Behavioral & Physiological Evidence for Differential Learning of Fear, Safety, & Reward

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Introduction

- Neurobiologically, posttraumatic stress disorder (PTSD) is theorized to be driven by amygdala hyper-activity in response to threat[1], however this research has ignored the fact that fear responding occurs *after* fear discrimination, while prior research shows that individuals with PTSD exhibit difficulty in discriminating between fear and safety when measured behaviorally (e.g., self-report) and at the neural level (e.g., amygdala reactivity).[2,3]
- Together, this suggests a difficulty in discriminating fear vs. safety cues in PTSD as an underlying deficit.[4-6]
- In rodents, discrete sub-populations of cells in the amygdala code fear (foot shock) vs. reward (sucrose) vs. safety cues[7], and these cells are different from those that contribute to learning about fear vs. reward when paired with a safety cue.
- The study of the amygdala during differential learning of fear, safety, and reward is therefore thought to be consequential for better understanding the pathophysiology of PTSD; however, no study has yet translated these findings to humans.

Research Aim

- **In this pilot study, we adapted a rodent task of stimulus discrimination to humans as a first step in a translational affective neuroscience program of research in the study of stimulus discrimination deficits in those with PTSD.**

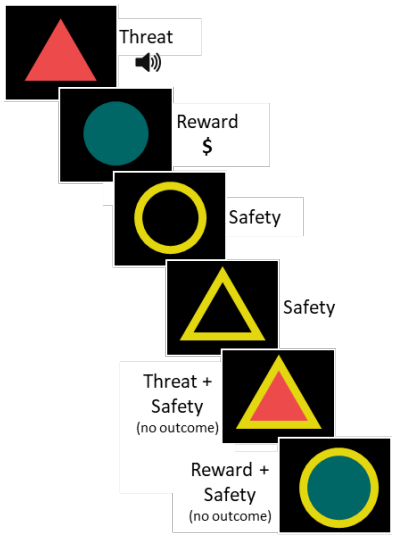
Methods

N = 20 Marquette undergraduate students (*demographics available upon request*) completed a fear, reward, and safety (FSAR) task adapted from rodent work (**Fig. 1**). Fear cues were co-presented with white-noise burst; reward cues with $0.25, and safety cues with no outcome. Ability to discriminate was tested two ways:

1. Behaviorally, participants provided self-report ratings of likeability of cues on a 1-10 scale (1 = very bad; 10 = very good)
2. Physiologically, we measured skin conductance response (SCR; Biopac MP160) to cues

Results

Figure 1. Fear, Safety, And Reward (FSAR) Task



8 cues of each type were presented for 3-5 sec with 8-10 sec inter-stimulus intervals

Figure 2. Behavioral Results

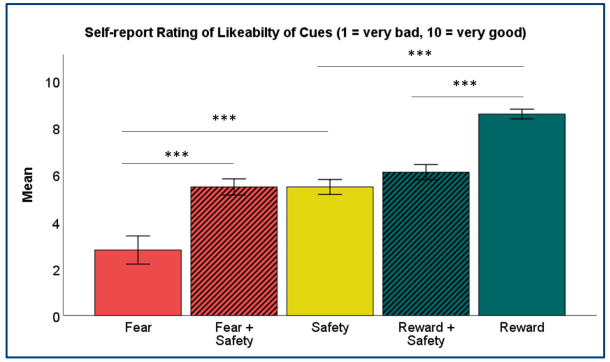
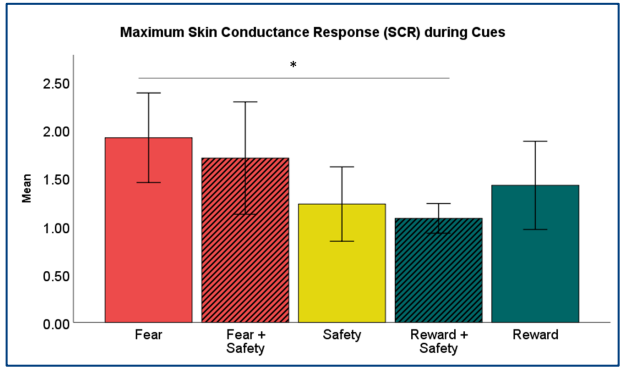


Figure 3. SCR Results



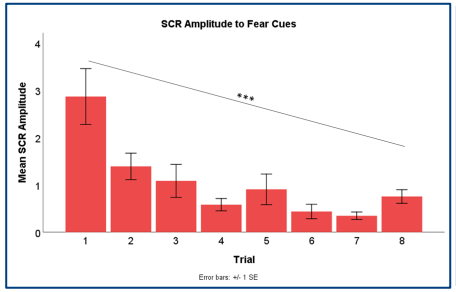
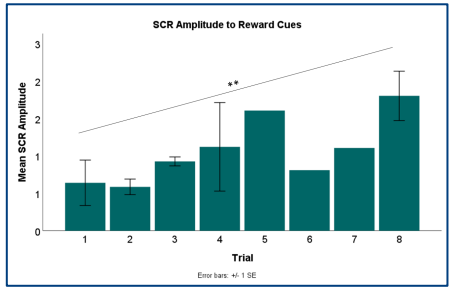


Figure 4A & 4B.

SCRs to Fear Cues Declined Over Time (Habituation) (p < 0.001) & SCRs to Reward Cues Increased Over Time (p = 0.003) (Sensitization)



Conclusions & Future Directions

- Behaviorally participants were able to discriminate among cues (ANOVA: $p < 0.001$), such that pairing of safety with threat/reward altered likability (p's < 0.001); SCRs differed between cues (ANOVA: $p = 0.010$), such that Fear was more arousing > Reward + Safety ($p = 0.018$)
- As the amygdala is the neural source for SCR[8], SCR differences to cue types and differential SCR habituation (to fear) vs. sensitization (to reward) suggest that the amygdala codes cues differentially in humans, replicating rodent research.
- Future research will extend these findings in clinical samples of PTSD and with the use of neuroimaging to study amygdala reactivity to cues.

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