

The Effects of Primary Light Sources on Worker Performance and Alertness

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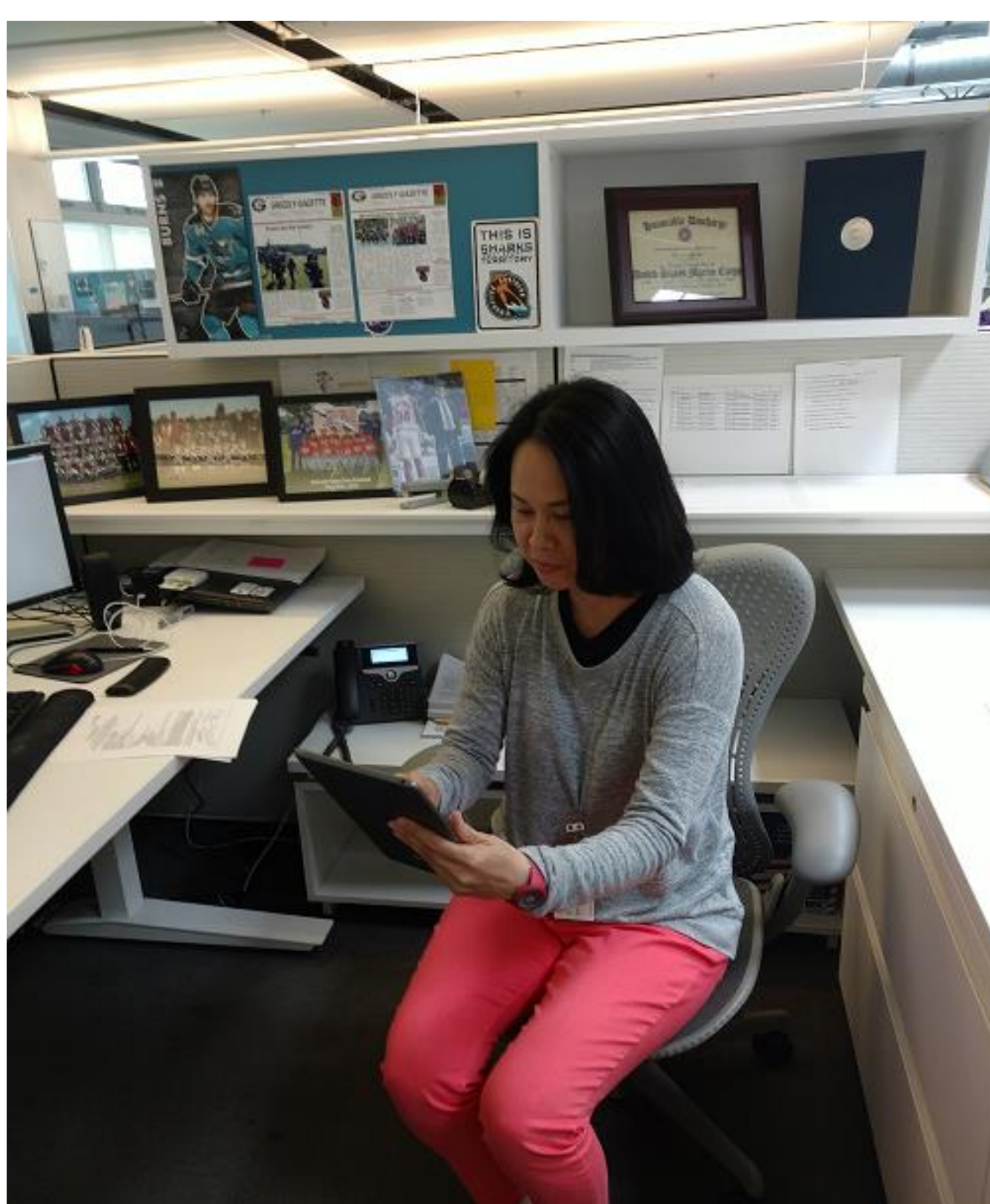
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Background

Traditional office buildings use a variety of primary light sources (e.g., LED/fluorescent lights). As interest in LEED certified office buildings increase and research has shown that enhanced lighting design improves human performance and alertness (Viola et al., 2008; Juslén & Tenner, 2005; Edwards & Torcellini, 2002), more office buildings are incorporating a daylighting design. We investigated the differences between employee performance and alertness in two different building types (daylight vs. artificial light). We hypothesized that employee performance and sleep duration would be improved in a building designed to increase exposure to natural daylight compared to traditional office settings.

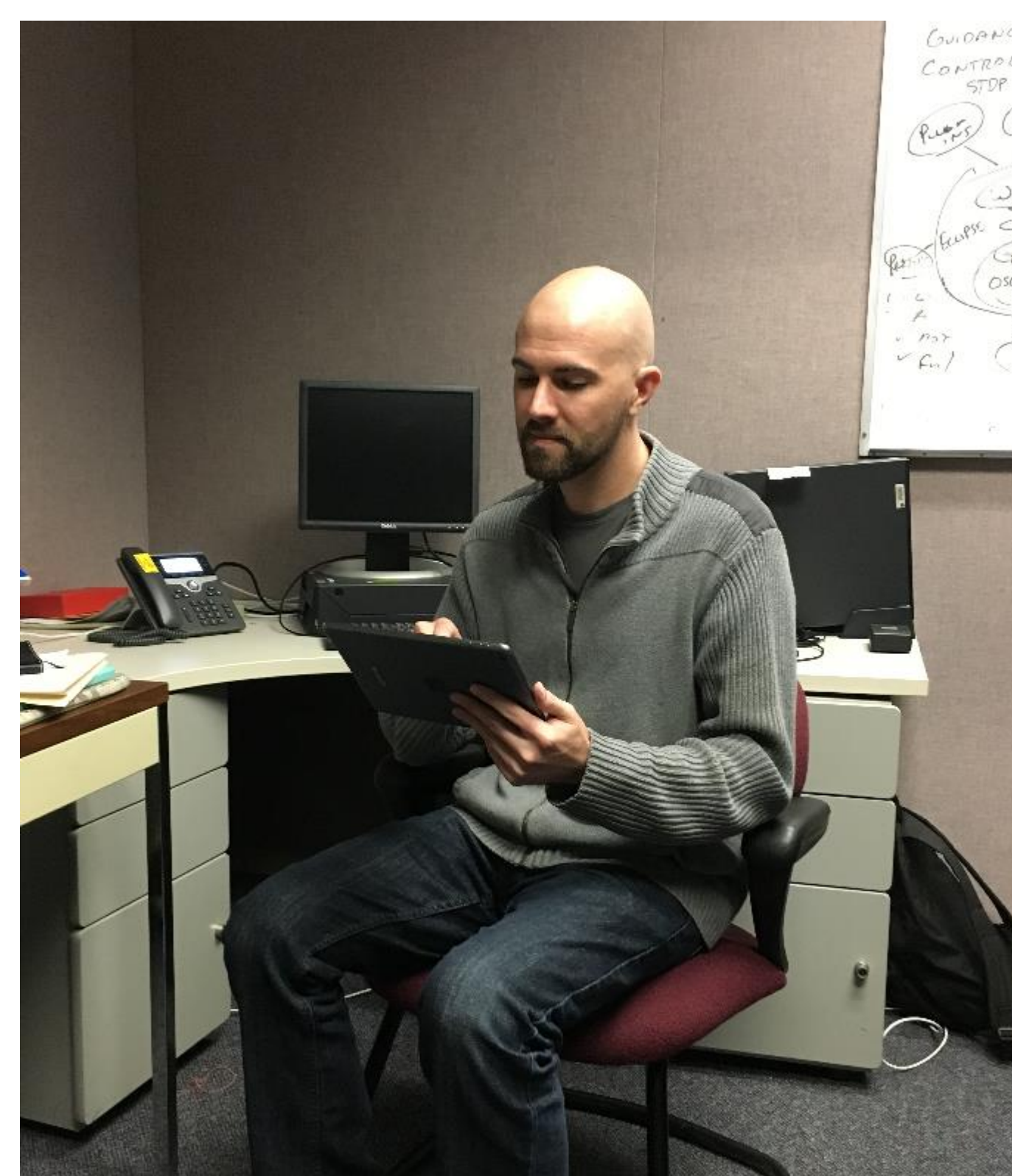
Methods

LEED certified sustainable building (SUS)



Primary light source: sunlight

Traditional office building (TRA)



Primary light source: florescent lights

- Participants age and gender-matched
- Sleep outcomes collected via actigraphy (Actiwatch II, Phillips Respironics) and daily sleep diaries
- Psychomotor Vigilance Task (PVT) completed upon arrival to work, midday and prior to leaving work over five days
- Data analysis via paired t-tests

Results

- No significant differences in sleep or performance outcomes between buildings
- SUS light range: 13.1-155 lux; TRA light range: 1.03-94.2 lux

	SUS (mean, range)	TRA (mean, range)
Age (years)	36.6 (18-66)	33.9 (19-56)
Gender	8 females, 12 males	8 females, 12 males
Sleep Duration	5.99 hrs (2.90-9.08)	5.87 hrs (2.43-9.17)
Habitual Sleep Time	23:24 (21:30-01:00)	00:12 (21:30-03:18)
Habitual Wake Time	07:36 (06:30-8:54)	07:48 (05:00-10:24)
PSQI	5.85 (3-10)	6.05 (2-10)
MEQ	50.75 (39-65)	50.35 (27-69)

References

- Viola, A. U., James, L. M., Schlangen, L. J., & Dijk, D. J. (2008). Blue-enriched white light in the workplace improves self-reported alertness, performance and sleep quality. *Scandinavian journal of work, environment & health*, 297-306.
- Juslén HT, Tenner AD. (2005), Mechanisms involved in enhancing human performance by changing the lighting in the industrial workplace. *International Journal of Industrial Ergonomics*. 35, 843-855.
- Edwards, L., & Torcellini, P. (2002). Literature Review of the Effects of Natural Light on Building Occupants (No. NREL/TP-550-30769). National Renewable Energy Lab., Golden, CO.(US).

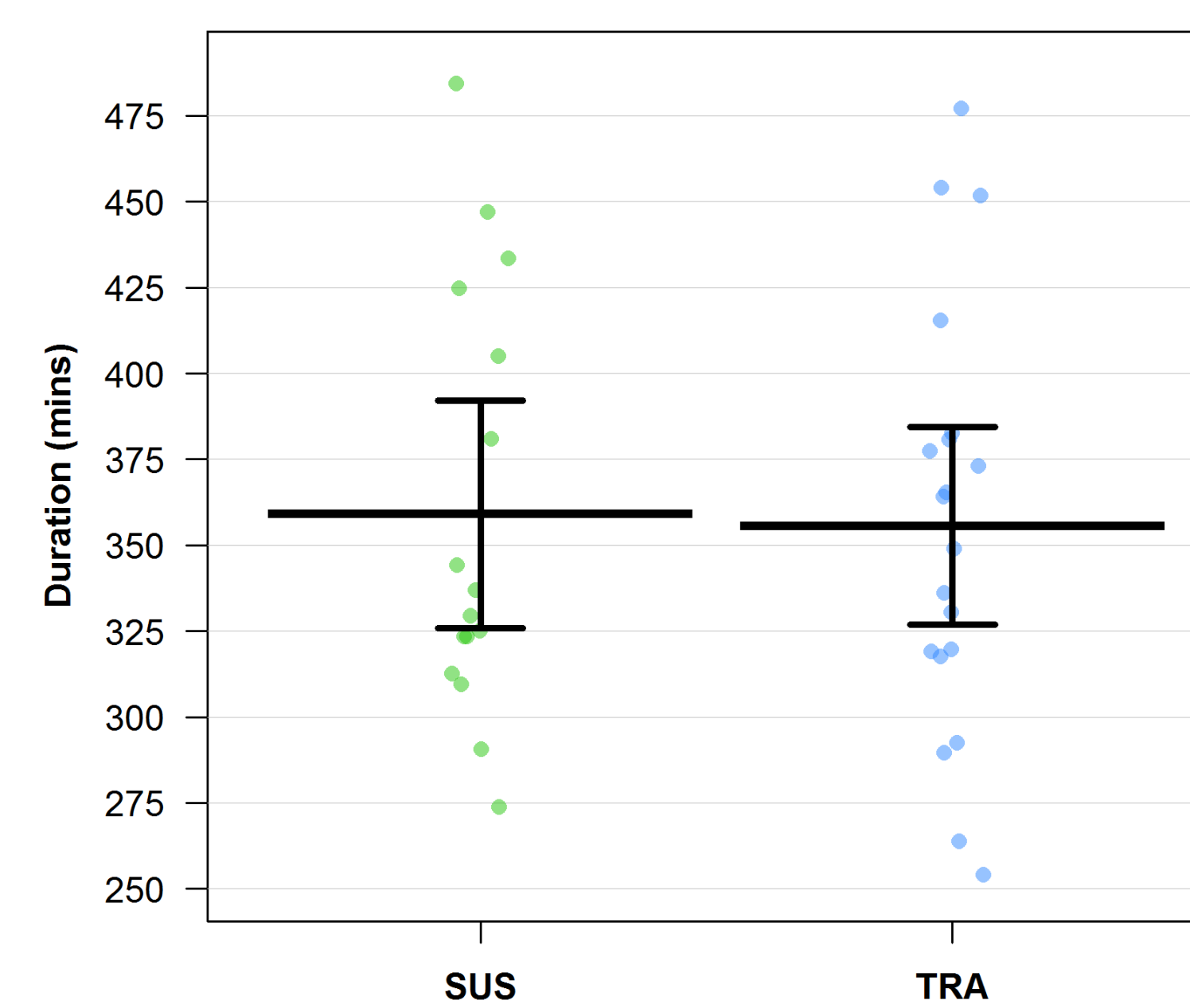


Fig. 1: Average sleep duration of participants from the sustainable (SUS) and traditional (TRA) office buildings.

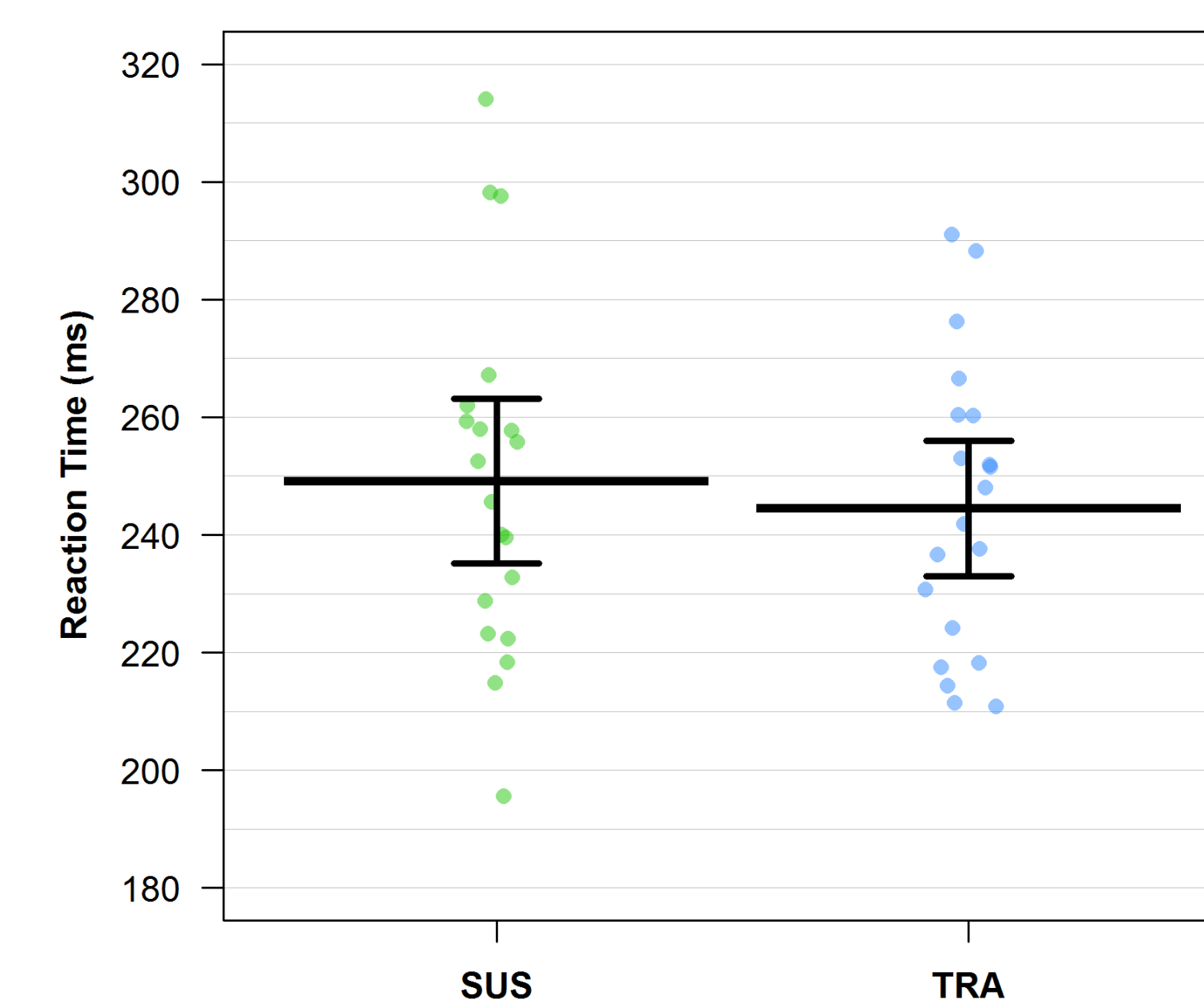


Fig. 2: Mean reaction time. SUS (249.13 ± 29.93) vs. TRA (244.51 ± 24.64); $t(19) = 0.53$, $p = 0.60$, $d = 0.16$

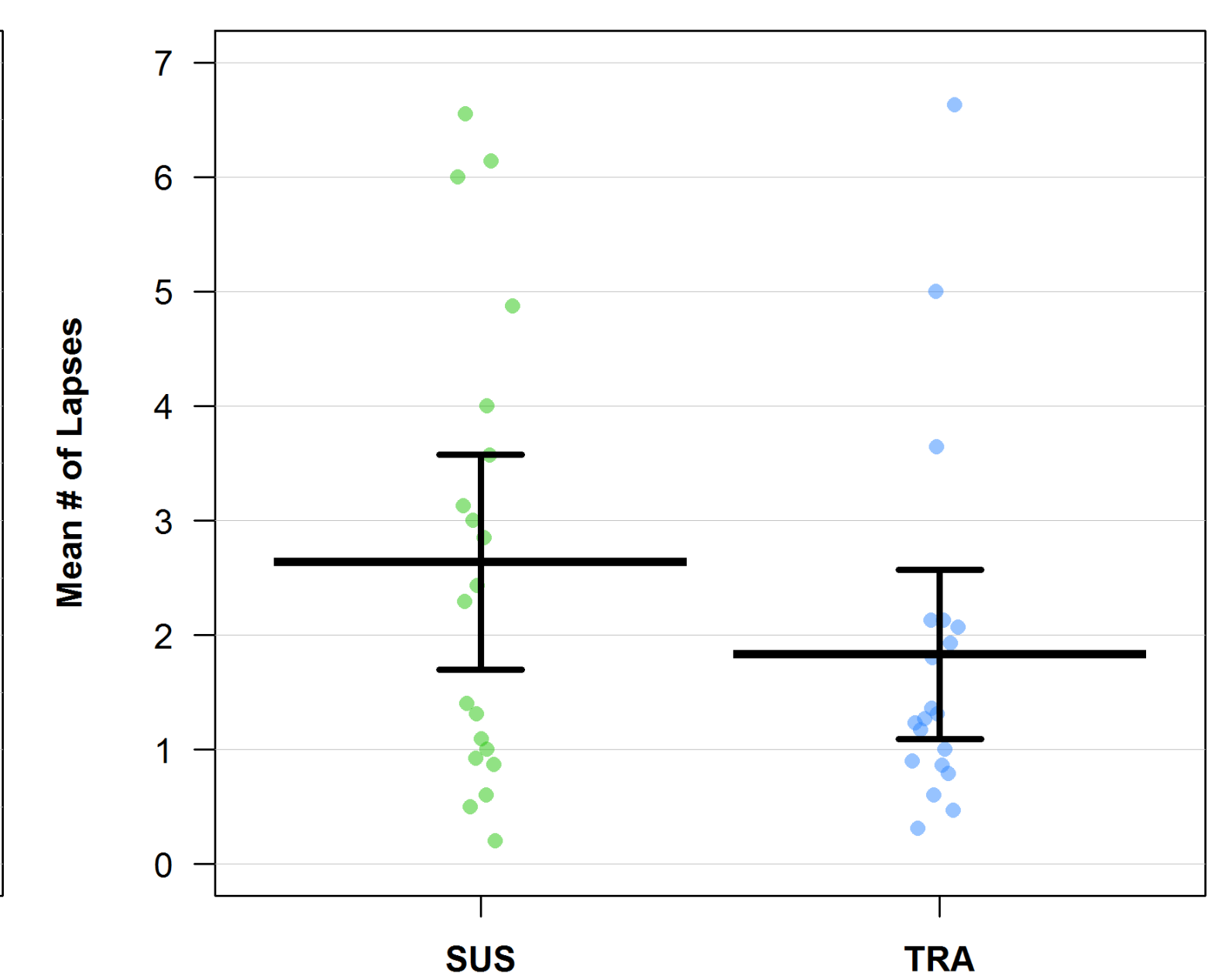


Fig. 3: Mean # of lapses. SUS (2.64 ± 2.00) vs. TRA (1.83 ± 1.58); $t(19) = 1.46$, $p = 0.16$, $d = 0.36$.

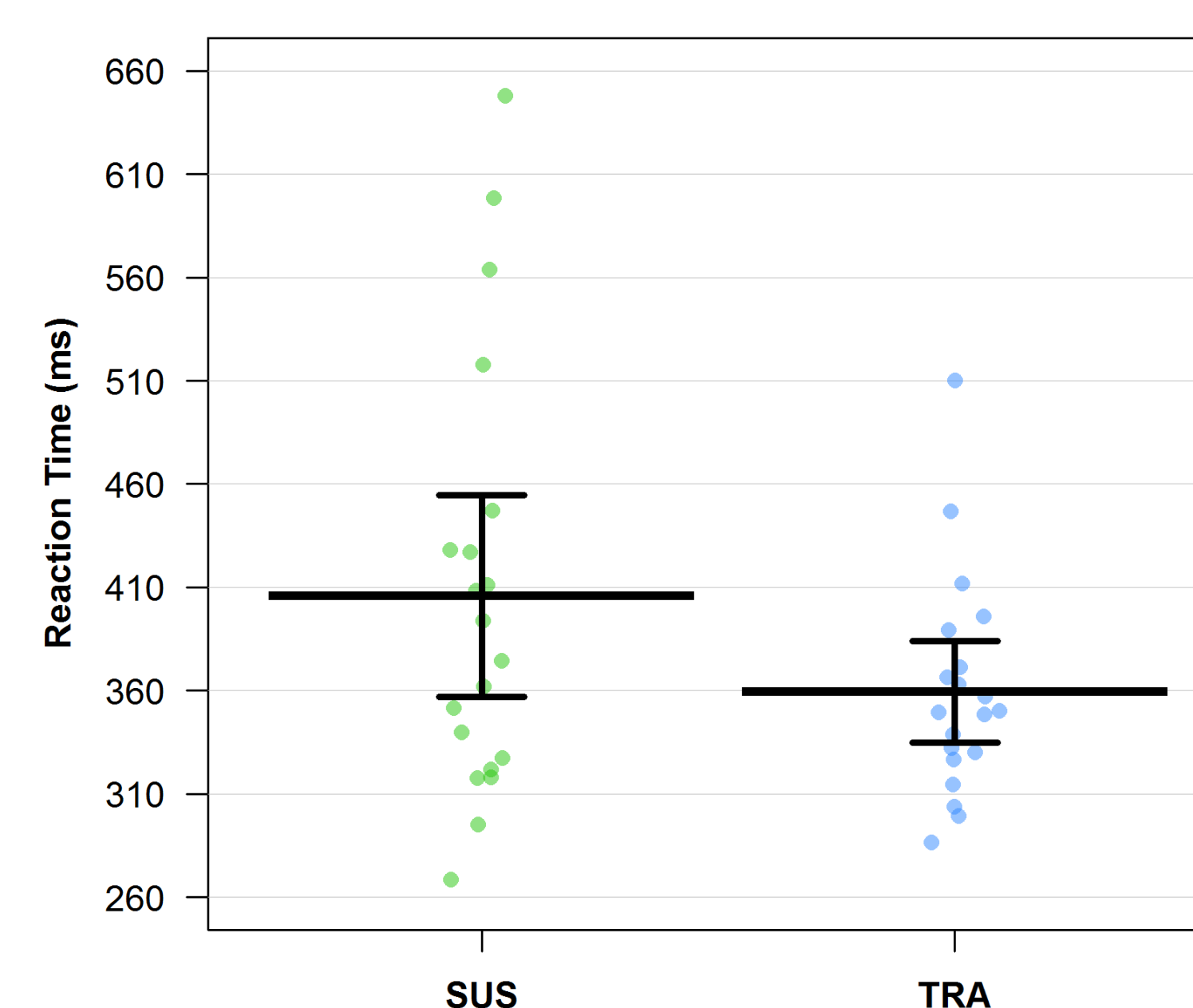


Fig. 4: Slowest 10% means. SUS (405.86 ± 104.12) vs. TRA (359.44 ± 52.81); $t(19) = 1.81$, $p = 0.09$, $d = 0.56$.

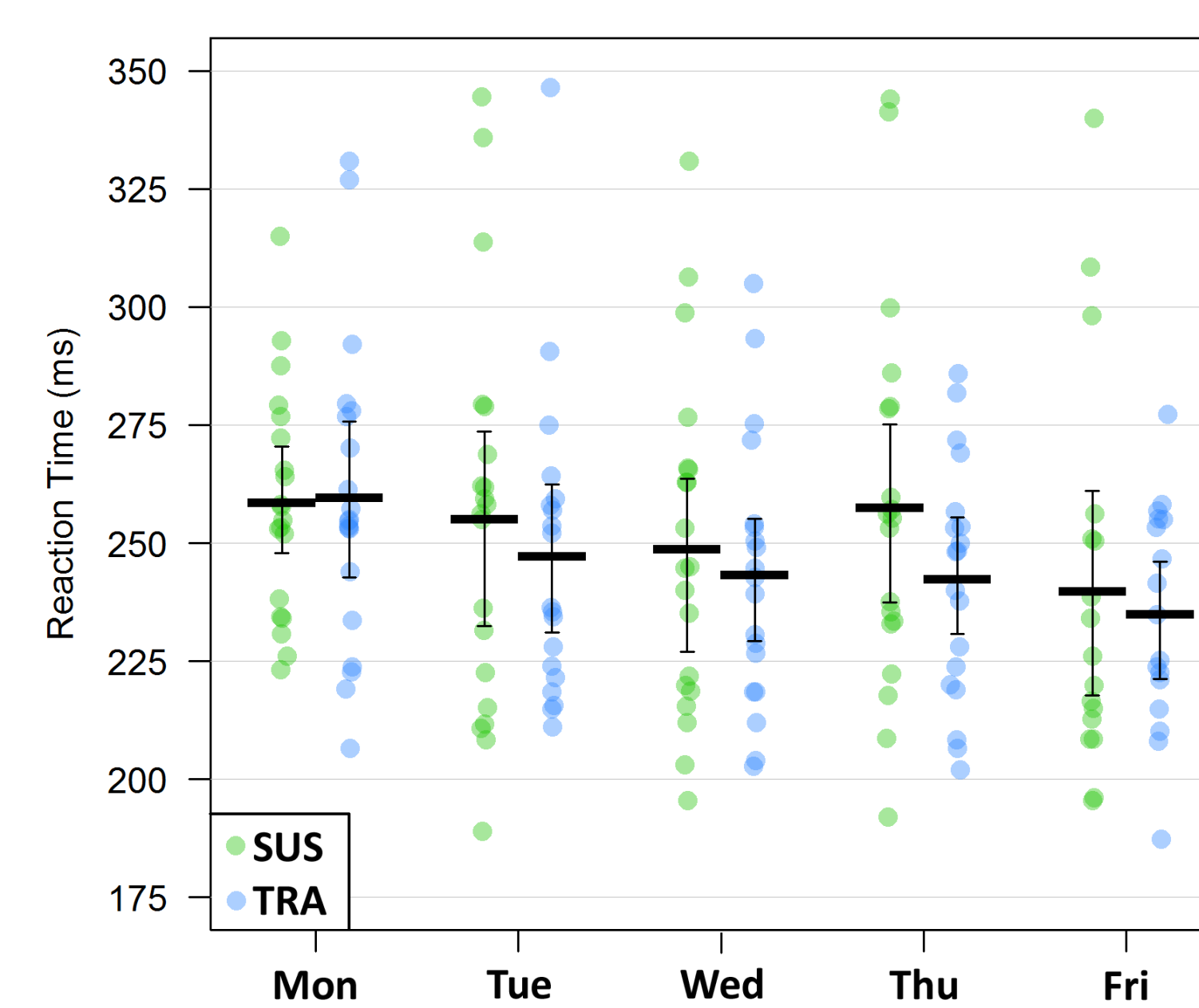


Fig. 5: Mean Reaction Time Across Work Week

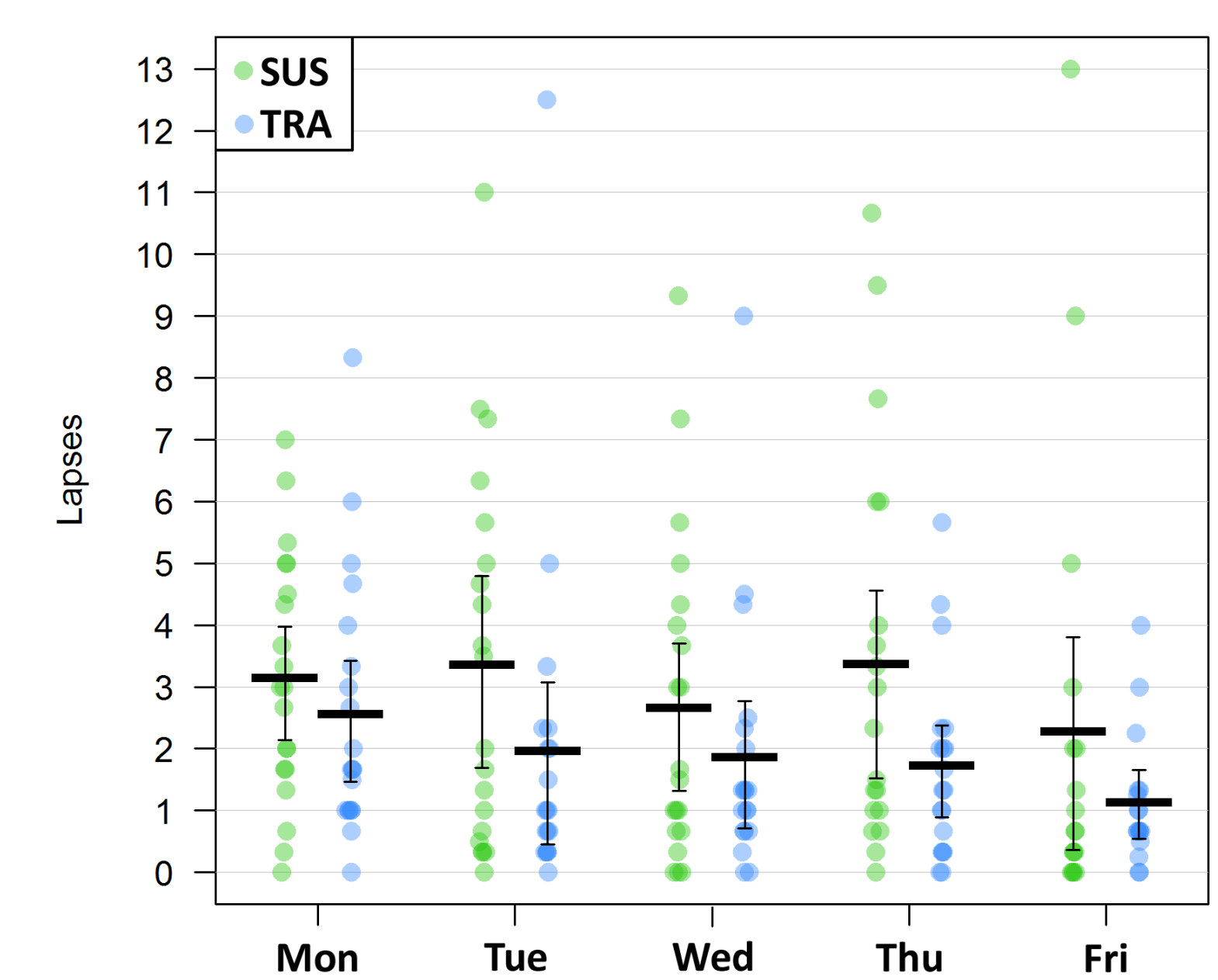


Fig. 6: Mean Lapses Across Work Week

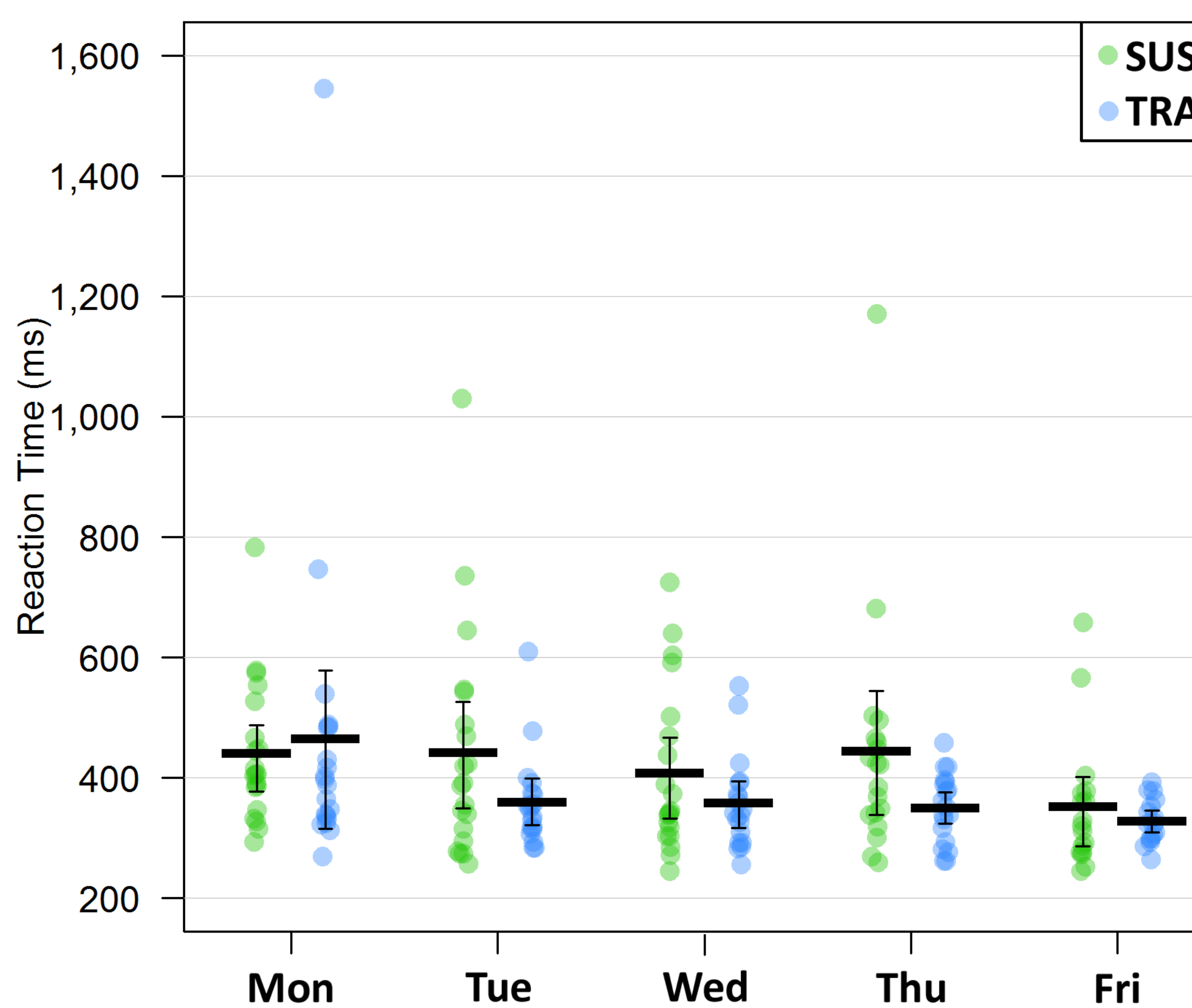


Fig. 10: Mean Slowest 10% Across Work Week.

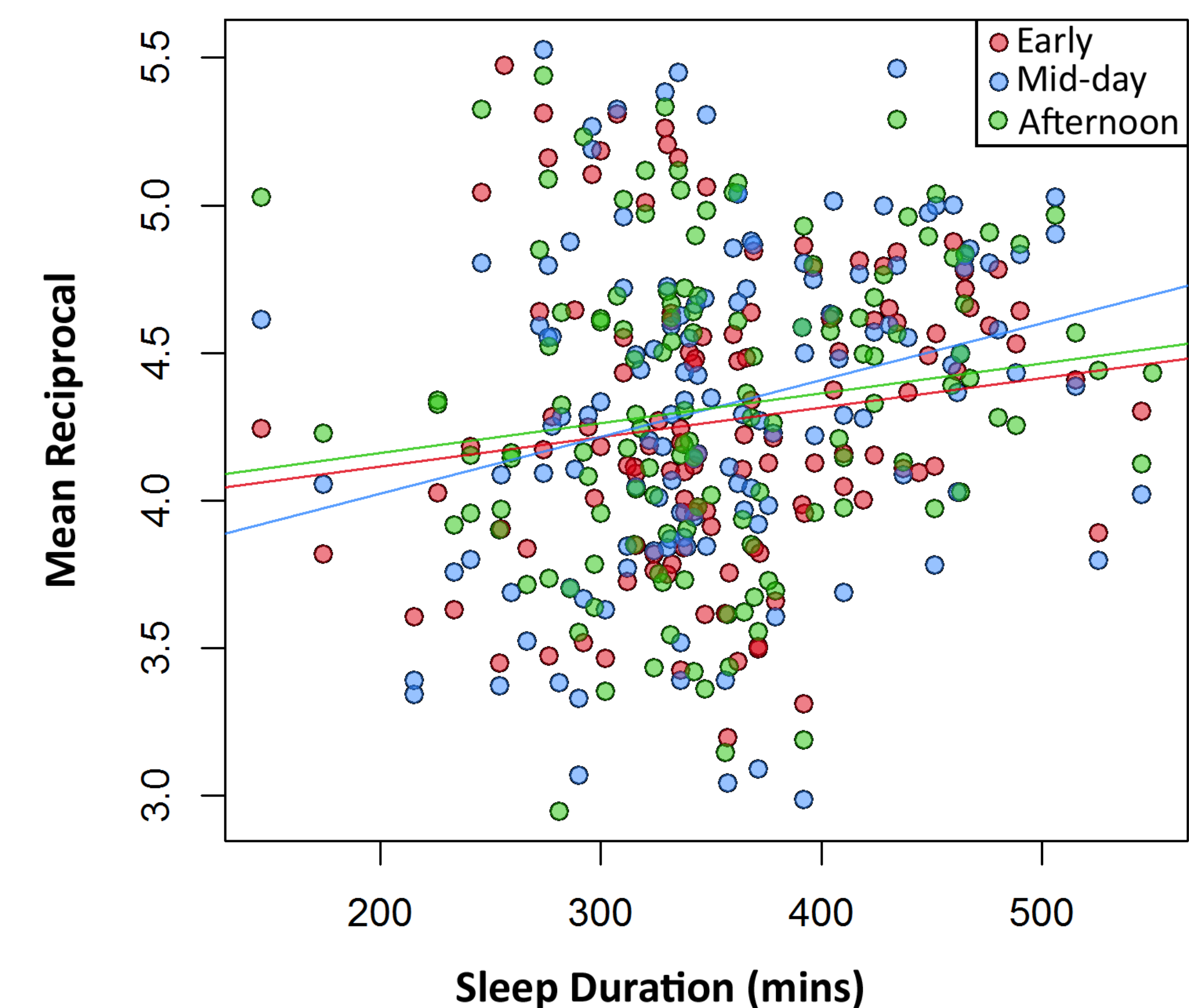


Fig. 11: Relationship between sleep duration and reaction time. Early $r = .14$; Mid-day $r = .26$; Afternoon $r = .15$.

Conclusions

- Exposure to natural light in the work environment was not associated with improved performance or sleep duration despite differences in light levels
- Sleep duration averaged less than six hours per night
- It is possible that enhanced lighting design is not sufficient to improve performance among individuals who are chronically sleep deprived
- We did not collect information about other aspects of health and wellness, which may be improved with exposure to natural light