Psychomotor Vigilance Task Evaluation for Touchscreen Devices

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Background of PVT

• PVT-192 – widely used in laboratory studies
• Palm-PVT – 5-min widely used in field studies.
• Various PVTs developed for laptop use and hand-held mobile devices.
# Background of PVT

<table>
<thead>
<tr>
<th>PVT-192</th>
<th>Palm-PVT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulky, used on laboratory</td>
<td>Small, easy to carry around – used in the field</td>
</tr>
<tr>
<td>Cannot be used by multiple subjects</td>
<td>Can be used easily by multiple subjects (distinguished by study code and name)</td>
</tr>
<tr>
<td>Subjects have to declare their handedness in advance</td>
<td>Handedness can be entered just before first session</td>
</tr>
<tr>
<td>LED display</td>
<td>LCD display</td>
</tr>
<tr>
<td>Running-timer stimulus</td>
<td>Black-and-white circular target</td>
</tr>
<tr>
<td>Immediate feedback</td>
<td>Feedback is provided at the end of each session</td>
</tr>
<tr>
<td>ISI – 2-10s following a rectangular distribution</td>
<td>Uses N discrete foreperiods determined by a user-specified step size and then randomizes without replacement in blocks of 2N.</td>
</tr>
</tbody>
</table>
Study goal

- To develop and validate a PVT for touchscreen devices that would have the same characteristics as PVT-192.
NASA - PVT

- It has the same features as PVT-192
  - ISI interval 2-10 sec, randomly (rectangular distribution)
  - Stimulus represented by a milliseconds-counter in a small rectangular box
  - Left and right areas predefined on the screen to serve as left or right buttons
  - Immediate feedback
NASA-PVT

- Presence of FS or ERR on screen when participants react too fast to the stimulus or use the wrong finger to answer to the stimulus.
- The handedness can be entered at the beginning of the first session.
- It can be used by multiple subjects (change study code and id).
Study protocol/Participants

- 10 participants (5 males, 5 females) between 19 and 38 years of age (M = 25.1, SD = 6.17)

O = Orientation

* = 5-min PVT-192, 5-min Nasa-PVT

Participant is discharged home in a cab or with a friend/family member
Touchscreen device latency

- Latency - the time between user action (touches the screen) and the system’s response.
Touchscreen device latency

- Device latency = 77.42 (16.77).
- The mean device latency was subtracted from each PVT trial before analyzing the PVT data.
PVT outcome

- Mean 1/RT - reciprocal response time or response speed, measured in seconds.
- Lapses - the cumulative number of RTs exceeding 500 ms.
- Fastest 10% RT - the fastest 10% of response times for all trials. It indicates the best performance a participant is capable of producing.
- Slowest 10% 1/RT (cognitive slowing) - the slowest 10% of reciprocal response times for all trials. It indicates the vigilance response slowing.
- Mixed effects ANOVA with 2 two within subjects factors: Time and PVT type.
Mean 1/RT

- Main effect of time \((p < .001)\) The mean 1/RT of both PVTs became worse over time.
- Significant linear decrease in performance over time for both PVTs.
- Main effect of PVT \((p = .001)\) The mean 1/RT for the two PVTs were significantly different overall.
Lapses

• Main effect of time ($p < .001$). The mean lapses of both PVTs increased significantly across time.
• Significant linear increase in lapses over time for both PVTs.
• No main effects of PVT.
Slowest 10% of 1/RT

- Main effect of time (p < .001) The mean slowest 10% 1/RT of became significantly worse across time.
- Significant linear decrease in performance over time for both PVTs.
- Main effect of PVT (p < .01).

![Graph showing performance over time for PVT-192 and NASA-PVT]
Fastest 10% RT

• Main effect of time ($p < .001$) The mean fastest 10% RT of both PVTs changed significantly across time.
• Significant linear increase over time for both PVTs.
• Main effect of PVT ($p < .05$).
Conclusions

• NASA-PVT follows the same shape and is similar on mean RTs and lapses after the latency cutoff was applied.
• Our results are limited to acute sleep deprivation.
• Future studies -
• Problems with touchscreen devices: latency, double touch, variability within and between subjects.
Problems with touchscreen devices

• Latency
• Double touch
• Variability of latency between trials in the same test for the same subject
• Variability of latency between subjects
Contributors

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