Emotional Reactivity under Social Evaluative Threat: A Social Neuroscience Investigation

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Introduction

- Recent theoretical and empirical developments have highlighted the importance of emotion when investigating Hypothalamic-Pituitary Adrenal (HPA) Axis reactivity to social evaluative threat (SET).
- It is of interest to examine both trait-level (behavioral inhibition: BIS) and state-level (fear and shame) affect-related variables which may interact to influence emotional and HPA reactivities to social stress.
- Many self-report indices have failed to reliably predict HPA reactivity in the extant literature, thus it may be fruitful to utilize non-invasive measurements of affect-sensitive psychophysiology.
- Since the HPA axis is stimulated during social stress via a limbic circuit involving the anterior cingulate cortex (ACC), measurements of neural activities in the ACC during stress may reveal processes by which emotional perturbation affects HPA reactivity.
- One proposed CNS indicator of ACC activities is the Error-Related Negativity (ERN), a neuroelectric potential recorded over frontal-midline scalp sites ~80 ms after an erroneous response has been executed in behavioral paradigms.

Methods

Subjects

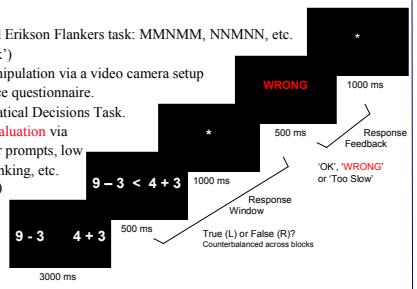
- 55 right-handed U of A students participated.

Electrophysiological Setup

- 26 channels, 1000 Hz sampling, 500X amplification, bandpass .05 – 200 Hz, impedances < 5 KΩ, standard eye blinks corrected via a regression procedure, online Cz reference: re-referenced to linked mastoids offline.

Procedure

- 1st: Modified Erikson Flankers task: MMNMM, NNMNN, etc. ('Letters task')
- 2rd: SET manipulation via a video camera setup & intelligence questionnaire.
- 3rd: Mathematical Decisions Task. Negative evaluation via experimenter prompts, low percentile ranking, etc. ('Math task')



ERN

- Only *self-corrected* error trials were utilized.
- ERN_diff was computed as the difference wave of the ERN – 'correct trial negativity' in order to isolate error-specific activities.

Affect & Appraisals

Appraisals & Rumination Ratings: 1-7 scale

Pre-task appraisal of abilities: (*expected difficulty, have the skills to do well & expect to do well*; α=.81) Coded +

Post-task appraisal of performance: (*comparison to others, experimenter rating, how difficult, too difficult, threatening, stressful* ; α=.77) Coded –

Rumination: (*expressing worry during the task, still feeling upset at their performance, having a hard time moving on*; α=.87)

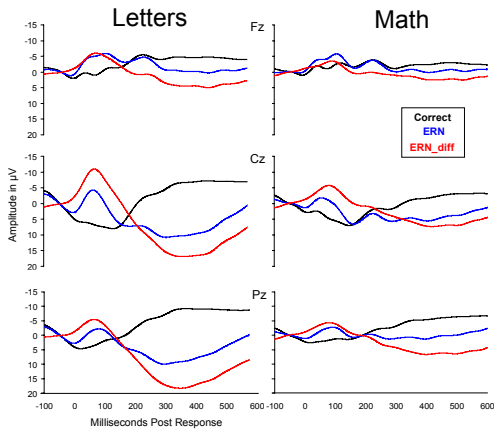
Retrospective Emotion Ratings: 0-8 scale

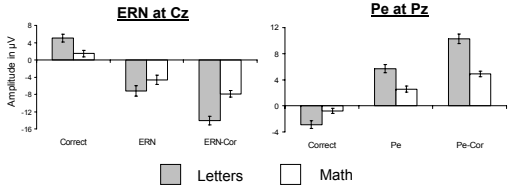
Fearful: (*fear, nervous, anxious, afraid*; α=.83)

Shame: (*ashamed, humiliated, embarrassed*; α=.95)

Withdrawal: Fearful + Shame (α=.92)

The ERN and Pe



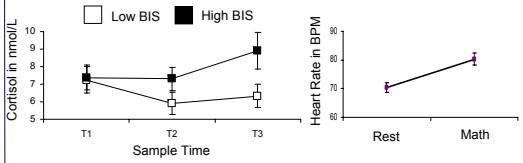


For Correct Trials, the Math **correct-trial negativity** t(38)=4.7, p<.01 and **positivity** t(37)=-3.5, p<.01 were larger in absolute amplitude than the Letters task

On self-corrected error trials, the Math **ERN** t(38)=-2.1, p<.05 and **Pe** t(37)=4.6, p<.01 were smaller in absolute amplitude than the Letters task.

Consequently, the Math **ERN_diff** t(38)=-6.2, p<.01 and **Pe_diff** t(37)=6.2, p<.01 were smaller in absolute amplitude than the Letters task.

Biological Reactivity



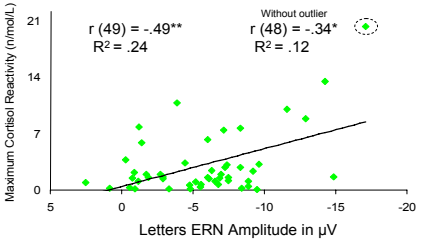
T1: 45 mins post-arrival T2: 25 mins post-SET manipulation T3: 20 mins post-T2

Both the T3-T2 difference **(Task-Specific Reactivity)** t(52)=2.9, p<.01 and the Max Value – Min Value **(Maximum Reactivity)** t(53)=5.0, p<.01 showed significant cortisol mobilization occurred during the task; however neither of these reactivities were moderated by BIS.

Preliminary **Heart Rate** data (n=32) also indicate a significant task-related increase t(31)=7.7, p<.01.

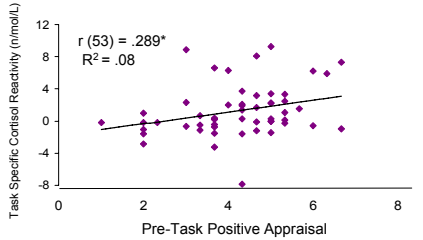
Investigations into affective & cognitive reactions to the task may help to interpret the stress-specific correlates of decreased ERN & Pe amplitudes and increased cortisol and HR during the task.

Predictors of 'Stress'



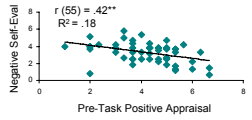
Baseline Letters ERN and ERN_diff amplitudes at Fz predicted both Maximum Cortisol reactivity and Task-Specific reactivity, even when excluding the outlier.

While these effects were not significant at Cz, a regression model which included both Fz and Cz achieved significance even when excluding the outlier.



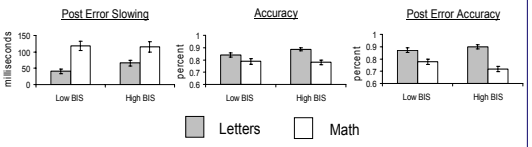
	BIS	Withdrawal	Rumination
Withdrawal	r = .263†		
Rumination	r = .337*	r = .721**	
Neg Self Eval	r = .093	r = .591**	r = .658**

All n=55; † = p<.10; * = p<.05, ** = p<.01



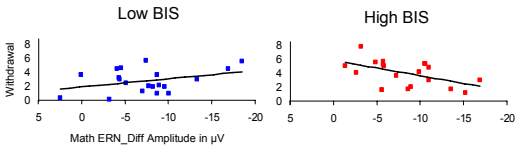
Negative emotional (Withdrawal: Fear & Shame) and cognitive (Negative Self Evaluation and Rumination) consequences clustered together, especially in high BIS individuals; however none of these metrics predicted acute cortisol reactivity.

Pre-Task Positive Appraisals of ability did predict Task-Specific cortisol reactivity and were inversely related to Negative Self Evaluation. These descriptive data indicate that self-reported negative affect & appraisal and cortisol reactivity represent different aspects of the stress response in this sample.



In lieu of the apparent trends in behavioral measures of performance and post-error adjustment, BIS (median split) moderation was only significant in a 2 (task) X 2 (group) ANOVA for **Post-Error Accuracy**: F(1,53)=4.9, p<.05.

Trait * State Moderation

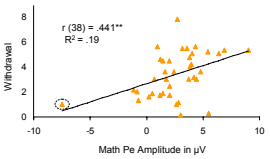


BIS interacted with self-reported emotional withdrawal during the Math task to account for variance in the amplitude of the ERN_diff:

□ Omnibus: F(3,35)=3.8, p<.05, η2 =.25 □ BIS * W: F(1,35)=9.1, p<.01, η2 =.21

Math task residualized ERN_diff (from Letters ERN_Diff) displays the same relationship:

□ Omnibus: F(3,35)=2.7, p=.059, η2 =.19 □ BIS * W: F[1,35]=6.4, p<.05, η2 =.15



Withdrawal significantly predicted Math Pe amplitude, even when excluding the lower left outlier.

Math Pe also significantly correlated with Negative Self-Evaluation.

Math task residualized Pe (from Letters Pe) show the same significant relationships.

General Discussion

- Available evidence suggests that ERN family amplitudes as well as HPA activities are related to task-engagement as well as punishment sensitivity. Indeed, baseline ERN difference amplitude predicts cortisol reactivity during a subsequent stress task.
- The personality construct of Behavioral Inhibition (BIS) is characterized by sensitivity to conditioned signals of punishment and non-reward. Withdrawal (fear and shame) emotionality are predicted by BIS, and these emotions may predict task-disengagement under stress – which may also be associated with a detriment in post-error adjustment.
- Higher withdrawal emotionality predicts smaller ERN difference amplitudes only in high BIS individuals. BIS may be a trait-level personality construct that moderates the effects of emotional and motivational processes on CNS reactivities during social stress.
- The ERN may function as both a trait and state level variable sensitive to motivation and affect. The functional significance of the Pe is less well-known, but it may reflect a P3-like awareness of the environment. A positive correlation between the Pe and emotional withdrawal during stress may indicate that a degree of environment – sensitive awareness is still involved in affect – related disengagement.

Future Directions

- Emotion-driven disengagement may account for the lack of a cortisol response during social evaluative threat. In McEwen's Allostasis model, both prolonged cortisol activity and an inadequate cortisol response are highlighted as risk factors for development of high Allostatic Load.
- Consequences of differential stress reactive styles should be investigated using measurements of CNS activities in the future, especially in the search for predictors of prolonged cortisol reactivity and affect – driven disengagement.

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