Passive Keypress & Speech Biomarkers for Monitoring Cognitive & Psychosocial Fluctuations in Dementia Caregivers

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Issue and Purpose

Methodological Issue:

- Family caregivers of persons living with dementia bear substantial cognitive, emotional, and functional burdens that can compromise both caregiving capacity and personal well-being.
- Standard cognitive screening tools (e.g., MMSE) may lack sensitivity to detect subtle day-to-day fluctuations in cognition or affective distress experienced by caregivers.
- Mobile digital assessment tools—including **passive keypress analytics** and **active speech-based evaluations**—offer promising avenues for more continuous, ecologically valid monitoring of caregiver functioning.
- This study addresses this methodological gap by evaluating the concurrent validity and complementarity of keypress- and speech-derived metrics in family dementia caregivers.

Purpose:

- This pilot study examines the feasibility, validity, and convergence of passive keypress data, active speech assessments, and self-reported outcomes in dementia caregivers.

Methods

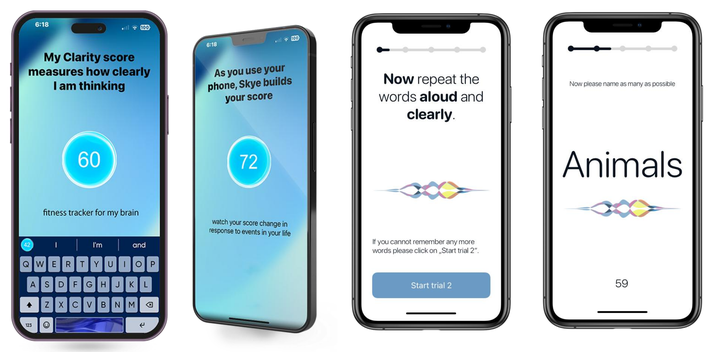
- 19 family dementia caregivers (mean age=61 years, SD=14; 68% women; 63% married; 89% co-residing with care recipient; 79% college-educated) were recruited from UCSD and UCLA.
- -Participants completed 60 consecutive days of mobile keypress tracking using the KeyWise AI app and weekly speech-based assessments using the ki:elements Mili app on personal iPhones.
- **Keypress metrics:** typing speed, typing variability, and the KeyWise Clarity score (a composite measure of keypress-derived cognitive performance).
- **Speech-based metrics:** Speech Biomarker for Cognition (SB-C) composite score and its memory, processing speech, and executive function subdomain.
- Standardized self-report surveys assessed mood, fatigue, self-efficacy, & caregiver burden.
- Relationships among keypress metrics, speech-derived composite scores, & self-report measures were analyzed to evaluate marker redundancy, complementarity, and predictive value.

Conclusion

- These preliminary findings support the feasibility and potential validity of active and passive digital biomarkers for detecting subtle cognitive and affective challenges among dementia caregivers.
- Variability-based keypress metrics and speech-derived cognitive composites each captured unique yet complementary aspects of caregiver functioning and well-being.
- Integrating passive and active mobile data may enable more ecologically valid, continuous monitoring of dementia-related risk and resilience—offering a valuable adjunct to traditional cognitive screening tools.

Main Results

Characteristic	Summary
Age (years)	Mean (SD): 61 (14)
Years caregiving	≤5 years: 11 (73%) >5 years: 4 (27%)
Hours caregiving per week	Mean (SD): 68 (43) Median [Q1, Q3]: 55 [33, 98] Min–Max: 20–154
Gender	Woman: 13 (68%)
Marital status	Married/living as married: 12 (63%) Divorced/Separated/Never Married: 7 (37%)
Live with care receiver	Yes: 17 (89%) No: 2 (11%)
Education	High school/GED/Some college: 4 (22%) College graduate: 6 (32%) Graduate/professional: 9 (47%)
Employment status	Employed for wages: 10 (56%) Unemployed: 1 (6%) Retired: 7 (39%)
Household income	≤$100,000: 7 (37%) >$100,000: 10 (53%)
Hispanic/Latino ethnicity	Yes: 4 (21%) No: 15 (79%)
Relationship to care receiver	Spouse: 10 (53%) Mother: 4 (21%) Father: 3 (16%) Other: 3 (16%)



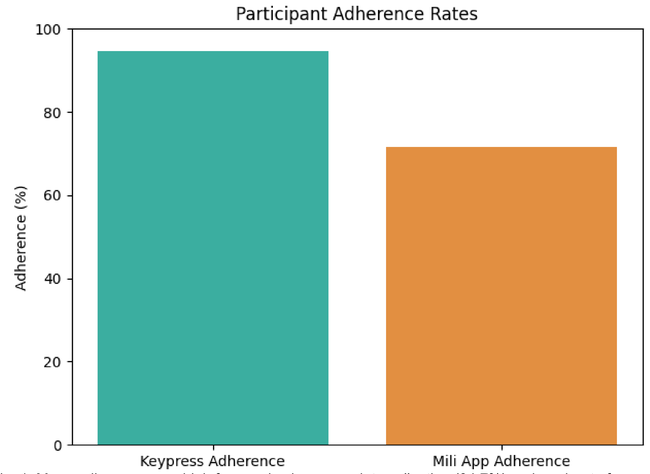


Fig. 1. Mean adherence was high for passive keypress data collection (94.7%) and moderate for active mobile assessments via the Mili app (71.7%; mean = 5.7 completed surveys).

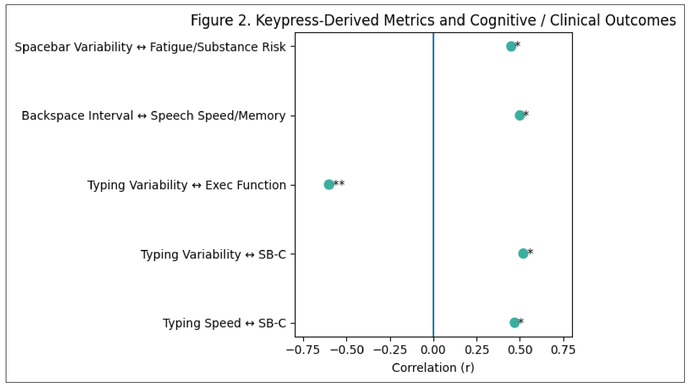


Fig. 2. Keypress-derived behavioral metrics demonstrated moderate associations with cognitive & clinical measures, greater typing variability with poorer executive function, and longer backspace intervals with reduced speech-based processing speed & memory. Increased variability in spacebar transitions was associated with greater psychological fatigue and substance use risk.
Note for Fig 2 & 3. *p < .05; **p < .01; † trend-level association.

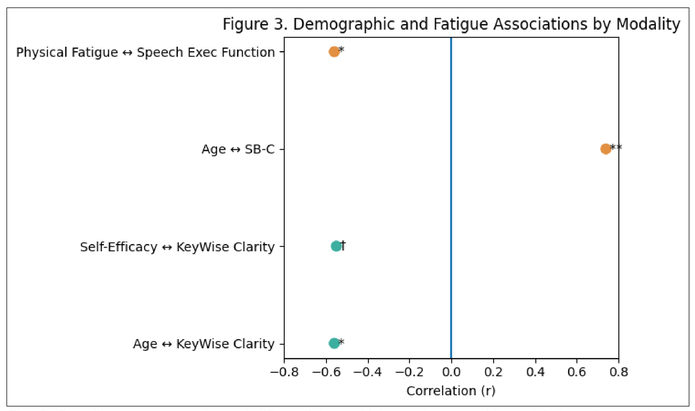


Fig. 3. Cognitive measures showed differential sensitivity to demographic and fatigue factors. Lower KeyWise Clarity scores associated with older age & lower self-efficacy, while higher SB-C scores were observed in older participants. Speech-based executive function declined with greater physical fatigue.

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