



# A Gamified Attention Bias Modification App Reduces Stress Reactivity during Pregnancy

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## INTRODUCTION

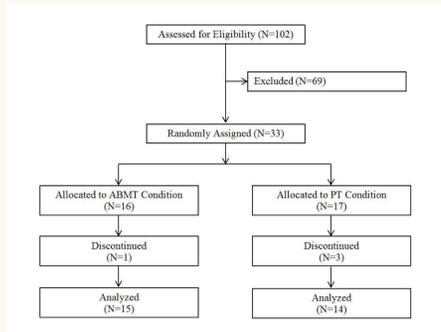
- Stress and anxiety in the perinatal period affect a range of health outcomes in both mothers and children, including preterm labor, birth complications, post-partum depression and neurodevelopment of children (Glover, 2014).
- Cost-effective and easily-accessible treatments to reduce stress is thus essential to optimizing the health and well-being of pregnant women and their children (Adler et al., 2011; Evans et al., 2015).
- Computerized attention bias modification training (ABMT) is the targeted reduction of a key cognitive mechanism in stress and anxiety, the threat bias, or selective and exaggerated attention to threat (Bar-Haim et al., 2007; Hakamata et al., 2010).
- We have taken the **core components of ABMT and embedded them in a gamified mobile app called Personal Zen** currently available for iOS devices. In two recent placebo-controlled studies with moderately anxious adults, Personal Zen reduced anxiety, stress reactivity, and threat bias in a single, lab-based session (Dennis & O'Toole 2014; Dennis-Tiwary et al., 2016).
- The present study was a placebo-controlled randomized pilot clinical trial of Personal Zen in moderately anxious pregnant women over the course of one month. Biobehavioral indices of stress reactivity (cortisol, observed) and self-report of anxiety were collected (Buchanan et al., 1999; Hellhammer et al., 2009).
- To examine personalization of ABMT, we tested whether distinct neural responses to threat, measured via scalp-recorded event-related potentials, predicted ABMT response (Dennis-Tiwary et al., 2016).

## PREDICTIONS

- ABMT versus placebo training (PT) versions of Personal Zen will reduce threat bias, anxiety, and stress reactivity.
- The magnitude of neural responses to threat prior to training will predict ABMT efficacy.

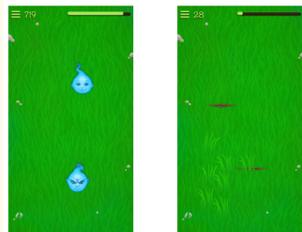
## METHOD AND RESULTS

**Participants:** Women aged 23-45 ( $M = 32.97$ ,  $SD = 5.52$ ) between their 15<sup>th</sup> and 29<sup>th</sup> week of pregnancy were recruited from a large city hospital.



**Training:** Participants played Personal Zen for ~ 10 min/day 4 days/week for one month.

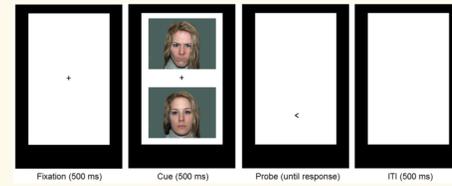
- ABMT version** ( $n = 15$ ), participants swiped a grass trail left behind by a pleasant sprite.
- Placebo Training (PT)** version ( $n = 14$ ), participants were equally likely to swipe a grass trail left behind by a pleasant or angry sprite.



**Depression Anxiety Stress Scale (DASS):** The DASS-21 (Henry & Crawford, 2005) is a 21-item questionnaire that measures the severity of depression, anxiety, and stress-related symptoms.

**The Hamilton Anxiety Scale (HAM-A):** The HAM-A (Hamilton, 1959) was used to assess severity of anxiety symptoms with scores ranging from 0 to 56 and higher scores indicating increased severity.

## Threat Bias Assay

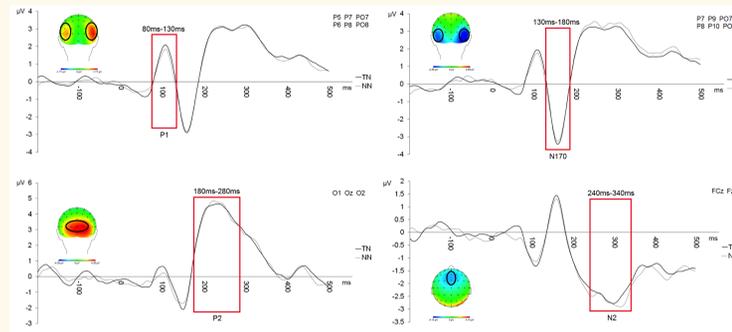


## Salivary Cortisol Collection

- After training, saliva was collected at home twice in the AM and once before bed.
- After training, saliva was collected three times [arrival, mid-stressor (EEG application and Trier Social Stress Test), and post-stressor].
- Cortisol reactivity:** concentration of the 3<sup>rd</sup> - 1<sup>st</sup> sample; **Area under the curve (AUC):** direction of change in cortisol secretion, with negative values reflecting decrease over time and positive values increase over time.

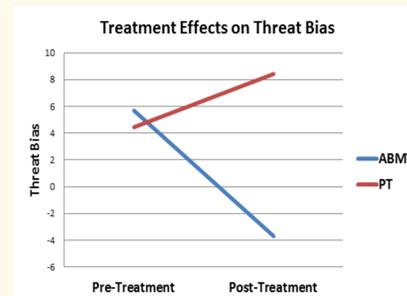
## EEG Recording and Analysis

- EEG activity was recorded during the dot probe via BioSemi 64 Ag/AgCl scalp electrodes, sampled at 512 Hz. Reference: average of the entire scalp; filter: .1 - 30 Hz. Stimulus-locked data were segmented into epochs from 200 ms before stimulus presentation to 2000 ms after stimulus onset, with a 200 ms baseline correction.



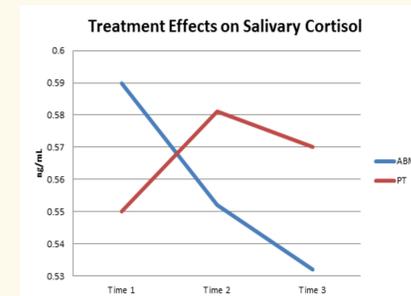
## Personal Zen Reduced Threat Bias

- Training Group effect on attention bias,  $F(1, 25) = 3.72$ ,  $p = .065$ , partial  $\eta^2 = .13$ . Attention towards threat was reduced for ABMT versus PT.

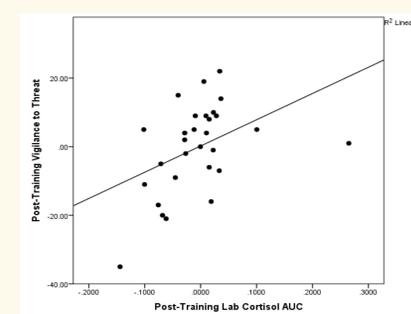
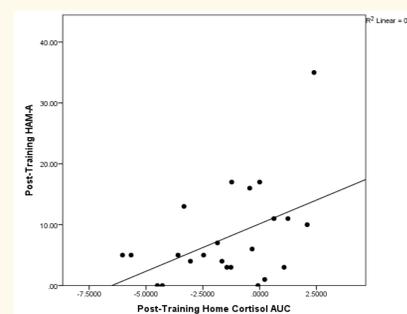


## Personal Zen Reduced Cortisol

- Training Group effect on cortisol,  $F(1, 25) = 4.96$ ,  $p = .037$ , partial  $\eta^2 = .18$ . Cortisol secretion over the course of the lab visit was reduced for ABMT versus PT.

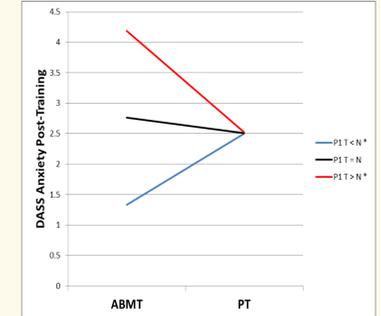


## Reductions in Cortisol were Associated with Less Anxiety and Threat Bias

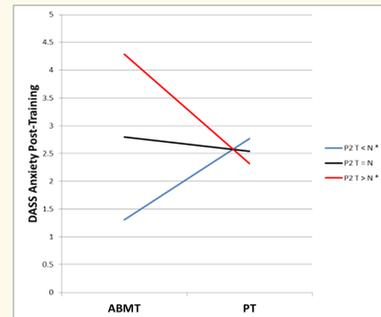


## Neural Responses to Threat Predicted ABMT Effects on Anxiety

- Training Condition x P1 interaction: Anxiety was reduced when participants showed *smaller* P1 amplitudes, but was increased with *larger* P1 [Full model:  $F(5, 22) = 13.33$ ,  $p < .001$ ,  $R^2 = .75$ ; interaction step change statistics:  $F(1, 22) = 3.60$ ,  $p = .07$ ,  $R^2 = .04$ ].



- Training Condition x P2 interaction: Anxiety was reduced when participants showed *smaller* P2 amplitudes but was increased with *larger* P2 [Full model:  $F(5, 22) = 15.39$ ,  $p < .001$ ,  $R^2 = .78$ ; interaction step change statistics:  $F(1, 22) = 5.98$ ,  $p = .02$ ,  $R^2 = .06$ ].



## DISCUSSION

- Using Personal Zen, a mobile ABMT game, for a few minutes a day, a few days a week over the course of a month had a detectable positive impact during pregnancy.
- Threat bias was reduced in the ABMT versus PT group.
- Cortisol secretion was reduced during lab-based stressors in the ABMT versus PT group.
- Self-reported anxiety was reduced when those in the ABMT group showed less early visual processing of threat (*smaller* P1 and P2 amplitudes).
- Taken together, results suggest that extended use of a gamified, mobile ABMT intervention effectively reduced biobehavioral indices of stress and anxiety, but highlight the importance of identifying those for whom ABMT may be most effective.
- Findings highlight the utility of using digital mental health tools that target cognitive biases (Dennis-Tiwary et al., 2016; Dennis & O'Toole, 2014; Enock & McNally, 2013; Holmes et al., 2009) during times of elevated sensitivity and risk due to stress and anxiety, such as pregnancy.

## REFERENCES

References available upon request.



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