---

3 Smartphone Digital Phenotyping for Unobtrusive and Continuous Assessment of Everyday Cognition and Movement Trajectories in Older Adults

Katherine Hackett[1], Shiyun Xu[2], Moira McKniff[1], Emma Pinsky[1], Sophia Holmqvist[1], Giuliana Vallecorsa[1], Ian Barnett[2], Tania Giovannetti[1]
[1]Temple University, Philadelphia, PA, USA.
[2]University of Pennsylvania, Philadelphia, PA, USA

Objective: To evaluate the feasibility, usability, and preliminary validity of a digital phenotyping protocol to capture everyday cognition and activities in vivo among older adults.
Participants and Methods: Eight participants (M age=69.1 $\pm$ 2.6; M education=18.0 $\pm$ 1.4; 50% female; 88% non-Hispanic White) with normal cognition or mild cognitive impairment used an open-source smartphone application (mindLAMP) to passively and continuously capture sensor data including global positioning system (GPS) trajectories for a 4-week study period. Baseline neuropsychological tests and measures of depression, self-reported cognitive decline and mobility patterns were collected as external validators for digital data. Participants downloaded mindLAMP onto their smartphones and resumed their daily routines for 4 weeks before removing mindLAMP and completing a debriefing questionnaire. A cognitive composite was derived by averaging T-scores across domains of attention, executive functioning, processing speed, memory, and language. GPS raw data were processed to generate monthly average and standard deviation mobility metrics for each participant, including time spent at home, distance travelled, radius of gyration, flight length, and circadian routine. Feasibility and usability findings are presented along with correlation coefficients $\geq$.4 between GPS metrics and external validators.

Results: 100% of enrolled participants completed the 4-week study without requesting to withdraw. Usability ratings ranged from poor to excellent. 75% of participants agreed that mindLAMP was easy to use, whereas only 1 participant enjoyed using mindLAMP. 100% of participants were satisfied with the study team's explanation of procedures, privacy safeguards, data encryption methods and risks/benefits, reflected in an average score of 98.8% on the comprehension of consent quiz. No participants reported feeling uncomfortable, suspicious, or paranoid due to the study application running on their smartphone. No participants endorsed new problems using their smartphone, though 75% reported charging it more frequently during the study period. On average each day, participants spent 1121 $\pm$ 227 minutes at home, travelled 38727 $\pm$ 36210 geodesic units, and had 201 $\pm$ 149 minutes of missing GPS data. Overall, greater amounts of activity (monthly average) and higher variability (monthly standard deviation) in GPS metrics were associated with better outcomes. Specifically, less time spent at home, greater distance travelled, larger radius of gyration, greater flight length, and greater variability in home time, distance travelled, radius of gyration and flight length were associated with less depression, less self-reported cognitive decline, better cognition, and greater self-reported mobility (.40< $|r|$ <.69). On the other hand, greater circadian routine was associated with more self-reported cognitive decline (r=.66) and less self-reported mobility (r=-.43).
Conclusions: Smartphone digital phenotyping is a feasible and acceptable method to capture everyday activities in older adults. Continuous collection of data from personal devices warrants caution; however, participants denied privacy concerns and expressed an overall positive experience. High frequency GPS data collection impacts battery life and should be considered among relative risks and confounds to naturalistic assessment. Patterns of behavior from passive smartphone data show promise as an unobtrusive method to identify cognitive risk and resilience in older adults. Subsequent analyses will evaluate additional sensor metrics across a larger and more heterogeneous cohort.

Correspondence: Katherine Hackett Temple University katherine.hackett@temple.edu

---

4 Ushering in Modern and Objective Ways of Assessing Financial Decision Making in Clinical Settings: The Development and Validation of an Online Money Management Credit Card Task

Preeti Sunderaraman[1], Silvia Chapman[2], Whitney Hartstone[2], Jillian L Joyce[2], Yaakov Stern[2], Adam M Brickman[2], Stephanie Cosentino[2]
[1]Boston University School of Medicine, Boston, MA, USA. [2]Columbia University Medical Center, New York, New York, USA

Objective: Historically, assessment of financial decision making (FDM) has largely relied on self- or informant-reports, and paper-and-pencil tests. However, subjective report is prone to under/over-estimation biases, and most available tests probe increasingly outdated tasks such as writing checks and checkbook management. Advances in technology have made online methods one of the most common and preferred styles of managing money. There is thus a critical need to develop modern and objective methods to assess financial decision making that can be used in clinical settings. The current study aimed to develop and validate a novel, simulated online money management (OMM) credit card task mimicking a real-world task.

Participants and Methods: *Development.* The OMM task was conceptualized based on collaborations with a diverse team of experts spanning neuropsychology, geriatrics, computer science, and economics. *Administration.* The task involves several sub-tasks including logging into a simulated credit card account, navigating a few pages to download a statement for a specific month, answering questions about where certain pieces of information are in the statement, identifying erroneous transactions in the account activity section, and answering questions involving practical aspects of managing a credit card. *Pilot phase.* Using an iterative process, the task was refined and piloted in ten participants.
Validation. Performance was examined in relation to an existing online automated teller machine (ATM) task. *Design & Setting.* Cross-sectional, community-based prospective study.
Measures: *OMM task.* The newly developed OMM credit card task consists of two broad areas, (i) online navigation and (ii) content-focused (simple literacy, complex literacy, monitoring, awareness). *ATM task.* This measure consists of sequential tasks such as checking the balance in one's account, transferring money between accounts, and withdrawing cash. Both the OMM and ATM tasks were administered remotely by a neuropsychologist using Zoom and Team Viewer on a Dell laptop.
Participants: Thirty-five cognitively healthy older adults were included with mean age=70.06 years (SD=3.82) and mean education=21.89 (SD=1.76). 72% were women, the majority were White (77%) while 20% were Black and 3% belonged to other races; 91% were non-Hispanic.
Statistics & Metrics: Bivariate correlations between the OMM task, ATM task and demographic variables were examined. Time and steps/clicks to complete the OMM task were the primary outcome metrics.
Results: All participants were able to complete the OMM task. No significant associations were found between demographics (age, gender, education) and OMM metrics, and among OMM metrics (time and clicks). Significant associations in the expected direction were present between the OMM and ATM tasks. Time taken to answer the questions on the OMM task was associated with time required to complete the ATM task ($r = 0.57$, $p < 0.001$). Increased number of clicks on the OMM task was associated with increased number of errors ($r = 0.54$, $p < 0.001$) and increased time to complete the ATM task ($r = 0.41$, $p = 0.01$).
Conclusions: This is one of the first studies to develop and demonstrate the validity of a technologically based and practically relevant measure of financial decision making. Studies are ongoing to more comprehensively understand the psychometric properties of this novel task.

Correspondence: Preeti Sunderaraman, Ph.D. Assistant Professor of Neurology Boston University School of Medicine Department of