

GPS-derived Mobility Phenotypes and Cognitive Function in Older Adults

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TAKE-HOME MESSAGE. GPS-derived mobility phenotypes may serve as ecologically valid behavioral indicators of cognitive functioning among older adults, with the most consistent associations observed for executive function (EF). Social interaction partially accounted for mobility–EF associations, suggesting that GPS mobility may capture behavioral contexts relevant to cognitive health and inform future behavioral interventions.

INTRODUCTION

- GPS digital assessment methods can provide objective, sensitive, and ecologically valid representations of real-world mobility patterns.
- Mobility phenotypes may indicate:**
 - Early signal for ADRD risk:** Given that early ADRD pathology may contribute to both subtle cognitive inefficiency and narrowing of daily life space, GPS mobility phenotypes may serve as a functional behavioral signal of ADRD risk.
 - Modifiable risk factors of ADRD:** GPS mobility may capture behavioral contexts that influence cognitive health (e.g., social engagement), which are potentially modifiable through behavioral interventions. Thus, it is important to clarify whether these behaviors explain mobility–cognition associations.
- Aim:** We examined (1) whether GPS-based mobility phenotypes were associated with performance on standard neuropsychological assessments, and (2) whether daily social interaction accounted for the mobility—cognition associations.

METHODS

Participants: 141 community-dwelling older adults from the Bronx, NY, enrolled in the Einstein Aging Study (EAS) (Mean age = 75 years; 66% female; 38% non-Hispanic Black).

Participants completed a comprehensive neuropsychological assessment at baseline and then a 14-day (5x/day) ecological momentary assessment (EMA) protocol with passive monitoring of GPS location.

Measures

GPS-based mobility phenotype: The following five mobility features were derived from GPS data at the daily level and then summarized at the participant level as mean (iMean) and day-to-day variability (iSD):

- Time spent out of home
- Maximum distance from home
- Overall convex hull area: overall geographic area covered by 14-day daily movements
- Local convex hull area: geographic area covered within 1 km of home
- Number of unique places visited

Cognitive outcomes include processing speed, executive function (EF), visuospatial ability, language, and episodic memory, derived from a battery of 13 neuropsychological tests included in the conventional Uniform Data Set (UDS).

Social interaction: Mean daily social interaction frequency assessed from the EMA self-reported questionnaire.

Analytic Approach: Linear regression models were conducted for each cognitive domain, adjusting for age, sex, race, education, # of GPS monitoring days, and neighborhood deprivation.

RESULTS

Table 1. Results from linear regression: Associations between GPS-based mobility phenotype and cognition (coefficient (standard error)).

GPS mobility phenotype		Speed	EF	Visuo spatial	Language	Memory
iMean of	Out of home time	0.71 (0.83)	0.94 (0.81)	0.76 (0.81)	0.33 (0.80)	0.76 (0.86)
	Max distance from home	1.17 (0.85)	1.91 (0.82)	0.89 (0.83)	1.31 (0.79)	1.27 (0.87)
	Convex hull (overall)	0.96 (0.89)	1.78 (0.86)	1.72 (0.86)	1.30 (0.83)	1.88 (0.91)
	Convex hull (local)	0.60 (0.82)	1.71 (0.78)	0.89 (0.79)	1.35 (0.77)	1.50 (0.83)
	# unique places visited	0.83 (0.83)	1.09 (0.80)	0.51 (0.80)	0.78 (0.79)	1.23 (0.85)
iSD of	Out of home time	0.61 (0.85)	1.27 (0.83)	1.26 (0.84)	0.36 (0.80)	0.81 (0.89)
	Max distance from home	1.05 (0.84)	2.12 (0.81)	0.94 (0.83)	1.30 (0.78)	1.35 (0.88)
	Convex hull (overall)	1.45 (0.90)	2.44 (0.86)	2.02 (0.87)	1.75 (0.84)	2.36 (0.92)
	Convex hull (local)	0.34 (0.82)	1.76 (0.79)	1.56 (0.79)	1.23 (0.76)	1.60 (0.84)
	# unique places visited	-0.07 (0.83)	0.56 (0.81)	0.35 (0.82)	-0.06 (0.78)	1.75 (0.85)

Note. All cognitive domain scores are T-standardized; mobility phenotypes are Z standardized. EF = executive function. iSD = intraindividual standard deviation. Boldface values indicate $p < .05$.

GPS mobility & cognition

- GPS-derived mobility phenotypes, particularly larger activity space area (convex hull), were associated with multiple cognitive domains, except processing speed.
- Both average mobility levels (iMean) and day-to-day variability (iSD) were associated with cognitive performance.
- EF showed the most consistent associations across mobility phenotypes.

The role of social interaction

- When EMA social interaction was entered in the above models, the effect of mean convex hull within 1km of home location on EF was attenuated by 16.4% after controlling for EMA social interaction.

DISCUSSION

- GPS-based mobility phenotypes can feasibly capture individual differences in cognition that may be related to cognitive aging.
- In addition, mobility phenotypes may be a proxy of daily engagement and environmental complexity, which are potentially modifiable through behavioral interventions.
- Future studies with longitudinal cohorts are needed to assess directionality.

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