Training anxious children to disengage attention from threat: a randomized controlled trial

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Background: Threat-related attention biases have been implicated in the etiology and maintenance of anxiety disorders. As a result, attention bias modification (ABM) protocols have been employed as treatments for anxious adults. However, they have yet to emerge for children. A randomized, double-blind placebo-controlled trial was conducted to examine the efficacy of an ABM protocol designed to facilitate attention disengagement from threats, thereby reducing anxiety and stress vulnerability in children. Methods: Participants were 34 chronically high-anxious 10-year-olds. An emotional attention spatial cueing task was used. In the ABM condition (n = 18), threat faces never cued the targets’ locations, such that the valid–invalid ratio was 0%/100%, respectively. The valid–invalid ratio on neutral cue trials was 25%/75%, respectively. In the control condition, the valid–invalid ratio was 25%/75% for both neutral and threat faces. Anxiety and depression were measured pre- and post-training and pre- and post-stress induction. Results: ABM facilitated attention disengagement from threat. In response to the stressor task, children in the ABM condition reported less state anxiety relative to controls. Conclusion: Computerized attention training procedures may be beneficial for reducing stress vulnerability in anxious children. Keywords: Threat bias, anxiety, children, attention bias modification treatment.

Conflict of interest statement: No conflicts declared.

1 For a different protocol see Dandeneau, Baldwin, Baccus, Sakellaropoulou, and Pruessner (2007).
target at the cued location on a majority of the trials (valid cue) and at the alternative location on a minority of the trials (invalid cue). Speeding on valid trials is attributed to the benefits of attentional engagement with the cued location. Slowing on invalid trials is associated with the costs of having to disengage attention from the cued location. Systematic manipulation of the emotional content of cues reveals the effect of cue valence on attention. Studies using this task typically report increased dwelling time on threat invalid cues relative to neutral invalid cues in anxious relative to nonanxious individuals (Bar-Haim et al., 2007). This is thought to reflect a difficulty in disengaging attention from threats among anxious individuals.

To our knowledge, no published ABM study has specifically trained anxious participants to disengage attention from threat. In addition, no randomized controlled ABM studies in anxious children have been reported. In the present study we used an emotional variant of Posner’s spatial cuing task to assess the effect of training to disengage attention from threat on anxiety symptoms and stress vulnerability in anxious children. A group of children who reported chronically high anxiety over the course of two years were randomly assigned into either ABM (training to disengage attention from threat) or Control (cue-target contingencies not designed to modify attention) protocols. The attention training procedure was expected to induce faster response latencies on invalid threat trials in the ABM group (i.e., faster disengagement from threat). It was also expected that relative to children in the ABM group, children in the control condition would display larger increases in anxiety in response to a subsequent stressor.

Method

Participants

Thirty-five children (10 males), mean age 10.1 years (SD = .46 years) were recruited out of a sample of 102 children who participated in a longitudinal study of attention–emotion interactions during childhood. Participants were included if they self-reported a stable profile of high anxiety. The SCARED is designed to modify attention) protocols. The attention training procedure was expected to induce faster response latencies on invalid threat trials in the ABM group (i.e., faster disengagement from threat). It was also expected that relative to children in the ABM group, children in the control condition would display larger increases in anxiety in response to a subsequent stressor.

Table 1 Sample characteristics by attention training group

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<tr>
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<th>ABM</th>
<th>Control</th>
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<tr>
<td>n</td>
<td></td>
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<tr>
<td>Male/Female ratio</td>
<td>5/13</td>
<td>5/11</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>10.20 (.47)</td>
<td>10.00 (.40)</td>
</tr>
<tr>
<td>SCARED – 8 years</td>
<td>27.73 (9.92)</td>
<td>30.35 (14.22)</td>
</tr>
<tr>
<td>SCARED – 9 years</td>
<td>34.66 (10.47)</td>
<td>31.13 (5.80)</td>
</tr>
<tr>
<td>SCARED – 10 years</td>
<td>39.13 (18.23)</td>
<td>45.13 (24.01)</td>
</tr>
<tr>
<td>Pre treatment – STAIC</td>
<td>33.84 (9.35)</td>
<td>34.50 (5.99)</td>
</tr>
<tr>
<td>Post treatment – STAIC</td>
<td>31.40 (9.87)</td>
<td>30.80 (7.03)</td>
</tr>
<tr>
<td>Pre treatment – CDI</td>
<td>9.94 (8.60)</td>
<td>7.44 (4.03)</td>
</tr>
<tr>
<td>Post treatment – CDI</td>
<td>9.06 (8.72)</td>
<td>6.61 (4.75)</td>
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Self-report scales

Screen for Child Anxiety Related Emotional Disorders (SCARED). The SCARED (Birmaher et al., 1999, 1997) is a 41-item child report instrument used to screen for anxiety disorders. The response scales range from 0 (not true or hardly ever true) to 2 (true or often true). The SCARED was developed to screen for the following childhood anxiety disorders: generalized anxiety, separation anxiety, somatic/panic, social phobia, and school phobia. The total SCARED score was used in the present study to select participants showing a stable profile of high anxiety. The SCARED is a valid and reliable child anxiety instrument (e.g., Birmaher et al., 1999, 1997; Muris, Mayer, Bartelds, Tierney, & Bogie, 2001).

State-Trait Anxiety Inventory for Children (STAIC) – Trait Scale. The trait scale of the STAIC (Spielberger, Edwards, Lushene, Montuori, & Platzer, 1973) consists of 20 child-reported items measuring enduring tendencies to experience anxiety. Translation of the STAIC to Hebrew was done according to the instructions of Spielberger and Diaz-Guerrero (1976), and was found to be reliable and valid for use with Israeli children (Teichman & Melnic, 1979).

Analog mood scales. Changes in negative mood state before and after stress induction were assessed using two analog mood scales (MacLeod et al., 2002). Each scale consisted of a 15cm horizontal line, divided into 30 equal-sized partitions. One analog scale displayed the terminal labels ‘relaxed’ and ‘anxious’ (analog anxiety scale), and the other displayed the terminal labels ‘happy’ and ‘sad’ (analog depression scale). Children used the computer mouse to move a cursor along the line to a point corresponding to their current mood state. This yielded a score between 1 and 30 depending on which partition of the line was selected. Higher scores indicated a more anxious or depressed state.

Children’s Depression Inventory (CDI). The CDI (Kovacs, 1985) has 27 items related to the cognitive, affective, and behavioral signs of depression. Each item contains three choices, and children select the one that best describes them during the last two weeks. The CDI was translated to Hebrew and found to be reliable in studies of depression in the Israeli pediatric population (Zalsman et al., 2005).
The emotional spatial cueing task

Stimuli. The face stimuli consisted of chromatic photographs of 12 different actors (6 male) from the NimStim stimulus set (Tottenham et al., 2009). Two pictures of each actor were selected depicting an angry and a neutral expression. Each photograph subtended 70mm by 43mm. Faces were presented either left or right of a fixation cross located at the center of the screen (6.85cm between center of face and center of fixation).

Procedure. The sequence of events in valid and invalid trials of the emotional-spatial cueing task is presented in Figure 1. Each trial began with a black fixation cross at the center of the screen (500ms). Then, two black rectangle frames (70mm high, 45mm wide, 1 pixel stroke), one of which framed either a neutral or an angry face, appeared to the left and right of the fixation cross (500ms). The face was then removed and a target (a star) appeared for 200ms at the center of one of the rectangles. On 75% of the trials targets appeared at the location of the face cue (valid trials). On the remaining 25% of the trials targets appeared on the opposite location (invalid trials). Participants had to determine the side on which the target appeared by pressing one of two buttons on a response box. A new trial began 1,800ms after target offset. Feedback on incorrect responses was provided (a beep tone).

The pictures of the 12 different actors were divided into two subsets; each consisted of pictures of 6 actors (3 female). One subset was used during the pre-training and the training phases. The other set was presented at post-training. The order of subset presentation was counterbalanced across participants within each group.

Trial composition in the pre- and post-training assessments. Before the pre-training assessment participants received 16 randomly presented practice trials comprised of 4 trials per condition (Valid/Invalid Neutral, Valid/Invalid Angry). Practice was repeated if needed. The pre- and post-training attention bias assessments were comprised of 192 trials each, presented in two blocks of 96 trials. Within each block 50% of the trials presented angry faces and 50% presented neutral faces. Of the total number of trials, 25% were invalid cues and 75% of the trials were valid cues.

Trial composition in the ABM/Control phase. Each child completed two attention training sessions according to his or her designated condition with 384 trials per session (768 trials total). Each session consisted of 8 blocks, each with 96 trials. A short break was allowed between blocks. In the ABM condition, 100% of the angry-face trials were invalid cues, while the ratio for neutral-face trials remained at 25% invalid and 75% valid. This distribution provided a specific training bias to disengage attention from angry faces. In the control group the valid–invalid ratio remained identical to that of the pre-training assessment (25% invalid and 75% valid, for both neutral and angry faces).

Stress-induction task

Modeled after Eldar et al. (2008), the purpose of this task was to elicit a negative mood state in order to assess stress vulnerability. Children were informed that they would be videotaped while attempting to complete three difficult puzzles (Rush Hour Traffic Jam Puzzles). One puzzle was solved with the child as an example, then the video camera was turned on and the child was provided with 3 minutes to complete the remaining puzzles. None of the children succeeded in solving all three puzzles within the allocated time.

General procedure

The protocol was approved by the institutional ethics committee. Informed consents were obtained from parents and children. The study consisted of four one-hour sessions conducted on four separate days scheduled over a period of 14 days (Figure 2). In the first session (S1), children were administered the emotional spatial cuing task, the STAIC, and CDI to assess baseline threat-related attention bias, trait anxiety, and trait depression, respectively. In the second session (S2), participants in the ABM group completed a set of training trials to disengage attention from threat, whereas children in the Control group completed the placebo protocol not intended to modulate attention patterns. Procedures for the third session (S3) were identical to those employed in S2, providing additional training/placebo trials. In the fourth and final session (S4), all participants completed the STAIC and CDI again. Then, before and after participation in the stressor task children completed the depression and anxiety analog mood scales. Finally, threat-related attention bias was measured using the same emotional spatial cuing task as in S1, but using a different set of face stimuli. The time interval between S1 and S2 was
2–4 days (Mean = 2.7), the time interval between S2 and S3 was restricted to 4–6 days (Mean = 4.8), and the time interval between S3 and S4 was 5–8 days (Mean = 6.4).

Data analyses

To assess the effects of ABM on task performance two repeated-measures analyses of variance (ANOVAs) on response times (RTs) were computed, one for invalid trials and one for valid trials. For both analyses, Group (ABM, control) served as a between-subjects variable, whereas Time (pre-training, post-training) and Face Emotion (angry, neutral) served as within-subject measures. Significant interaction effects were followed by post-hoc contrasts.

To elucidate the effects of attention training on participant’s learning curves, two block-by-block repeated-measures ANOVAs, one for the first day of training and one for the second day of training, were computed on RT data on invalid angry trials (the targeted ABM trial type). Group (ABM, control) served as a between-subjects variable, and Time (blocks 1–8) served as a within-subject variable. Follow-up contrasts were used to clarify within- and between-group differences on specific training blocks.

To assess the effects of ABM on trait anxiety and depression two ANOVAs were computed on STAIC scores and CDI scores, respectively. In both ANOVAs Group (ABM, control) served as a between-subjects variable and Time (pre-training, post-training) served as a within-subject variable. To assess the effects of ABM on stress vulnerability, two additional ANOVAs were computed on the analog mood scales scores for anxiety and depression. Group (ABM, control) served as a between-subjects variable and Time (pre-stressor, post-stressor) served as a within-subject variable.

Finally, Pearson correlations were used to explore the impact of attention disengagement training on vulnerability to stress. Change in RTs on invalid angry trials throughout training was correlated with change in anxiety scores in response to the stressor task (anxiety analog scale post-stressor minus anxiety analog scale pre-stressor).

Results

Performance on the emotional spatial cueing task

Incorrect responses, responses faster than 150ms, and responses ±2 standard deviations (SDs) from a participant’s mean in a specific trial type were excluded. Mean accuracy across the full sample was 94.17% and 96.91%, SDs = 6.03 and 2.53, for the pre- and post-training assessments, respectively. The two groups did not differ in accuracy levels across the different trial types, all ps > .30. Mean RTs and SDs for invalid and valid cue trials by Group, Time, and Emotion are presented in Table 2.

Analyses of invalid cue trials. Faster RTs were recorded on invalid trials post-training (416ms) relative to pre-training baseline (465ms), F(1, 32) = 7.57, p < .01. This main effect was subsumed under a Time by Group by Emotion three-way interaction effect, F(1, 32) = 4.93, p < .05. This interaction indicated that participants in the ABM group displayed a larger decrease in RT (72ms) compared to controls (18ms) in response to the targeted training trials (i.e., invalid angry), t(32) = 2.58, p < .05 (Figure 3). This difference was smaller and nonsignificant when considering RTs to invalid neutral trials (64ms vs. 42ms for the ABM and Control groups, respectively), p > .10. No other main or interaction effects reached statistical significance.

Learning curves associated with the targeted training trials (invalid angry) by group are depicted in Figure 4. Analysis of the first training session revealed a main effect of Time, F(7, 224) = 6.44, p < .001, and a nonsignificant, but very clear, trend of Time by Group interaction effect, F(7, 224) = 1.97, p = .06. Further analyses within each group revealed a steep learning curve of attention disengagement from the angry faces in the ABM group, F(7, 119) = 5.99, p < .0001, and only a trend level effect in the Control group, F(7, 105) = 2.26, p = .075. Of
note is the fact that the two groups significantly differed in RT to invalid angry trials only on the last of the eight blocks delivered in this session, $t(32) = 2.33, p < .05$. Importantly, this learning was retained for the next training session (4–6 days later), in which the ABM group was faster to disengage from the angry faces than the Control group throughout the blocks, $F(7, 217) = 3.64, p < .01$. No other main or interaction effects were found.

Analyses of valid cue trials. We observed faster RTs on valid trials post-training (393ms) relative to pre-training baseline (446ms), $F(1, 32) = 9.84, p < .005$. In addition, a Time by Emotion interaction effect was found, $F(1, 32) = 6.97, p < .05$. During pre-training participants were faster to respond to neutral faces relative to angry faces, and this pattern reversed at post-training. More importantly, no other main or interaction effects were significant, indicating that the attention manipulation on the invalid angry trials did not affect performance on valid trials.

Effects of ABM on anxiety and depression

Trait anxiety and depression pre- and post-training. Relative to baseline (M = 34.16, SD = 7.96), trait anxiety (STAIC) was reduced following attention training (M = 31.13, SD = 8.57) regardless of training regimen, $F(1, 32) = 5.34, p < .05$. No changes were noted in depression (CDI).

Vulnerability to stress. Relative to the pre-stressor anxiety measurement (M = 5.02, SD = 5.47), greater state anxiety was recorded on the anxiety analog scale following stress induction (M = 7.29, SD = 6.96), $F(1, 32) = 10.22, p < .005$. This main effect was subsumed under a significant Time by Group interaction effect, $F(1, 32) = 4.92, p < .05$. Children in the placebo group reported a significant increase in anxiety from pre- to post-stressor measurement, $t(15) = 3.39, p < .005$, whereas no change was detected in the ABM group, $p > .40$ (Figure 5).

The analysis concerning the depression analog scale revealed greater depression across all participants following stress induction (M = 9.21, SD = 8.77) relative to the pre-stressor measurement (M = 5.32, SD = 5.48), $F(1, 32) = 12.18, p < .001$. No other main or interaction effects were found.

Change in attention disengagement and change in stress response. To further explore the impact of attention disengagement training on vulnerability to stress, changes in RTs on invalid angry trials (block 1 of training minus block 16 of training) were correlated with changes in state anxiety in response to the stressor task (score on the anxiety analog scale post-stressor minus score on the anxiety analog

### Table 2

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<tr>
<th></th>
<th>ABM</th>
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<tbody>
<tr>
<td></td>
<td>Angry Mean</td>
<td>Neutral Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-training</td>
<td>477 123</td>
<td>441 114</td>
</tr>
<tr>
<td>Post-training</td>
<td>392 79</td>
<td>390 85</td>
</tr>
<tr>
<td></td>
<td>Angry Mean</td>
<td>Neutral Mean</td>
</tr>
<tr>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Pre-training</td>
<td>464 126</td>
<td>461 125</td>
</tr>
<tr>
<td>Post-training</td>
<td>392 84</td>
<td>397 88</td>
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</tbody>
</table>

Figure 3 Response times and standard error bars on invalid angry and invalid neutral cue trials pre- and post-attention training by group. *** $p < .001$
scale pre-stressor). Steeper learning curves within the ABM group were associated with lower anxiety response to the stressor task, $r(18) = .62, p = .006$. This association was nonsignificant in the control group, $r(18) = .10, p = .72$. Fisher’s r-to-Z comparison indicated that despite the numeric difference between the two correlations, and a significant relation only in the ABM group, the difference between groups was only at a trend level of significance, $p = .099$, two-tailed.

Discussion

The results of the current study suggest that the ABM protocol facilitated attention disengagement from threat, and reduced vulnerability to stress in highly anxious 10-year-olds. These findings are consistent with previous work on the use of ABM procedures to modify emotional vulnerabilities to stressors in adults (Hakamata et al., 2010; MacLeod et al., 2009), and support the utility of computerized attention modification procedures in treating anxious children (Bar-Haim, 2010). The present findings are also in accord with two dot-probe ABM studies that provided indirect behavioral (Koster, Baert, Bockstaele, & De Raedt, 2010) and neurological (Eldar & Bar-Haim, 2010) indications that attention training protocols using that task modulate late (e.g., disengagement) rather than early (e.g., engagement) components of attention.

ABM is particularly relevant for pediatric anxiety since barriers to treatment are higher in children than in adults. Although there are a number of evidence-based psychological and pharmacological treatments for pediatric anxiety disorders (Barrett, Duffy, Dadds, & Rapee, 2001; Birmaher, et al., 2003; Kendall, 1998; Walkup et al., 2008; Walkup et al., 2001), many children with anxiety do not receive these treatments due to economic and geographic constraints, concerns about stereotyping, concerns about potential side-effects, or a lack of motivation on the part of the child or the parents. Moreover, many children who present for treatment respond poorly, do not respond at all, or drop out of treatment (Kendall & Sugarman, 1997). Computer-based training of attention may be more acceptable for children than traditional in-person therapy formats, allowing for the delivery of a systematic and sustained intervention (Pine et al., 2009). Furthermore, ABM may be delivered over the internet (MacLeod, Soong, Rutherford, & Campbell, 2007) thus facilitating accessibility and reducing therapy costs. Unfortunately, except for Eldar et al. (2008), who applied an ABM protocol with nonanxious children, and the present report concerning highly anxious children, no other pediatric ABM data has been published.

The present study shows that it is feasible to specifically target the disengage component of attention for ABM treatment. Such specificity may prove important for the development of future custom-made ABM protocols, in which the specific attentional bias displayed by the patient is detected and subsequently targeted through training.
two training sessions, each consisting of 384 trials, produced a significant training effect such that anxious children were better able to disengage their attention from threat faces. Three important observations arise from these data: First, the training gains reached an asymptote and differed from the control condition towards the end of the first training session, suggesting that approximately 200 critical training trials are needed to produce a valid ABM effect. Second, training gains were retained for approximately five days, indicating that at the very least the effect achieved by the present ABM treatment could last between standard once-weekly therapy sessions. Future studies should determine whether additional gains could be achieved with additional training, and whether such potential gains contribute toward further reduction in anxiety symptoms and stress vulnerability. Finally, the present data indicate that the training effects achieved with one set of threat stimuli generalize to facilitated disengagement from a separate set of threat stimuli not used during the training phase. This finding provides cautious optimism concerning the potential transfer of the attentional change achieved with this protocol to other contexts. Of note is the fact that although the present ABM protocol was specifically designed to train disengagement from threat faces, it also produced a remarkable albeit nonsignificant facilitation in disengagement from neutral faces. This trend suggests that more general learning processes may be associated with the applied ABM protocol. Elucidation of such processes requires further research.

Both the ABM and the control protocols produced significant reductions in self-reported trait anxiety from pre-to-post training and had no effect on depression. These findings seem to contrast with ABM findings in clinically diagnosed treatment-seeking adults, for which anxiety symptoms reduction was reported as a function of ABM (e.g., Amir, Beard, Burns, et al., 2009; Amir, Beard, Taylor, et al., 2009). The present results may reflect nonspecific treatment effects such as care attention or therapeutic gains due to repeated exposure to the threat faces (i.e., systematic desensitization). Alternatively, specific modification of the disengage component of attention might not achieve as strong an effect as ABM protocols using the less specific dot-probe task.

In contrast to the lack of specificity in pre-to-post ABM impact on anxiety symptoms, the findings concerning changes in stress vulnerability show both specificity and selectivity, and are consistent with previous results in non-clinical samples (Eldar et al., 2008; MacLeod et al., 2002; Mathews & MacLeod, 2002). Relative to children in the control condition, children trained to disengage attention from threats were less vulnerable to the stress induced by the stressor task. This finding suggests that ABM may produce anxiolytic effects that proceed beyond treatment culmination and impact core processing of threat during stressful events. Because attention may act as an initial filter on the processing of environmental cues (Corbetta & Shulman, 2002; Duncan, 1984; Kastner & Ungerleider, 2000; Posner & Petersen, 1990; Rensink, Oregan, & Clark, 1997), facilitated disengagement from threats may alter threat perception during early stages of appraisal, thereby moderating the cascade of maladaptive cognitions and emotions typical of highly anxious individuals (Amir, Beard, Taylor, et al., 2009; Derakshan & Eysenck, 2009; Eysenck, Derakshan, Santos, & Calvo, 2007; Gross, 1998, 2002).

Both groups showed increased depression following the stressor task attesting to the efficacy of this task as a means of elevating negative mood state. The divergent results for anxiety and depression in the present study are in accord with Eldar et al.’s (2008) findings in nonanxious children, and stand in contrast to the findings of MacLeod et al. (2002), who reported elevated depression and anxiety following a stressor task in adults. The anxiety-related specificity found here may be related to the fact that comorbidity between anxiety and depression appears to intensify with age (Brady & Kendall, 1992; Pine, Cohen, Gurley, Brook, & Ma, 1998).

Additional neurocognitive research is needed to more fully answer what are the attentional mechanisms underlying reduction in stress vulnerability following ABM. However, in the context of previous research showing that threat-related attention biases are causally related to stress vulnerability (Amir, Weber, Beard, Bomyea, & Taylor, 2008; Eldar et al., 2008; MacLeod et al., 2002), a procedure that normalizes such biases should also be expected to reduce stress vulnerability (Amir, Beard, Taylor, et al., 2009).

The results of the present study should be viewed in light of some limitations. First, although participants in the current study had symptom severity scores in the range previously reported for clinical pediatric samples (Birmaher et al., 1999, 1997), and this symptom level was sustained over a 3-year period, formal clinical diagnosis was not available. In light of this limitation the present sample should be considered analogous and caution should be exercised in generalizing its results to clinical populations. Additional randomized controlled trials with formally diagnosed anxious children are needed to ascertain applicability of the present ABM protocol in clinical settings. Second, sample size was small and therefore limited in power to conduct full mediational analysis on the associations between bias modification and change in stress vulnerability. Third, although state anxiety scores in the two groups were equivalent prior to stress induction, stress vulnerability was not measured at baseline. This leaves open the possibility that differences in vulnerability existed prior to intervention. As such, the findings suggesting that ABM inoculates children against stress, relative to controls, should be considered with caution.
Conclusion
The current study provides support for the hypothesis that modifying attention disengagement from threats reduces stress vulnerability. This result indicates that it may be possible to utilize attention disengagement training to treat anxious children. In doing so we may be able to identify the specific contribution of attention mechanisms to the development of pediatric anxiety. The current findings are promising considering the short duration of the intervention and the potential it has for dissemination over the internet or in the clinic with little supervision from highly trained professionals. Future studies could determine whether other components of attention, such as attention orienting and engagement, could be effectively trained and used to induce increased resilience to stress.

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Key points
• Recent studies have shown that threat biases can be modified via computer-based attention bias modification (ABM) protocols.
• Randomized control trials in adult patients have shown that ABM significantly reduces anxiety symptoms.
• The current study shows that systematic ABM targeting disengagement from threats reduces stress vulnerability in stably high anxious children.
• Computerized attention training procedures may be beneficial for reducing stress vulnerability in clinically anxious children.

References
Fo, E., Russo, R., Bowles, R., & Dutton, K. (2001). Do threatening stimuli draw or hold visual attention in subclin-
Rensink, R.A., Oregan, J.K., & Clark, J.J. (1997). To see or not to see: The need for attention to perceive changes in scenes. Psychological Science, 8, 368–373.

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