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Predictors of Performance Monitoring Abilities following Traumatic Brain Injury: The Influence of Negative Affect, Cognitive Dysfunction, and Injury Severity

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INTRODUCTION

Performance Monitoring and Traumatic Brain Injury
• Survivors of severe traumatic brain injury (TBI) often demonstrate impairments in cognitive control and performance monitoring.
• Performance monitoring is a cognitive control process modulated by both cognitive and affective variables.
• Performance monitoring functions can be evaluated using the error-related negativity (ERN) and post-error positivity (Pe) components of the event-related potential (ERP).
  • ERN amplitude is decreased in individuals with severe TBI and high levels of NA.
  • ERN amplitude is also consistently altered in individuals with high levels of negative affect.
• Purpose: to determine the relative contributions of negative affect and cognitive abilities to reflections of performance monitoring following severe TBI.

METHOD

Task: Single Trial Computerized Stroop
• Color-naming condition (600 trials)
• 70% congruent (e.g., RED)
• 30% incongruent (e.g., RED)

EEG Acquisition
• 64 channel sensor net
• Impedence < 50 kW
• 250Hz sampling rate
• 10-100Hz bandpass
• Average re-referenced to electrodes Cz and Pz

ERP Reduction
• BESA artifact/EOG corrected
• 15Hz low-pass filter
• Response locked: –200 to 3000ms
• 200ms baseline correction

ERN
• Average of 15ms pre-to 15ms post-peak
• Average across 3 centro-parietal sites

Statistical Methods
• Scores on neuropsychological tests and measures of NA were standardized and combined to form “cognitive performance” and “negative affect” variables.
• Variables were converted to z-scores based on age- and sex-stratified data, and scores on neuropsychological tests and measures of NA were standardized and combined to form “cognitive performance” and “negative affect” variables.
• Multiple regression analysis with ERN amplitude as the dependent variable and cognitive performance and injury severity, cognitive performance, and negative affect variables as independent variables.

REGRESSION ANALYSES

Regression Model with ERN Amplitude as the Dependent Variable

<table>
<thead>
<tr>
<th>Variables</th>
<th>R²</th>
<th>F-value</th>
<th>p-value</th>
<th>B (Std. Error)</th>
<th>Beta</th>
<th>p-value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Model</td>
<td>0.58</td>
<td>6.81</td>
<td>0</td>
<td>-7.5 (18)</td>
<td>-0.76</td>
<td>0</td>
<td>1.13</td>
</tr>
<tr>
<td>NA composite</td>
<td>-0.38 (14)</td>
<td>0.58</td>
<td>0.02</td>
<td>1.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive composite</td>
<td>.04 (03)</td>
<td>0.27</td>
<td>0.21</td>
<td>1.46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Regression Model with Pe Amplitude as the Dependent Variable

<table>
<thead>
<tr>
<th>Variables</th>
<th>R²</th>
<th>F-value</th>
<th>p-value</th>
<th>B (Std. Error)</th>
<th>Beta</th>
<th>p-value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Model</td>
<td>0.26</td>
<td>1.47</td>
<td>0.2</td>
<td>-1.4 (31)</td>
<td>-0.11</td>
<td>0.06</td>
<td>1.13</td>
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<tr>
<td>NA composite</td>
<td>.54 (24)</td>
<td>0.63</td>
<td>0.64</td>
<td>1.6</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive composite</td>
<td>.07 (05)</td>
<td>0.43</td>
<td>0.14</td>
<td>1.46</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSIONS

• Both cognitive and affective composites significantly predicted ERN amplitude.
• NA is a stronger predictor of the ERN reflection of performance monitoring than cognitive performance or injury severity.
• With ERN amplitude as the dependent variable, the regression model was statistically significant—accounting for 58% of the variance in ERN amplitude.
• Increased levels of NA are associated with decreased ERN amplitude.
• Cognitive performance, but not NA, predicted Pe amplitude; although the model was not statistically reliable.
• Cognitive composite was negatively correlated with level of error-rate interference, length of LOC, and length of PTA.

Implication 1: The dissociation between the ERN and Pe: It is possible the ERN may be more related to affective processes, and the Pe related to cognitive processes.

Implication 2: Examining levels of NA may be at least equally useful in evaluating performance monitoring decrements as typical cognitive performance measures.

ACKNOWLEDGEMENTS

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