Transcranial Electrical Stimulation to Sustain Aviator Performance: The Effects of Timing of Stimulation and Individual Differences

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The United States Army’s Future Vertical Lift (FVL) will likely include increased automation that will require for aviators to sustain attention to react to manual cues while performing long-duration flights and missions. Transcranial direct current stimulation (tDCS) has been shown to enhance attention and performance. The United States Army Aeromedical Research Laboratory (USAARL) conducted a study to test if tDCS can sustain aviators’ attention during high performance flights while delivering active and sham stimulations.

15. SUBJECT TERMS  
transcranial direct current stimulation, tDCS, Future Vertical Lift, FVL

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The U.S. Army Future Vertical Lift (FVL) program will likely include increased automation longer duration missions where Aviators will likely be required to sustain attention to react to manual cues.

Transcranial Direct Current Stimulation (tDCS) can aid aviators’ attention by delivering a low intensity current (1 to 2 milliamps) to the brain through electrodes placed on the scalp (Brunoni et al., 2012; Dedoncker et al., 2016).

The main objective of this study was to test if tDCS can sustain aviators’ performance due to its effects on alertness and attention.

**Methods**

- Total of twenty-six male Aviators, max age was 40 years ($M = 36.69; SD = 2.75$).
- Aviators were required to have a minimum of 200 hours and had flown in the previous six months.
- Single-blinded, randomized, sham-controlled, mixed design to evaluate the main effects of stimulation and the time of delivery (prior to the flight and during the flight) on flight performance.
- Participants were randomly assigned groups, 10 members in "preflight stimulation group, 12 members in "during flight stimulation group and 4 members in the control group.
- 18 questionnaires and cognitive task were used to measure individual differences of performance outcomes and the duration of the stimulation effects.

**Results**

<table>
<thead>
<tr>
<th>Portion of Flight</th>
<th>Outcome</th>
<th>Sham Mean</th>
<th>Sham SD</th>
<th>Active Mean</th>
<th>Active SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-Flight</strong></td>
<td><strong>RMSD Altitude</strong></td>
<td>32.00</td>
<td>5.32</td>
<td>34.10</td>
<td>7.82</td>
</tr>
<tr>
<td></td>
<td><strong>RMSD Airspeed</strong></td>
<td>1.33</td>
<td>0.63</td>
<td>1.26</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td><strong>RMSD Heading</strong></td>
<td>1.15</td>
<td>0.45</td>
<td>1.06</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td><strong>Torque Split ID</strong></td>
<td>215.00</td>
<td>63.00</td>
<td>207.00</td>
<td>105.00</td>
</tr>
<tr>
<td><strong>Post-Flight</strong></td>
<td><strong>RMSD Altitude</strong></td>
<td>42.30</td>
<td>13.60</td>
<td>37.70</td>
<td>8.94</td>
</tr>
<tr>
<td></td>
<td><strong>RMSD Airspeed</strong></td>
<td>1.50</td>
<td>0.94</td>
<td>1.42</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td><strong>RMSD Heading</strong></td>
<td>1.57</td>
<td>1.22</td>
<td>1.73</td>
<td>1.49</td>
</tr>
<tr>
<td><strong>Approach</strong></td>
<td><strong>Glideslope</strong></td>
<td>0.17 (a)</td>
<td>0.15</td>
<td>0.05 (b)</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td><strong>Localizer</strong></td>
<td>0.09</td>
<td>0.08</td>
<td>0.07 (c)</td>
<td>0.06</td>
</tr>
</tbody>
</table>

- There were no statistically significant differences within or between groups for either the pre-turn or post-turn metrics.
- Approach metrics: both glideslope and localizer values were statistically different between groups, \(t(9.33) = 2.49, p = 0.033, d = 1.62; t(15.46) = 2.92, p = 0.010, d = 1.50\), respectively.
- There was a statistically significant difference between the sham and active conditions within the during flight group for glideslope values, \(t(10) = -2.57, p = 0.028, d = 1.50\).

**Discussion**

- The findings suggest that tDCS improves aviators’ performance outcomes during attentional tasks when stimulation is applied during flight. This was important to determine whether tDCS can be used prescriptively during long duration flight missions that can tax attention in a high performance operation.
- Future research should further examine whether there are non-inflight applications for which tDCS can benefit the aviator.
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