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A Randomized Controlled Trial of Attention Bias Modification Treatment in Youth With Treatment-Resistant Anxiety Disorders

Jeremy W. Pettit, PhD, Michele Bechor, PhD, Yasmin Rey, PhD, Michael W. Vasey, PhD, Rany Abend, PhD, Daniel S. Pine, MD, Yair Bar-Haim, PhD, James Jaccard, PhD, Wendy K. Silverman, PhD

Objective: Randomized clinical trials of augmentation strategies for youth with treatment-resistant anxiety disorders do not exist. This report presents findings from an efficacy trial of attention bias modification treatment (ABMT) as an augment for this population compared with attention control training (ACT).

Method: Sixty-four youths (34 boys; mean age 11.7 years) who continued to meet for anxiety diagnoses after completing cognitive-behavioral therapy were randomized to ABMT or ACT. ABMT and ACT consisted of dot-probe attention training trials presenting angry and neutral faces; probes appeared in the location of neutral faces on 100% of trials in ABMT and 50% of trials in ACT. Independent evaluators, youths, and parents completed ratings of youth anxiety severity, and youths completed measures of attention bias to threat and attention control at pretreatment, post-treatment, and 2-month follow-up.

Results: The 2 arms showed significant decreases in anxiety severity, with no differences between arms. Specifically, across informants, anxiety severity was significantly decreased at post-treatment and decreases were maintained at follow-up. Primary anxiety disorder diagnostic recovery combined across arms was 50% at post-treatment and 58% at follow-up. Attention control, but not attention bias to threat, was significantly improved at post-treatment in the 2 arms.

Conclusion: This is the first study to show anxiety can be decreased in youth who did not respond to cognitive-behaviorial therapy, and that the anxiety-decreasing effect is found using these 2 attention training contingency schedules. These findings and increases in attention control in the 2 arms raise intriguing questions about mechanisms of decreasing anxiety in treatment-resistant youth with attention training that require further research.

Clinical trial registration information: Attention Bias Modification Training for Child Anxiety CBT Nonresponders; https://clinicaltrials.gov/; NCT01819311.

Key words: anxiety, children, treatment, attention bias modification

J Am Acad Child Adolesc Psychiatry 2020;59(1):157–165.

Cognitive-behavioral therapy (CBT) is the strongest evidence-based psychosocial treatment for anxiety disorders in children and adolescents (hereafter referred to as youth).[1] Nevertheless, up to 50% of youth with anxiety disorders do not respond to CBT.[1,2] No randomized controlled efficacy trials of treatment augmentation strategies for treatment-resistant anxious youth exist. There is critical need to have alternative treatments available for this population because anxiety is associated with significant distress and impairment in functioning and poses substantial burden on the health care system.[3]

This article reports the first randomized controlled efficacy trial that tests an augmentation strategy for youths who continued to meet for a *DSM-IV*[4] anxiety disorder, despite having completed 12 to 14 sessions of CBT. The augmentation strategy we tested was attention bias modification treatment (ABMT), given its promise for youths who do not respond to CBT. Relevant background to note is that attentional processes in individuals with anxiety disorders, including youth, are characterized by perturbations in rapidly deployed attention allocation to threat.[5,6] Further, perturbations in attention allocation to threat predict youths' poor response to CBT.[7] Therefore, in ABMT, attention perturbations are targeted directly when patients complete hundreds of computer-based training trials of a dot-probe task. In each trial, a pair of threatening

and neutral stimuli is presented simultaneously, followed immediately by a probe. The probe appears 100% of the time in the location of the neutral stimulus, establishing a contingency between neutral stimulus and probe location, facilitating decreases in attention allocation to threat. Meta-analyses have shown a significant small to medium effect of ABMT for anxiety disorders over various controls.[8-10]

Therefore, ABMT is a promising augment to CBT especially because each approach has a distinct emphasis. CBT's emphasis is on top-down strategies for decreasing anxiety in its use of explicit instruction and practice in effortful strategies such as cognitive restructuring and exposure to feared stimuli. ABMT's emphasis is on bottom-up strategies for decreasing anxiety in its use of implicit training of early automatic attention allocation.[11-13] Accordingly, ABMT's constrained and intensive training to decrease attention to threat leads to diminished engagement of neural circuity and downstream cognitive-affective processes that subserve anxiety, resulting in decreased anxiety.[13] Targeting bottom-up processes could be of particular importance in youth for whom top-down strategies were previously unsuccessful.

In the commonly used comparison arm, attention control training (ACT), youth complete the same dot-probe task as in ABMT, with the important exception that the probe appears with equal frequency in the locations of the neutral stimulus and threatening stimulus. By having no contingency between stimulus valence and probe location, ACT was designed to control for nonspecific effects on attention focusing, sustaining, and shifting. These features of ACT allow for disentangling and testing the training of attention away from threat as a mechanism of ABMT's anxiety-decreasing effects.

Randomized controlled trial data support ABMT's efficacy in lessening anxiety in clinically anxious samples of youths.[8,14] However, data from only 1 very small open trial with treatment-resistant anxiety disorders exist.[15] Specifically, in 6 youths who completed CBT and still met for anxiety disorder diagnoses, ABMT decreased youth anxiety severity in youth and parent ratings.[15] We built on these preliminary data in the present study by conducting a randomized controlled trial of ABMT and ACT in a larger treatment-resistant sample. Based on the training contingencies in ABMT, we hypothesized that ABMT compared with ACT would result in significantly lower levels of attention bias to threat and anxiety severity as rated by independent evaluators (IEs), youths, and parents at post-treatment (POST) and a follow-up evaluation 2 months after treatment (FOLLOW-UP). That is, we expected between-group contrasts to be statistically significant at POST and FOLLOW-UP, indicating lower attention bias to threat and anxiety severity in ABMT compared with ACT.

Although ACT was designed initially as a comparator control arm, data have recently emerged suggesting attention control improvement with this comparator is a possible mechanism of decreasing anxiety. ABMT and ACT have been shown to produce increases in attention control and decreases in anxiety, suggesting repeated practice on attention training protocols lessens anxiety.[16,17] This is because attention control improvements relate to the ability for individuals to focus, sustain, and flexibly deploy attention to modulate anxious thoughts and feelings.[12,16,18] ABMT and ACT require participants to focus, sustain, and shift their attention over hundreds of trials, leading to increases in attention control. Based on these recent data, we hypothesized that levels of attention control would be significantly higher and levels of anxiety severity would be significantly lower at POST and FOLLOW-UP compared with pre-treatment (PRE) in ABMT and ACT. That is, we expected the within-group effect of time to be statistically significant, indicating higher attention control and lower anxiety severity at POST and FOLLOW-UP compared with PRE, in ABMT and ACT.

We also explored attention control as a moderator of ABMT's anxiety-decreasing effects. Two clinical trials of ABMT in youths with anxiety disorders found attention control moderated anxiety-decreasing effects, although the direction of the moderation differed between studies.[19,20] This could be because youths with lower regulatory ability benefit more from an intervention that targets bottom-up attention bias to threat than youths with higher attention control.[19] Alternatively, youths with higher regulatory ability might assimilate the attention training more than youths with lower attention control.[20] Given these contradictory findings, we took an exploratory approach to analysis of attention control as a moderator.

METHOD

Participants

We recruited participants from youths 7 to 16 years old (mean age 11.7 years, SD 2.43; 53.1% boys; 85.9% Hispanic) who previously completed CBT for anxiety disorders in a separate clinical trial (ClinicalTrials.gov identifier NCT01819311) or general clinic services and continued to meet criteria for a primary *DSM-IV* anxiety disorder diagnosis at the conclusion of CBT and 1-year follow-up evaluation.[4] The criterion of a diagnosis at 1-year follow-up ensured all participants were nonresponders and not delayed responders. The most common primary diagnoses at PRE of the present study were social anxiety disorder (39.1%), generalized anxiety disorder (31.3%), specific

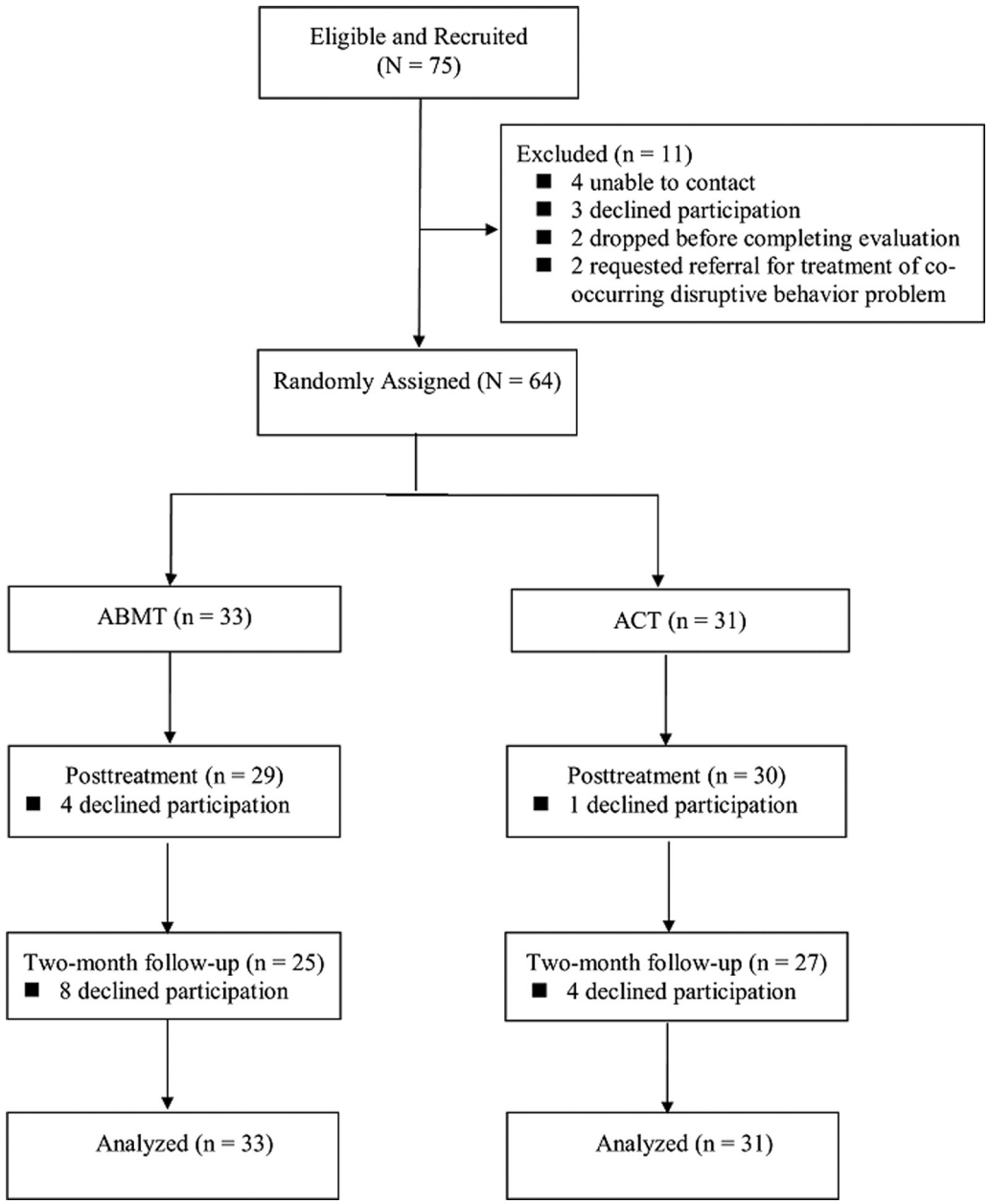
phobia (14.1%), and separation anxiety disorder (9.4%). Exclusion criteria were developmental disabilities, psychosis, or current involvement in another psychosocial treatment. See Procedure for a brief description of the manual-based CBT and CBT outcomes.

As shown in Figure 1, 75 youths were eligible and recruited for this study. Of these 75 youths, 64 (85.3%) and their parents agreed to participate, provided informed parental consent and youth assent, and enrolled in the study. Of these 64 youths, 56 (87.5%) completed CBT in the clinical trial and 8 (12.5%) in general clinic services. There were no statistically significant differences on sociodemographic or clinical variables between the 2 subsamples.

Materials and Task

We administered the Anxiety Disorder Interview Schedule for Children–IV: Child and Parent Versions (ADIS-IV-C/P)[21] to youths and parents, respectively, to determine diagnoses. The disorder most interfering/impairing was primary. The ADIS-IV-C/P yields retest reliability κ values of

FIGURE 1 CONSORT Diagram



Note: *ABMT = attention bias modification treatment; ACT = attention control training.*

0.80 to 0.92 for diagnoses, interrater reliability κ values of 0.57 to 0.86 for specific anxiety diagnoses, and significant associations with youth anxiety ratings.[22-24] In this study, we collected interrater reliability on diagnoses in 25% of participants; κ coefficients were 1.0 for social anxiety disorder, 1.0 for generalized anxiety disorder, 0.63 for specific phobia, and 0.86 for separation anxiety disorder.

Outcomes. We measured primary outcome using IE ratings of youth anxiety symptom severity on the 6-item version of the Pediatric Anxiety Rating Scale (PARS).[25] IEs administered and scored the PARS in accordance with instructions provided by the PARS developers.[25] Specifically, using information obtained in separate interviews with youths and parents, an IE masked to participants' assigned study arm scored each of 50 anxiety symptoms as present or absent during the past week. Then, IEs rated endorsed symptoms on 6 dimensions of global severity and impairment. The PARS has adequate internal consistency (α coefficients.64–.91) and interrater reliability (intraclass correlation0.78–0.97), sensitivity to change in treatment studies, and convergent validity through significant correlations with youth self-ratings and parent ratings on youth anxiety scales.[25,26] In this sample, the α coefficient for the 6-item PARS was .77.

We measured secondary outcomes using youth self-ratings and parent ratings of youth anxiety symptom severity on the Screen for Child Anxiety Related Emotional Disorders–Child and Parent Versions (SCARED-C/P).[27] The SCARED-C/P consists of 41 items on which youth or parents rate youth anxiety symptoms. The SCARED-C/P has adequate test-retest reliability (range 0.70–0.90) and convergent and divergent validity through expected patterns of correlations with other screening scales.[27] In this sample, the α coefficient was .93 for the SCARED-C and .92 for the SCARED-P.

Attention Control. We measured youth attention control using the Attentional Control Scale for Children (ACS-C).[28] The ACS-C consists of 20 items on which youth rate their ability to maintain attention on a stimulus and shift attention from one stimulus to another. The ACS-C has demonstrated good psychometric properties and convergent validity compared with performance on tests of selective attention, attentional switching, and sustained attention[29] and higher levels of anxiety severity.[30] In this sample, the α coefficient was .70.

Dot-Probe Task. We used the emotional faces dot-probe task from the Tel Aviv University and National Institute of Mental Health ABMT Initiative (http://people.socsci.tau.ac.il/mu/anxietytrauma/research/) to measure attention bias toward threatening stimuli.[31] Facial stimuli were photographs of 10 Caucasian actors (5 men, 5 women), with 2 photographs of each actor (1 neutral, 1 angry). In each trial, a white fixation cross appeared for 500 ms in the center of the screen, followed by a pair of faces (chromatic) appearing for 500 ms. The pair of faces of the same actor showing a neutral or angry (ie, threatening) expression appeared on the top and bottom of the screen. In each trial, the pair of faces displayed was 1 of 2 combinations (80 angry-neutral or 40 neutral-neutral) for a total of 120 trials. Immediately after the faces, a probe (< or >) appeared in the location of the top or bottom face. Participants were instructed to indicate the orientation of the probe by clicking the left or right mouse button (left for <, right for >) using their dominant hand. The probe remained on screen until the participant responded, response was followed by an intertrial interval (500 ms), and then the next trial began immediately. Angry face location, probe location, probe type, and actor were fully counterbalanced in presentation.

Responses on the dot-probe task were used to calculate attention bias scores. Trials in which the probe replaced the angry face were considered congruent trials, and trials in which the probe replaced the neutral face were considered incongruent trials. Bias scores were computed as reaction time differences of incongruent minus congruent trials. Positive attention bias scores indicate a bias toward angry faces (ie, threat) and negative values indicate a bias away from threat. Inaccurate responses, trials with response latencies shorter than 150 ms and longer than 1,200 ms, and trials with response latencies plus or minus 2.5 SDs from the participant's mean were excluded.[32]

Procedure

Previous CBT. All participants in the present trial previously received manual-based CBT. CBT in the clinical trial and general clinic services was administered in a youth anxiety disorders specialty research university clinic by the same trained therapists, supervised by the first and/or last author; for details on CBT administration, see Pettit *et al.*[33] Participants met criteria for a primary *DSM-IV* anxiety disorder diagnosis 1 year after their CBT participation.[4] Pediatricians, school psychologists, and other professionals were major referral sources for the CBT for these youths.

The manual-based CBT involved 12 to 14 weekly sessions of 60 minutes in duration.[33] CBT targeted youth anxious symptoms, with initial sessions focused on psychoeducation, and with emphasis placed on graded exposures to feared or anxiety-provoking stimuli and cognitive restructuring. CBT sessions were video recorded and carefully supervised by the first or last author. IEs, not involved in the study, rated a randomly selected 30 videotaped sessions from the clinical trial on a checklist derived from past studies that assessed the presence of the ingredients that

were expected to be delivered in accordance with the manual.[23] Adherence to the manual was rated as 96.6%.

At the conclusion of the youths receiving CBT and again at 1-year follow-up evaluation, 32% of youths continued to meet criteria for a primary *DSM-IV* anxiety disorder diagnosis (ie, 68% were recovered).[4] The effect size for decreases in youth anxiety symptom severity after the conclusion of CBT was 0.78 (by Cohen *d*) for youth self-ratings and 0.92 (Cohen *d*) for parent ratings. There were no significant differences between the clinical trial and general clinic services. This diagnostic recovery rate and magnitude of anxiety symptom severity decrease are comparable to previous clinical trials of CBT for youth with anxiety disorders, attesting to the proper implementation of CBT.[2,23,34,35]

Present Study. The present study received human ethics approval from the university's institutional review board (ClinicalTrials.gov identifier NCT01819311). The study was conducted at the Florida International University in Miami from April 2013 to June 2017. As noted, we recruited for this study all youths 7 to 16 years old who continued to meet criteria for a primary *DSM-IV* anxiety disorder diagnosis at the conclusion of CBT and 1-year follow-up evaluation.[4] All measures were completed at PRE, POST, and FOLLOW-UP 2 months after POST. After PRE, participants were randomized in equal proportion to ABMT or ACT. Participants and researchers were masked to study arm assignment. Before conducting interviews, IEs received extensive training in administration and scoring protocol and met 100% reliability criteria on 5 videotaped child–parent assessments. Doctoral-level psychology graduate students administered ABMT and ACT sessions.

Attention Bias Modification Treatment. Consistent with past ABMT studies, youths completed 2 weekly sessions of ABMT over 4 weeks, for a total of 8 sessions.[15,19,36] At each session, participants completed 160 trials of the ABMT protocol. Trials of the ABMT protocol were identical to trials of the attention bias to threat assessment task except that a unique set of faces was used (ie, different from those used in the assessment task) and the probe replaced the neutral face on 100% of the trials.

Attention Control Training. ACT was identical to the ABMT protocol except for the frequency with which the probe replaced the neutral face. Eighty percent of trials included 1 neutral face and 1 angry face. On these trials, angry face location, probe location, and actor were fully counterbalanced. Probe type appeared with equal probability for angry face location, probe location, and actor. The other 20% of trials included neutral-neutral face pairs.

Statistical Analysis

To examine the influence of treatment on anxiety variables and attention variables, we used 2-way analyses of covariance in a structural equation modeling framework.[37] In each model, participant age, CBT arm (clinical trial or general clinic services), and PRE score on the outcome variable were included as covariates. Likelihood ratio tests were used to examine differences between PRE and POST mean scores and POST and FOLLOW-UP mean scores for anxiety and attention variables (collapsing across treatment arms). To examine the associations between changes in anxiety variables and changes in attention variables, we used fixed-effects regression analyses for panel data at PRE, POST, and FOLLOW-UP.[38] This approach regressed anxiety variables onto attention variables on a within-person basis, documenting how much anxiety changed given a 1-unit change in attention variables. Non-model and model-based outlier analyses were undertaken. Two outliers were found. Analyses were conducted with and without the outliers and conclusions did not change. We present results for analyses conducted with the outliers to better represent the population of interest. We used a maximum likelihood estimator with robust standard errors as implemented in the MPlus 6.12 statistical software program (https://www.statmodel.com/version6.12.shtml). To examine missing data bias, a dummy variable was created that indicated the presence or absence of missing data on each variable in the analyses. Associations between the dummy variables and other study variables were examined. No meaningful bias was observed. Missing data were accommodated using full information maximum likelihood.[39] Modified linear probability models were used to examine probability differences between treatment arms on diagnostic recovery rates at POST and FOLLOW-UP.[40,41] Across all analyses, significant effects were detected at an α value no higher than .05. All tests were 2-sided.

RESULTS

There were no meaningful differences at PRE between participants in ABMT and participants in ACT on any study variables, including sociodemographic variables, primary diagnosis, and scores on any of the anxiety or attention variables (Tables 1 and 2). Of the 64 youths who were randomized, 61 completed the assigned treatment arm (60 [93.8%] completed all 8 sessions, 1 [1.6%] completed 7 sessions), 59 (92.2%) completed POST, and 52 (81.3%) completed FOLLOW-UP. Attrition did not significantly differ across study arms at POST or FOLLOW-UP. There were no statistically significant differences between study completers and non-completers at PRE on any study variables. Outcome analyses included study completers and

TABLE 1 Participant Sociodemographic and Diagnostic Characteristics at Pretreatment

	ABMT (n = 33)	ACT (n = 31)
Age, mean (SD)	12.18 (2.69)	11.26 (2.16)
Female gender, n (%)	18 (54.5)	12 (38.7)
Hispanic ethnicity, n (%)	28 (84.8)	27 (87.1)
Annual family income, n (%)		
0–20,999	7 (21.2)	6 (19.4)
21,000–60,999	8 (24.2)	11 (35.5)
61,000–99,999	9 (27.3)	5 (16.3)
>100,000	6 (18.2)	7 (22.6)
Not reported	3 (9.1)	2 (6.5)
Primary diagnosis, n (%)		
Social anxiety disorder	13 (39.4)	12 (38.7)
Generalized anxiety disorder	11 (33.3)	9 (29.0)
Specific phobia	6 (18.2)	3 (9.7)
Separation anxiety disorder	2 (6.1)	4 (12.9)
Other	1 (3.0)	3 (9.7)

Note: ABMT = attention bias modification treatment; ACT = attention control training.

TABLE 2 Means (SDs) for Anxiety Symptoms and Attention Variables at Pretreatment, Posttreatment, and 2-Month Follow-up

Measure	ABMT (n = 33)	ACT (n = 31)
PARS		
Pre	14.55 (3.57)	13.12 (3.83)
Post	8.92 (5.51)	8.23 (4.99)
Follow-up	9.38 (6.04)	5.77 (4.44)
SCARED-C		
Pre	23.03 (12.61)	22.87 (15.39)
Post	14.15 (12.55)	12.83 (13.37)
Follow-up	17.40 (15.51)	13.78 (12.93)
SCARED-P		
Pre	27.74 (14.34)	26.24 (12.26)
Post	22.22 (13.98)	18.05 (12.28)
Follow-up	21.47 (13.48)	17.13 (12.58)
Attention bias to threat		
Pre	3.21 (34.61)	1.65 (42.81)
Post	−2.80 (63.66)	14.61 (58.35)
Follow-up	15.17 (36.78)	12.08 (36.23)
ACS-C		
Pre	52.05 (7.46)	50.58 (7.25)
Post	55.65 (9.31)	53.80 (10.48)
Follow-up	54.71 (9.46)	53.41 (9.32)

Note: Means (SDs) of attention bias to threat are presented in milliseconds. ABMT = attention bias modification treatment; ACS-C = Attentional Control Scale for Children; ACT = attention control training; PARS = Pediatric Anxiety Rating Scale; SCARED-C = Screen for Child Anxiety and Related Disorders–Child Version; SCARED-P = Screen for Child Anxiety and Related Disorders–Parent Version.

non-completers. We determined maintenance of masked assignment to study arm by asking youths and their parents at FOLLOW-UP to indicate to which study arm the youth was assigned (ABMT or ACT). Youths' and parents' ability to identify study arm assignment did not exceed chance.

Outcomes Analyses

Means and SDs on anxiety variables and attention variables for each study arm are presented in Table 2. Collapsing across study arms, mean total scores were significantly lower at POST than at PRE for the PARS ($z = 6.10$, $p < .001$; Cohen $d = 1.21$), SCARED-C ($z = 5.24$, $p < .001$; Cohen $d = 0.88$), and SCARED-P ($z = 3.96$, $p < .001$; Cohen $d = 0.67$). Mean scores at POST were not significantly different from mean scores at FOLLOW-UP for the PARS or SCARED-C. For the SCARED-P, mean total scores were significantly lower at FOLLOW-UP than at POST ($z = 2.34$, $p = .02$; Cohen $d = 0.34$). There were no significant differences between study arms at POST or FOLLOW-UP for the PARS ($z = -0.08$, $p = .94$; $z = 0.92$, $p = .36$), SCARED-C ($z = 1.23$, $p = .22$; $z = 1.62$, $p = .10$), or SCARED-P ($z = 1.76$, $p = .08$; $z = -0.04$, $p = .97$).

At POST, the primary anxiety disorder diagnostic recovery rate was 39% in ABMT and 60% in ACT. At FOLLOW-UP, the primary anxiety disorder diagnostic recovery rate was 50% in ABMT and 65% in ACT. No significant differences in diagnostic recovery rates were found between arms at POST ($z = 1.50$, $p = .14$) or FOLLOW-UP ($z = 1.01$, $p = .31$). Across arms, the primary anxiety disorder diagnostic recovery rate was 50% at POST and 58% at FOLLOW-UP.

Attention Bias and Attention Control Analyses

Collapsing across study arms, mean attention bias scores did not significantly differ between PRE and POST or between POST and FOLLOW-UP. There were no significant differences between study arms on mean attention bias scores at POST ($z = -1.14$, $p = .25$) or FOLLOW-UP ($z = 0.05$, $p = .96$). In fixed-effects panel regression analyses, changes in attention bias scores were not significantly associated with changes in anxiety severity. Given past data showing patterns of attention bias can change with youth age,[5] we explored the association between age and attention bias and explored age as a moderator of change in attention bias. Significant age effects were not found in these analyses.

Collapsing across study arms, mean attention control scores on the ACS-C were significantly higher at POST than at PRE ($z = 3.51$, $p < .001$; Cohen $d = 0.42$). The mean ACS-C score at POST was not significantly different

from the mean score at FOLLOW-UP. There were no significant differences between study arms on mean ACS-C scores at POST ($z = -0.41$, $p = .68$) or FOLLOW-UP ($z = 0.54$, $p = .59$). Examination of ACS-C scores at PRE as a moderator of anxiety-decreasing effects yielded no statistically significant effects. In fixed-effects panel regression analyses, changes in ACS-C scores were not significantly associated with changes in anxiety severity on the PARS or SCARED-P. The coefficient for the SCARED-C was at trend level (coefficient $= -0.23$, $z = -1.93$, $p = .05$), indicating that for every 1-unit increase in ACS-C, SCARED-C scores decreased on average by 0.23 unit.

DISCUSSION

In this sample of youths with CBT-resistant anxiety disorders, we found statistically significant anxiety decreases from PRE to POST, with medium to large effect sizes across IE ratings, youth self-ratings, and parent ratings. Further, 50% of youths no longer met criteria for their primary anxiety diagnosis at POST. These anxiety decreases and diagnostic recovery effects were maintained at 2-month FOLLOW-UP. These are the first data to demonstrate successful anxiety-decreasing effects in youths who previously did not respond to treatment.

These also are the first data to show ABMT and ACT did not differ significantly in a sample of youths with treatment-resistant anxiety disorders. That is, we found medium to large anxiety-decreasing effects and diagnostic recovery in the 2 arms. The absence of between-groups differences was unexpected because meta-analyses have shown a significant, although not large, effect of ABMT compared with ACT.[8-10] However, the presence of within-group anxiety-decreasing effects in ABMT and ACT was expected and is consistent with a recent review of 31 trials of ABMT and ACT.[42] Most trials included in the review found anxiety-decreasing effects in ABMT and ACT. This suggests a common mechanism or mechanisms might contribute to anxiety-decreasing effects in each of these attention training protocols.

Emerging evidence suggests that improvements in attention control could provide insight into a common mechanism. Consistent with other recent trials of ABMT,[16,17] youths in the 2 arms showed increases in attention control. Further, every 1-unit increase in attention control was associated with a 0.23-unit decrease in youth self-ratings on anxiety severity. These findings suggest that attention training protocols (ie, 100% to neutral in ABMT; 50% to neutral in ACT) can increase attention control and thereby lessen anxiety.[12,18] This is because repeated practice focusing, sustaining, and shifting attention during training can lead to improvements in regulatory abilities that enable youth to flexibly deploy attention to modulate their emotional experiences. In addition, repeated exposure to threatening stimuli in the context of attention training, as occurs in ABMT and ACT, could enhance anxiety-decreasing effects by increasing attention control specifically in the presence of a distracting threat.[42]

This latter possibility could be related to the slightly superior, albeit nonsignificant, effects observed in ACT compared with ABMT. Compared with ABMT, which establishes a contingency between threatening stimuli and probe location (ie, the probe always appears in the location opposite threatening stimuli), ACT might train greater flexibility in the deployment of attention by requiring participants to ignore distracting threatening stimuli that are irrelevant to efficient completion of the task.[43] More research is needed on the optimal attention training contingency schedules for enhancing attention control in youth with treatment-resistant anxiety disorders.

Participants' expectations are another possible common mechanism to consider for decreasing anxiety, especially because this is a unique sample compared with past samples in ABMT trials. There are 2 sides of the coin to consider in this regard. On one side, these youths, who went through a CBT protocol only to still be experiencing impairing anxiety at completion, might have entered the novel computer-based attention training protocols with enhanced hope and expectation, contributing to the positive outcomes observed in the 2 arms. If this side of the coin has merit, it suggests a striking example of the power of expectations (eg, that 50% of these treatment-resistant youths showed diagnostic recovery at POST; 58% showed diagnostic recovery at FOLLOW-UP). The other side of the coin is that expectancy was not a major factor because the youths' lack of response to CBT in fact might have dampened their hopes and expectations. Further research using alternative comparators to permit study of expectancy effects vis-á-vis attention control and exposure to threatening stimuli will help clarify common and unique mechanisms underlying ABMT and ACT.

Of further note, we did not find statistically significant decreases in youths' attention to threat as measured by reaction time scores on the dot-probe task. Studies have raised questions about the sensitivity of reaction time measures of attention bias to threat.[44,45] Reaction time measures are several steps removed from the allocation of attention and thus are subject to inter-participant variability in downstream processes, including strategic decision making and motor response.[45,46] Further, instability in reaction times can arise from ongoing interplay between top-down attention control processes and bottom-up attention alerting and orienting processes. Use of eye-tracking technology or neural responses to threat signals with more precise temporal resolution, such as event-related potentials, could

provide more sensitive measures of attention to threat in future studies.[46,47] Studies also have raised questions about developmental influences on attention bias to threat.[5] We did not find an association between age and attention to threat in this study or evidence that age moderated the effect of ABMT on attention to threat. Future studies that are sufficiently powered to test moderation could further explore age as a potential moderator.

In addition, in this first study of a clinical next step to allay treatment-resistant anxiety in youth, we sampled youths who showed treatment-resistant anxiety immediately after the conclusion of CBT and at 1-year follow-up. We adopted this approach to ensure our sample included "true" nonresponders, not delayed responders who might improve in the weeks and months after CBT. Going forward, it will be important to identify nonresponders earlier and initiate adjunctive treatment quickly instead of waiting until CBT has ended. We previously demonstrated an empirical approach to identifying youth anxiety nonresponders by the midpoint of treatment.[33] Further research with this and other approaches will be helpful to identify youth with treatment-resistant anxiety early and evaluate whether initiating adjunctive attention training with these youth will result in more rapid decreases in anxiety severity.

This study's findings should be interpreted in view of its strengths and limitations.

Strengths include the evaluation of treatment-resistant status a full year after CBT ended, the double-masked, randomized controlled design, the multi-informant assessment approach, and the follow-up evaluation to examine maintenance of effects 2 months after attention training ended. One limitation is the absence of a waitlist control or an alternative comparison arm. In the absence of such an arm, it is not possible to conclude that enhancements in attention control accounted for decreases in anxiety severity. A second limitation is the reliance on a rating scale to measure youth attention control. Future studies could include performance-based measures of attention control, such as the Attention Network Task[48] or the Antisaccade Task.[49] Because the sample consisted of predominantly Hispanic/Latino participants, the generalizability of findings to other populations is unknown. We know of no theoretical or empirical reason to expect attention to threat to differ across racial or ethnic groups of youth. However, racial/ethnic minority status predicted a better response to attention training in a clinic-referred sample of adults with anxiety disorders.[50] Further research is needed on the association between youth race/ethnicity and response to attention training.

Despite these limitations, these data demonstrate the promise of augmentation with attention training in youths who are treatment resistant to CBT. Indeed, 68% of these youths showed diagnostic recovery after the conclusion of CBT. Moreover, 50% of youths who continued to meet criteria for a primary anxiety disorder after CBT showed diagnostic recovery after 4 weeks of attention training. The result is an overall diagnostic recovery of 84% (ie, 68% after CBT plus 16% after attention training). This diagnostic recovery rate is higher than rates reported in previous clinical trials of CBT alone or combined with sertraline, which ranged from approximately 45% to 75%.[2,23,34,35] These are exciting, novel data that lay the groundwork for further innovative efforts to improve the outcomes of young people who suffer from anxiety disorders but are not responsive to CBT. The data also set the stage for further mechanistic research on attention training protocols, using alternative comparison arms.

Accepted March 1, 2019.

Drs. Pettit, Bechor, and Rey are with the Florida International University, Miami. Dr. Vasey is with The Ohio State University, Columbus. Drs. Abend and Pine are with the National Institute of Mental Health, Bethesda, MD. Dr. Bar-Haim is with Tel Aviv University, Israel. Dr. Jaccard is with New York University, New York, NY. Dr. Silverman is with Yale University, New Haven CT.

This study was supported by National Institute of Mental Health grant R34MH097931. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Mental Health. Work by Drs. Abend and Pine was supported by the Intramural Research Program at the National Institute of Mental Health.

Dr. Jaccard served as the statistical expert for this research.

The authors gratefully acknowledge Yesenia Martinez, LMHC, Daniella Vaclavik, MS, Victor Buitron, MS, and Raquel Melendez, MS, of the Florida International University, for their assistance in administering attention training sessions and collecting data.

AUTHOR CONTRIBUTIONS
Conceptualization: Pettit, Vasey, Pine, Bar-Haim, Silverman
Data curation: Pettit, Bechor, Rey
Formal analysis: Pettit, Rey, Abend, Jaccard
Funding acquisition: Pettit, Vasey, Pine, Bar-Haim, Jaccard, Silverman
Investigation: Pettit, Bechor, Rey, Vasey, Pine, Bar-Haim, Silverman
Methodology: Pettit, Abend, Pine, Bar-Haim, Silverman
Software: Abed, Bar-Haim
Project administration: Pettit, Bechor, Rey, Vasey, Abend, Pine, Bar-Haim, Jaccard, Silverman
Writing—original draft: Pettit, Silverman
Writing—review and editing: Bechor, Rey, Vasey, Pine, Bar-Haim, Jaccard

Disclosure: Dr. Pettit has received book royalties from the American Psychological Association and New Harbinger Publications. Dr. Silverman has received royalties as an author of the *Anxiety Disorders Interview Schedule for Children*. Drs. Bechor, Rey, Vasey, Abend, Pine, Bar-Haim, and Jaccard have reported no biomedical financial interests or potential conflicts of interest.

Correspondence to Jeremy W. Pettit, PhD, Center for Children and Families, Florida International University, 11200 SW 8 Street, AHC-1 RM 140, Miami, FL, 33199; e-mail: jpettit@fiu.edu

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https://doi.org/10.1016/j.jaac.2019.02.018

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