Attention Bias Modification in High Trait Anxious Adults: An ERP Study
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• Clinical and non-clinical anxiety are associated with exaggerated attention to threatening stimuli.
• The potential of this threat bias as a target for intervention is supported by almost two decades of research showing that reducing threat bias via computerized attention bias modification treatment (ABMT) who reduces anxiety severity at levels comparable to gold-standard treatments (Hakamata et al., 2010). ABMT has been shown to reduce threat bias, stress reactivity (Amir et al., 2006), and symptoms of generalized anxiety disorder (Amir et al., 2009a), social anxiety disorder (Schmidt et al., 2009), social phobia (Amir et al., 2009), and pathological worry (Hazen et al., 2009).
• Despite its promise, little research to date has delineated specific mechanisms underlying ABMT’s effects on anxiety (Heren et al., 2013), nor identified predictors of treatment response. It remains unclear how and by whom ABMT is effective, limiting clinical translation.
• One potential explanation is that behavioral measures may fail to distinguish between two distinct cognitive processes that may be modified by ABMT: attentional capture, the relatively bottom-up, initial evaluation of stimulus threat value, which is elevated in anxiety (Beck & Clark, 1997; Mogg & Bradley, 2002; Wilson & MacLeod, 2003); and cognitive control, the relatively strategic, top-down control of threat processing and reactivity, which appears to be dampened in anxiety (Bishop, 2009; Derbyshire & Read, 2002).
• Scalp-recorded event-related potentials (ERPs) are sensitive to both types of cognitive processes and can capture changes in bottom-up attentional capture (PT; N1; Hillard & Avin-Youm, 1998; Luck et al., 1990; Luck & Hillyard, 1995) and top-down cognitive control (NT; Foileten & Van Petten, 2008; Newsom et al., 2005; van Veen & Carter, 2002) on the order of milliseconds. This temporal and functional sensitivity makes them ideal candidate neural correlates to measure the time course of the anxiety-related attentional bias to threat and its remediation through ABMT (Edgar & Bar-Haim, 2010; O’Toole & Dennis, 2012).
• The present study takes an additional innovative approach by including more salient stimuli (i.e., pictures of scenes versus words or emotional faces). It is important to explore whether the use of higher arousal non-verbal stimuli yield comparable ABMT effects.

Hypothesis 1: ABMT versus placebo training (PT) will reduce threat bias, anxiety, stress reactivity, and alter ERP responses indicating reduced early attention capture by threat (i.e., reduced P1 and N1 amplitudes) and increased control of attention to threat (i.e., greater N2 amplitudes) and increased control of attention to threat (i.e., greater N2 amplitudes).

METHOD
Participants
• Fiftyfour adults (45 females), aged 18-38 (M = 20.28, SD = 4.33), participated in this study.
• Participants were recruited for the study based on elevated trait anxiety scores (>1 SD from college norm, Spieberger, 1983). Trait anxiety scores ranged from 49-75 (M = 55.52, SD = 5.71).

Procedure
• Participants spent approximately three hours in the laboratory. They completed a pre-training assessment of threat bias, anxiety, and stress reactivity, suggesting these ERPs are viable measures of neurocognitive processes underlying ABMT (how ABMT works). Exploratory analyses will test whether ERP responses at baseline predict treatment outcomes, helping to clarify who is most likely to benefit from ABMT (for whom ABMT is effective).

Anxiety Assessment
• State anxiety was measured using the STAI (Spieberger, 1983).

Attention Bias Modification Training
• Participants were exposed to a training condition using the dot probe task to induce an attention bias away from threatening stimuli (non-threat cues only, n = 27) or a placebo training condition (equal numbers of threat and non-threat cues, n = 27). There were 576 training trials in both training conditions.

RESULTS
Hypothesis 1: ABMT versus PT will reduce threat bias, anxiety, stress reactivity, and alter ERP responses indicating reduced early attention capture by threat and increased control of attention to threat.
• This hypothesis was tested with a series of ANCOVAs with post-training as the dependent variable, the corresponding pre-training measure as the covariate, and Training as the between-subjects factor.

Figure 1. Counter to predictions, there was a significant effect of Training on state anxiety such that participants in the ABMT group versus PT group showed greater state anxiety. Additionally, there was a trend-level effect of Training on N2 amplitudes such that, as predicted, participants in the ABMT group versus PT group showed greater N2 amplitudes to threat.

EEG Recording and Analysis
• ERP activity was recorded during the passive viewing and co-reappraisal tasks via BioSemi 64 Ag/AgCl scalp electrodes, sampled at 512 Hz and amplified with a band pass of 0.16-160 Hz. Eye movements were monitored by electrooculogram (EOG) signals.
• Using Brain Vision Analyzer, data were referenced off-line to the average of the entire scalp and filtered with a low-cutoff frequency of 1 Hz and a high-cutoff frequency of 30 Hz. Stimulus-locked data were segmented into epochs from 200 ms before cue presentation during the dot probe task to 500 ms after stimulus onset, with a 200 ms baseline correction.
• Following occular correction (Gratton & Coles, 1983), artifacts were identified and removed from analyses: voltage steps greater than 50 μV, changes within a given segment greater than 300 μV; and artifacts at 5 μV per 100 ms. In addition to this semi-automatic identification of artifacts, trials were also visually inspected for any further artifacts and were removed on a trial-by-trial basis.

Stress Reactivity Assessment
• The Trier Social Stress Test (TST; Kirschbaum, Pirke, & Hellhammer, 1993) includes both a social-evaluative threat, where participants must give a speech in front of two judges, and a lack of control task where participants must complete an arithmetic task.

Self-Reported Mood
• Self-reported mood was recorded before and after the social stressors using the 65-item Profile of Mood States (POMS; McNair, Lorr, Hechternick & Droppelman, 2003). The POMS measures six different mood states (Tension/Anxiety, Depression/Dejection, Anger/Hostility, Vigor/Activity (reversed scored), Fatigue/Inertia, Confusion/Bewilderment) which are combined to generate a Total Negative Mood score. Difference scores of post-TST versus pre-TST are generated for the pre- and post-training stressors to index changes in negative mood.

Hypothesis 2: ERP responses will predict ABMT effects on threat bias anxiety, and stress reactivity.
• Each of the post-training measures were entered separately as the dependent variable with the following variables entered in separate steps: 1) the corresponding pre-training measure; 2) Training; 3) ERP (P1, N1, or N2), 4) interaction between Training and ERP (e.g., ABMT x N2).