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Effectiveness of an online interpretation training as a pre-treatment for cognitive behavioral therapy for obsessive-compulsive disorder in youth: A randomized controlled trial

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ABSTRACT

Background: Cognitive behavioral therapy (CBT) is the treatment of choice for pediatric obsessive-compulsive disorder (OCD), but not all patients profit sufficiently. Long waitlists and wide variations in improvement rates ask for new interventions. We examined the effectiveness of a Cognitive Bias Modification–Interpretation (CBM-I) training that was offered during the waiting period for CBT. We tested 1) whether the CBM-I training is an effective intervention during a waitlist period for CBT, and 2) whether augmenting CBT with CBM-I improves treatment effect.

Methods: Participants (74 children with OCD, 8–18 years) were randomly assigned to either a CBM-I training or a waitlist, both followed by CBT.

Results: indicated that compared to the waitlist, the CBM-I training was effective in reducing OCD severity, with a medium effect size. Patients in the CBM-I training condition started subsequent CBT with less severe OCD, and this advantage was maintained during CBT. However, the CBM-I training did not result in a faster decline of symptoms during subsequent CBT.

Conclusion: These findings indicate that CBM-I training could be an easy to implement, helpful intervention during a waitlist period. However, replications in larger samples and comparisons to active control conditions are needed.

1. Introduction

Cognitive behavioral therapy (CBT) is recommended as first line treatment for pediatric obsessive-compulsive disorder (OCD) (National Institute for Health and Care Excellence, 2005; Geller et al., 2012). Although CBT is an effective treatment for OCD, not all children profit sufficiently. CBT is not effective for all patients. Improvement rates vary between 40-65% (O'Kearney, Anstey, Von Sanden, & Hunt, 2010), and a substantial number of patients do not respond sufficiently. In addition, usually there are long waitlists for treatment, which may lead to worsening of symptoms and a decrease in motivation for treatment.

Cognitive Bias Modification of interpretation (CBM-I; Krebs et al., 2018; Salemink, Wolters, & de Haan, 2019) training, an online training without involvement of a therapist, as an augmentation to CBT, may have the potential to address these problems, at least to some part. CBM-I could be offered already during the waiting period for CBT, and CBM-I and CBT may mutually reinforce each other which may improve treatment effect.

CBM-I is a relatively new intervention aimed at modifying maladaptive interpretations of ambiguous situations (Mathews & Mackintosh, 2000). In the training functional solutions for ambiguous situations are trained through repeated trials, which may lead to more functional beliefs and less symptomatology. CBM-I is an excellent candidate for improving OCD treatment. First, given that CBM-I can be offered as an

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online training, it is an intervention with 24/7 access, that can be done at home, already during the waitlist period for CBT. It may also address other barriers associated with CBT, such as problems related to scheduling treatment sessions and travelling issues, treatment associated costs, and shame (Herbst et al., 2012; Marques et al., 2010). Second, given that CBM-I training and CBT have a different approach in targeting cognitive processes, they could be complementary. Whereas the cognitive part of CBT is based on a rational approach with explicitly challenging thoughts, the approach in CBM-I is training-based with directly practicing adaptive interpretations over and over again (Baert, Koster, & De Raedt, 2011). Third, CBM-I is a relatively cheap intervention as no therapist time is needed. If CBM-I can enhance CBT, treatment for OCD might become more cost-effective.

Most CBM-I studies in OCD focused on non-clinical, adult populations using single-session training paradigms (e.g., Beadel, Ritchey, & Teachman, 2016; Black & Grisham, 2016; Clerkin & Teachman, 2011; Siwiec, Davine, Kresser, Rohde, & Lee, 2017). Results suggest that CBM-I training was successful in modifying dysfunctional obsessive-compulsive (OC)-related beliefs, but generally no effects on OC symptoms were found. This could be explained by the fact that only single-session training paradigms were used, as meta-analyses on CBM for anxiety have indicated that more training sessions were associated with larger effects (Hallion & Ruscio, 2011; Menne-Lothmann et al., 2014). Recently, we conducted the only controlled CBM-I study thus far in a clinical sample of youth with OCD ($N = 16$) (Salemink, Wolters, & de Haan, 2015). Patients in the CBM-I training group reported less OC symptoms post-training than patients in the placebo condition. In line with this, clinicians reported fewer obsessive symptoms in the active training condition relative to the placebo condition.

In the present study we built on the lessons learned from the latter study. We made two important, and unique adaptations to the CBM-I training. First, we improved the match between the content of the training scenarios and a participant's OC symptoms. Usually, the same set of training scenarios is applied to all participants in a one-size-fits-all manner. However, given the wide variety of OC symptoms across individuals, and the relevance of domain specificity (Beadel et al., 2016), it is important to tailor treatment to individual needs. We developed unique sets of training scenarios for different OCD subtypes to match the scenarios to current symptoms. This way, we increased the amount of relevant training scenarios, and removed irrelevant training scenarios, with the additional advantage that the training session length was significantly reduced. Second, we added behavioral action tendencies alongside cognitions in the training scenarios. Broadening the scope of the training by including behavioral aspects was based on several arguments: 1) the previously used cognitive approach is quite demanding for youth (Salemink et al., 2015); 2) not all patients with OCD report obsessions (Cougle & Lee, 2014); and 3) new insights highlight the role of a behavioral approach (exposure) to change dysfunctional beliefs (Arch & Abramowitz, 2015).

In the present multicenter randomized controlled study, we offered the renewed CBM-I training to children and adolescents with OCD during the (natural) waitlist for CBT to examine whether CBM-I training is an effective intervention during the waitlist period, and to examine whether augmenting CBT with CBM-I can improve treatment effect. Our hypotheses were that 1) during the waitlist period, CBM-I training results in a stronger reduction in OC symptoms compared to the waitlist condition, and 2) during CBT treatment, the trajectory of change in OC symptoms would differ between conditions, with CBM-I + CBT resulting in a faster decline in OC symptoms compared to waitlist + CBT. Finally, we explored broader effects of CBM-I + CBT on psychological well-being and co-morbid problems compared to waitlist + CBT.

2. Methods

2.1. Design

The present study was approved by the Medical Ethical Committee of Amsterdam UMC (NL44055.018.13) and pre-registered in the Dutch clinical trial register (NTR4275, https://www.trialregister.nl/trial/4073). The study was a randomized controlled trial with two parallel arms. Participants were randomly assigned to either a CBM-I training (50%) or a waitlist (50%), both followed by CBT. Randomization was accomplished via a computer program, and stratified on treatment center and OCD subtype (i.e., primary subtype based on the Dimensional Obsessive-Compulsive Scale; DOCS; Abramowitz et al., 2010). The trial was ended because the intended number of participants was reached. One participant was not able to complete the study because the CBT was not yet terminated at the study's end date.

2.2. Participants

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). Inclusion criteria were a primary diagnosis of OCD, a minimum score of 16 on the Children's Yale-Brown Obsessive-compulsive Scale (CY-BOCS, Scahill et al., 1997) at intake, and sufficient mastery of the Dutch language. Exclusion criteria were no stable dosage of medication for at least twelve weeks (SSRI, tricyclic antidepressants, or antipsychotic medication) or four weeks (methylphenidate, Risperidone) before the start of the study, previous state-of-the-art CBT within three months before the start of the study, drug or alcohol abuse, IQ below 80, and psychosis.

Between October 2013 and October 2016, 135 children were screened for eligibility and 79 children (59%) were included; 40 participants in the CBM-I + CBT condition and 39 in the waitlist + CBT condition. Four participants dropped out (one in the waitlist + CBT and three in the CBM-I + CBT condition) for the following reasons: being assigned to a waitlist ($n = 1$), start with medication ($n = 1$), discontinuation of the training due to the impression that the time investment did not outweigh effectiveness ($n = 1$), and completed less than 75% of the training due to practical problems ($n = 1$). One participant in the CBM-I condition had a missing assessment post-CBM-I/waitlist (T1). Therefore, T1 data was available for 74 participants (CBM-I $n = 36$; waitlist $n = 38$). See Fig. 1 for the flow chart. Table 1 shows baseline characteristics of the participants. Seventy-three percent reported one or more co-morbid disorders, as measured with the *Anxiety Disorder Interview Schedule* for DSM-IV-Child and Parent Version (ADIS-C/P, Silverman & Albano, 1996[ab]). Participants did not receive any other interventions for OCD besides the CBM-I training and CBT during the study period.

2.3. Treatment

2.3.1. CBM-I training

The CBM-I training consisted of twelve sessions with 24 training scenarios each. Scenarios were short, three-line stories that were presented on a computer (Salemink et al., 2015). Each scenario described a potential OCD-related problem. The final sentence of the scenario offered a functional solution 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.

Example of a training scenario:

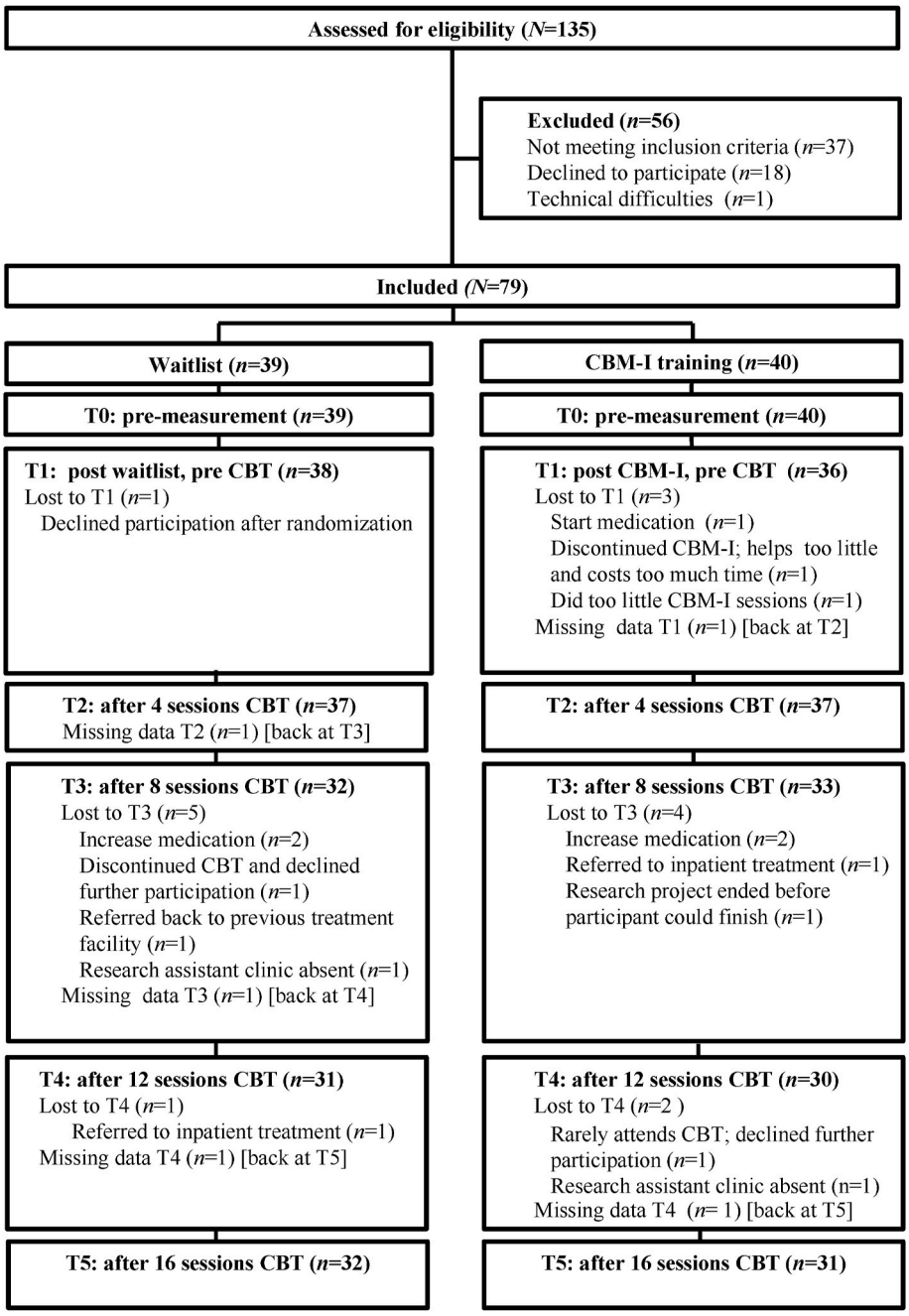

Fig. 1. Flowchart.

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.

Scenarios were matched to the OCD subtype of individual participants. Scenarios were developed according to the following subtypes: Contamination, Responsibility, Unacceptable thoughts, Symmetry/Not Just Right experiences, and Perfectionism (based on the DOCS, Abramowitz et al., 2010). For each subtype 72 unique scenarios were presented twice during the training (in different training sessions). Training scenarios addressed cognitive as well as behavioral facets of OCD to provide strategies to resist the urge to perform compulsions. Slightly different versions were developed for males and females, and for children and adolescents, to optimize the fit of the training.

The training incorporated a reward system, and a horizontal bar at the top of the computer screen showed the progress during the training. The duration of a training session was approximately 15 min. Participants had to complete the training within a period of four weeks, with a maximum of 5 consecutive days without training, and only one training session per day. When no sessions were completed for three consecutive days participants received a reminder via email. After four days without training participants received another email and a telephone call. After

Table 1
Baseline characteristics of participants.

	Total sample		CBM		Waitlist		Comparison conditions
	N=74		*n*=36		*n*=38		(t-test/Pearson chi square)
Age *M* (*SD*)	13.6	(2.9)	13.2	(3.1)	14.0	(2.8)	$t(72)$=-1.07, p=.29
Gender	40♂	(54%)	23♂	(64%)	17♂	(45%)	$\chi^2(1)$=2.73, p=.10
	34♀	(46%)	13♀	(36%)	21♀	(55%)	
CY-BOCS *M* (*SD*)	25.1	(5.6)	24.4	(5.2)	25.6	(5.9)	$t(72)$=-0.92, p=.36
ADIS Nr of comorbid diagnoses (*M*, *SD*)	1.8	(1.8)	1.8	(1.8)	1.8	(1.8)	$t(72)$=-0.02, p=.98
Co-morbidity (*N*) anxiety disorder	54	(73%)	26	(72%)	28	(74%)	
mood disorder	53	(72%)	25	(69%)	28	(74%)	
ADHD/ODD	14	(19%)	6	(17%)	8	(21%)	
	12	(16%)	6	(17%)	6	(16%)	
SRS (*t*-score) (*n*=73) *M* (*SD*)	56.7	(13.4)	55.9	(12.9)	57.5	(13.9)	$t(71)$=-0.50, p=.62

the fourth and eighth training session, participants received a supporting and motivating email. When the training period exceeded five weeks, participants were excluded from this study.

2.4. CBT

Manualized individual CBT was based on the evidence-based Dutch treatment manual 'Control your OCD' (De Haan & Wolters, 2009; Wolters, de Haan, Hogendoorn, Boer, & Prins, 2016). This CBT program consists of 16 weekly sessions (45–60 min) involving psychoeducation, a symptom hierarchy, exposure with response prevention, cognitive interventions, and relapse prevention. Parents are actively involved in the treatment. CBT was delivered by master level clinicians experienced in treating childhood OCD. Therapists were trained in the protocol and attended group supervision every two weeks combined with optional individual supervision (EdH).

2.5. Measures

ADIS-C/P (Silverman & Albano, 1996a,b): This is a semi-structured interview to assess anxiety disorders and other childhood psychopathology, showing good psychometric properties (Silverman, Saavedra, & Pina, 2001; Wood, Piacentini, Bergman, McCracken, & Barrios, 2002). The ADIS-C/P consists of a parent version (parent report about the child) and a child version (child report). The outcome includes clinician's severity ratings (CSR; ranging from 0 to 8) for each diagnosis for which criteria are met. A CSR of 4 or higher is indicative of a clinical diagnosis. The combined CSR was used which is the highest report from either the child or the parent interview. The ADIS-C/P has demonstrated good to excellent test–retest and interrater reliability, and adequate concurrent validity (Silverman et al., 2001; Wood et al., 2002).

Dimensional Obsessive-Compulsive Scale (DOCS): This is a 20-items measure that assesses four OCD symptom dimensions over the past month: Contamination, Responsibility, Unacceptable thoughts, and Symmetry. Each symptom dimension is assessed by five items covering time occupied by obsessions and compulsions, avoidance behavior, distress, functional interference, and difficulty disregarding obsessions/refraining from compulsions. Each item is answered on a 5-point scale ranging from 0 (no problems) to 4 (extremely problematic). The DOCS demonstrated good internal consistency (Cronbach's α .90 - .93) (Abramowitz et al., 2010). For the purpose of the present study, we added a fifth dimension 'Perfectionism' to the DOCS.

Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS) (Scahill et al., 1997): This scale contains a clinician-rated semi-structured interview used to assess severity of OC symptoms. The CY-BOCS is divided into an obsession and a compulsion subscale, with five items each concerning frequency/time, interference, distress, resistance, and level of control. Items are rated by the clinician on a five-point scale from 0 to 4. The total score (the sum of both subscales) ranges from 0 to 40. A total score of 16 or more is considered clinically significant (e.g., Pediatric OCD Treatment Study (POTS) Team, 2004). The CY-BOCS demonstrated good internal consistency, good test-retest reliability and adequate divergent and convergent validity (Scahill et al., 1997; Storch et al., 2004).

Children's Global Assessment Scale (CGAS; Shaffer et al., 1983): This scale provides an indication of general functioning. The CGAS is a continuous scale ranging from 1 through 100. Higher scores are indicative of better functioning, and scores above 70 indicate functioning in the normal range. The CGAS showed good interrater reliability (r = .84) and retest stability (r = .85) (Shaffer et al., 1983).

Child Behavior Checklist (CBCL; Achenbach, 1991): This is a parent-report questionnaire to assess a range of problem behavior in children (6–18 years). The CBCL consists of 113 questions that are rated on a 3-point scale. Results are presented as a total score and two broadband syndrome scales (i.e., internalizing and externalizing problem behavior).

Youth Self Report (YSR; Achenbach, 1991): This is the corresponding self-report version for children 11–18 years old. Reliability and validity of the CBCL and YSR were adequate (Verhulst & Van der Ende, 2013).

Children's Depression Inventory (CDI; Kovacs, 1992): This is a self-report questionnaire about depressive symptoms. Total scores range from 0 to 54 with higher scores reflecting more depressive symptoms. Internal consistency in a Dutch sample was good (Timbremont, Braet, & Roelofs, 2008).

Social Responsiveness Scale (SRS; Roeyers, Thys, Druart, De Schryver, & Schittekatte, 2011): This is a parent-rated questionnaire to assess the severity of autistic symptoms (Roeyers et al., 2011). The questionnaire consists of 65 items rated on a 4-point scale. Higher scores reflect more autistic symptoms (t-scores 0–40 low to normal range; 61–75 mild to medium problems; > 75 severe problems). Internal consistency (Cronbach's α) in a Dutch sample varied from .93 to .95 (Roeyers et al., 2011).

Evaluation form: This self-developed form was used for evaluation of the CBM-I training. The questions were: 1) Did you learn anything from the training?; 2) Was the training helpful?; 3) Did the stories fit to your problems?; 4) How do you rate the duration of the training sessions?; 5) How do you rate the amount of training sessions; 6) Do you have any tips regarding the training? The first question was answered with 'yes' or 'no', other questions were rated on a 7-point Likert scale,

ranging from 1 (not at all, much too short/little) to 7 (very much/good, far too long/much).

2.6. Procedure

Trained clinicians evaluated obsessive-compulsive and other psychiatric symptoms. The ADIS-C/P was administered to the child and parent(s) independently. IQ score (>80) was estimated by a mean standard score of 6 on the subtests Block design and Vocabulary of the Wechsler Intelligence Scale for Children (WISC III; Kort et al., 2005), or when available a total IQ score. After obtaining informed consent, participants were randomly allocated to either the CBM-I or the four-week waitlist condition. Participants were directly informed about the outcome of the randomization. Assessments were performed at the following time points: at baseline (T0), post-CBM-I/waitlist, which was also the start of CBT (T1), after four (T2), eight (T3), and 12 sessions CBT (T4), and post-CBT (16 sessions; T5). The YSR was only completed by participants from 11 years. See Table 2 for an overview of the assessments.[2] Due to practical constraints, the CY-BOCS interviews were accomplished by evaluators who were not always blinded for condition (incomplete blinding). To reduce the potential risk that incomplete blinding may have affected CY-BOCS scores, a random selection was evaluated in bi-weekly supervision with supervisors blinded for condition and treatment phase. In case of diverging scores, the differences were discussed until consensus was reached.

Participants in the CBM-I + CBT condition received information about the training at the baseline assessment (T0). Before the start of the training, the DOCS was administered and based on the two highest rated subscales, two sets of training scenarios were selected for each participant. All participants received a small compensation (a 10 Euro gift voucher at T1 and T5).

2.7. Statistical analyses

Analyses were conducted on cases that had completed assessments at T0 and T1 ($N = 74$), since this part contained the experimental manipulation. However, for the sake of completeness we checked whether results for the effect of the CBM-I training versus waitlist (primary outcome measure) were comparable for the intention-to-treat-sample ($N = 79$). Cases with missing data on the primary outcome (CYBOCS) did not differ significantly from cases with complete data with respect to age, gender, baseline CY-BOCS, presence of a comorbid disorder, and experimental condition. Consequently, missing data was considered to be missing at random. For the intention-to-treat analysis (ANOVA), missing values were imputed using the multiple imputation function in SPSS version 24. No missing values were imputed for the linear mixed model analyses, since an algorithm for handling missing data is integrated in this method.

To examine whether the CBM-I training was effective in reducing OCD symptoms (Hypothesis 1), we compared the pre- and post CYBOCS scores for the CBM-I condition to the waitlist condition using a mixed design ANOVA with Condition (CBM-I vs waitlist) as the between-subjects variable and Time (T0 vs T1) as the within-subject variable. Effect size (d) was computed using the formula for pretest-posttest control group designs based on the pooled pretest standard deviation (d_{ppc2}; Morris, 2008).

To investigate if trajectories of symptom change during CBT differed between participants in the CBM-I + CBT and waitlist + CBT condition (Hypothesis 2), a series of linear mixed models was run with CY-BOCS scores as the dependent factor, and Condition, Time (T1-T5), and the interaction between Condition and Time as independent factors (fixed effects). Analyses were performed with a random intercept. It was tested whether the addition of a random slope, and the correlation between the random intercept and random slope, increased model fit. Regarding the residuals the default option (unrelated residuals) as well as the autoregressive variance structure (related residuals) were tested. This resulted in six models. Model fit was evaluated based on Akaike's Information Criterion (AIC). Effect size (d) for CBT was calculated by the mean difference CY-BOCS score pre (T1) versus post (T5) CBT, divided by the standard deviation of the difference score pre versus post CBT (Norman & Streiner, 2008).

Finally, to test if the CBM-I training had a broader effect on psychological well-being and co-morbid problems, mixed design ANOVAs were performed with Time (T0, T5) as the within-subject factor, Condition (CBM-I, waitlist) as the between-subjects factor, and secondary outcomes (CGAS, CBCL, YSR, CDI) as dependent variables.

2.8. Calculation of sample size

In an a priori power analysis, we calculated the required sample size for the CBM-I versus waitlist comparison in the waitlist period. To detect a difference in CY-BOCS score of −3.0 between conditions (12% symptom improvement by a mean CY-BOCS score of 24) (Wolters et al., 2016), a sample size of 37 participants per condition is required (80% power).

3. Results

3.1. Effect CBM-I versus waitlist on OCD

To examine whether the CBM-I training resulted in a stronger reduction in OC symptoms compared to the waitlist (Hypothesis 1), the ANOVA revealed a significant main effect of Time, $F(1,72) = 22.62$, $p < .001$, $\eta_p^2 = .24$, and of the predicted Time*Condition interaction effect, $F(1, 72 = 7.62$, $p = .007$, $\eta_p^2 = .10$. Decomposing this interaction effect, paired-samples t-tests revealed a significant decrease in CY-BOCS from baseline to post-training in the CBM-I condition, $t(35) = 5.42$, $p < .001$, and no significant change in the waitlist condition, $t(37) = 1.39$, $p = .17$. Effect size (d_{ppc2}) for the CBM-I training (compared to waitlist) was .48, indicating a medium effect size. Comparable results were found for the intention-to-treat analysis ($N = 79$). Results showed a significant main effect of Time ($p < .01$), and a significant Time*Condition effect on CY-BOCS scores (p ranged from .001-.020). These results confirm our hypothesis that CBM-I resulted in a stronger OC symptom reduction compared to the waitlist.

3.2. Effect CBM-I versus waitlist on CBT effectiveness

Linear mixed model analyses were performed to examine if CBM-I, compared to waitlist, resulted in a faster decline in OCD severity in subsequent CBT (Hypothesis 2). Best fit was found for the model with a random intercept and a random slope (no interaction), and related residuals (autoregressive covariance structure). Results revealed a significant main effect of Time, $F(1, 70.98) = 132.00$, $p < .001$, and Condition, $F(1, 78.44) = 4.10$, $p = .046$. The interaction effect between Time*Condition was not significant, $F(1, 70.98) = .84$, $p = .36$. See Table 3 for the parameters. For both conditions, CYBOCS scores significantly decreased over time during CBT. The slope of the CYBOCS trajectories during CBT did not significantly differ between children that had completed the CBM-I training, and children allocated to the waitlist condition. However, on average, CYBOCS scores during CBT were consistently lower for CBM-I participants than for waitlist participants, indicating that patients from the CBM-I training experienced less OCD severity during the entire duration of the CBT (i.e., 16 weeks) compared to patients on the waitlist (see Fig. 2). See Table 4 for a more detailed picture of CBT effectiveness in both conditions.

[2] Additional measures were administrated to examine cognitive mediating mechanisms and predictors of treatment effect. These measures are not described in the present paper.

Table 2
Overview assessments.

	T0 (baseline)	T1 (post-CBM-I/waitlist; Start CBT)	T2 (CBT session 4)	T3 (CBT session 8)	T4 (CBT session 12)	T5 (post-CBT, session 16)
CY-BOCS	X	X	X	X	X	X
CGAS	X	X				X
YSR/CBCL	X					X
CDI	X					X
SRS	X					
CBM-I evaluation form		X				

Table 3
Parameter information.

	b	*SE* b	95% *CI*
Time	−3.25	.37	−3.98, −2.52
Condition	−3.80	1.87	−7.53, −.07
Time*Condition	.48	.52	−.56, 1.53

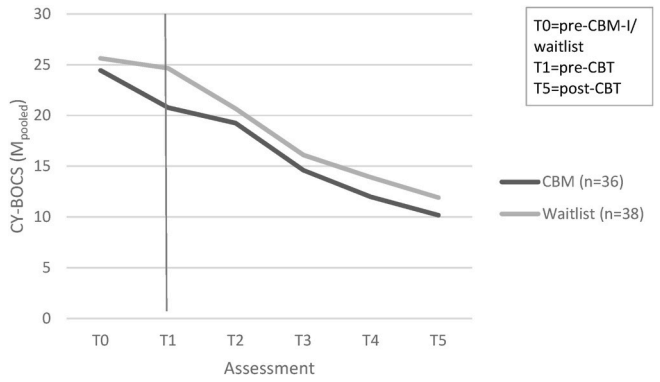

Fig. 2. CY-BOCS Trajectories during Treatment (N = 74; missing values imputed).

3.3. Secondary outcomes

Mixed design ANOVAs were conducted to test if CBM-I training increased the effect of CBT on psychological well-being and comorbid problems (see Table 5 for Means and SDs for secondary outcomes). Results showed a significant main effect of Time for all outcomes, and no significant interaction effects between Time*Condition (see Table 5 for more details). Overall, participants reported a significant reduction in depressive symptoms (CDI) and problem behavior (CBCL, YSR), and better psychological well-being (CGAS) after the full treatment trajectory, independent of condition (CBM-I + CBT or waitlist + CBT). Only for the CGAS, we found a significant effect for Condition: over the full treatment trajectory, CGAS scores in the CBM-I + CBT condition were higher than CGAS scores in the waitlist + CBT condition, indicating better psychological well-being for CBM-I + CBT.

3.4. Evaluation CBM-I training

Forty participants (100%) assigned to the CBM-I training completed an evaluation form about the training. Thirty participants (75%) reported that they have learned something from the training. Participants experienced the training as a bit helpful ($M = 3.5$, $SD = 1.4$), and the fit of the stories to individual problems was moderate ($M = 3.8$, $SD = 1.2$). The duration of the training sessions and the amount of sessions was rated as 'exactly right' ($M = 4.3$, $SD = 0.8$; $M = 4.3$, $SD = 0.9$, respectively). With respect to general suggestions: overall, the children were positive about the training. Some participants reported that the stories did not optimally match with their specific problems, and some participants suggested to convert the training into a computer game. Below, we report some quotes from participants.

Table 4
Treatment effect for CBT presented for the total sample, and for the CBM-I and waitlist group separately.

	Symptom reduction (%) *M* (*SD*)	Clinical status % participants with CY-BOCS < 16	Remission rate % participants with CY-BOCS ≤ 12	Treatment response % participants with ≥35% symptom reduction	Effect size (*d*)
Total sample (*N* = 74)	55% (34) (*N* = 62)	68% (*N* = 63)	56% (*N* = 63)	68% (*N* = 62)	1.43 (*N* = 62)
CBM-I + CBT (*N* = 36)	56% (33) (*N* = 30)	77% (*N* = 31)	65% (*N* = 31)	73% (*N* = 30)	1.43 (*N* = 30)
Waitlist + CBT (*N*=38)	54% (35) (*N* = 32)	59% (*N* = 32)	47% (*N* = 32)	63% (*N* = 32)	1.43 (*N* = 30)
Intention-to-treat basis					
Total sample (*N* = 79)	53%* (33–40)	62–70%	51–58%	63–70%	1.30-1.49
CBM-I + CBT (*N* = 40)	55%* (32–43)	70–80%	58–68%	68–75%	1.16-1.52
Waitlist + CBT (*N* = 39)	52%* (35–40)	51–64%	41–54%	54–67%	1.16-1.48

Note. * M_{pooled}.

"I increasingly realized that I do not have to listen to OCD."

"Because it was often repeated that I can ignore a bad feeling, I was able to think about this when the bad feeling came up."

"The training gave confirmation that my OCD was unrealistic and unnecessary"

"The training helped a bit. I started to try reducing my hand washing."

"I learned that not every thought tells the truth."

"I learned that other people sometimes have the same thoughts and feelings as I do. I always thought I was the only one with these problems."

3.5. Adverse events

No adverse events reported spontaneously by the subject or observed

Table 5
Secondary outcomes pre-versus post treatment.

		Pre CBM/waitlist (T0) *M* (*SD*)	Post CBM/waitlist (T1) *M* (*SD*)	Post-CBT (T5) *M* (*SD*)	Results Mixed Design ANOVA
CGAS category[a]	CBM-I + CBT	5.58 (0.69) ($N = 36$)	5.72 (0.78) ($N = 36$)	7.23 (1.38) ($N = 31$)	Time: $F(1.27, 76.46) = 71.71$, $p < .001$, $\eta_p^2 = .54$
	Waitlist + CBT	5.22 (0.71) ($N = 37$)	5.26 (0.78) ($N = 35$)	6.61 (1.31) ($N = 31$)	Condition: $F(1, 60) = 6.82$, $p = .01$, $\eta_p^2 = .10$
					Time*Condition: $F(1.27, 76.46) = 0.44$, $p = .56$, $\eta_p^2 = .07$
CDI	CBM-I + CBT	25.7 (2.43) ($N = 36$)		21.7 (6.74) ($N = 31$)	Time: $F(1, 60) = 16.02$, $p < .001$, $\eta_p^2 = .21$
	Waitlist + CBT	25.8 (2.91) ($N = 38$)		22.06 (6.79) ($N = 31$)	Condition: $F(1, 60) = 0.02$, $p = .89$, $\eta_p^2 < .001$
					Time*Condition: $F(1, 60) = 0.05$, $p = .83$, $\eta_p^2 = .001$
CBCL total (*t* values)	CBM-I + CBT	62.2 (7.08) ($N = 33$)		57.8 (10.25) ($N = 30$)	Time: $F(1, 55) = 10.72$, $p < .01$, $\eta_p^2 = .16$
	Waitlist + CBT	62.4 (8.44) ($N = 36$)		59.5 (8.17) ($N = 30$)	Condition: $F(1, 55) = 0.37$, $p = .55$, $\eta_p^2 = .007$
					Time*Condition: $F(1, 55) = 1.18$, $p = .28$, $\eta_p^2 = .02$
YSR total (*t* values)	CBM-I + CBT	57.0 (7.52) ($N = 24$)		51.2 (6.27) ($N = 19$)	Time: $F(1, 42) = 24.62$, $p < .001$, $\eta_p^2 = .37$
	Waitlist + CBT	56.1 (10.22) ($N = 30$)		52.0 (10.56) ($N = 26$)	Condition: $F(1, 42) = 0.19$, $p = .66$, $\eta_p^2 = .005$
					Time*Condition: $F(1, 42) = 2.24$, $p = .14$, $\eta_p^2 = .05$

Note. [a]CGAS category 5 refers to CGAS score 41–50; category 6 refers to CGAS score 51–60; category 7 refers to CGAS score 61–70; category 8 refers to CGAS score 71–80.

by the researcher or the therapist that logically could be expected to be related to study participation, the present CBM-I training or CBT treatment, were recorded.

4. Discussion

We examined if augmenting CBT with an adapted CBM-I training for pediatric OCD during the waitlist period could improve treatment effect. First, we tested the effect of the CBM-I training during the waitlist period, and second, we examined if the pretreatment CBM-I training enhanced treatment effect of subsequent CBT. Results indicated that the CBM-I training was more effective in reducing OCD severity than a waitlist. These results imply that CBM-I training can be a useful intervention during a (natural) waitlist for CBT, thereby offering an opportunity to start treatment even when no CBT therapist is yet available. Contrary to hypothesis 2, the CBM-I training did not enhance CBT effectiveness. The trajectory of change in OC symptoms did not differ between the two conditions; CBM-I + CBT did not result in a faster decline in OC symptoms during CBT compared to waitlist + CBT. However, participants that had completed the CBM-I training started subsequent CBT with less severe OCD relative to participants that had not completed the training, and this advantage was maintained during CBT.

A possible explanation for the finding that the CBM-I training did not result in a faster decline of symptoms during subsequent CBT is the discontinuity between the training and following CBT. Although in both interventions the same cognitions and behaviors are addressed, participants may experience changing OC problems via a computer different from changing OC problems in real life with a therapist. This explanation may imply that the CBM-I training could be improved by a better integration of the CBM-I training and CBT, either in time (e.g., CBM-I parallel to CBT), or in method (for instance by developing individualized CBM-I scenarios together with the CBT therapist).

In general, the children evaluated the CBM-I training positive and only two participants prematurely terminated the training, indicating that for most children the training was acceptable. For some children that were reluctant to start with CBT, the online CBM-I training served as a more accessible and acceptable step, opening the way to CBT. The present results also show individual differences in training effects, indicating that CBM-I offers a suitable solution for some but not for all patients. The CBM-I training did not affect CBT effectiveness on comorbid problems.

The positive findings for the CBM-I training in this study differ from previous studies where generally no effects of CBM-I on OC symptoms were found. Besides differences in samples, and using multiple training sessions, our adaptations to the CBM-I training (matching training scenarios to OCD subtypes, targeting cognitions *and* behavior), may have contributed to these positive results.

Limitations of the present study should be taken into account. First, because CBM-I was not compared to an active control condition, we cannot exclude the possibility of a placebo effect rather than a training effect. We used a waitlist control to reflect current clinically practice where most patients are placed on a waitlist for CBT, in order to examine if offering a pre-treatment CBM-I training could improve current clinical practice. While a first meta-analysis focusing on anxiety *and* depression in children and adolescents concluded that CBM targeting attentional or interpretive bias did not outperform an active control condition (Cristea, Mogoaş;e, David, & Cuijpers, 2015), a recent meta-analysis focusing specifically on CBM-I in anxious youth did find better CBM-I effects relative to an active control condition (negative training condition; Krebs et al., 2018). In our previous pilot study, an OCD-relevant CBM-I training was compared to a neutral CBM-I training (placebo variant) (Salemink et al., 2015). Although findings should be interpreted in the light of a small pilot study, results suggested a decrease in OC symptoms in favor of the OCD-relevant CBM-I training. These findings make it less likely that the positive effect that we found for the present CBM-I training, could be fully attributed to a placebo effect. A second limitation was the lack of blinding of the evaluators of the CY-BOCS interviews. However, to reduce the risk of biased outcomes, a random selection of the CY-BOCS interviews was evaluated by supervisors blinded for condition and treatment phase. A third limitation was missing data for secondary outcomes at the follow-up assessment.

For future studies, it would be important to determine the longevity of CBM-I effects, to compare CBM-I to active control conditions, and to further examine CBM-I effect in larger samples. Furthermore, it would be interesting to examine for whom CBM-I works and for whom other solutions might be more effective. In addition, it would be worthwhile to further improve the present training, for example by using idiosyncratic training scenarios to maximize the match between individual symptoms and training content, or using virtual reality to increase imagery and motivation for training (Otkhmezuri et al., 2019). In addition, we do not know the optimal amount and frequency of training sessions. Whereas in the present study a training period of four weeks was used, other training schedules might increase training effects. Alternative applications for CBM-I could also be considered. Possible options are offering a CBM-I training parallel to CBT to intensify treatment, and to examine if CBM-I could play a role in relapse prevention.

To conclude, results from the present study indicate that an adapted version of a CBM-I training for pediatric OCD as a pre-treatment for CBT can lead to OCD symptom reduction already during a waitlist period for

CBT, and that this advantage can be maintained during the entire treatment (subsequent CBT). This could make the CBM-I training a user-friendly, relatively easy to implement and cheap intervention, since the treatment can be completed at home without support from a therapist. However, replications in larger samples and comparisons to active control conditions are needed. Furthermore, in future studies, it would be interesting to explore possibilities to further improve the present training, and to examine predictors of training effect. It should be noted that the present CBM-I training has been developed with the intention to supplement CBT and not to replace or to delay CBT. This being said, we believe that the addition of a CBM-I training during a natural waitlist period for CBT, could make a difference for patients, since earlier improvement, even moderate or small, may lead to less OCD-related impairment, it may provide hope and motivation, and in case of reluctant patients it might open the way to further treatment.

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Declaration of competing interest

All authors declare that they have no conflicts of interest.

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