms, and minimum allowed activity of .5 μV within 100 ms.

Response locked ERP's were averaged separately for correct and error trials with a baseline correction from − 400 to − 200 ms before response. To measure the ERN, mean amplitude for the ERN and CRN were measured − 100 to 100 ms prior to and following the response, based on visual inspection of grand averages. The ΔERN was calculated as the incorrect minus correct responses evaluated at Cz, a commonly used location in ERN studies with preschool aged children [23, 35].

Statistical Analyses

Psychometric evaluation of the OCYC included exploratory factor analysis to examine factor structure and determination of subscales, Chronbach's alpha and scale if item deleted, communalities to test internal consistency and Pearson's correlations to determine stability of OCYC scores. We tested demographic and group (PO-MDD versus healthy) differences on the OCYC to include as covariates. To test convergent validity, correlations and partial correlations, controlling for significant demographic and group differences, were completed between the OCYC and executive functioning (BRIEF), behavioral inhibition and activation (BIS/BAS), social functioning (HBQ) and dimensional symptoms of psychopathology (CBCL). We used independent samples *t*-tests to examine OCYC differences on comorbid anxiety and externalizing disorders in the PO-MDD group. We examined convergent validity with neurobiological and behavioral indicators of performance monitoring using correlations and partial correlations of OCYC and neural and task-based behavioral indicators. All statistical analyses were performed using SPSS (version 25).

Results

Psychometric Evaluation of OCYC

Exploratory factor analyses of original 25 items (n = 147) using principal axis factoring with oblique rotation allowed for correlation between factors. Items were deleted in iterative models if they failed to sufficiently load on any factor or the item loaded in a theoretically uninterpretable fashion. This resulted in the retention of 21 items. In the final model, using direct oblimin rotation, Kaiser–Meyer–Olkin was .83 and Bartlett's test was significant, ($p < .001$), indicating suitable factorability of data and three components, explaining a cumulative 46.85% of the variance. All values demonstrated loadings > .4 on only one factor with low loadings on other factors except two items (7, 25; loadings > .3). These items were retained because Chronbach's α would have decreased if excluded; this is true for all included items (see Table 1). Visual inspection of scree plots validated the three-factor solution.

Factor 1 included nine items tapping into inflexibility and frustration with change (e.g., "*gets frustrated when s/he can't seem to get it right the first time…*"). Factor 2 included nine items regarding social concern and perfectionism (e.g., "*frequently compares his/her abilities with that of peers and siblings*"). Factor 3 included three items tapping BI (e.g., "*is quiet and uncertain in new situations*"). Internal consistency for each subscale was good (α's = .86, .80, and .68 for Factors 1–3, respectively). The 21-item full scale demonstrated good internal consistency (α = .86) however, alpha increased (α = .88) when BI items were deleted. The inflexibility/frustration factor was correlated with social concern/perfectionism ($r = .59$, $p < .001$) but the BI subscale was not correlated with either subscale (r's = .02, .01, p's > .82 inflexibility/frustration, social concern/perfectionism respectively). Given the moderate psychometric consistency, lack of association with other subscales, and availability of multiple existing valid measures of BI [55], we excluded the BI subscale from the measure, resulting in an 18 item total measure consisting of two 9-item subscales.

Test–retest reliability results indicated significant correlations with retest, inflexibility/frustration: $r = .83$, social concern/perfectionism: $r = .65$, and total: $r = .77$; p's < .001, indicating stability of overcontrol across several months.

Table 1 Pattern matrix and communalities for PCA of 21-item OCYC

Item	Factors I	Factors II	Factors III	r	Communalities
Factor I: inflexibility/frustration (eigenvalue = 6.19, 29.46% variance explained)					
4. Gets upset or has trouble when plans change at short notice	**.727**	−.082	.084	.601	.486
20. Is easy-going and flexible (R)	**.663**	−.062	.068	.563	.409
2. Finds schedule changes more difficult than peers (e.g., difficulty adjusting to school transition, changes at home or in the family)	**.635**	−.014	.201	.563	.444
16. Becomes upset if things don't go how s/he thinks they should	**.616**	.019	−.044	.567	.393
19. Becomes very upset if criticized or given suggestions on how to do things differently	**.564**	.271	−.086	.682	.558
3. Gets frustrated when s/he can't seem to get it right the first time (e.g., when solving a puzzle, when completing a math problem)	**.550**	.052	−.189	.528	.365
23. Is rigid in his/her way of doing things	**.539**	.196	.049	.587	.441
14. Wants things done his/her own way (i.e., wants to play his/her way, wants to make the rules)	**.531**	.162	−.191	.577	.430
8. Has difficulty taking suggestions or receiving help from parents or peers	**.487**	.174	−.103	.559	.365
Factor II: social concern/perfectionism (eigenvalue = 1.97, 9.37% variance explained)					
6. Frequently compares his/her abilities with that of peers and siblings	−.20	**.713**	−.03	.482	.403
17. Pays a lot of attention to how s/he does things compared with others	−.131	**.701**	−.029	.551	.425
21. Gets mad at him/herself when s/he makes a mistake, especially in front of others	.153	**.620**	.083	.598	.507
18. Becomes upset when s/he thinks s/he has done poorly on something	.099	**.467**	−.009	.504	.227
25. Often feels not good enough compared with peers or siblings	.167	**.458**	.034	.474	.317
15. Looks for reassurance that s/he has done well or done the right thing more than siblings or other kids his/her age	.087	**.440**	.077	.423	.244
10. Is concerned with doing things just right (e.g., hair parted the right way, food on plate certain way)	.170	**.407**	.037	.482	.266
7. Often thinks there is only one right way to do things	.283	**.388**	−.009	.478	.345
24. Becomes upset when others don't follow the rules	.146	**.316**	.036	.375	.169
Factor IIII: Behavioral inhibition (eigenvalue = 1.68, 8.01% variance explained)					
13. Is quiet and uncertain in new situations	.123	.060	**.678**	.489	.487
1. Is shy/hesitant when meeting new children	.021	.026	**.671**	.560	.450
22. Likes being the center of attention (R)	−.142	−.007	**.510**	.365	.277

Items 5, 9, 11, and 12 were deleted prior to final analysis; highest factor loading for each item in boldface; r = Corrected correlation between the item and its' subscale

Moreover, retest scores demonstrated good internal consistency: inflexibility/frustration: α = .82, social concern/perfectionism: α = .77 and total: α = .87.

Preliminary Results

Older children exhibited higher total ($r = .17$, $p = .04$) and social concern/perfectionism scores ($r = .23$, $p = .007$). Income-to-needs, (p's > .16), race (p's > .17), or gender (p's > .39) were not associated with OCYC scores. Depressed preschoolers showed elevated inflexibility/frustration ($t(145) = -11.98$, $p < .001$), social concern/perfectionism ($t(145) = -5.56$, $p < .001$) and total scores ($t(145) = -10.04$, $p < .001$). As expected, BI (BIS; M = 19.41, SD = 4.04) was associated with elevated inflexibility/frustration ($r = .23$, $p = .007$), social concern/perfectionism ($r = .57$, $p < .001$), and total scores ($r = .44$, $p < .001$). Although overcontrol often occurs in the context of BI, in order to isolate the independent validity of overcontrol, all further analyses controlled for BI, age, and depression status.

Convergent Validity with Executive and Social Functioning and Temperament

See Table 2 for partial correlations controlling for BI, age and depression status between OCYC scores with executive function (BRIEF), social functioning (HBQ), and behavioral activation (BAS). OCYC total scores were associated with deficits across executive functioning domains. Subscales demonstrated specificity as inflexibility/frustration was associated with BAS drive but not peer relations while social concern/perfectionism was associated with worse peer relations, and not BAS drive.

Table 2 Partial correlations (controlling for behavioral inhibition, age and depression) of OCYC and criterion variables

	Mean	SD	OCYC		
			Total	Inflexibility/ frustration	Social concern/ perfectionism
OCYC					
Total	8.52	5.00	–	.85**	.83**
Inflexibility/frustration	4.75	2.97		–	.42**
Social concern/perfectionism	3.76	2.63			–
BRIEF					
Inhibit	56.15	12.90	.41**	.50**	.19*
Shift	57.11	13.55	.49**	.54**	.27**
Emotional control	60.08	15.59	.44**	.50**	.23*
Working memory	54.71	12.56	.32**	.33**	.21*
Plan/organize	52.54	11.56	.43**	.43**	.29*
HBQ[a]					
Global Peer relations	3.43	.48	− .19	− .05	− .29*
Peer acceptance	3.42	.51	− .20	− .09	− .26*
Bullied	1.56	.56	.15	.001	.26*
BAS					
Drive	19.96	4.87	.23*	.31**	.07
Reward seeking	23.75	3.05	− .06	− .02	.09
CBCL					
Internalizing	54.93	12.21	.22*	.24*	.13
Externalizing	54.26	14.21	.46**	.49**	.28*
Depression	59.27	9.04	.20*	.23*	.11
Anxiety	58.17	9.72	.07	− .001	.12
ADHD	55.20	7.23	.19*	.26*	.05
ODD	60.81	10.85	.38**	.44**	.21*
Somatic complaints	54.80	6.44	.18*	.18*	.12

BRIEF behavior rating inventory for executive functioning, *HBQ* Health and Behavior Questionnaire, *BAS* behavioral activation revised scales, *CBCL* child behavior checklist

[a]The HBQ was only administered in the depressed preschoolers and so depression status is not controlled for

*$p < .05$, **$p < .001$

Because overcontrol was associated with impairments across executive functioning domains, we also utilized linear regressions predicting OCYC scores, controlling for BI, age and depression status, simultaneously entering all cognitive domains (inhibit, shift, emotional control, working memory, and plan/organize) to test which domains demonstrated incremental validity. Above covariates, only impairment in shifting predicted total ($F(5,117) = 13.23$, $R = .85$, $\Delta R^2 = .15$, $p < .001$; B(SE) = .13(.03), p < .001) and social concern/perfectionism scores ($F(5,117) = 3.42$, $R = .73$, $\Delta R^2 = .07$, $p = .006$; B(SE) = .05(.02), $p = .02$). Impairment in shifting ($F(5,117) = 18.87$, $R = .87$, $\Delta R^2 = .20$, $p < .001$; B(SE) = .08(.02), $p < .001$) and inhibition (B(SE) = .06(.02), $p = .002$) predicted inflexibility/frustration.

Convergent Validity with Psychopathology

Dimensional relationships between psychopathology and OCYC indicated when controlling for BI, age and depression, OCYC total scores were associated with higher symptom scores across all domains except anxiety (Table 2). Additionally, inflexibility/frustration was specific to elevated internalizing, depression, ADHD, and somatic symptoms. Because overcontrol was associated with impairments across most symptom domains, we again utilized linear regressions predicting OCYC total and subscale scores, controlling for BI, age and depression, simultaneously entering the externalizing and internalizing scores to test incremental validity. Externalizing symptoms significantly contributed to higher total ($F(2,121) = 12.98$, $R = .81$,

$\Delta R^2 = .07$, $p < .001$; B(SE) = .14(.03), p < .001), inflexibility/frustration ($F(2,121) = 15.30$, $R = .81$, $\Delta R^2 = .09$, $p < .001$; B(SE) = .09(.02), $p < .001$) and social comparison/perfectionism scores ($F(2,121) = 4.12$, $R = .51$, $\Delta R^2 = .03$, $p = .02$; B(SE) = .05(.02), $p = .02$).

Within the PO-MDD group, comorbid anxiety disorders (n = 26; M = 5.53,SD = 2.94) were associated with a trend in elevated social concern/perfectionism $t(86) = -1.96$, $p = .053$, compared to depressed preschoolers without an anxiety disorder (M = 4.29,SD = 2.62) while comorbid externalizing disorders (n = 27) were associated with elevated inflexibility/frustration (M = 7.41, SD = 1.72) $t(86) = -3.28$, $p = .001$) and total scores (M = 12.63, SD = 3.54) $t(86) = -2.54$, $p = .01$), compared with depressed preschoolers without an externalizing disorder (inflexibility: M = 5.74, SD = 2.38; total: M = 10.15, SD = 4.49).

Neural and Behavioral Validity

Behavioral and ERP Results

Accuracy and RT data are in Table 3. RT differed as a function of response type, $F(1,63) = 90.61$, $p < .001$, children were faster on error than correct trials. Post-error RT differed as a function of prior error response; children were slower on go-trials after a no-go error (M = 633.83, SD = 161.75) compared with go-trials after a no-go correct response (M = 538.41, SD = 108.63), $F(1,63) = 44.91$, $p < .001$. PES and PEA were not significantly associated $r = -.15$, $p = .25$. Grand average response-locked ERP at Cz is depicted in Fig. 1; the ERN response was more negative after errors than correct responses, $F(1,63) = 112.55$, $p < .001$.

Associations with OCYC

Total and social concern/perfectionism scores demonstrated similar correlations with behavioral indicators: children with higher scores had faster RT's and more errors on no-go trials (see Table 3). Interestingly, elevated total and social concern/perfectionism scores were positively associated with PEA: after making an error on a no-go trial, children with higher overcontrol were more likely to be correct on the following trial. For neural indicators, the total and both subscale scores were associated with a blunted ΔERN. However, when controlling for BI, age, and depression status, neural and behavioral findings were no longer significant.

Table 3 Behavioral and neural performance, correlations and partial correlations (controlling for behavioral inhibition, age and depression status) of OCYC and behavioral and neural and measures of error-monitoring from Zoo Go/no-go task in subset of sample (n = 64)

	Mean (SD)	Correlations			Partial correlations		
		Total OCYC	Inflexibility/ frustration	Social concern/ perfectionism	Total OCYC	Inflexibility/ frustration	Social concern/ perfectionism
Behavioral indicators							
Reaction time (ms)							
Error no-go trials	540.11(95.09)	−.20	−.11	−.27*	−.05	.02	−.12
Correct go trials	613.37(95.74)	−.32*	−.24	−.34*	−.19	−.12	−.21
Accuracy							
No-go trial errors [%]	25.09(11.48) [36%]	.26*	.20	.27*	.07	.02	.09
Go trial errors [%]	25.66(21.15) [12%]	.20	.18	.19	.16	.11	.16
Post-error responding							
Post-error slowing	101.15(16.61)	−.09	−.11	−.05	−.004	−.02	.02
Post-error accuracy	−.85(.08)	.28*	.23	.27*	.10	.07	.11
Neurobiological indicators							
ERPs (μV)							
ERN	5.21(6.00)	−.03	−.01	−.06	.01	.04	−.04
CRN	−2.07(6.34)	−.32*	−.24	−.34*	−.14	−.08	−.16
ΔERN[a]	−7.28(5.49)	.31*	.26*	.30*	.15	.13	.12

Mean (SD). Post-error reaction time = reaction time when previous no-go response was incorrect; post-error reaction time = reaction time when previous no-go response was correct; post-error slowing percentage = (RT when prior trial was incorrect no-go—RT when prior trial was correct go)/RT when prior trial was correct go; post-error accuracy percentage = (accuracy when prior trial was incorrect go—accuracy when prior trial was correct go)/accuracy when prior trial was correct go

[a]Greater ERN is a more negative value

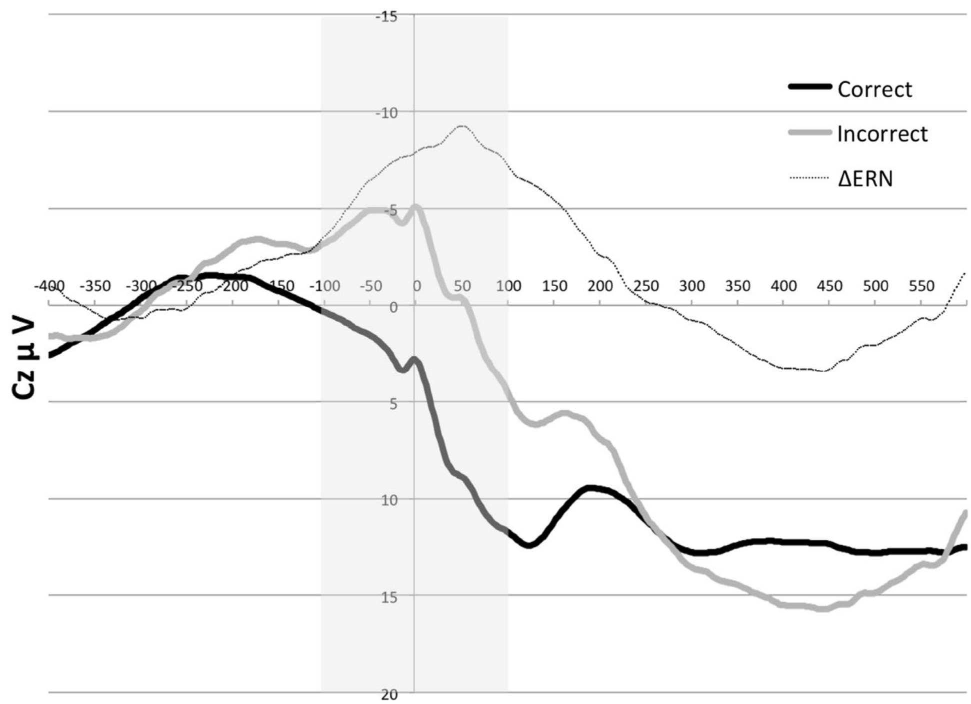

Fig. 1 Grand average response-locked ERPs at Cz. *Note* Electrode Cz is shown and indicates the time window (in gray) used to isolate the ERN

Discussion

The current study provided initial psychometric validation of a novel, quick, and easy-to-administer parent-report measure of early childhood overcontrol, a risk factor associated with transdiagnostic psychopathology [5–7]. The OCYC, the first parent-report measure of childhood overcontrolled tendencies, demonstrated preliminary face validity and convergent validity with cognitive, social, psychopathological, performance-based behavioral and neural indicators in children aged 4–7 years old.

The OCYC is devised of a total and two subscales (inflexibility/frustration with change and social concern/perfectionism), all which demonstrated good internal consistency and test–retest reliability. Convergent validity was evidenced by overcontrol being associated with elevated BI, and independent of demographic factors and BI, was associated with poor social functioning, including worse peer relations and being bullied and worse executive functioning. Notably, poor cognitive shifting/flexibility was the only executive functioning deficit to be incrementally associated, over BI and other executive functioning deficits, with all OCYC scales.

Psychopathological outcomes were also associated with overcontrol. Depressed preschoolers demonstrated higher overcontrol than healthy preschoolers, and within the depressed preschool sample, comorbid anxiety disorders were associated with trending elevated social concern/perfectionism while comorbid externalizing disorders were associated with elevated inflexibility/frustration with change and total scores. Moreover, dimensional externalizing symptoms predicted elevated overcontrol above BI, covariates and internalizing symptoms.

Although the association with externalizing presentations was not hypothesized, overcontrol stabilizes around ages 4–7 [3]. As such, the *desire* or *need* for control may be present while the cognitive ability to *enact* control may still be developing. In response to an inability to exert desired levels of control, externalizing outbursts and presentations might ensue. This speculative conclusion parallels the development of anxiety. Specifically, irritability and emotional outbursts often occur in the context of elevated anxiety in young children [56, 57]. Further support for this hypothesis is provided by a study demonstrating that 6-year old children with externalizing symptoms as well as five specific symptoms (irritability, blaming others, not being liked by others, crying often and being solitary in early childhood) longitudinally predict anxiety in adolescence [58]. Of note, these five symptoms overlap with overcontrol in early childhood, possibly indicating an overlap between overcontrol and externalizing presentations at young ages that transitions into anxiety presentations across development. Future work would benefit from tracking the developmental trajectories and differing phenotypic presentations of overcontrol across development.

Overcontrol was associated with several indicators of behavioral performance: faster reaction times, possibly demonstrating increased engagement with the performance-focused task, yet also more errors. Following errors, overcontrolled children showed improved accuracy on the next trial. Previous work in adults indicates perfectionists demonstrate better post-error accuracy [59]. For overcontrolled children in the current study, the saliency of the error possibly increased attention to avoid a subsequent error on the next trial. Both the ERN and post-error behavioral adjustments are units of analysis in the Research Domain Criteria (RDoC) construct of performance monitoring and the OCYC was associated with both units, indicating it may represent a valid developmentally appropriate measure of performance monitoring in early childhood.

Importantly, the OCYC was also associated with a neural indicator, a blunted ΔERN, consistent with research demonstrating temperamental fear, maternal history of anxiety [35] and anxiety symptoms [34] to be associated with a blunted ΔERN in preschoolers. The ΔERN is thought to index error monitoring [22, 24], and maps onto checking behaviors and social performance [33, 60], all of which characterize overcontrol. Thus, the ΔERN may be a particularly useful neural marker for childhood overcontrol. However, findings did not hold after controlling for age, BI and depression status, suggesting larger samples will be needed to further investigate these potential interactive relationships.

Overcontrol is often studied within the context of BI, however current findings underscore that it is a dissociable construct that should be investigated independently. When controlling for BI (with exception of neural and behavioral markers), social and psychopathological impairments remained significant. Additionally, BI does not involve a cognitive component, while overcontrol demonstrated significant associations with executive functioning deficits, further supporting overcontrol to be a unique construct.

Overcontrol is evident across the lifespan and measures for adolescents and adults similarly tap into the construct of overcontrol. The Childhood Retrospective Perfectionism Questionnaire (CHIRP) [45] has been adapted to children and adolescents age 7–17 [61] and assesses perfectionism and preoccupation with details while the Pathological Obsessive Compulsive Personality Scale (POPS) [62] assesses emotional overcontrol, rigidity and perfectionism in adults. The current study developmentally extends the assessment of overcontrol and related constructs downward by validating the first parent-reported assessment in early childhood.

Multiple limitations should be considered. First, the sample size was small, and only a subset completed neural and behavioral measures. Moreover, the sample consisted of a dichotomous split between depressed and healthy preschoolers. Future studies should examine the OCYC in larger community samples, possibly enriched for BI, to understand dimensional overcontrol from normative to pathological. Second, psychometric validation should be replicated across broader age ranges to further examine development and stability of overcontrol. Third, neural findings did not hold after controlling for age, BI and depression status. Given there is immense change in the ERN between the ages of 3 to 8 [23], development could be influencing findings. It will be imperative for future work to explore developmental trajectories of overcontrol to parse interactive roles with BI and development on neural and behavioral indicators.

Summary

Overcontrol is an early-emerging transdiagnostic characteristic associated with psychopathology and poor outcomes. The current study demonstrates overcontrol can be detected in early childhood using the OCYC. The OCYC showed face validity, convergent validity, and some discriminant validity from BI, suggesting it is a developmentally valid construct in young children. Given the importance of early intervention, the OCYC may aid in identifying this transdiagnostic risk factor early in development, prior to psychopathology.

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Compliance with Ethical Standards

Conflict of interest KG, DB and JL have received research grants from National Institute of Health.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Research Involving Human Participants and/or Animals All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Moffitt TE et al (2011) A gradient of childhood self-control predicts health, wealth and public safety. Proc Natl Acad Sci USA 108:2693–2698
2. Eisenberg N et al (2001) The relations of regulation and emotionality to childrens externalizing and internalizing problem behavior. Child Dev 72(4):1112–1134
3. Eisenberg N, Spinrad TL, Eggum ND (2010) Emotion-related self-regulation and its relation to children's maladjustment. Annu Rev Clin Psychol 6:495–525

4. Donnellan BM, Robins RW (2010) Resilient, overcontrolled and undercontrolled personality types: issues and controversies. Soc Pers Psychol Compass 3:1–14
5. Zucker NL et al (2007) Anorexia nervosa and autism spectrum disorders: guided investigation of social cognitive endophenotypes. Psychol Bull 133(6):976–1006
6. Altman SE, Shankman SA (2009) What is the association between obsessive-compulsive disorder and eating disorders? Clin Psychol Rev 29(7):638–646
7. Lynch TR (2018) Radically open dialectical behavior therapy: theory and practice for treating disorders of overcontrol. Context Press, Oakland
8. Kagan J et al (1984) Behavioral inhibition to the unfamiliar. Child Dev 55:2212–2225
9. Derryberry D, Rothbart MK (1997) Reactive and effortful processes in the organization of temperament. Dev Psychopathol 9(4):633–652
10. Fox NA et al (2005) Behavioral inhibition: linking biology and behavior within a developmental framework. Annu Rev Psychol 56:235–262
11. Henderson HA, Pine DS, Fox NA (2015) Behavioral inhibition and developmental risk: a dual-processing perspective. Neuropsychopharmacology 40(1):207–224
12. Fox NA et al (2013) Commentary: to intervene or not? Appreciating or treating individual differences in childhood temperament—remarks on Rapee (2013). J Child Psychol Psychiatry 54(7):789–790
13. Block JH, Block J (1980) The role of ego-control and ego-resiliency in the organization of behavior. Dev Cogn Affect Soc Relat 13:39–101
14. Asendorpf JB, van Aken MA (1999) Resilient, overcontrolled, and undercontrolled personality prototypes in childhood: replicability, predictive power, and the trait-type issue. J Pers Soc Psychol 77:815–832
15. Robins RW, John OP, Caspi A (1998) The typological approach to studying personality. In: Cairns RB, Bergman LR, Kagan J (eds) Methods and models for studying the individual. Sage Publications, Thousand Oaks, pp 135–160
16. Hart D et al (2003) Personality and development in childhood: a person-centered approach. Monogr Soc Res Child Dev 68: i122
17. Asendorpf JB et al (2001) Carving personality description at its joints: confirmation of three replicable personality prototypes for both children and adults. Eur J Pers 15(3):169–198
18. Costa PT, McCrae RR (1992) Professional manaul: revised NEO personality inventory (NEO-PI-R) and NEO five-factor inventory (NEO-FFI). Psychological Assessment Resources, Odessa
19. Gilbert KE, Whalen D, Jackson JJ, Tillman R, Barch DM, Luby J (under review) Identifying observed preschool personality types and their associations with longitudinal symptom trajectories
20. Eisenberg N et al (2000) Dispositional emotionality and regulation: their role in predicting quality of social functioning. J Pers Soc Psychol 78:136–157
21. White LK et al (2011) Behavioral inhibition and anxiety: the moderating roles of inhibitory control and attention shifting. J Abnorm Child Psychol 39(5):735–747
22. Moser JS et al (2013) On the relationship between anxiety and error monitoring: a meta-analysis and conceptual framework. Front Hum Neurosci 7:466
23. Meyer A et al (2018) Early temperamental fearfulness and the developmental trajectory of error-related brain activity. Dev Psychobiol 60(2):224–231
24. Gehring WJ et al (2012) The error-related negativity (ERN/Ne). In: Luck SJ, Kappenman ES (eds) The Oxford handbook of event-related potential components. Oxford University Press, New York, pp 231–291
25. Eisenberg N, Fabes RA (1992) Emotion, regulation, and the development of social competence. In: Clark MS (ed) Review of personality and social psychology. Sage, Newbury Park, pp 119–150
26. Newman DL et al (1997) Antecedents of adult interpersonal functioning: effects of individual differences in age 3 temperament. Dev Psychol 33:206–217
27. Robins RW et al (1996) Resilient, overcontrolled, and undercontrolled boys: three replicable personality types. J Pers Soc Psychol 70(1):157–171
28. Thorell L, Bohlin G, Rydell A-M (2004) Two types of inhibitory control: predictive relations to social functioning. Int J Behav Dev 28:193–203
29. Brooker RJ, Kiel EJ, Buss KA (2016) Early social fear predicts kindergarteners' socially anxious behaviors: direct associations, moderation by inhibitory control, and differences from nonsocial fear. Emotion 16(7):997–1010
30. Riesel A et al (2015) Overactive performance monitoring as an endophenotype for obsessive-compulsive disorder: evidence from a treatment study. Am J Psychiatry 172(7):665–673
31. Gehring WJ, Himle J, Nisenson LG (2000) Action-monitoring dysfunction in obsessive-compulsive disorder. Psychol Sci 11:1–6
32. Meyer A et al (2015) Enhanced error-related brain activity in children predicts the onset of anxiety disorders between the ages of 6 and 9. J Abnorm Psychol 124(2):266–274
33. Weinberg A et al (2016) Error-related negativity (ERN) and sustained threat: conceptual framework and empirical evaluation in an adolescent sample. Psychophysiology 53(3):372–385
34. Meyer A et al (2012) The development of the error-related negativity (ERN) and its relationship with anxiety: evidence from 8 to 13 year-olds. Dev Cogn Neurosci 2(1):152–161
35. Torpey DC et al (2013) Error-related brain activity in young children: associations with parental anxiety and child temperamental negative emotionality. J Child Psychol Psychiatry 54(8):854–862
36. Botvinick M et al (2001) Conflict monitoring and cognitive control. Psychol Rev 108(3):624–652
37. Buzzell GA et al (2017) Error-induced blindness: error detection leads to impaired sensory processing and lower accuracy at short response-stimulus intervals. J Neurosci 37(11):2895–2903
38. Jentzsch I, Dudschig C (2009) Why do we slow down after an error? Mechanisms underlying the effects of posterror slowing. Q J Exp Psychol 62(2):209–218
39. Egger HL, Angold A (2006) Common emotional and behavioral disorders in preschool children: presentation, nosology, and epidemiology. J Child Psychol Psychiatry 47(3–4):313–337
40. Luby JL et al (2018) A randomized control trial of parent-child psychotherapy targeting emotion development for early childhood depression. Am J Psychiatry 175:1102–1110
41. Achenbach TM, Rescorla LA (2000) Manual for the ASEBA preschool forms and profiles: an integrated system of multi-informant assessment; Child Behavior Checklist for ages 1 1/2–5; Language Development Survey; Caregiver-Teacher Report Form. University of Vermont, Burlington
42. Achenbach TM (2001) Manual for ABESA school-age forms & profiles. Research Center for Children, Youth, & Families, University of Vermont, Burlington
43. Kim J et al (2011) Psychometric properties of the behavioral inhibition questionnaire in preschool children. J Pers Assess 93(6):545–555
44. Scahill L et al (1997) Children's Yale-Brown obsessive compulsive scale: reliability and validity. J Am Acad Child Adolesc Psychiatry 36(6):844–852
45. Southgate L et al (2008) The development of the childhood retrospective perfectionism questionnaire (CHIRP) in an eating disorder sample. Eur Eat Disord Rev 16(6):451–462

46. Gibbons FX, Buunk BP (1999) Individual differences in social comparison: development of a scale of social comparison orientation. J Pers Soc Psychol 76(1):129–142
47. Gioia GA, Espy KA, Isquith PK (2003) Behavior rating inventory of executive function-preschool version. Psychological Assessment Resources, Lutz
48. Gioia GA, Isquith PK, Guy SC, & Kenworthy L (2000) Behavior rating inventory of executive function (BRIEF): a professional manual. Psychological Assessment Resources, Lutz, Florida
49. Pagliaccio D et al (2015) Revising the BIS/BAS scale to study development: measurement invariance and normative effects of age and sex from childhood through adulthood. Psychol Assess 28(4):429–442
50. Gaffrey MS, Luby, JL (2012) Kiddie-Schedule for affective disorders and schizophrenia - early childhood version (K-SADS-EC). Washington University School of Medicine, St. Louis, MO
51. Armstrong JM, Goldstein LH, T.M.W.g.o.O. Assessment (2003) Manual for the MacArthur Health and Behavior Questionnaire (HBQ 10). In: Kupfer DJ (ed) MacArthur Foundation Research Network on psychopathology and development. University of Pittsburgh, Pittsburgh
52. Grammer JK et al (2014) Age-related changes in error processing in young children: a school-based investigation. Dev Cogn Neurosci 9:93–105
53. Schneider W, Eschman A, Zuccolotto A (2002) E-Prime (version 2.0) [Computer software and manual]. Psychology Software Tools Inc, Pittsburgh, PA
54. Gratton G, Coles MG, Donchin E (1983) A new method for off-line removal of ocular artifact. Electroencephalogr Clin Neurophysiol 55(4):468–484
55. Bishop G, Spence SH, Mcdonald C (2003) Can parents and teachers provide a reliable and valid report of behavioral inhibition. Child Dev 74(6):1899–1917
56. Cornaccchio D et al (2016) Irritability and anxiety severity among youth with anxiety. J Am Acad Child Adolesc Psychiatry 55(1):54–61
57. Stoddard J et al (2014) Irritability in child and adolescent anxiety disorders. Depression Anxiety 31(7):566–573
58. Rouquette A et al (2018) Emotional and behavioral symptom network structure in elementary school girls and association with anxiety disorders and depression in adolescence and early adulthood: a network analysis. JAMA Psychiatry 75:1173–1181
59. Stahl J et al (2015) Perfect error processing: perfectionism-related variations in action monitoring and error processing mechanisms. Int J Psychophysiol 97(2):153–162
60. Buzzell GA et al (2017) A neurobehavioral mechanism linking behaviorally inhibited temperament and later adolescent social anxiety. J Am Acad Child Adolesc Psychiatry 56(12):1097–1105
61. Park JM et al (2016) Obsessive-compulsive personality traits in youth with obsessive-compulsive disorder. Child Psychiatry Hum Dev 47:281–290
62. Pinto A, Ansell EB, Wright AGC (2011) A new approach to the assessment of obsessive compulsive personality. In: Integrated paper session conducted at the annual meeting of the Society for Personality Assessment, Cambridge, MA