

Repeated Real-Time Measurement of Cognition Using a Digital N-Back Task: A Pilot Study



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Introduction

- Ecological momentary assessment (EMA) is a form of data collection involving repeated assessment of affect, behavior, and cognitions in real time that can be useful for gathering detailed real-time information to identify patterns and fluctuations in behavior over time (Shiffman et al., 2008)
- Despite the advantages, utilizing EMA to obtain an objective measure of cognition is particularly challenging because practice effects may obfuscate the accuracy of serial testing sessions
- If a stable level of 'baseline' performance can be reached, then fluctuations in performance on the cognitive task throughout the day could be used to provide real-time information about cognition

Purpose

- This was a feasibility study designed to identify the number of test administrations required before practice effects are negligible on a brief cognitive task, and to determine whether fluctuations in performance on the cognitive task throughout the day could be related to factors such as physical activity, cognitive engagement, sleep, fatigue, and stress

Participants

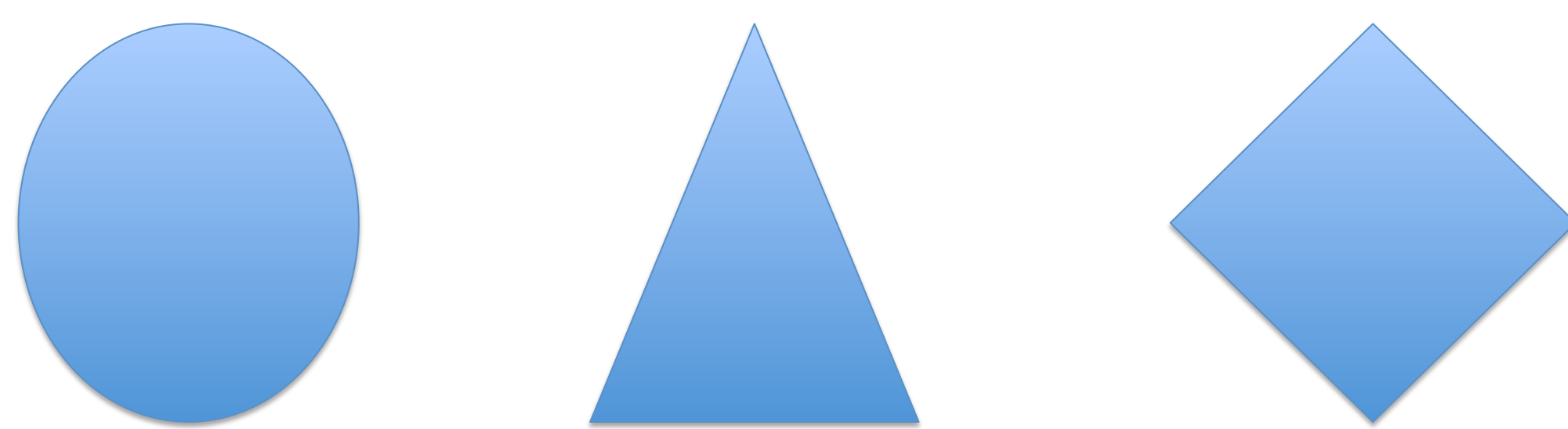
- Five participants were recruited from an undergraduate summer research program (four women, one man, $M = 24.00$ years of age, $SD = 3.74$, age range 21 – 29 years)
- One participant was excluded because questionnaire and cognitive data could not be matched

Methods

N-Back Task

- Participants were administered a 45-second cognitive task (n-back) using a computerized tablet
- Shapes are presented consecutively on a computer tablet and the participants must press the "Yes" or "No" button to indicate whether the shape was or was not the same as the shape previously presented
- The total number of trials completed in each 45 sec test block was calculated for each block

Figure 1. Shapes presented in n-back task



Baseline Assessment

- The n-back task was first administered repeatedly until a plateau in performance occurred (approximately 30 - 40 blocks)
- Baseline performance was established by the final 10 blocks determined by a plateau in performance

N-back questionnaire

- Following baseline assessment, participants were instructed to complete one block of the n-back four times a day after various activities for seven consecutive days
- Various activities included, but are not limited to exercise, reading, watching TV, etc.
- After completing the n-back task, participants were instructed to answer a series of questions regarding the activity they were engaged in prior to completing the task
- Activities were classified into one of five categories: exercise, sleep, cognitive, non-cognitive, and physical
- The average number of trials completed was computed for each category

Methods

Activity Classification

- Exercise: Activities such as gym, workout, and other forms of exercise
- Sleep: Going to sleep, waking up and sleep
- Cognitive: Activities such as working, editing a powerpoint, data entry
- Non-cognitive: Activities such as relaxing, watching TV, talking on the phone
- Physical: Activities like walking to and from lab and cleaning

Results

- The left-side of Figures 2-5 displays descriptive statistics that represent the average number of n-back trials completed during the 10-block baseline assessment
- The right-side of Figures 2-5 displays descriptive statistics for average number of n-back trials following specific activities completed by participants over the course of a 7 day period

Figure 2. Participant A.

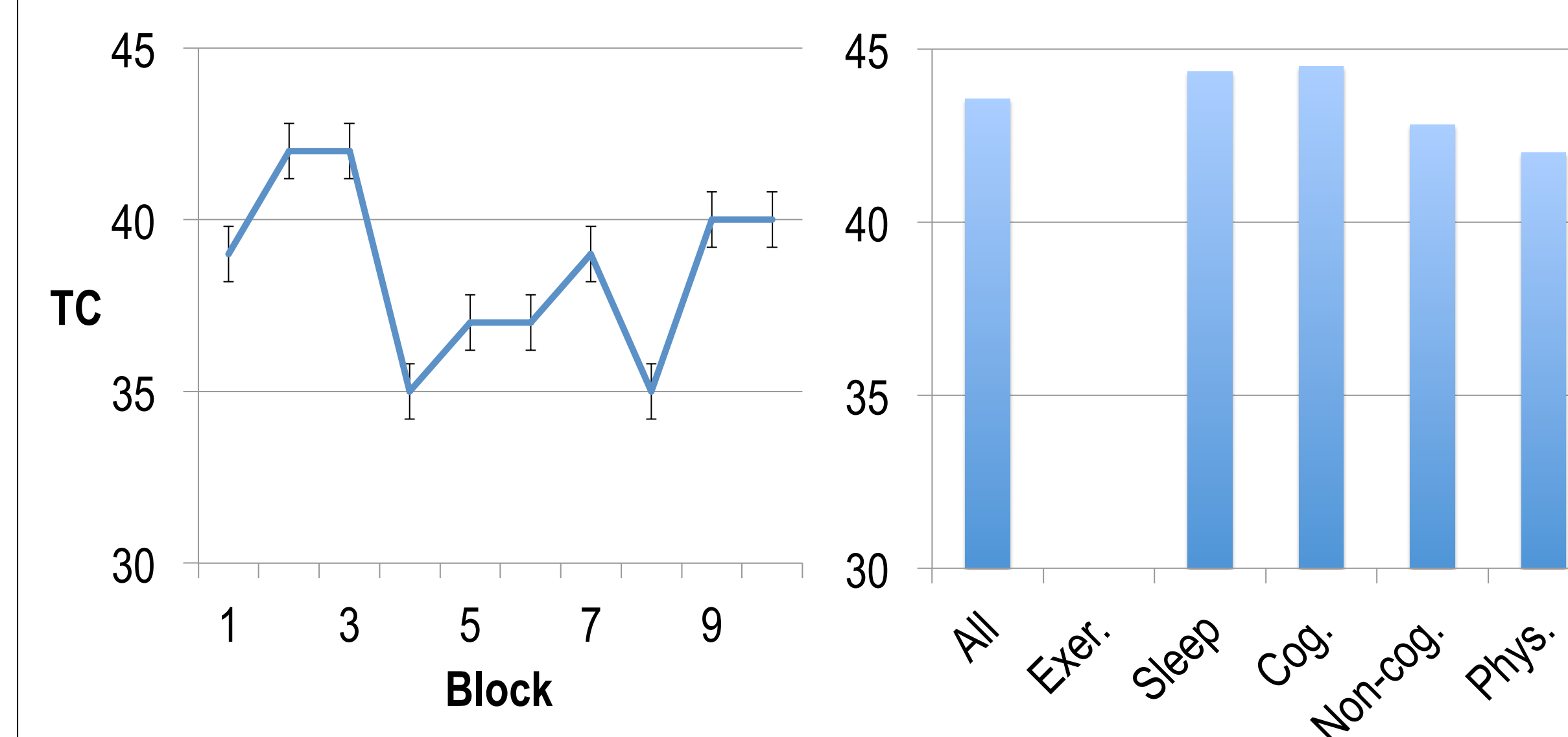


Figure 3. Participant B.

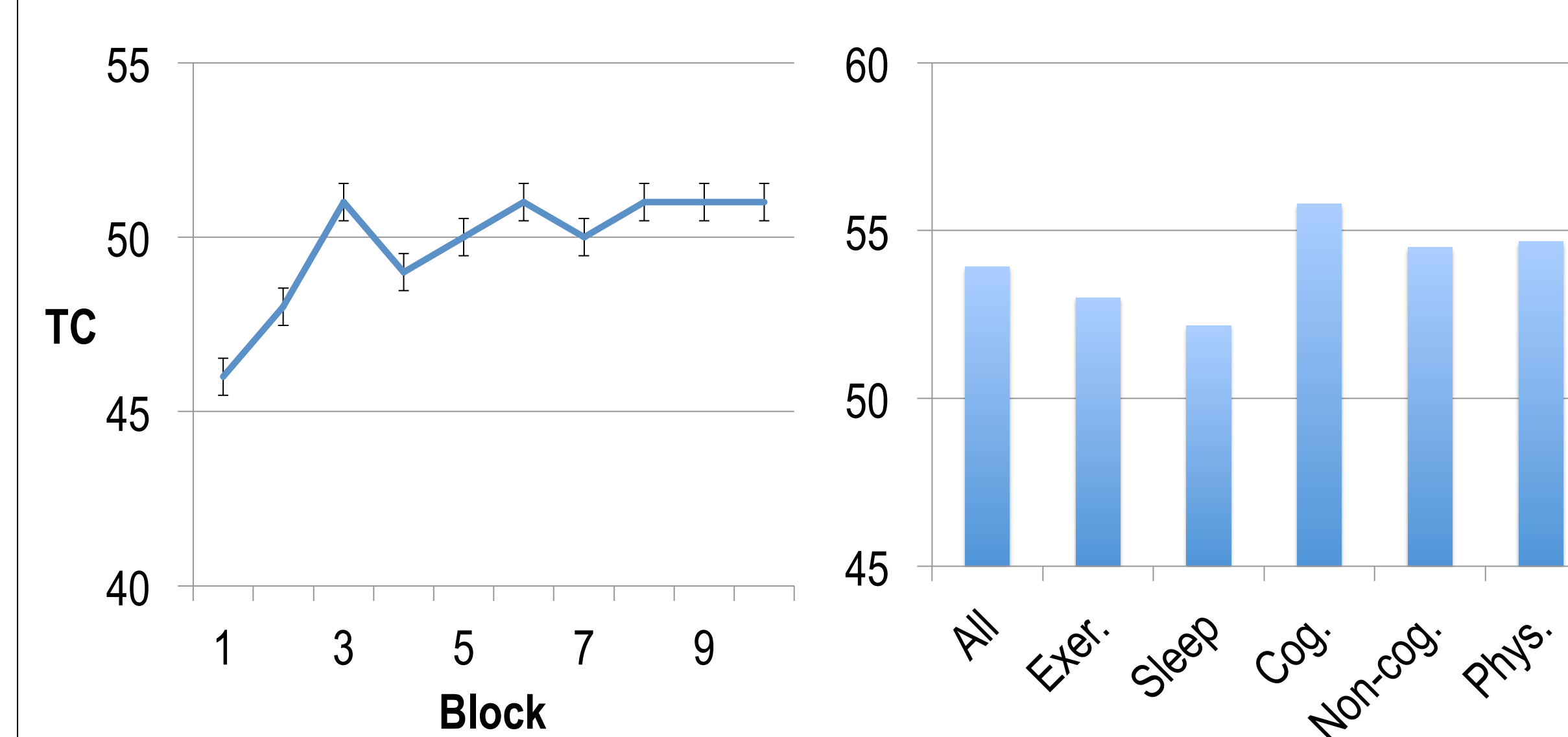
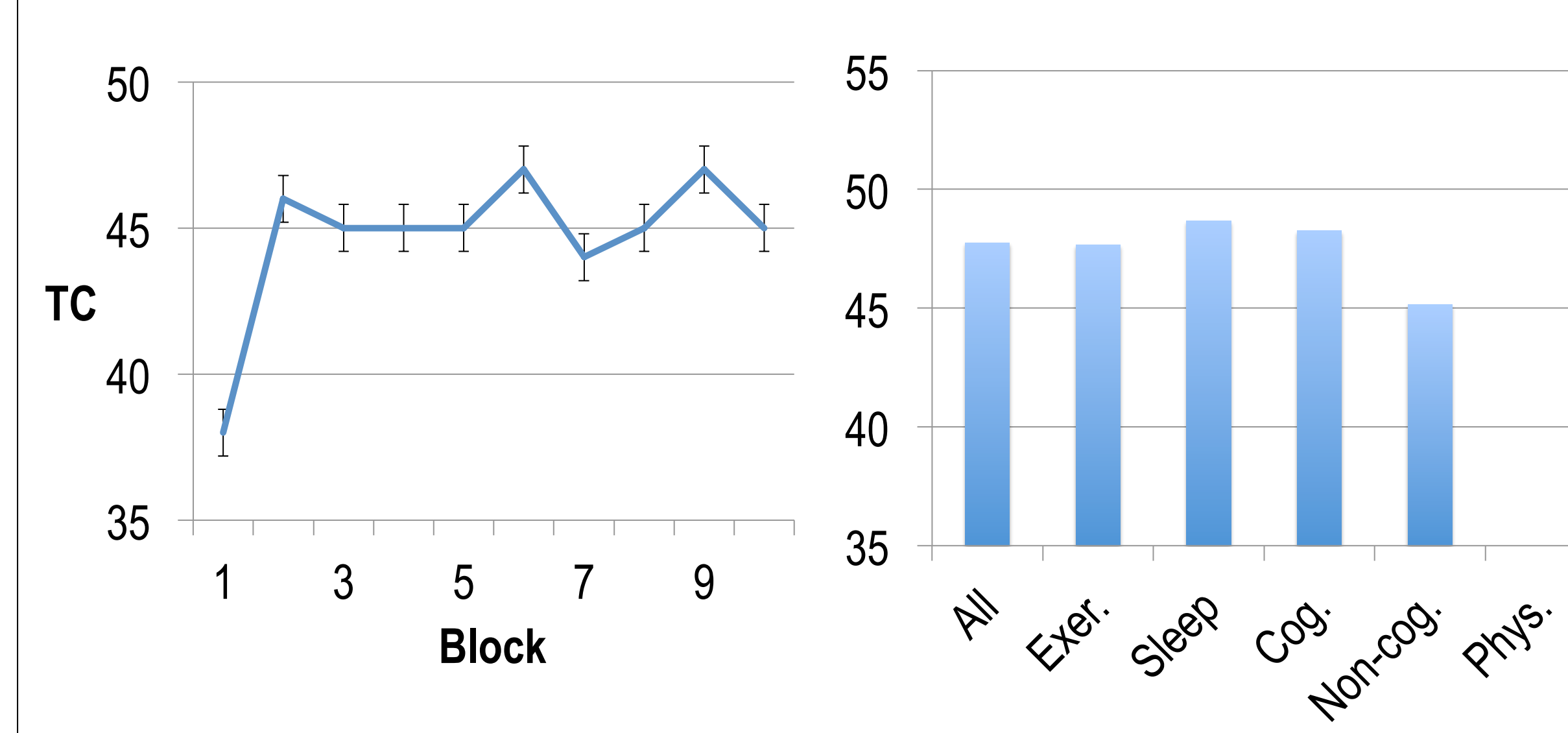


Figure 4. Participant C.



Results

Figure 5. Participant D.

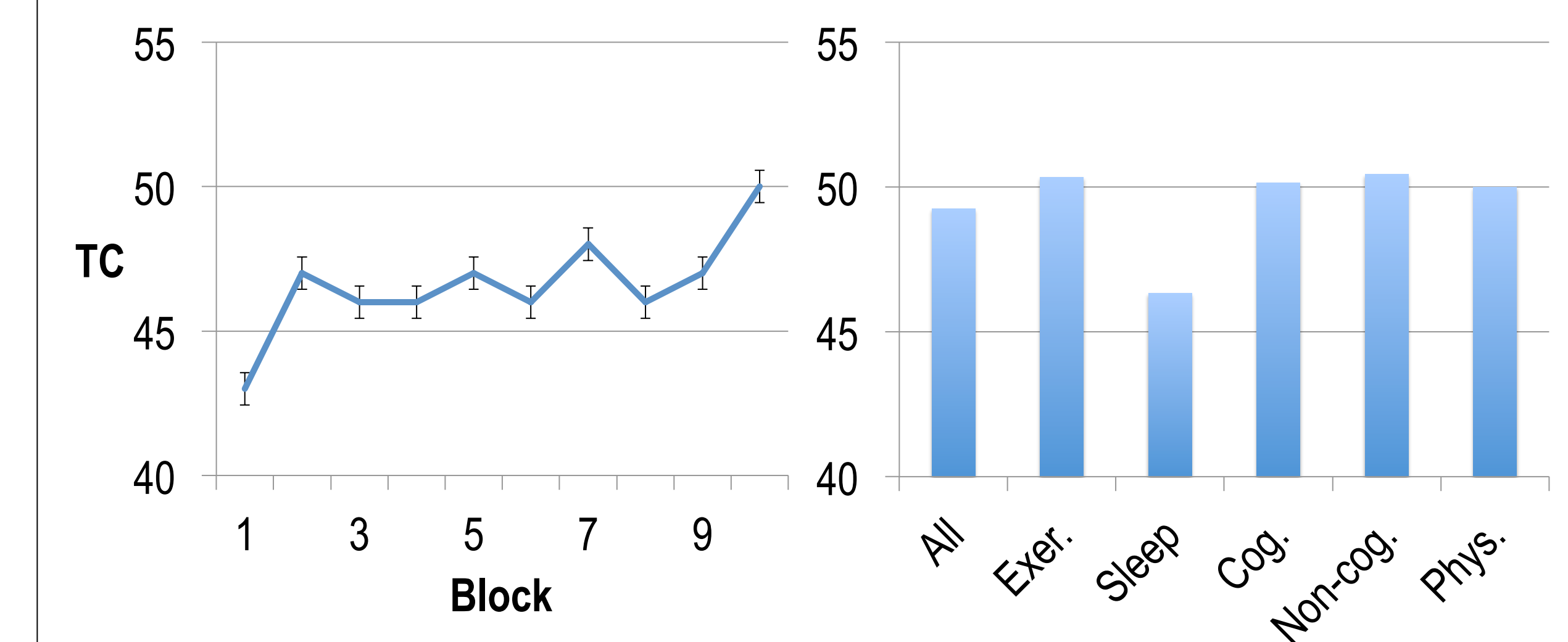


Figure 6. Frequency of reported activities completed prior to n-back task

Participant	All	Exercise	Sleep	Cognitive	Non-cognitive	Physical
A	22	0	3	6	10	3
B	25	3	6	5	8	3
C	24	3	6	8	6	1
D	24	3	6	7	7	2
All	95	9	21	26	31	9

Discussion

- The results of this preliminary study demonstrate the feasibility of utilizing a cognitive task in EMA
- The findings revealed test administration of a brief cognitive task can reach a baseline performance
- For two participants, completing the n-back task when sleep was identified as the activity seemed to be associated with fewer trials completed
- There may also be variability between individuals in the types of activities that are related to better performance on the n-back but future research is needed
- Other variables such as time of day, self-reported fatigue etc. also need to be investigated
- Although baseline performance was reached for some participants, replication in larger sample that could further elucidate the variability in the present study is needed
- Because the questionnaire was not administered through an EMA application on a tablet, the present pilot study was subject to recall bias, a limitation of autobiographical memory

Future Directions

- This n-back task with an EMA application on a tablet will be used to examine the natural variability in cognitive performances that may occur throughout the day or be related to certain other environmental or physiological factors (e.g., fatigue, stress) in a future study
- It is expected that this data will reveal fluctuations in cognitive abilities that can be matched to daily tasks (e.g., sleep) suggesting that repeated administration of a brief neuropsychological task could be used to provide real-time information about cognition

References

Schiffman S. et al., (2008) Annual Review of Clinical Psychology, 4, 1–32.

Acknowledgements

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