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Effects of Mood on Error Processing

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INTRODUCTION

Error-Related Negativity (ERN)
- The ERN is a putative reflection of performance/error-monitoring mechanisms.
- The ERN is a response-locked negativity following errors thought to reflect automatic performance- and error-monitoring and generated by the anterior cingulate cortex (ACC).

Possible Cognitive Mechanism of ERN Generation
- ERN amplitudes are larger when task is attached to item of motivational significance (i.e., error commission earns fewer points, error commission is paired with aversive stimuli, participant is told to be accurate).
- ERN may be a cognitive mechanism to cue/motivate the brain to greater vigilance to task.

Error Processing in Affective Traits & State Conditions
- Clinical anxiety traits, mild chronic depression, or unusually high positive or negative affect traits correspond with larger ERN amplitudes.
- Participants who received negative feedback for error commission (thereby inducing a anxiety state) did demonstrate larger ERN amplitudes.
- Affective traits modulate attentional significance (and thus ERN amplitude) of error commission, yet it is unclear whether affect states do the same.

Hypotheses
- In mood-induced states, anxious participants were most attentive, happy and calm participants were intermediate attentive, and sad participants least attentive.
- This study investigates if participants in mood-induced states will demonstrate ERN amplitudes that correspond to the outcomes demonstrated in the above study in which greater attentiveness should correspond to larger ERN amplitudes and visa versa.

METHODS

Tasks
- Flanker Task
  - Identify direction of central arrow
  - 50% congruent (e.g., >>>>> or <<<<<)
  - 50% incongruent (e.g., <<<<> or >>><>)
  - 3 blocks, 200 trials/block

Mood Induction
- Participants instructed to listen to mood appropriate classical music selections and ruminate on past mood appropriate events for 10 minutes.
- Participants rated mood on 9-point valence by 9-point arousal grid before, during, and after mood induction task.
- Participants rated mood on this grid after blocks of Flanker task.

EEG Acquisition
- 128 channel sensor net
- Horizontal and vertical EOG
- Cz referenced
- 10-100Hz bandpass
- 250Hz sampling rate
- Impedence < 50 kΩ
- Average referenced

RESULTS

Behavioral Results 4-Group x 2 Congruency ANOVA

<table>
<thead>
<tr>
<th>Variable</th>
<th>Calm</th>
<th>Anxious</th>
<th>Happy</th>
<th>Sad</th>
<th>F Value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cong. Accuracy</td>
<td>0.98(0.01)</td>
<td>0.98(0.01)</td>
<td>0.98(0.01)</td>
<td>0.98(0.01)</td>
<td>3.42(3.13)</td>
<td>0.59</td>
</tr>
<tr>
<td>Incong. Accuracy</td>
<td>0.91(0.04)</td>
<td>0.90(0.05)</td>
<td>0.91(0.06)</td>
<td>0.91(0.06)</td>
<td>2.85(2.27)</td>
<td>0.50</td>
</tr>
<tr>
<td>Cong. RT</td>
<td>355.68(31.41)</td>
<td>346.86(19.83)</td>
<td>347.01(28.26)</td>
<td>360.41(33.29)</td>
<td>9.81(5.25)</td>
<td>0.00</td>
</tr>
<tr>
<td>Incong. RT</td>
<td>419.58(34.00)</td>
<td>416.02(26.15)</td>
<td>416.77(34.39)</td>
<td>428.15(34.20)</td>
<td>11.49(5.20)</td>
<td>0.00</td>
</tr>
<tr>
<td>Number Correct</td>
<td>525.88(35.91)</td>
<td>462.00(81.13)</td>
<td>476.81(70.32)</td>
<td>501.61(65.18)</td>
<td>14.23(5.20)</td>
<td>0.00</td>
</tr>
<tr>
<td>Number Error</td>
<td>21.08(11.84)</td>
<td>27.89(17.52)</td>
<td>25.38(16.67)</td>
<td>23.48(17.67)</td>
<td>0.85(0.85)</td>
<td>0.43</td>
</tr>
<tr>
<td>ERN Amplitude</td>
<td>-0.52(1.47)</td>
<td>-0.79(1.55)</td>
<td>0.07(2.33)</td>
<td>-0.86(1.47)</td>
<td>1.52(1.52)</td>
<td>0.22</td>
</tr>
<tr>
<td>ERN Latency</td>
<td>-3.45(2.72)</td>
<td>-3.42(3.13)</td>
<td>-2.85(2.27)</td>
<td>-3.90(3.12)</td>
<td>0.67(0.67)</td>
<td>0.50</td>
</tr>
<tr>
<td>LRN Amplitude</td>
<td>48.32(19.18)</td>
<td>47.40(18.21)</td>
<td>50.46(19.30)</td>
<td>47.82(21.59)</td>
<td>0.51(0.51)</td>
<td>0.69</td>
</tr>
</tbody>
</table>

CONCLUSIONS

- Mood-induced states did not correspond to ERN amplitude, which may suggest that mood states not attached to the significance of error commission are not involved in ERN generation.
- This explanation accounts for the absence of ERN amplitude changes in the state fear-induction study with tarantulas and for ERN amplitudes changes in anxiety state conditions in the verbal feedback study.
- Because ERN amplitude is not strictly related to affective states, but rather is likely related to affective states related to the significance of the error, studies should consider their findings in light of the motivational significance of errors.
- ERN amplitude is not a neurophysiological affective state indicator.

ACKNOWLEDGEMENTS

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- Thanks to Kevin Voisin for help with participants & Scott Steffensen the thesis referee.

EROS RESULTS

MOOD INDUCTION

Participants

<table>
<thead>
<tr>
<th>DemoGraphic &amp; Affective Scales</th>
<th>Calm</th>
<th>Anxious</th>
<th>Happy</th>
<th>Sad</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male(Female)*</td>
<td>12(13)</td>
<td>11(16)</td>
<td>13(13)</td>
<td>8(15)</td>
</tr>
<tr>
<td>Age</td>
<td>13.16(1.13)</td>
<td>13.57(1.30)</td>
<td>13.06(1.37)</td>
<td>13.39(1.52)</td>
</tr>
<tr>
<td>Years Ed.</td>
<td>5.48(3.87)</td>
<td>7.59(3.14)</td>
<td>6.19(3.89)</td>
<td>5.91(4.39)</td>
</tr>
<tr>
<td>BDI</td>
<td>52.40(17.48)</td>
<td>57.93(15.50)</td>
<td>55.31(15.85)</td>
<td>58.22(13.38)</td>
</tr>
<tr>
<td>STAI-S</td>
<td>37.48(6.66)</td>
<td>38.74(7.40)</td>
<td>36.88(8.16)</td>
<td>37.57(7.78)</td>
</tr>
<tr>
<td>Pos. Affect</td>
<td>11.92(5.94)</td>
<td>13.96(4.89)</td>
<td>15.04(5.46)</td>
<td>12.00(11.9)</td>
</tr>
</tbody>
</table>

*P<0.70, Person Chi-Square