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ORIGINAL PAPER

Cognitive Bias Modification of Interpretations in Children: Processing Information About Ambiguous Social Events in a Duo

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Abstract Cognitive bias modification of interpretations (CBM-I) programs, in which individuals are trained to interpret ambiguous scenarios in a benign way, appear effective in altering anxiety-related cognitive biases in both children and adults. In this experimental study, we explored the effectiveness of a novel CBM-I training tool for children, which involves joint discussions of ambiguous information with a same-gender peer. 10- to 11-year-old boys and girls ($n = 20$) were provided with ambiguous social vignettes, each followed by two interpretations, and then asked to select one of them after a brief discussion with a same-gender peer. A further group of participants did not participate in any training but only completed pretraining and posttraining measures ($n = 18$). Results indicated that children who completed the interpretation training made less negative interpretations, endorsed less negative emotional consequences, reported less social anxiety, and performed better in a stressful task compared with the no-intervention group. Clinical implications of the results are briefly discussed.

Keywords Cognitive bias modification · Peer influences · Social anxiety · Children · Interpretation

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Introduction

Contemporary conceptualizations of social anxiety suggest that cognition plays an important role in the maintenance of the disorder (Clark and Wells 1995; Hofmann 2007). In addition, there is preliminary and indirect evidence that when presented with ambiguous social information, socially anxious children will interpret it in an anxiety-provoking fashion (Cartwright-Hatton et al. 2011). For example, a socially anxious person who sees a companion yawn is likely to interpret this yawn in a negative self-confirmatory light, "I am boring" compared to a less anxious person who might interpret it as showing that his/her companion simply had a hard day (although this is not always the case—see Creswell et al. 2014). Given recent evidence suggesting that negative cognitions are a risk factor for social anxiety (Miers et al. 2013), there is an urgent need for effective, developmentally-appropriate, and easy-to-administer interventions for early social anxiety.

During the past 15 years, innovative interpretation training programs have been developed, known as Cognitive bias modification of interpretations (CBM-I), that appear to be successful in modifying negative interpretations for ambiguous cues (Lester et al. 2011a, b; Muris et al. 2008, 2009; Vassilopoulos et al. 2009, 2012). In the study reported by Vassilopoulos et al. (2009), children (aged 10–11 years) high in self-reported social anxiety received three brief sessions in which they were presented with a series of ambiguous scenarios (e.g., "During arts education, you ask your classmate for one of his/her crayons but s/he refuses") followed by a benign (e.g., "S/he needs the crayon to finish his/her painting") or negative interpretation (e.g., "S/he dislikes you"). After the children had indicated which interpretation described how they would think in that situation, they were given feedback on what

was the "correct" (always benign) interpretation. It was found that the training not only reduced the negative interpretations of the children, but also reduced their social anxiety. The trained group also showed lower anxiety about an anticipated social encounter. These results suggest that negative cognitions in children are malleable, and that interpretation training could have beneficial effects on important aspects of social anxiety. However, in a subsequent study Vassilopoulos et al. failed to replicate the effects of the interpretation training on children's social anxiety levels (Vassilopoulos et al. 2013) suggesting that there is considerable room to improve the procedure.

A line of research (e.g., Lau et al. 2013b; Vassilopoulos et al. 2014) has been interested in how interpretation training paradigms may be made more effective in inducing the relevant bias. This can shed light both on potential factors affecting acquisition of negative biases in childhood, and also on how positive biases may be trained more effectively for therapeutic purposes. So far, in most interpretation training programs developed for children, participants work on their own with a series of hypothetical scenarios and it is the experimenter (or another authority figure) who provides feedback on the "correct" response (for a review see Beard 2011). However, these training procedures have been somewhat problematic in that participants report experiencing them as extremely boring, cumbersome, meaningless or strange (e.g., Beard et al. 2012). Moreover, it is the standard procedure in these experimental programs that no explanation for the "correct" response is given (e.g., see Vassilopoulos et al. 2009) and we have noted that some children appear puzzled or suspicious about the validity of the feedback provided or find it difficult to identify themselves with the positive outcomes described in training (see also Mathews et al. 2007, for similar observations in adults).

Mathews et al. (2007) managed to increase the acceptance of positive interpretations in adults by modifying the training material so as to introduce positive outcomes in a more graded fashion, beginning as nonnegative and gradually becoming explicitly positive. Following a different procedure, Lau et al. (2013b) also attempted to optimize the effects of positive CBM-I on children by involving parents. Specifically, they investigated multisession CBM-I training administered by parents as bedtime stories. CBM-I trained children showed increased endorsement of benign interpretations, a non-significant reduction in endorsement of negative interpretations, and reduced social anxiety symptoms, compared to a no-intervention group.

Notwithstanding the important work of Lau et al. (2013b), there are good reasons to believe that involving peers rather than parents could be equally advantageous, if not more so. First, during early adolescence boys and girls show a strong preference for forming groups of same-sex peers, which groups exert an influence on their attitudes and behaviour (Cole and Cole 1996). Second, despite evidence suggesting that parental rearing practices can affect children's cognitive development, it is also possible that preadolescents' attributional style is influenced by their peers (see Freeman et al. 2011, for an investigation of the potential role of peer contagion in the emergence of hostile attributions in preadolescents). Third, when implementing evidence-based techniques in school settings, it is perhaps more practical to engage peers than parents, as parents are difficult to reach and are often unavailable or unwilling to participate. Finally, instructing children to participate in joint discussions with same-gender peers might make the interpretation training more appealing, engaging, and intuitive: problem-solving group interventions are considered to be among the most effective counselling and psychotherapy strategies with children and adolescents (Webster-Stratton and Reid 2004).

There is already evidence showing that when children are asked to evaluate a potential threat after a brief discussion with a same-gender peer, a fear-suppression effect occurs. Specifically, 9- to 12-year-olds boys and girls in the study by Muris and Rijkee (2011) were provided with ambiguous and positive information about novel animals (i.e., Australian marsupials) and then asked to provide a subjective fear rating of the animals. For each child, the procedure was conducted under two conditions: fear of one animal was assessed individually by the child on its own, whereas fear of the other animal was measured after a brief discussion on fear-related issues with a same gender peer. It was found that children who evaluated the fear level of the animals after a discussion with a same-gender peer, displayed lower levels of fear than children who evaluated the fear level of the animals fully on their own. Thus, there are reasons to believe that when children are asked to process positive information about potentially fear-eliciting situations with their peers, this may result in lower levels of fear.

The aim of this study was to develop a new variant of CBM-I and test its impact on interpretation bias and social anxiety symptoms in comparison to a test–retest control group. The new training variant (duo CBM-I) instructs participants to select one of the two (negative and benign) resolutions after a brief discussion with a same-gender peer. Based mainly on the findings reported by Muris and Rijkee (2011), we hypothesized that the duo CBM-I would be effective in reducing social anxiety symptoms and changing interpretation bias towards a more positive direction. Another aim was to further investigate the effects of interpretation training on performance and emotional vulnerability by including a real stress-evoking task whereby participants have to complete an insoluble anagram task. There is preliminary evidence that the induction

of an interpretation bias can affect participants' performance on this behavioural measure (Vassilopoulos et al. 2014). Therefore, we set out to replicate these early findings by testing the hypothesis that the effects of the new training variant on cognition and social anxiety symptoms would translate into associated change in objective and subjective performance during a stress-evoking task.

Method

Participants

Participants were 38 primary school children (18 girls) enrolled in 5th grade class from two public schools in the southwest of Greece, who were predominantly from a middle-class SES background. The participants were all Caucasian and ranged in age from 10 to 11 years ($M = 10.4$, $SD = .3$). This specific age group was selected because it has been found that preadolescents show a strong preference for same-sex peers (Cole and Cole, 1996). We obtained verbal permission to perform the study from the principal of the school and each child's teacher. Parental consent was also obtained via letter and an opt-out procedure. All children had normal or corrected-to-normal vision and hearing and were informed that they are free to withdraw or not participate in the study at any time without giving reason.

Procedure

The study was conducted in two sessions. In the first session, the SASC-R, CDI, and the measures of interpretation and judgmental biases were administered. Then participants completed then the first anagram task and the performance measures to establish baseline scores. All children were visited by the experimenter 2–3 days after completing the scales. They were randomly assigned to either the duo CBM-I or the control group and received instructions either in pairs (duo CBM-I group) or in larger groups (control group).

For the duo CBM-I group, children were tested together with a quasi-randomly selected same-sex peer from his/her class (close friends and relatives were not tested jointly). Children were provided with the vignettes, after which they were explicitly asked to confer with each other and then individually select one of the two possible interpretations that followed each hypothetical story. No correct feedback was provided by the experimenter. During the training, a second research assistant was present monitoring the procedure, but kept herself apart, and intervened only to answer any questions regarding the hypothetical vignettes and the alternative interpretations or to interrupt any discussion between children. The mean training time was 15 min. The re-administration of the measures of interpretation and judgmental biases took place immediately after the experimental manipulation, using a new set of items for the interpretation and judgmental bias ratings, with sets used at test and re-test balanced over participants within groups. During the completion of the scales, children in the duo condition were clearly separated by the experimenter and no longer allowed to communicate. Finally, participants completed the second version of the anagram task and the performance ratings and were debriefed. Participants allocated to the control condition were also visited after the same interval, and were asked to complete the same tests of interpretation and judgmental bias together with the SASC-R and the anagram task.

Measures

Social Anxiety Assessment

Before and after training, social anxiety was measured with the Greek version of the social anxiety scale for children—revised (*SASC-R*; La Greca and Stone 1993). The SASC-R is a 22-item scale that assesses children's subjective feelings of social anxiety during various social situations and its correlates, including avoidance and inhibition. In the present study a 3-point scale (0 = *never true*, 1 = *sometimes true*, 2 = *always true*) was used instead of the original 5-point scale to make it more straightforward for the children. Cronbach's alpha was .73 and .71 at pre-training and post-training, respectively.

Depression Assessment

Before training, depression was measured with the Greek version of the children's depression inventory—short form (*CDI*; Kovacs 1992). The CDI is a 10-item questionnaire designed to assess the presence of depressive symptoms in children and adolescents aged between 7 and 17. The standard response scale (1 = absence of symptom, 2 = mild symptom, 3 = definite symptom) was used. Cronbach's alpha was .66. This measure was included for a better description of our sample.

Interpretation Bias

A series of 18 ambiguous social scenarios (Vassilopoulos et al. 2009) were presented reflecting commonly occurring events that are relevant for the age group in question, such as inviting classmates to your birthday party some of whom do not reply, approaching a group of peers who stop talking upon seeing you, and going to your classmate's home to play together where nobody opens the door for you. Each description was followed by two thoughts that might sometimes occur to people in these situations. One interpretation always involved a negative judgment about

oneself and the other interpretation involved a benign judgment of oneself or the situation. Participants rated the explanations in terms of the extent to which they would be most likely to come to their mind if this event had happened to them, using a 5-point Likert-type scale ranging from 1 (*I would not think of it at all*) to 5 (*I would think of it immediately*). To assess judgmental bias (negative consequences), participants also answered the question: "How bad would it be for you if such an event had *really* happened?", using a 5-point Likert-type scale ranging from 1 (*not at all bad*) to 5 (*very bad*). Negative and benign interpretations for each situation were presented in a fixed random order. In order to control for unintentional order effects, half the event descriptions were presented at pre-assessment and the other half were presented at post-assessment in a counterbalanced order. Cronbach's alphas were .82, .54, .85 (for negative interpretations, benign interpretations, and emotional consequences, respectively) at pre-assessment, and .84, .85, .84 at post-assessment. Children's mean benign and negative interpretation bias scores were calculated for pre- and post-training phase.

Interpretation Training Program

Children allocated to the duo CBM-I condition were presented with 20 descriptions of hypothetical social events, written in the second person. Each of the descriptions was presented on a different laminated card. At the beginning of the training session, participants were informed that they are about to read some hypothetical event descriptions with a same-gender peer and were encouraged to imagine themselves as the central character in each description, irrespective of whether they thought such a situation could ever actually happen to them. Then, each child received a pack of 20 cards with the event descriptions printed on them and was asked to read one description at a time, discuss the hypothetical event with his/her fellow student, and then answer the question that follows. After each event description, participants answered a question designed to elicit the required response by circling one of the two alternative interpretations following each description. For example, one item read as follows:

> During arts education, you ask your fellow student for one of his/her crayons, but he/she refused.
> What would you think if this happened to you?
>
> (a) He/she dislikes me (negative interpretation)
> (b) He/she needs the crayon to finish his/her painting (benign interpretation)

It is important to note here that one decision to make quite early was whether to provide children with alternative interpretations or ask them to generate and then evaluate their own interpretations of the hypothetical stories. We finally followed the first solution to this problem, mainly based on the findings reported by Rohrbacher et al. (2014) indicating that self-generation of positive resolutions for the scenarios does not add anything to the effectiveness of CBM-I.

After circling their response upon the card, participants turned to the next card and repeated this procedure for the rest of the cards. Note that these vignettes have been successfully employed in numerous studies to in order to manipulate children's interpretations of ambiguous social situations.

Control Condition

Children allocated to the control condition did not participate in any training and were simply asked to complete the same pretraining and posttraining measures (together with the anagram tasks) to control for maturation effects.

Stressor Task: Anagram Completion

The task was adapted from the anagram stress task used by Lester et al. (2011c, Experiment 2). Two versions of the anagram task were developed and piloted for administration at baseline and test with difficulty level matched across versions. This task was piloted with six children to ensure that it was possible to solve approximately half of the anagrams within the allotted time (3 min). Each version consisted of five items varying in difficulty, determined by the number of letters (4–10 letters) and extent of rearrangement, (easy-small number of letters moved out of positions, e.g., school (loochs), hard-large number of letters moved out of position, e.g., unedsnt (student). In addition, 1 anagram in each version was age-inappropriate (e.g., verbalism) and another was impossible because it actually involved a pseudoword. Participants were instructed to solve as many anagrams as possible by writing down the correct words on a response sheet. Immediately afterward they completed two visual analogue scales (0–100) asking them to rate how they felt about their performance on the task (frustrated, successful). Actual performance was measured by the number of correctly solved anagrams.

Results

All participants completed the pre-assessment and post-assessment. Groups did not significantly differ in levels of social anxiety [SASC-R; $t(36) = 1.32$, $p = .19$, Cohen's $d = .43$], depression [CDI; $t(36) = .15$, $p = .87$, Cohen's $d = .05$], negative interpretation ratings [$t(36) = .41$, $p = .68$, Cohen's $d = .13$], benign interpretation ratings [$t(36) = 1.01$, $p = .31$, Cohen's $d = .33$], and emotional consequences estimates [$t(36) = 1.06$, $p = .29$, Cohen's $d = .34$] at pre-assessment.

Table 1 Means (and standard deviations) of interpretation ratings, negative consequence ratings and trait measures for each condition on each occasion of testing

Measure	Duo CBM-I		Test–retest	
	Pre	Post	Pre	Post
Age	10.35 (.32)		10.50 (.29)	
Gender (f:m)	(8:12)		(10:8)	
Children's depression inventory	12.80 (3.17)		12.66 (1.81)	
Social anxiety scale for children	15.50 (5.60)	12.10 (5.63)	13.11 (5.51)	14.00 (4.56)
Hypothetical social events (1–5)				
Negative interpretations	3.55 (1.16)	2.82 (1.11)	3.40 (1.12)	3.53 (.95)
Benign interpretations	3.42 (.79)	3.57 (1.09)	3.17 (.72)	3.34 (1.11)
Negative consequences	3.95 (.94)	3.15 (1.07)	3.60 (1.09)	3.60 (.80)

Means and standard deviations are presented in Table 1. Gender was initially included as a between-subject factor in all analyses, but this variable failed to yield any significant main effects or interactions so we collapsed across gender in the reported analyses.

Interpretation Bias

We predicted that children in the duo CBM-I would be less likely to endorse negative interpretations and/or more likely to endorse benign interpretations after training than would those in the control group. This hypothesis was tested using mixed ANOVAs with Group (duo CBM-I versus control) as the between-subjects factor and Time (pre- versus post-training) as the within-subjects factor. In the ANOVA on negative interpretations, there was a significant interaction of time with group, $F(1, 36) = 7.18, p = .01$, partial $\eta^2 = .17$, which was consistent with our hypothesis of a greater reduction in negative interpretation following training as compared to the control condition. Post hoc comparisons showed a significant reduction in negative interpretation ratings after training, $t(19) = 2.58, p = .018$, but no significant reduction in ratings for the control group, $t(17) = 1.05, p = .30$ (see Fig. 1). The analysis of benign interpretation scores showed no significant main or interaction effects (all $ps > .10$). Mean scores for each group are provided in Table 1.

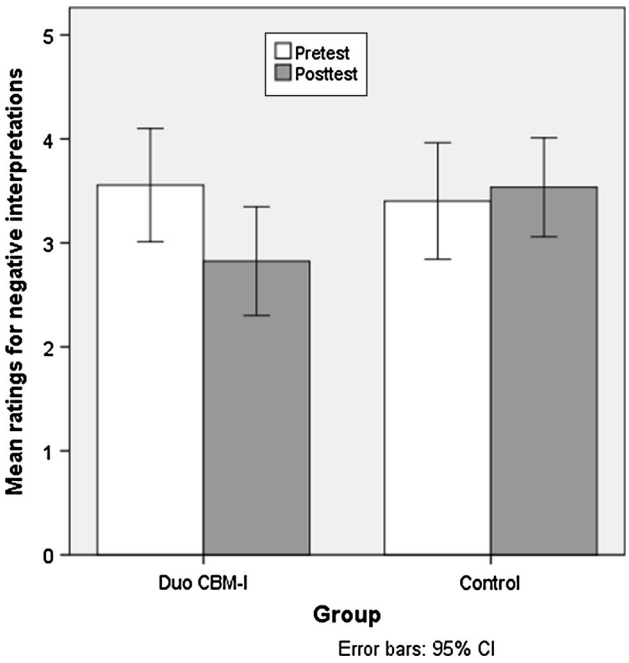

Fig. 1 Changes in the endorsement of negative interpretations in the duo CBM-I group and test–retest control group from pre- to post-test session

Social Anxiety

The hypothesis that participants in the duo CBM-I condition would show greater reduction in social anxiety than those in the control condition was tested using a similar ANOVA to that described above. As with the negative interpretation ratings, there was a significant interaction of time with group, $F(1, 36) = 5.94$, $p = .02$, partial $\eta^2 = .14$, which was consistent with our hypothesis of a greater reduction in social anxiety symptoms following interpretation training as compared to the control condition. According to our post hoc comparisons, the duo CBM-I group showed a significant reduction in social anxiety scores, $t(19) = 2.56$, $p = .019$, but social anxiety scores did not significantly change for the control group, $t(17) = .79$, $p = .43$ (see Fig. 2).

Negative Emotional Consequence Estimates

Changes in estimates of negative emotional consequences of the hypothetical social events from pre-training to post-training were examined using a similar mixed ANOVA. There was a significant main effect of time, $F(1, 36) = 7.17$, $p = .01$, partial $\eta^2 = .17$, qualified by a significant interaction of time by group, $F(1, 36) = 7.17$, $p = .01$, partial $\eta^2 = .17$. Post hoc comparisons revealed significant reductions in negative consequence ratings after training, $t(19) = 3.56$, $p = .002$, but no change in ratings for the control group, $t(17) = .1$, $p = 1$(see Table 1).

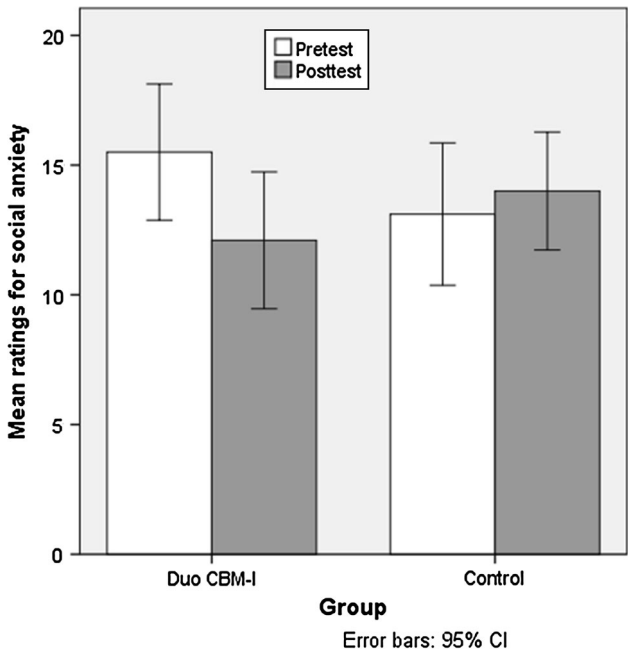

Fig. 2 Changes in social anxiety symptoms in the duo CBM-I group and test–retest control group from pre- to post-test session

Stressor Task: Anagram Completion

Changes in the number of anagrams correctly completed were tested using a similar mixed ANOVA. A main effect of time, $F(1, 36) = 5.43$, $p = .03$, *partial* $\eta^2 = .13$, was qualified by a marginally significant interaction of group with time, $F(1, 36) = 4.04$, $p = .05$, *partial* $\eta^2 = .10$. Post hoc comparisons showed that children in the duo group solved significantly more anagrams post-training compared to their pre-training performance, $t(19) = 3.13$, $p = .005$, whereas children in the control condition did not show any change in the number of anagrams solved, $t(17) = .22$, $p = .82$.

Participants' evaluation of performance (frustration, successfulness) was submitted to the same mixed ANOVA analysis. For successfulness ratings there was no significant main effect or interaction (Fs $< .5$). For frustration ratings, again the interaction of time with group was significant, $F(1, 36) = 7.33$, $p = .01$, *partial* $\eta^2 = .17$. Similarly, post hoc comparisons showed that participants in the duo group reported significantly less frustration after the 2nd anagram task, $t(19) = 2.43$, $p = .03$, whereas for participants in the control group there was a no-significant increase in frustration ratings, $t(17) = 1.57$, $p = .13$ (see Table 2).

Correlational Analysis

Change in social anxiety from pre-training to post-training was significantly correlated with change in negative interpretation ratings, $r(38) = .60$, $p < .001$, and with change in negative emotional consequence ratings, $r(38) = .47$, $p = .003$, such that reduction in social anxiety was associated with a reduction in negative interpretation and consequence ratings. In addition, change in negative interpretation ratings was significantly correlated with change in negative consequence ratings, $r(38) = .52$, $p = .001$. Moreover, social anxiety levels and interpretation bias at pre-training significantly correlated with changes in social anxiety and negative interpretation ratings, respectively [rs$(38) = .59$, $.51$, ps $< .001$]. In addition, changes in the number of anagrams solved showed a negative correlation with changes in frustration ratings, $r(38) = -.37$, $p = .02$, such that an increase in the number of anagrams correctly solved was associated with a reduction in ratings of frustration. Finally, negative interpretation ratings at post-training showed a significant negative correlation with number of anagrams correctly completed during the second version of the anagram task, $r(38) = -.49$, $p = .002$. No other correlation was found to be significant.

Discussion

The goal of this study was to design and evaluate a new variant of CBM-I and test its effectiveness in comparison to a no-intervention group. Unlike most other cognitive bias modification techniques, in which the participant is trained in isolation and receives feedback regarding the 'correct' response (Lester et al. 2011a, b; Muris et al. 2008, 2009; Vassilopoulos et al. 2009, 2012), here, active discussions with a peer, during which no feedback on the 'correct' interpretation is provided, became the 'mode' of training. Thus we capitalised on the known role of (same-

Table 2 Mean (and standard deviations) ratings for the stressor task used in the study

	Duo CBM-I		Test–retest	
	Pre	Post	Pre	Post
Anagram task: actual performance [number of correct responses (/5)]				
	1.65 (.93)	2.40 (.68)	1.83 (.98)	1.88 (.67)
Anagram task: performance evaluation (0–100)				
Successfulness	73.00 (24.30)	77.00 (24.08)	77.55 (29.79)	71.66 (30.34)
Frustration	47.50 (26.13)	31.00 (19.70)	43.33 (33.07)	59.44 (32.44)

gender) peers in influencing preadolescents and at the same time—we speculate—the whole procedure became more meaningful and engaging.

These early data hold promise. First, they suggest that our duo version of CBM-I was successful in decreasing negative interpretations as well as negative emotional consequence estimates, whereas no such change was seen in the control condition. Second, and perhaps more crucially, our data showed that the experimental intervention could reduce social anxiety symptoms in an unselected sample of children and across a single session, a change that did not characterize participants in the comparison test–retest group. These results confirm the effectiveness of a more active version of CBM-I involving joint discussion with a same-gender peer. They also consistent with the study by Muris and Rijkee (2011), which also report that the processing of positive information about novel, potentially fear-eliciting stimuli with peers could result in lower levels of fear.

Another goal of this study was to examine the possibility that the positive effects of the CBM-I variant would generalize to performance and emotional vulnerability in response to a real-life stressful task. In line with our initial hypotheses, it was found that children participating in joint-discussion with a peer reported feeling much less frustrated after completing the second anagram task, compared to those that have received no intervention. However, these group differences in frustration ratings probably reflected differences in actual performance, since anagram performance in the duo CBM-I group increased from before to after the interpretation training, whereas for the control group the performance remained stable. Thus, although both groups rated their performance in the anagram tasks as equally successful, nevertheless, the superior anagram performance of the CBM-I group posttraining probably influenced the level of frustration felt, as the correlational analysis has shown. Nevertheless, our data replicate previous findings (Vassilopoulos et al. 2014) in that they also suggest that participating in an interpretation training program can lead to an improvement of objective performance in a subsequent stressful task. Indeed, the significant negative correlation between performance on the anagram task and negative interrelation ratings posttraining found in the current study appears to support this possibility. We speculate that an important mediator of such effects would be children's sense of self-efficacy. For example, there is already evidence indicating that cognitive bias modification procedures can increase participants' self-confidence and self-esteem (Dandeneau et al. 2007), which, in turn, could lead to improved performance on a subsequent stress-evoking task.

The effect sizes for change in cognitive biases and social anxiety symptoms were rather large ($\eta^2 = .17$ for both negative interpretation bias and negative emotional consequence estimates, .14 for social anxiety) and compare favourably to previous findings regarding feedback-learning interpretation training paradigms (Vassilopoulos et al. 2012; negative interpretations $\eta^2 = .04$, emotional consequence estimates $\eta^2 = .12$, social anxiety $\eta^2 = .03$). As with previous work, the effects of interpretation training were more pronounced for negative interpretations than for benign interpretations. This is promising for future comprehensive psychoeducational group programs that want to exploit the potential of cognitive bias modification procedures to modify pre-existing biases toward threat in high trait and clinically anxious children. Thus, instead of giving the child a feedback-learning CBM-I task to complete individually, participants could be instructed to form same-gender pairs and jointly discuss a series of hypothetical ambiguous social stories in order to determine which of the two interpretations that follow is the most helpful or rational one. In that way children are not only passive recipients of experimenter-provided feedback but active problem-solvers, and their communication skills, complex reasoning and critical thinking are enhanced. Moreover, the whole procedure is probably becoming more enjoyable, intuitive, and engaging.

A number of limitations of the study need to be highlighted. A clear limitation is that an untrained (test–retest) control group was used, so that it is difficult to disambiguate whether the reductions in social anxiety and interpretative bias emerged from the interpretation training program alone, from simple exposure to joint problem-solving activities or from intrinsically rewarding experiences of successful interactions with peers (or a combination of them). Future studies could tease apart different mechanisms by which our tool work by the inclusion of different comparison conditions, such as instructing same-gender peers to discuss stories about non-social situations (i.e., events that impact upon the protagonist alone, such as wondering why the bicycle you have just repaired has started to make a strange noise; see Vassilopoulos and Banerjee 2012), or asking them practice problem-solving skills. Alternatively, some of the results reported here could arise from demand effects. Nonetheless, it is difficult to explain how demand effects could lead to superior performance on a real stress-evoking task (insoluble anagram test) for the duo CBM-I group. Also, we could further optimize the effects of the interpretation training by pairing high with low socially anxious children (and, at the same time, minimize the possibility that children might persuade each other to interpret the ambiguous scenarios in a more negative way) and this is an interesting avenue for future research. In addition, because we were not allowed to audiotape the conversations of the duos, we cannot comment on the content of the communication within pairs and whether there were differences between boys and girls on the way they discussed various hypothetical situations. Further, acceptability and satisfaction with duo CBM-I were not systematically investigated and more rigorous

research is needed to ascertain whether duo CBM-I training is more acceptable to children than standard CBM-I training. A final limitation is the use of a non-clinical sample and there is a need to replicate these results in clinically referred preadolescents with social anxiety disorder in order to ensure the generalizability of the findings.

Notwithstanding the limitations mentioned above, our new training variant is still notable in its capacity to reduce symptoms and emotional vulnerability across pre-adolescents. This makes it an appealing and developmentally-appropriate tool for prevention particularly in pre-adolescence, which has been linked to a burst in social anxiety levels (Miers et al. 2013). These results also set the current procedure apart from other CBM-I packages used in young people today, where changes in cognitive bias do not translate into associated change in objective and subjective performance during a stress-evoking task [with the exception of the study reported by Lau et al. (2013a)]. One factor that may enhance the effectiveness of our duo CBM-I procedure is the use of an active training in the form of same-gender peer discussions. Indeed, Hoppitt et al. (2010) have shown that 'active' compared to 'passive' procedures can lead to a greater modification of later responses to new emotionally ambiguous descriptions. Another factor may lie in the fact that it capitalises on social learning mechanisms by which cognitive biases are shaped in this age range (Freeman et al. 2011). Involving peers in bias modification training thus closely mimics naturally occurring events by which preadolescents' interpretational styles are acquired and shaped (Field and Lester 2010; Freeman et al. 2011), and may therefore provide a more powerful strategy than learning in isolation or via brief computerized (CBM-I) programs (Lau et al. 2013b).

In summary, the present study has shown the potential of an interpretation training program involving joint discussions with a same-gender peer for modifying biases related to social anxiety, and social anxiety itself in a sample of unselected preadolescents. Moreover, the effects of the program were generalized to a real life stress-evoking task. Although much more work on its effectiveness is needed, it could prove to be a valuable, easy to deliver, and developmentally-appropriate intervention to combat anxiety and maladaptive cognitions in young people.

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