The Role of Anxiety and Mood in Context-Sensitivity of Threat Bias

Samantha Denefrio[2], Olga Gulyayeva[1], Laura Egan[3], Courtney Louis[1], & Tracy A. Dennis-Tiwary[1,2]

[1]Hunter College, The City University of New York, [2]The Graduate Center, The City University of New York, [3]Queens College, The City University of New York

INTRODUCTION

- Directing attention toward emotionally salient information is adaptive in identifying signs of potential danger in the environment. However, threat bias (TB), or selective and exaggerated attention towards threat in the absence of immediate danger, has been examined as a potential neurocognitive mechanism in anxiety. TB is thought to promote anxiety by increasing anxious arousal, reducing opportunities to disconfirm anxiety-related beliefs, and to utilize adaptive coping strategies (Bar-Haim, Lamy, Pergamin, et al., 2007).

- Although TB has been well-documented in both clinical (e.g., Amir, Elias, Klump et al., 2003; Amir, Beard, Burns et al., 2009) and trait-anxious individuals (e.g., Honk, Tuiten, de Haan et al., 2001), less is known about individual differences and contextual factors that may directly impact the emergence and plasticity of TB.

- Several lines of research suggest that TB is highly intertwined with emotional state. MacLeod, Rutherford, Campbell et al. (2002) found that when non-anxious participants were trained to attend *to* threat, via attention bias modification training (ABMT) anxiety increased in response to a laboratory stressor. Furthermore, Cavanagh, Urry and Shin (2011) found that negative mood-induced shifts in attention to threat predicted increased levels of anxiety later on. Conversely, positive mood induction prior to training towards both pleasant and threat cues was associated with increased life satisfaction. Most recently, findings from our lab document that a brief stressor can significantly impact TB expression within a single session (Egan & Dennis-Tiwary, in prep).

- Taken together, these studies suggest that TB is both state- and context-sensitive (Zvielli, Bernstein & Koster, 2015) and that shifts in mood may be associated with increased attention to threatening information even in a non-anxious sample.

- The present study directly examined factors influencing the state- and context-sensitivity of TB by conducting an experimental stress induction (versus control condition) prior to attention training *towards* threat combined with continuous mood assessment in a large group of healthy adults.

HYPOTHESES

1. Biased attention towards threat prior to the stress induction will be associated with higher levels of negative mood and anxiety and lower levels of positive mood.

2. Stressor-induced changes in mood and anxiety will influence the magnitude of ABMT effects, such that increased negative mood will be associated with increased attention to threat following ABMT towards threat.

METHOD

Participants
- 110 adults (84 females), aged 18-39 ($M = 19.88$, $SD = 3.43$) participated in this study.

Mood and Anxiety Self-Reported Measures

Baseline (Prior to Stressor and ABMT) (Table 1)
- *The State Trait Anxiety Inventory* (*STAI*; Spielberger, 1983) was administered to assess levels of state and trait anxiety.
- *The Beck Anxiety Inventory* (*BAI*; Beck, Epstein, Brown, & Steer, 1988) was used to assess general level of nervousness, anxiety, and shyness.
- *The Beck Depression Inventory-II (BDI-II;* Beck et al., 1996) was administered to assess depressed mood over the past two weeks
- *Positive and Negative Affect Schedule (PANAS;* Watson, Clark, Tellegen, 1988) was administered in order to assess participants' positive and negative affect in 1) General and 2) Today (day of the study visit).

Table 1. *Descriptive Statistics*

	Min	Max	M (SD)
STAI State	20	63	36.63 (9.08)
STAI Trait	20	63	41.79 (9.80)
BDI	0	33	9.78 (7.09)
BAI	0	43	12.84 (10.68)
PANAS General PA	16	50	30.96 (7.95)
PANAS General NA	10	32	15.55 (4.84)
PANAS Today PA	11	50	26.79 (8.06)
PANAS Today NA	10	26	13.60 (4.05)

Note: Independent Samples t-tests revealed no group differences between anagram conditions, $p > .20$.

Pre and Post Stressor (Anagrams Task)
- *The Analog Mood Scale (AMS)* is a brief measure of positive and negative mood, taken from the TAU/NIMH standardized ABMT paradigm. It consists of three questions (How anxious are you?, How sad are you? and How happy are you?). Participants are asked to identify a number on a scale of 1 to 30 that best represents their mood at the present time.
- *Positive and Negative Affect Schedule (PANAS;* Watson, Clark, Tellegen, 1988) was administered in order to assess participants' positive and negative affect immediately before and after the stressor. The PANAS consists of 20 items describing discrete positive and negative emotions (e.g., enthusiastic, ashamed). Participants rate themselves on each emotion on a 5-point scale of very slightly or not at all (1) to extremely (5).

Threat Bias Assessment
Threat Bias was assessed using the dot probe task (MacLeod & Mathews, 1988) following parameters of the Tel-Aviv University/National Institute of Mental Health protocol (Figure 1).
- Two attention bias scores were generated.
  1. **Threat Bias** was calculated as average RT for neutral probes minus average RT for threat probes. Positive scores indicate an attention bias toward threat.
  2. **Disengagement** was calculated as average RT for neutral probes following threat-neutral pairs minus average RT for neutral probes following neutral-neutral pairs. Positive scores indicate difficulty in ability to disengage from threat.

Attention Bias Modification Training (ABMT)
ABMT was conducted also following parameters of the Tel-Aviv University/National Institute of Mental Health protocol. Participants underwent ABMT towards threat, where the probe is always cued by threat on threat/non-threat paired trials (Figure 2).

Timeline

1. Questionnaires

STAI, BAI, BDI, PANAS (General, Today)

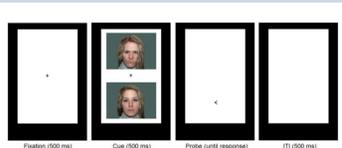**2. Bias Measure 1 (Baseline)**

Dot Probe Task

Figure 1. An example of a non-threat cued trial.

3. Mood Assessment

PANAS (Right Now) & AMS

4. Anagram Stressor Task

The Anagram Task (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002) includes 40 medium to difficult anagrams. presented on a computer. Participants were instructed to complete as many anagrams as possible in three minutes. Half of the participants received difficult anagrams (e.g. TAENSIG; OSLURDEH) meant to induce stress response (stressor; n = 55; 44 females) and the other half an easy version (e.g., UNR; control; n = 55; 40 females).

5. Mood Assessment

PANAS (Right Now) & AMS

6. Bias Measure 2 (Pre Training)

Dot Probe Task
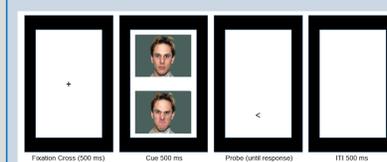
7. Attention Bias Modification (ABMT)

Figure 2. An example of a threat cued trial.

8. Bias Measure 3 (Post Training)

Dot Probe Task

RESULTS

Baseline Correlations between Mood and TB
To test the hypothesis that TB will be associated with higher levels of negative mood and state anxiety and lower levels of positive mood at baseline, bivariate correlations were conducted between mood, state anxiety and TB.

- Higher positive affect ($M = 26.79$; $SD = 8.06$) was associated with better ability to disengage from threat at baseline ($M = 1.56$; $SD = 27.13$), $r(108) = -.33$, $p = .001$.

- Higher negative affect ($M = 13.60$; $SD = 4.05$) was associated with difficulty disengaging from threat at post training ($M = 2.73$; $SD = 25.38$) regardless of stressor condition, $r(108) = .20$, $p = .04$.
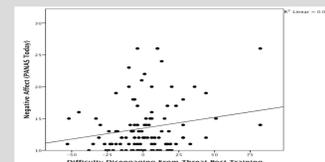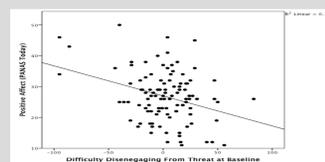
- In addition, a trend emerged that higher state anxiety was associated with higher threat bias at baseline, $r(109) = .16$, $p = .11$. There were no other significant correlations.

Stressor Manipulation Check
We confirmed that the difficult anagrams task significantly changed mood and anxiety using a series of paired-samples t-tests: individuals who completed the difficult versus easy anagrams task reported significantly higher levels of negative mood and anxiety as well as lower levels of positive mood (Table 2).

Table 2. *Stressor Manipulation Check*

	Pre-Stressor		t	df	p	Post-Stressor		t	df	p
	Easy	Difficult				Easy	Difficult			
AMS-Anxious	6.25 (5.65)	8.02 (7.44)	-1.40	100.74	n.s.	6.72 (7.42)	10.65 (8.80)	-2.52	107	.013*
AMS-Sad	2.85 (3.90)	2.80 (3.26)	.08	108	n.s.	2.91 (4.28)	6.71 (7.27)	-3.34	87.73	.001**
AMS-Happy	13.15 (7.13)	14.58 (7.61)	-1.02	108	n.s.	13.61 (7.16)	12.56 (6.82)	.78	107	n.s.
PANAS Right Now-NA	12.40 (2.42)	12.65 (3.12)	-.48	108	n.s.	11.91 (2.63)	16.65 (5.11)	-4.83	80.79	.000**
PANAS Right Now-PA	21.84 (8.32)	22.00 (7.90)	-.11	108	n.s.	23.80 (8.36)	20.16 (7.27)	2.43	108	.017*

Note: *p is significant at .05; **p is significant at .001

Impact of Stressor on TB and ABMT Effects
To test the effects of the stressor versus control task on TB and the magnitude of ABMT effects, we conducted a series of repeated measures ANOVAs.
- RTs across all trial types significantly decreased from baseline to post stressor and baseline to post ABMT [$F(1.65, 210) = 18.66$, $p < .001$, partial $\eta^2 = .15$]. This was unexpected since attention was trained *towards* threat and should have resulted in selective RT reductions for threat cues only. Moreover, there were no significant direct effects of stressor condition on TB or ABMT.
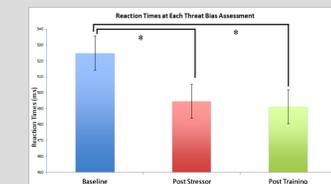

In addition, TB *decreased* (instead of increased) at the level of a trend from baseline to post training [$F(2, 210) = 2.67$, $p = .07$, partial $\eta^2 = .03$]. When controlling for state anxiety, this effect becomes significant ($p = .03$). Disengagement scores did not significantly change across threat bias assessments.

Associations among Stressor-Induced Mood Change, ABMT, and TB
In order to test the hypothesis that increased negative mood will be associated with higher levels of TB following ABMT, a series of partial correlations were run between post stressor mood scores and TB scores following ABMT controlling for pre-stressor mood and anxiety. Correlations were conducted separately for each stressor condition. As seen in the scatter plots below, all effects were significant for the stressor but not control condition.

- Higher ratings of anxiety ($M = 10.65$; $SD = 8.80$) were associated with increased difficulty disengaging from threat ($M = -.25$; $SD = 24.77$) $r(52) = .31$, $p = .02$.
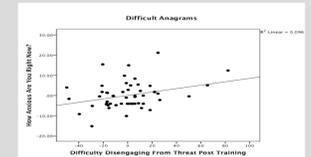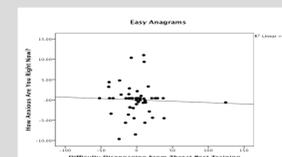
- Higher ratings of sadness ($M = 6.71$; $SD = 7.27$) were associated with increased threat bias post training ($M = -3.07$; $SD = 29.06$), $r(55) = .29$, $p = .03$.
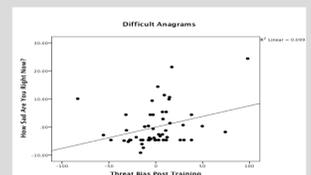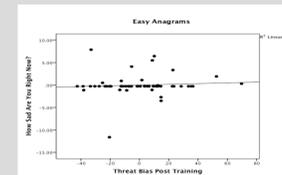
- Higher ratings of sadness ($M = 6.71$; $SD = 7.27$) were associated with difficulty to disengage from threat post training ($M = -.25$; $SD = 24.77$), $r(52) = .40$, $p = .003$.
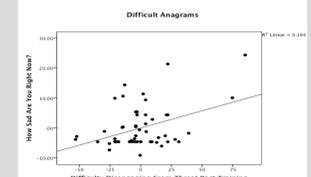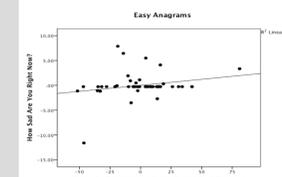
DISCUSSION

- This study was among the first to systematically examine the state- and context-sensitivity of TB in a large group of healthy adults. We found, interestingly, that ABMT alone did not influence the magnitude of TB, suggesting that non-anxious individuals are relatively resilient to the induction of TB. Indeed, participants trained *towards* threat instead showed a bias *away* from threat.

- However, stressor-induced shifts in mood disrupted this resilience. Those showing more negative mood after the stressor also showed increased attention to threat and difficulty disengaging from threat. Therefore, the presence of a mild stressor appeared to bolster ABMT efficacy and possibly triggered a vulnerability to evidence TB.

- The present findings provide experimental evidence that TB is highly sensitive to baseline and stress-induced mood states. Findings also suggest notable resilience among healthy adults in vulnerability to develop TB. Finally, results are consistent with previous clinical reports suggesting that with greater change in mood and anxiety, mild stressors may have similar effects on attention as life-threatening stress (e.g., Bar-Haim et al., 2010).

- Future research should explore novel methods to quantify state-related variability in the expression of attention to threat.

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