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Letter to the Editor

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A response to Basner et al. (2021): "Response speed measurements on the psychomotor vigilance task: how precise is precise enough?"

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Dear Editor,

The recent article by Basner et al. (2021), *Response speed measurements on the psychomotor vigilance test: how precise is precise enough?* [1] raises important issues regarding recording system biases when conducting the psychomotor vigilance test (PVT). Their aim was to establish to what extent system latency bias and variability would influence common outcome variables. To do this, they took previously recorded 10-minute PVT data from healthy adults after either total sleep deprivation or partial sleep deprivation and introduced increasing levels of bias and variability to the recorded response times (RT). They evaluated at what point the outcome measures of speed (1/RT) and number of lapses (RT > 500 ms) surpassed predefined thresholds (±0.1/second, ±1 lapse) in 5% of the data. Their conclusion is that a latency bias of ±5 ms with a standard deviation of ≤ 10 ms are the maximally allowable margins for PVT recording systems.

We fully support the authors' recommendation that future studies record and report system latency bias and variability, as this information can be critical when comparing different studies. However, we believe that the proposed thresholds may be unnecessarily strict, and result in many researchers unable to meet these equipment standards and possibly forgoing the PVT entirely. While dedicated hardware for recording the PVT exist (e.g. PVT-192, Ambulatory Monitoring, Ardsley, NY [2]), oftentimes in practice the easiest and sometimes only " solution is to run the test on commercially available computers and mobile devices. When running on time-sharing operating systems (i.e. Windows, iOS, Android) with different input equipment (keyboards, touchscreens, etc), there will always be a certain degree of uncontrollable recording latency and variability. While reducing these biases as much as possible is important, meaningful results can still be obtained with less precise recording devices.

It is important to note that the recommended allowable latency bias of ±5 ms is relative to biases of the authors' own recording system; all PVT devices are real-time systems, and a negative latency bias is not possible. It is therefore likely that the "true" margins are less stringent, although any negative latency bias compared to the authors' own recording system would be desirable. Furthermore, once the average recording system latency is measured, it becomes possible to remove any systematic latency bias from the recorded RTs, and therefore the primary concern becomes system latency variability.

Ultimately, the maximally allowable margins for PVT recording systems should depend on the application. For research purposes, this is not an issue of "validity" but rather "sensitivity"; more sensitive equipment means greater ability to discriminate smaller changes. Increases in the variability of system latencies will impact the PVT's sensitivity to changes in performance by increasing overall standard deviations and thus reducing effect sizes. The less additional variability is present in the data, the closer the calculated effect sizes will be to the "true values," and the more sensitive the PVT will be to smaller changes. In practice, a study investigating the effects of mild sleep restriction will need especially sensitive equipment to detect changes in RTs of tens of milliseconds. Conversely, research in sleep deprivation can afford more system latency variability, given that changes in RTs are in the order of hundreds of milliseconds [3]. When comparing outcomes of the PVT across studies, or when referencing normative data, standardized equipment calibration becomes more critical. Here again, however, acceptable calibration margins will depend on the underlying variability in RTs, the expected effect sizes, and the thresholds of interest.

Having the least amount of system latency bias and variability is always preferable. Practical applications of the PVT, such as a fitness-for-duty test, will require standardized and well-calibrated equipment. However, until such standards can be easily achieved, sleep research can still benefit from the PVT performed on a variety of equipment and a variety of calibration standards, provided that an appropriate signal-to-noise ratio can be achieved.

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References

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