NATIONAL ACADEMIES Sciences Engineering Medicine

Approaches to Address Unmet Research Needs in Traumatic Brain Injury Among Older Adults: A Workshop
21 October 2024| 9:00 am – 5:00 pm ET
Keck Center, Room 100
Washington, DC 20001

Session 4: Review of Approaches to Remedy Research Gaps and Promising Future Directions

Leveraging Digital Technologies to Improve Geriatric TBI Prevention, Research and Care

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NIA - Layton Aging & Alzheimer's Disease Center
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OREGON HEALTH & SCIENCE UNIVERSITY OHSU

Disclosure Statement

Dr. Kaye has received research support awarded to his institution, Oregon Health & Science University (OHSU) from the National Institutes of Health, National Science Foundation, the Digital Medicine Society, and AbbVie. He has been directly compensated for serving on Data Safety Monitoring Committees for Eli Lilly and Ionis Pharmaceuticals, and as an external Advisory Committee member for the Rush and Stanford University Alzheimer's Disease Research Centers. He receives reimbursement through Medicare or commercial insurance plans for providing clinical assessment and care for patients. He serves uncompensated on the editorial advisory board and as Associate Editor of the journal, Alzheimer's & Dementia. OHSU and Dr. Kaye have a financial interest in Life Analytics, Inc., a company that is developing remote monitoring software technology. The nature of this financial interest have been reviewed and managed by the Research Integrity Office at OHSU (coir@ohsu.edu).

Many roles for using 'smart' technologies

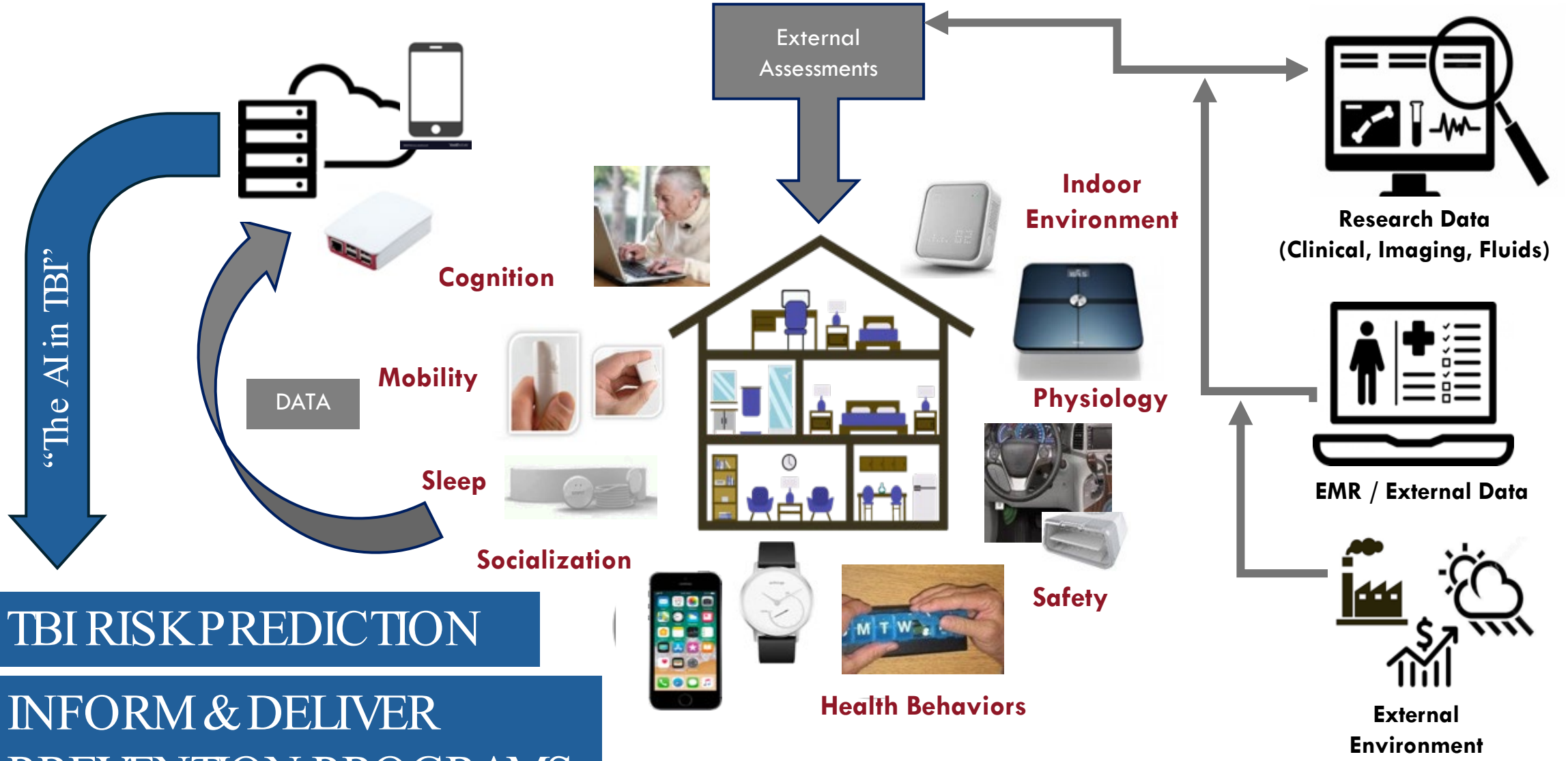
- Pre-TBI → Tech to identify those at risk for TBI preceding events (falls, poor driving, cognitive decline, etc.) or as interventions to reduce identified risk
  - Devices/sensors to detect functional change (gait, balance, perceptual skills, judgement, etc.)
  - Apps deliver this information to mitigate risk
- Post-TBI → Prevent deficit progression & facilitate rehabilitation and care
  - Gait training through robotic devices boosting neuroplasticity
  - Cognitive rehabilitation using virtual reality
  - Telerehabilitation
  - Neuromodulation devices

A.

https://tinyurl.com/4fsaph4e

Bonanno, M et al. Innovative Technologies in the Neurorehabilitation of Traumatic Brain Injury: A Systematic Review. Brain Sci. 2022, 12, 1678. https://doi.org/10.3390/brainsci12121678

..And many technologies & digitally enabled methods



- TBI RISK PREDICTION
- INFORM & DELIVER PREVENTION PROGRAMS

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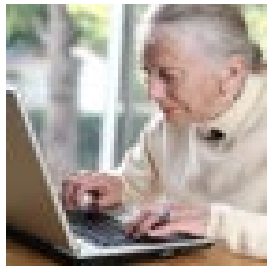
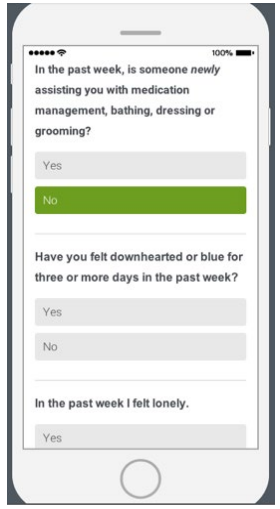
Beattie et al., 2020

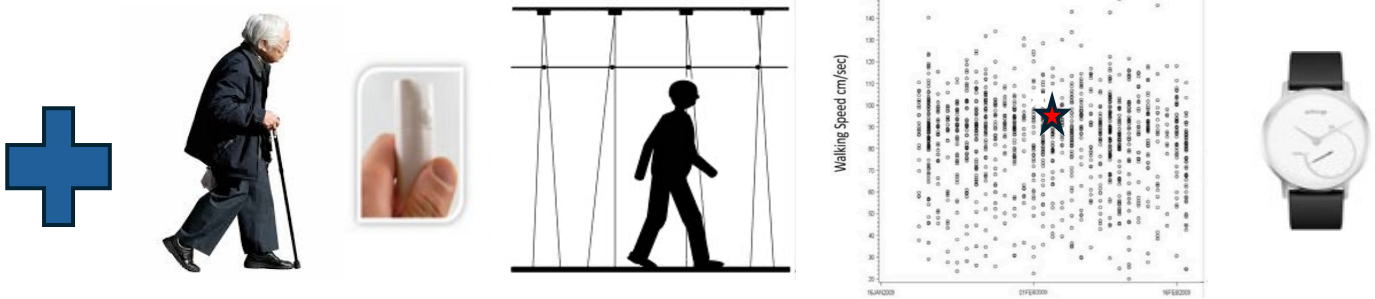
TBI prevention through prediction
Identifying those at high risk for TBI events - Falls

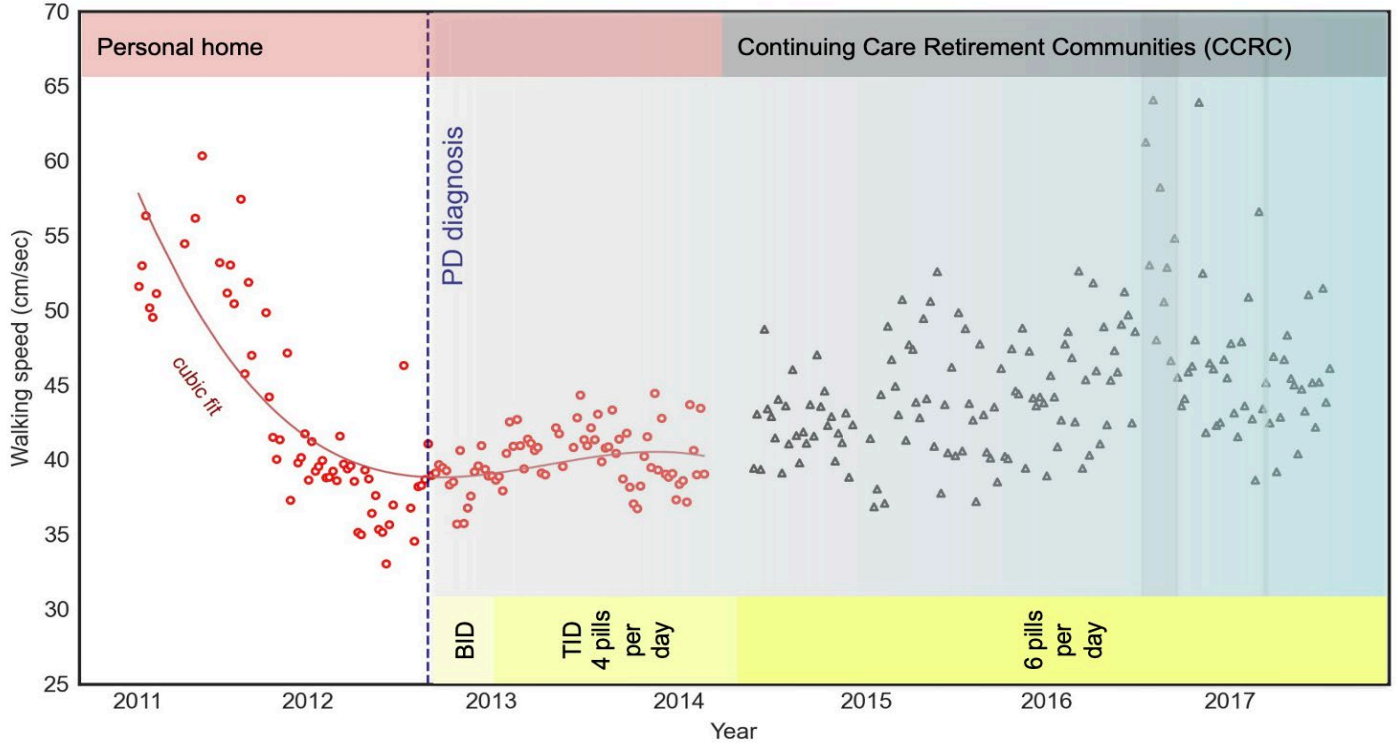


Weekly Online Queries
Timely Identification of Falls & Risk Factors



1	AWAY FROM HOME
2	VISITORS
3	MEDICATION CHANGE
4	FALLS
5	ACCIDENTS/INJURIES
6	HOSPITALIZATION/ER
7	HEALTH CHANGE/ILLNESS
8	LIFE SPACE CHANGE
9	ASSISTANCE
10	MOOD - BLUE
11	MOOD - LONELY
12	PAIN LEVEL (1-10)
13	PAIN INTERFERENCE





Kaye et al. J Gerontology, 2011; Kaye et al. Gait Posture, 2012

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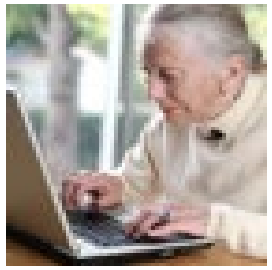

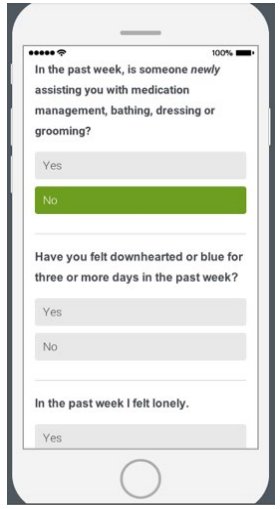

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doi:10.1093/gerona/glz128
Advance Access publication May 16, 2019

OXFORD

Research Article

When Will My Patient Fall? Sensor-Based In-Home Walking Speed Identifies Future Falls in Older Adults

Antoine Piau, MD, PhD,[1,2,*,] Nora Mattek, MPH,[1] Rachel Crissey, RA,[1] Zachary Beattie, PhD,[1] Hiroko Dodge, MD, PhD,[1] and Jeffrey Kaye, MD[1]

[1]Oregon Center for Aging & Technology (ORCATECH), Oregon Health & Science University, Portland. [2]Internal Medicine and Gerontology, University Hospital of Toulouse, France.

- No differences between those destined to fall and controls at baseline in clinical functional tests.
- Longitudinal decline in median daily walking speed over the 3 months before a fall in those destined to fall
- And walking speed variability was lower the month and the week just before the fall compared with 3 months before the fall

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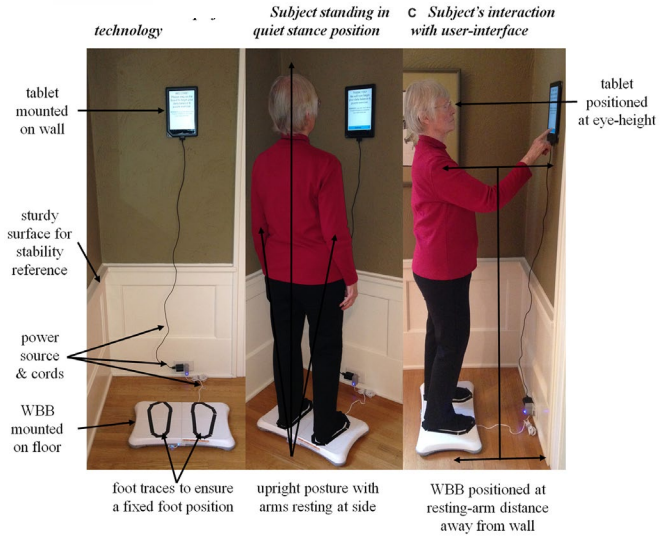
Kaye et al. J Gerontology, 2011; Kaye et al. Gait Posture, 2012

Many other tech enabled assessments of function relevant to TBI prevention – Balance, Driving, Cognition

BALANCE



DRIVING

J Alzheimers Dis. 2017 ; 59(4): 1427–1437. doi:10.3233/JAD-170116.

Passive Assessment of Routine Driving with Unobtrusive Sensors: A New Approach for Identifying and Monitoring Functional Level in Normal Aging and Mild Cognitive Impairment

Adriana Seelye[a,b,d,e,*], **Nora Mattek**[a,b], **Nicole Sharma**[a,b], **Phelps Witter IV**[a,b], **Ariella Brenner**[a,b], **Katherine Wild**[a,b], **Hiroko Dodge**[a,b,f], and **Jeffrey Kaye**[a,b,c]

Correlations between 6-month sensor driving summary variables (per day) and global cognition

Variable	Spearman's *r*	*p*-value
Mean # of trips per day	0.09	0.65
Day-to-day variability in # of trips	0.00	1.00
Mean distance driven per day (miles)	0.51	<0.01 **
Day-to-day variability in distance driven	0.47	0.01 *
Mean time driven per day (min)	0.39	0.04 *
Day-to-day variability in time driven	0.42	0.03 *
Mean first clock start time of driving per day	0.16	0.41
Day-to-day variability in first start time	0.44	0.02 *
Mean last clock start time of driving per day	0.15	0.44
Day-to-day variability in last start time	0.20	0.30
% of days at least one trip was taken out of all days monitored	−0.26	0.19
% of driving days ≥20 miles	0.44	0.02 *

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Many other tech enabled assessments of function relevant to TBI prevention – Multidomain Assessment

MCI

TABLE 3 Baseline sensor variable descriptives.

IADL domain	Sensor variable	Whole sample mean (SD)	CN mean (SD)	MCI mean (SD)	*t*	*P* value	No. days monitored mean (SD)
Computer use	Computer-use duration (h)	5.93 (4.43)	6.99 (5.14)	4.60 (2.90)	−2.49	0.008	
	Computer-use duration variability (h)	6.02 (6.61)	7.51 (7.31)	4.26 (5.25)	−2.16	0.017	84 (12)
Pillbox use	Mean time of first pillbox opening	10:32 (4.10)	10:31 AM (4.59)	10:32 AM (3.25)	0.01	0.498	
	Variability in time of first pillbox opening	2.77 (1.33)	2.62 (1.38)	3.01 (1.22)	1.44	0.077	88 (6)
Driving	Median distance driven per day (miles)	19.12 (11.48)	17.09 (10.53)	22.09 (12.30)	1.96	0.027	
	Day-to-day variability in distance driven (miles)	31.06 (27.98)	28.88 (28.04)	34.25 (27.97)	0.87	0.192	
	Mean duration driven on a highway (h)	0.36 (0.32)	0.30 (0.29)	0.44 (0.36)	1.81	0.038	89 (8)
	Mean duration driven during the day (h)	1.01 (0.40)	0.92 (0.35)	1.16 (0.43)	2.75	0.004	
	Duration driven at night (h)	0.17 (0.23)	0.02 (0.09)	0.04 (0.11)	1.92	0.030	

Abbreviations: CN, cognitively normal; MCI, mild cognitive impairment; SD, standard deviation.

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De Vito AN, et al. Cognitive dispersion is related to subtle objective daily functioning changes in older adults with and without cognitive impairment. Alzheimer's Dement. 2024;16:e12539. https://doi.org/10.1002/dad2.12539

Concluding summary observations &comments

- Many opportunities to utilize digital tools to assess for TBI risk and ultimately enable intervention prevention of TBI precipitating events
- Digital tools (preferably passive) can facilitate simultaneous identification of multiple TBI risk factors longitudinally in real-life settings (ecologically valid)
- TBI risk reduction needs to be considered integral to general geriatric health maintenance (not just TBI risk itself)
- If tech can deliver better, more timely data then what holds up progress? Implementation of risk surveillance and intervention programs using digital methods are hampered not by technical problems so much as political, business, and health systems issues.

Research Agenda - Recommendations

- Focus on using digital tools to deliver more objective and timely risk identification for TBI prevention ("if you can't measure it, you can't improve it")
- Test TBI digital risk factor identification methods in pragmatic trials. Embed/add digital assessments to existing geriatric function studies – To understand UX in deploying and maintaining systems
- Develop standards for digital methods that are technology agnostic, thus transparent, reproduceable, and comparable. This enables BYOD making studies and application more realistically scalable
- Move toward person-specific prediction models as high frequency digital assessments enable intraindividual prediction
- Explore methods for providing for optimal digital functional data feedback to older adults and clinicians


Thank you!
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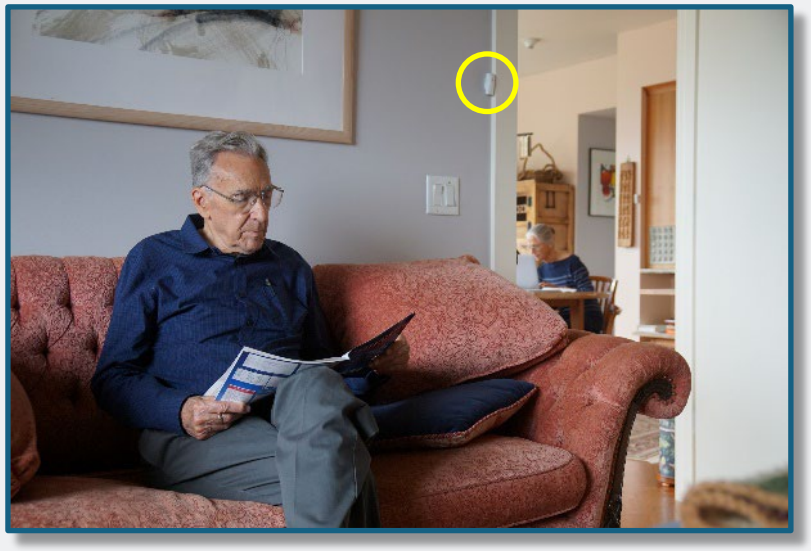
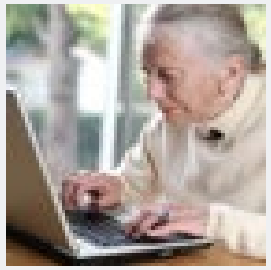
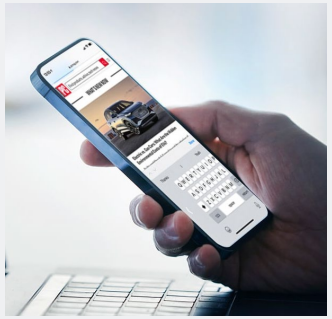
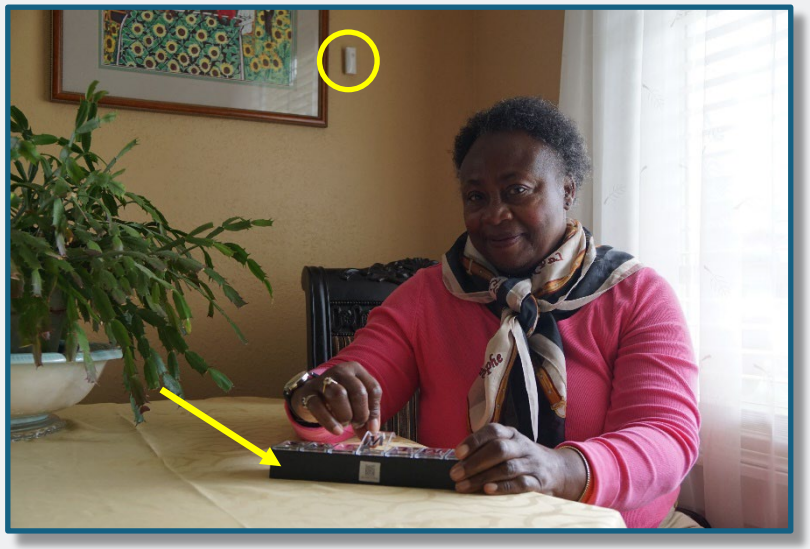
Ambient Home-Based Assessments









Beattie et al. 2020