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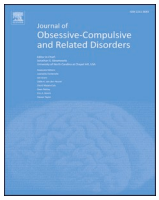

Cognitive Bias Modification of Interpretation training for youth with OCD: Who benefits? Examining the role of OCD severity, interpretation bias, and autism symptoms

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ABSTRACT

Cognitive Bias Modification–Interpretation (CBM-I) training has been put forward as a promising new intervention for youth with psychopathology. A recent Randomised Controlled Trial (RCT) showed that an online CBM-I training designed to reduce dysfunctional interpretations in youth with Obsessive Compulsive Disorder (OCD) had therapeutic benefits on OCD symptoms. In addition, there are practical benefits as the online and automated nature of the training allows for 24/7 accessibility, is cheap and an easy to implement intervention. There is, however, significant variability in CBM-I training effects on symptoms. By conducting secondary analyses of the online CBM-I RCT, we aimed to examine whether baseline OCD severity, interpretation bias, and degree of autism symptoms are related to training effectiveness. In the RCT, 36 children with OCD (8–18 years) followed 12-sessions CBM-I training. Bayesian analyses showed no evidence for any of the three predictors being associated with CBM-I effects on OCD symptoms. These results offer no answer to the question for whom CBM-I training works best. However, there is also no evidence that CBM-I might work less well for these subgroups. Future research with larger samples is necessary to test the robustness of these findings.

1. Introduction

Cognitive Behavioural Therapy (CBT) is an evidence-based treatment for pediatric obsessive-compulsive disorder (OCD) and reasonably effective (O'Kearney et al., 2010; Reid et al., 2021; Öst et al., 2016). However, there are large individual differences in treatment effect, and a significant portion of patients does not sufficiently profit from standardized treatment (e.g., Skarphedinsson et al., 2015; Torp et al., 2015). In addition, access to evidence-based care is also problematic with long waitlists.

Online Cognitive Bias Modification of Interpretations (CBM-I) is a potential, digital, solution to overcome some of these challenges as it can be easily offered during waitlist or as an add-on to CBT. CBM-I is a computerized training that encourages individuals to interpret ambiguous information in a more positive or benign way compared to the habitual tendency to interpret it in a negative or threatening way (Salemink et al., 2019). Cognitive theories of OCD argue that misinterpretations of intrusions are important in OCD (Salkovskis, 1985). Indeed, there is a wealth of empirical evidence suggesting that misinterpretations of intrusions as potentially dangerous, bad, or as predicting harm are related to OC symptoms in adults (Frost & Steketee, 2002) as well as in children and adolescents (Matthews et al., 2007; Reeves et al., 2010). It is argued that such misinterpretations result in anxiety and distress and that compulsions are performed in an attempt to reduce such distress. Given the role of misinterpretations in OCD, changing them via CBM-I training could reduce OCD symptoms. In addition, CBM-I's computerized format allows for offering the training online as a digital intervention with relatively low cost, easy access, and easy dissemination.

A meta-analysis (Krebs et al., 2018) examined the effects of CBM-I training on interpretations and anxiety in youth. Based on 26 studies, it was shown that CBM-I training had a moderate effect on interpretation

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bias. That is, CBM-I decreased negative interpretations and boosted positive interpretations. Furthermore, a small, but significant effect was observed on anxiety immediately following training and on anxiety vulnerability (assessed after a stressor); less anxiety was reported directly after training and after a stressor. This is consistent with recent meta-analyses in adults indicating medium CBM-I effects on bias (Martinelli et al., 2022) and effects on anxiety (Fodor et al., 2020). In the latter meta-analysis, it was concluded that CBM-I "emerged as a promising treatment" (p. 507, Fodor et al., 2020). Comparable promising findings have been observed in CBM-I studies in youth with OCD, though this is based on a small number of studies (no review or meta-analysis is available yet). In a small-scale randomized, controlled study in adolescents with OCD (Salemink et al., 2015), the value of adding eight sessions CBM-I training to treatment as usual was examined. Results indicated that patients in the CBM-I training showed a stronger reduction in obsessive symptoms (both self-report and clinician-rated) compared to patients in the placebo-control training. A recent randomised controlled trial (RCT) in youth with OCD (Wolters et al., 2021) offered 12 sessions CBM-I training during the wait period before starting CBT. The training resulted in a stronger decrease in OCD symptoms than the waitlist and patients in the CBM-I training condition started CBT with less severe OCD. This advantage of the training on symptoms was maintained during the subsequent CBT. That is, OCD symptoms were consistently less severe for CBM-I participants than for waitlist participants during the entire duration of CBT (i.e., 16 weeks). Collectively, these are promising findings suggesting positive effects of CBM-I training on OCD symptoms in youth.

However, there is variability in CBM-I's effectiveness, both across studies and within studies. The level of heterogeneity was for example substantial for the meta-analytic effects on interpretations and moderate for the effects on anxiety in youth (Krebs et al., 2018). Better understanding of this variability and relevant driving, individual differences factors is important as it allows for better understanding how and for whom training works best, and for optimizing the training so that more individuals may profit.

Here, we focus on the role of individual differences in baseline symptoms, baseline interpretation bias, and degree of comorbid autism symptoms on effects of CBM-I training in youth with OCD. Currently, the overall findings regarding the moderating role of baseline symptoms are inconsistent. While meta-analyses in youth (Cristea, Mogoaşe et al., 2015; Krebs et al., 2018) concluded that baseline level of anxiety did not moderate CBM-I effects, the findings in the adult literature are inconsistent with some showing differences related to baseline anxiety severity (Cristea, Kok et al., 2015, Menne-Lothmann et al., 2014; Martinelli et al., 2022), while many other meta-analyses do not (Jones & Sharpe, 2017). The moderating role of baseline interpretation bias level has received less attention in the CBM-I literature. When examining individual studies, there is some evidence that CBM-I training regarding social situations is more effective for adolescents with stronger biases at baseline (Salemink & Wiers, 2011). In adult samples, such moderation was not observed in the context of contamination fear (Beadel et al., 2016) and even an opposite pattern was observed with stronger training effects for individuals with minimal biases at baseline (Steinman & Teachman, 2015). Taken together, evidence for the moderating role of baseline level of symptoms or interpretation bias on CBM-I training effects has been inconsistent, while no such study has been conducted in youth with OCD.

Comorbid autism symptoms are common in pediatric OCD (Arildskov et al., 2016). It is often thought that CBT for youth with OCD and comorbid autism is less effective (Krebs & Heyman, 2010). However, in a review, it was concluded that, although the number of studies is scarce, CBT with some modifications can be successful for children with OCD and an Autism Spectrum Disorder (ASD; Kose et al., 2018). As the potential moderating role of comorbid autism symptoms has not been studied in the context of CBM-I, the influence of autism symptoms on CBM-I's effectiveness is unknown. On the one hand, it could be speculated that procedural features of the CBM-I training (i.e., the computerized delivery, the highly structured sessions and clear instructions) may address some difficulties faced by individuals with ASD (e.g., social and communication difficulties, need for structure and predictability), and therefore be appealing to these children. At the level of working mechanisms, the implicit nature of the CBM-I training in combination with concrete scenarios (in contrast to explicit, verbal cognitive techniques in CBT) might be helpful to children with ASD to open the way for cognitive change, addressing cognitive rigidity. On the other hand, difficulties in generalization may hamper putting new knowledge from the CBM-I training into practice.

By conducting secondary analyses of an online CBM-I RCT (reference blinded for review), we aim to exploratively examine what moderating factors are related to CBM-I effectiveness in changing OCD symptoms in youth. Increasing our understanding of who benefits the most from this training would ultimately allow us to optimize training and better match training to individuals. We examine whether baseline OCD severity, baseline interpretation bias, and degree of comorbid autism symptoms are associated with CBM-I's effects on OCD symptoms. In the RCT, youth with OCD (age between 8 and 18 years) followed 12-sessions CBM-I training (reference blinded for review). Given that matching training to the individual fear domain tends to enhance CBM-I effects in adults (Beadel et al., 2016), participants received CBM-I training scenarios related to their highest OCD symptom domains. OCD severity was the primary outcome and measured before and after CBM-I training. In addition, interpretation bias and degree of autism symptoms were also assessed before training.

2. Methods

2.1. Design

The full study was an RCT designed to examine 1) whether CBM-I training is an effective intervention during a waitlist period and 2) whether augmenting CBT with CBM-I can improve treatment effect. Participants were randomly assigned to either a CBM-I training (50%) or a waitlist (50%), both followed by CBT. The study was approved by the Medical Ethical Committee (METC) of Amsterdam UMC (NL44055.018.13). The RCT was pre-registered in the Dutch clinical trial register (NTR4275, now summarized in the International Clinical Trials Registry Platform, ICTRP Search Portal). Secondary analyses of this RCT were conducted to exploratively examine the current aim whether baseline OCD severity, baseline interpretation bias, and degree of comorbid autism symptoms are associated with CBM-I's effects on OCD symptoms. The moderator analyses were described in the METC protocol, though not in the pre-registration. Details regarding the full study have been described elsewhere (Wolters et al., 2021). Here, only the CBM-I training condition is reported.

2.2. Participants

Details regarding participants including a flowchart can be found elsewhere (Wolters et al., 2021). In short, participants were children and adolescents (8–18 years) who were referred for treatment for OCD to one of five participating centers for child psychiatry in the Netherlands (secondary and tertiary care). All participants had a primary diagnosis of OCD, a stable dosage of medication at start of the study (in case of pharmacological treatment), and had not received state-of-the-art CBT within three months before the start of the study. In total, there were 74 participants in the RCT: 36 in the CBM-I condition and 38 in the waitlist control condition. In the present paper, we report on participants in the CBM-I training condition.

Participants ($N = 36$) had a mean age of 13.2 years ($SD = 3.1$), 23 boys (64%) and 13 girls (36%). Seventy-two percent (26 participants) reported one or more comorbid disorders, as measured with the Anxiety Disorder Interview Schedule for DSM-IV-Child and Parent Version

(ADIS-C/P, Silverman & Albano, 1996ab). These were mainly anxiety disorders (n = 25; 69%), but also mood disorders (n = 6, 17%), and ADHD/ODD (n = 6; 17%). Participants did not receive any other interventions for OCD. Table 1 shows mean scores and standard deviations of the main variables.

2.3. CBM-I training

The online CBM-I training consisted of twelve training sessions with 24 training scenarios per session, in a period of four weeks (Wolters et al., 2021). Scenarios were matched to the two most relevant OCD subtype domains of individual participants (contamination, responsibility, unacceptable thoughts, symmetry/not just right experiences, or perfectionism). For each subtype domain, 72 unique training scenarios were presented twice during the training period (in different training sessions). The scenarios were based on scenarios that were successfully used in a pilot study (Salemink et al., 2015). In addition to the cognitive facets of OCD, the training scenarios also addressed behavioral facets of OCD to provide strategies to resist the urge to perform compulsions.

Each scenario described a potential OCD-related situation. The final sentence of the scenario offered a functional interpretation for this problem, but one word was missing. After disappearance of the scenario, the omitted word was presented as a word fragment. Participants were instructed to complete the word fragment as quickly as possible by typing the first missing letter. Correct answers resulted in a functional solution for the OCD problem. To reinforce the functional interpretation, each scenario was succeeded by a question about the solution. Participants answered these questions with 'yes' or 'no', and received feedback whether their answer was correct or incorrect. A final screen showed the correct answer with the main message of the scenario. An example of a training scenario is as following (Wolters et al., 2021):

> Your father has to work late unexpectedly. He is not yet home, and you have to go to bed without saying 'good night' to him. You are afraid that this may cause bad luck. You go to sleep anyway. Thoughts do not _____ the future.
>
> pr_dict
>
> 'e'
>
> (predict)
>
> Is it okay to let the thought that bad luck may happen because you did not say good night to your father, pass by?
>
> Y/N?
>
> (IN)CORRECT.
>
> You can just let this thought pass by.

Table 1
Descriptive statistics of main variables.

	M	SD
CY-BOCS (N = 36)		
baseline	24.4	5.2
post CBM-I	20.8	6.9
difference (pre – post)	3.7	4.1
SRS (t-score) (N = 36)	55.9	12.9
Recognition task (N = 35)		
OCD interpretations	2.2	0.5
OCD-unrelated interpretations	2.4	0.5
Bias index score	−0.2	0.8

Note. CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale; SRS = Social Responsiveness Scale.

2.4. Measures

Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) (Scahill et al., 1997). This clinician-rated semi-structured interview is used to assess severity of OC symptoms. The total score ranges from 0 to 40. The CY-BOCS showed good test-retest reliability, good internal consistency and adequate divergent and convergent validity (Scahill et al., 1997; Storch et al., 2004).

Social Responsiveness Scale (SRS; Roeyers et al., 2011). This parent-rated questionnaire is used to assess the severity of autism symptoms. The questionnaire consists of 65 items rated on a 4-point scale. Internal consistency (Cronbach's α) in a Dutch sample varied from 0.93 to 0.95 (Roeyers et al., 2011).

Test of interpretation bias: Recognition task. A recognition task was used to assess interpretation bias (Salemink et al., 2015; Salemink & van den Hout, 2010). It was completed on a computer and consisted of two parts. In the first part, twelve ambiguous scenarios were presented. Scenarios were matched on OCD subtypes of individual participants, corresponding to the CBM-I training. A scenario consisted of a title followed by a very short story in three lines and a matching picture to facilitate recognizability of the scenarios in the second part of the task. In the final sentence of the scenario, one word was missing. After pressing the spacebar, the missing word appeared on the screen as a word fragment with one missing character. Participants were asked to complete the fragment as quickly as possible, yet the valence of the story remained ambiguous. Afterwards, a comprehension question appeared to be sure that participants read the scenario. Participants answered this question and received feedback on their answer. In the second part of the recognition test, the titles and pictures of the ambiguous scenarios that were shown in part 1 appeared again, together with two possible interpretations of the scenario; an OCD interpretation, and an interpretation unrelated to OCD. Participants rated each interpretation independently by indicating the fit of the interpretation to the original scenario on a four-point scale ranging from 1 (very different) to 4 (very similar). In the recognition task, a set of six scenarios was presented first (both part 1 and 2), then the next set of six scenarios was presented.

Mean fit ratings were calculated for OCD interpretations and for OCD-unrelated interpretations separately. To obtain an interpretation bias index, mean fit ratings for OCD-unrelated interpretations were subtracted from mean fit ratings for OCD interpretations (higher scores indicate a stronger OCD-congruent interpretation bias). A comparable recognition task showed sufficient internal consistency in a Dutch sample; Cronbach's α = 0.78 (Klein et al., 2018).

2.5. Procedure

After written informed consent was obtained, participants were randomly allocated to either the CBM-I training or the four-week waitlist control condition. At baseline, the CY-BOCS, SRS and recognition task were completed. Participants had to complete the 12 training sessions of the online CBM-I training within a period of four weeks, with a maximum of 5 consecutive days without training, and only one training session per day. Each session lasted for approximately 15 min. After the training, the CY-BOCS was administered again, and participants received a small financial compensation (a 10 Euro gift voucher).

2.6. Statistical analyses

Our primary outcome measure for the effect of the CBM-I training is the CY-BOCS difference score which was calculated by subtracting the post-CBM-I CY-BOCS score from the CY-BOCS score at baseline. Positive difference scores indicate improvement post-CBM-I training, whereas negative difference scores indicate deterioration.

The data were analyzed within a Bayesian framework as Bayesian analyses can provide evidence for both the null hypothesis and alternative hypothesis, whereas frequentist analyses do not typically provide

Table 2
Bayesian Pearson correlations between baseline OCD severity, baseline interpretation bias, autism symptoms and change in OCD symptoms (CYBOCS difference score).

Variable		Baseline OCD severity	Baseline Interpretation bias	Baseline Autism symptoms
Baseline OCD severity	Pearson's r	–		
	BF_{10}	–		
Baseline Interpretation bias	Pearson's r	0.463	–	
	BF_{10}	9.062	–	
Baseline Autism symptoms	Pearson's r	0.087	−0.149	–
	BF_{10}	0.235	0.299	–
CYBOCS difference score	Pearson's r	−0.092	−0.069	−0.267
	BF_{10}	0.238	0.227	0.680

Note. BF = Bayes Factor.

evidence for the absence of an effect (i.e., null hypothesis; Krypotos et al., 2017). First, correlations between the variables of interest were inspected. Second, a simple Bayesian linear regression was carried out using baseline OCD severity (CY-BOCS), baseline interpretation bias (recognition task), and autism symptoms (SRS) as predictors of CBM-I training outcome (CY-BOCS difference score). With three predictors, there are eight possible models to predict the data: the null model with no predictors, the model in which all three predictors are included, three models including one predictor each and three models including two predictors each. All these models were tested in one Bayesian linear regression analysis (and models ordered from most to least evidence). Within the Bayesian framework Bayes factors are calculated to quantify the amount of evidence the data provide for each of the tested hypotheses. The larger this Bayes factor, the more evidence there is for this model, compared to the other models. In general, a Bayes factor of 1 indicates no evidence for the alternative nor the null hypothesis. A Bayes factor between 1 and 3 indicates anecdotal evidence for the alternative hypothesis. A Bayes factor between $^1/_3$ and 1 indicates anecdotal evidence for the null hypothesis. In the same fashion a Bayes factor between 3 and 10 indicates moderate evidence, between 10 and 30 strong evidence, between 30 and 100 very strong evidence and >100 extreme evidence (Lee & Wagenmakers, 2014). The analysis was executed using JASP, version 0.16.3 (JASP Team, 2022).

The model priors were set using the Beta binomial model prior with both alpha and beta set to 1. In this way, all models with the same number of predictors will, together, have the same prior probability as the null model, which can be seen as a way of correcting for multiple comparisons (standard setting in JASP). Descriptive statistics, boxplots and Q-Q plots were inspected for all variables. Three outliers were detected for baseline interpretation bias and one for baseline autism symptoms. As it was not a coding error and the outliers were judged as within a reasonable range that could be expected within a clinical sample, they were retained in the data set. For the interpretation task, an incorrect OCD subtype was used, leaving 35 participants to be included in the analysis.

3. Results

As a first step, correlations between the variables of interest were computed (see Table 2). An association between baseline OCD severity and interpretation bias was observed, *Pearson's r* = .463 with a Bayes factor of 9.062, which can be interpreted as moderate evidence for a correlation between the variables. A small negative association between autism symptoms and symptom change (CY-BOCS difference score) was observed, *Pearson's r* = −0.267 with a Bayes factor of 0.680, which can be interpreted as anecdotal evidence for the hypothesis that there is no correlation between the variables. For all other variables the support for the H0 (no linear correlation between the variables) is even stronger, indicating that there are likely no meaningful associations.

To examine the effect of baseline OCD severity, baseline interpretation bias, and autism symptoms on CBM-I training outcome, these variables were entered in a simple Bayesian linear regression.[1] Results indicated that the null model best predicted the data. None of the included variables showed predictive value for improvement in OCD symptoms following CBM-I training. The Bayes factors for all alternative models were below 1 (see Table 3). For all models besides the null model, 0 is included in the 95% confidence interval, providing further evidence that there is no predictive value in either direction for baseline OCD severity, interpretation bias, or autism symptoms (see Table 4).

Table 3
Model comparison Bayesian linear regression with baseline OCD severity, baseline interpretation bias, and autism symptoms as predictors of CBM-I outcome on OCD symptoms.

Models	P(M)	P(M|data)	BF_M	BF_{10}	R^2
Null model	0.250	0.496	2.955	1.000	0.000
Autism symptoms	0.083	0.144	1.856	0.873	0.071
OCD severity + Autism symptoms + Interpretation bias	0.250	0.095	0.314	0.191	0.077
OCD severity + Autism symptoms	0.083	0.064	0.749	0.386	0.076
Autism symptoms + Interpretation bias	0.083	0.061	0.712	0.367	0.072
OCD severity	0.083	0.060	0.697	0.360	0.009
Interpretation bias	0.083	0.054	0.624	0.325	0.001
OCD severity + Interpretation bias	0.083	0.027	0.303	0.162	0.009

Note. P(M) = the prior probability of the model, P(M|data) = the posterior probability of the model (after taking the data into account), BF_M is the change from prior to posterior model odds, BF_{10} is the ratio of the likelihood of the alternative hypothesis to the ratio of the likelihood of the null hypothesis, R^2 is the explained variance of the model.

4. Discussion

In the present study, we set out to exploratively examine for whom CBM-I works best in children and adolescents with OCD. The results showed no indications that baseline OCD severity, baseline interpretation bias, or autism symptoms have predictive value for symptom reduction following CBM-I training.

Theoretically, it was expected that individuals with more severe OCD symptoms have the greatest potential to benefit from CBM-I and would show the strongest reduction in symptoms. However, the current results indicated that baseline OCD symptom level did not predict CBM's impact on symptoms. This is consistent with results from a meta-analysis on CBM for youth with anxiety (Krebs et al., 2018), where no significant moderators were identified, including baseline symptom level (see also Cristea, Mogoaşe et al., 2015 for similar findings). It could be that baseline levels of OCD symptoms are not related to training effects and

[1] Since difference scores can be unreliable, the regression analysis was repeated using the baseline OCD relevant interpretations instead of the interpretation *bias* scores as the predictor. Outcomes were very similar.

Table 4
Posterior summaries of coefficients for the Bayesian linear regression using baseline OCD severity, baseline interpretation bias, and autism symptoms as predictors of CBM-I training outcome.

Coefficient								95% Credible Interval	
	P(incl)	P(excl)	P(incl|data)	P(excl|data)	$BF_{inclusion}$	Mean	SD	Lower	Upper
Intercept	1.000	0.000	1.000	0.000	1.000	3.667	0.675	2.327	5.027
OCD severity	0.500	0.500	0.245	0.755	0.324	−0.011	0.058	−0.178	0.123
Interpretation bias	0.500	0.500	0.236	0.764	0.309	-1.282^{e-4}	0.002	−0.005	0.004
Autism symptoms	0.500	0.500	0.364	0.636	0.572	−0.022	0.040	−0.135	0.015

Note. P (incl) is the prior inclusion probability; P (incl | data) is the posterior inclusion probability; $BF_{inclusion}$ is the change from prior to posterior inclusion odds; mean and sd are the posterior mean and standard deviation of the parameter after model averaging; lower and upper give a 95% central credible interval (CI) for the parameters.

that other factors such as comorbid symptoms, family variables (e.g., presence of OCD in first-degree relative, Kemp et al., 2021), social support, inflexibility in updating interpretations (Everaert et al., 2018), or readiness to change play a role in training effectiveness. Alternatively, the current sample is a selected sample of youth with an OCD diagnosis with moderate to high OCD severity. This has limited the variability in this predictor and it is an open question whether results would be different when also individuals with lower symptoms levels would be included. Actually, the CBM-I meta-analysis in youth (Krebs et al., 2018) likely also suffered from a restriction in range, though 'on the other side'. That is, most studies in youth examined CBM-I in unselected, analogue samples, thus lacking the high-end, clinical levels of symptoms scores in the moderator variable. In the current study with clinical levels of OCD, baseline severity was not associated with CBM-I effects on symptoms.

Also baseline level of interpretation bias did not moderate CBM-I training effects on OCD symptoms in the current study. This is consistent with results from an OCD-related single-session CBM-I training in adults (Beadel et al., 2016), though contrasts findings in unselected adolescents, where a single-session of social anxiety-related CBM-I training was especially successful in changing bias for adolescents who had a negative interpretation bias at baseline (Salemink & Wiers, 2011). Given the differences between studies in number of training sessions (single vs. multiple sessions), outcome measure (bias vs. symptoms), sample (adults vs. youth; clinical vs. nonclinical), and type of symptoms (OCD vs. social anxiety related), the findings of those studies are hard to directly compare and any difference in findings could be due to several factors. Alternatively, while baseline bias might be unrelated to training effectiveness, the null finding might also be related to the complexity of the recognition task that was used to assess interpretation bias. There were several participants who had difficulty understanding and completing the recognition task. It seems a difficult task especially for younger participants and this could have affected our results. However, as the interpretation bias scores were associated with OCD symptoms, this provides some validity for the recognition task.

The current findings also indicated that degree of comorbid autism symptoms does not moderate CBM-I training effects on OCD symptoms. As far as we know, this has not been tested before as often children with ASD are excluded from scientific studies. The current findings are in line with a recent review that concluded that children with OCD and ASD can benefit from CBT treatment when the standard CBT protocol is slightly modified (Kose et al., 2018). Those adjustments included increased use of visuals, positive reinforcement, and use of clear language and instructions. The current CBM-I training contains some of those adjustments, including repeated positive reinforcement after every trial and clear instructions. It is possible that the format of CBM-I training meets some of the needs of children with OCD and comorbid autism symptoms.

This is the first study examining moderators of CBM-I training in a pediatric OCD sample and several limitations should be taken into account. First, it is an explorative study based on a small sample. Power to detect effects is likely limited and the results should be interpreted tentatively as first indications. A Bayesian analytical approach was taken as this allowed us to quantify the amount of evidence that the data provide for both the null and alternative hypotheses. As the analyses indicated that there was substantial evidence for the null hypothesis that there is no moderating role for each of the three predictors, this provides some confidence in the current findings. Still, further studies are needed with larger sample sizes to examine the robustness and replicability of the current findings. Secondly, given the sample size, we limited the analyses a priori to a maximum of three predictors and included two commonly studied predictors (baseline symptoms and baseline bias), as well as one less commonly studied, though clinically relevant predictor (degree of autism symptoms). There are likely other factors that might play a role in understanding variability in CBM-I training in a clinical sample, such as comorbid symptoms (e.g., depression), family variables, social support, and readiness for change. Future research might examine the predictive utility of these factors. Thirdly, autism symptoms were measured with a parent-report questionnaire, which does not provide information about an autism diagnosis. As a result, our results cannot be generalized to children with an autism diagnosis.

To conclude, the current analyses indicated that baseline OCD symptoms, baseline interpretation bias, nor degree of comorbid autism symptoms impacted on the effectiveness of CBM-I training in pediatric OCD. As such, these findings offer no insights into the question for whom training works best. Given the clinical potential of CBM-I training (Fodor et al., 2020), either as a stand-alone intervention, or in combination with CBT (as a pre-treatment, parallel add-on, or as a booster intervention), future research is necessary to understand the variability in effectiveness. Ultimately, this could help in identifying subgroups or optimizing training so that more children and adolescents will profit. There clearly is room for exciting clinical research with respect to online CBM-I training in the domain of youth OCD.

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Declaration of competing interest

ES and AH declare that they have no conflicts of interest. EdH and LW receive royalties from Springer Media for co-authorship of a Dutch treatment protocol for paediatric OCD.

Data availability

The data that has been used is confidential.

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