A Three-Minute Mobile Version of The Psychomotor Vigilance Task

Sean Deering,[1,2] Adam Amdur,[2]

Joe Borelli, MD,[2] Will Headapohl,[2] & Carl Stepnowsky, PhD[1,2,3]

[1]Health Services Research & Development Unit, VASDHS; [2]American Sleep Apnea Association; [3]Department of Medicine, UCSD

sleepapnea.org
American Sleep Apnea Association

Introduction

The Psychomotor Vigilance Task (PVT) is timed test of sustained attention that assesses response times to visual stimuli. The standard PVT is computer-based and 10 minutes in duration (Dinges & Powell 1985). The PVT is one of the most widely employed measures of behavioral alertness and has been shown to be sensitive to sleep loss (Tucker et al., 2009).

3 and 5-minute PVT variants have been demonstrated to be comparable to the original 10 minute PVT at detecting sleep-related attention decrements (Basner & Dinges 2011, Thorne et al., 2005, Lamond et al., 2005), although one study found that the 5-minute PVT may be less sensitive to sleep loss than the original (Lamond et al., 2008). While the 10-minute PVT remains the standard, shorter versions are promising due to relatively good sensitivity and specificity in detecting sleepiness as well as greater utility in the field.

A 3-minute version of the PVT was included as part of the Sleephealth Mobile App Study (SHMAS) as an objective measure of alertness which could be compared to self-reported sleep metrics. SHMAS is an observational study available to adults 18 years of age and up residing in the United States via the Apple App Store. The SHMAS is focused on learning more about (1) app-based sleep research and (2) developing a better understanding about the relationship between sleep and next day functioning.

Methods

The 3-minute PVT was administered to SHMAS participants via mobile device. Participants were encouraged to complete the PVT at least once per day, but could complete more or less if they chose to.

Participants were instructed to hold their mobile device with their dominant hand while tapping the screen with their thumb or index finger as soon as the target stimuli appeared onscreen. At the end of the task, average reaction time (RT) was displayed and daily RTs were viewable and trackable on the SHMAS dashboard.

Lapses of attention were defined as RTs ≥ 500ms, although participants were not shown information about lapses at the end of a successful PVT block. Notifications to take the PVT were sent at random times once daily.

Figure 1. The instruction screen for the SHMAS Alertness Checker (3-minute variant of the Psychomotor Vigilance Task).
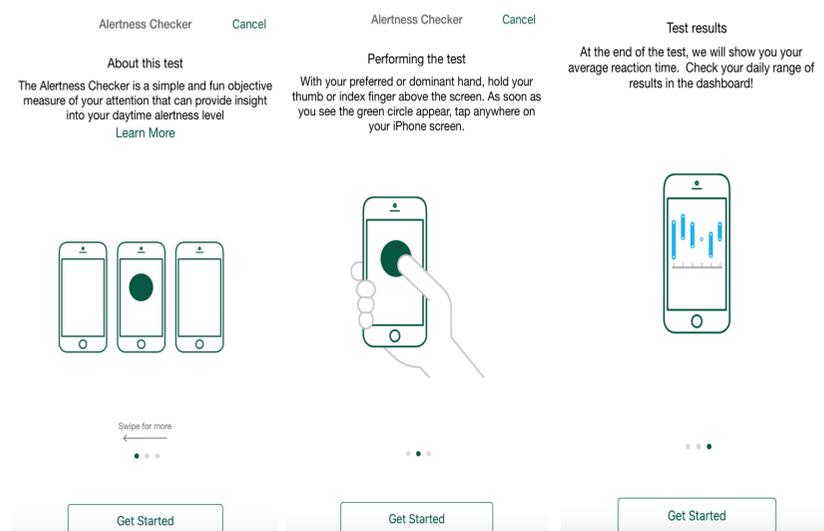
Results

Of 10,676 consented SHMAS participants, 5,473 completed at least one PVT session and 24,633 PVTs were started. Data were excluded from 161 participants who did not complete the task as intended (either completed <80% of trials or had >20% trials with false starts). Analyses were performed on 22,507 valid PVT trials (91%).

2,429 participants (44%) completed 1 session, 1,096 participants (20%) completed 2, 1,087 participants (20%) completed 3-5, and 861 participants (16%) completed ≥ 5 sessions. 417 participants completed ≥ 10 sessions. Mean RT was 481.1ms (SD=170ms; range: 183.6-5768.2ms) and mean lapses were 11.1 (SD=11.0; range: 0-45).

We combined cleaned first-night participant PVT data with self-reported TST data for the night prior to PVT administration, and assigned participants to groups based on percentile ranking (3-6, 6-7, 7-8, 8-12). We then calculated descriptive statistics of interest for each group (Mean RT, Median RT, Mean Lapses). Of note, we found a U-shaped pattern for both Mean Lapses and Median PVT RT, with the 7-8h group exhibiting the lowest Lapses and RTs. Using a lapse threshold of 11 (Basner & Rubenstein 2011), we found that participants in the 7-8h group would meet the criteria for high-performers using the aforementioned lapse threshold, whereas Groups 1, 3 and 4 were at or above that threshold. Although more research on shorter PVT variants is needed, our findings suggest that a 3-minute mobile PVT may be sensitive to sleep loss.

Figure 2. Mean lapses (RT ≥ 500ms) and Median PVT RT by TST groups. Participants in the 7 to 8h group showed the lowest mean lapses at 9.2 ± 9.7 (0-42).
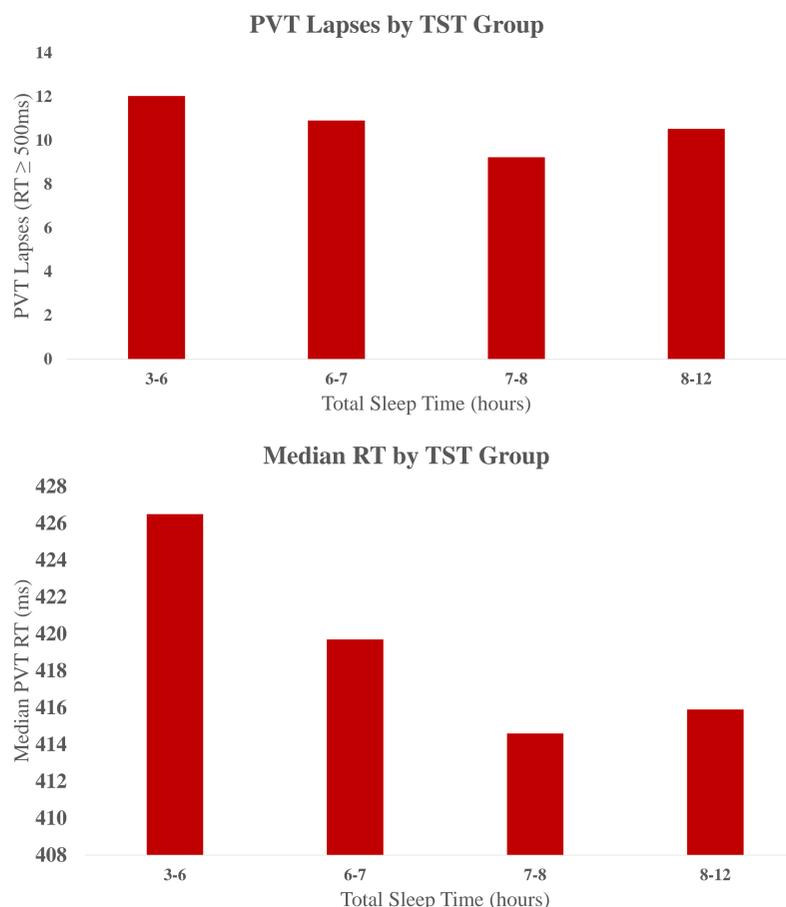

PVT Lapses by TST Group

Median RT by TST Group

Table 1

Table 1. Lapses and Mean Total Sleep Time (TST) Grouped by Mean TST. All Values are Mean ± SD (Range).

	Lapses	TST
Group 1 (n=684) 3 to 6h	12.0 ± 11.3 (0-43)	5.0 + 0.83 (3-6)
Group 2 (n=685) 6 to 7h	10.9 ± 11.1(0-43)	6.5 ± 0.38 (6-7)
Group 3 (n=685) 7 to 8h	9.2 ± 9.7 (0-42)	7.4 ± 0.34 (7-8)
Group 4 (n=685) 8 to 12h	10.5 ± 10.8 (0-43)	8.8 ± 0.84 (8-12)

Discussion

Many study participants were willing to complete the PVT more than once, and over 400 were "power users," meaning that they completed it ten or more times. The vast majority completed the task as instructed. This demonstrates that a mobile PVT used in conjunction with a mobile research study can potentially collect large amounts of useful and informative data. These data, when combined with other sleep metrics may provide useful insights into the relationship between individuals' sleep quality and daytime functioning.

Limitations/Future Directions

The SHMAS is currently limited to iOS devices. An Android version is currently in development, which will make the study along with the mobile PVT accessible to a wider range of participants. The SHMAS was carried out via mobile device, and not in a traditional lab setting. Many participants reported the shortened 3-minute PVT to be too time consuming, preventing them from using it over an extended period of time. Due to the paucity of studies on the reliability and validity of the 3-minute PVT, more research on this subject is needed.

References

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