



**THE USE OF SMART DEVICES TO
COLLECT COGNITIVE PERFORMANCE
AND SELF-REPORT ACTIVITY AND
AFFECT DATA IN OLDER ADULTS**

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SMART DEVICES FOR THE COLLECTION OF SURVEY & PERFORMANCE DATA?

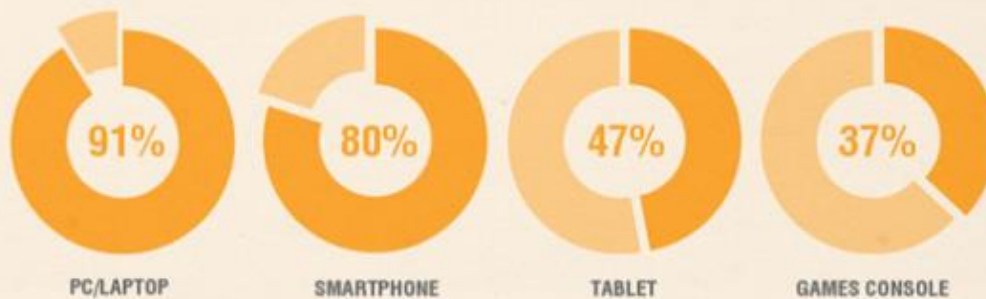


Americans in 2013: 91% have a cell phone; 86% are on the internet (Pew survey)

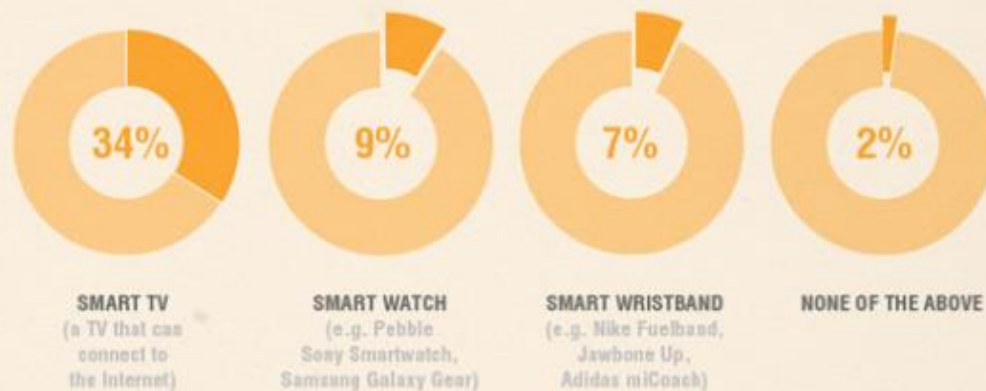
WHICH DEVICES ARE MOST POPULAR?

80% OF INTERNET USERS OWN A SMARTPHONE

Most Popular Devices Used to Search the Internet



Emerging Devices Used to Search the Internet



January
2015
Data

SOURCE:




<https://www.globalwebindex.net/blog/80-of-internet-users-own-a-smartphone>

POTENTIAL ADVANTAGES

- **Lower risk of data loss**
 - Data can be transmitted directly to the researcher
- **Greater accuracy**
 - Computerized collection limits nonsensical responses
- **Efficient data processing**
 - Elimination of data entry
- **Enhanced monitoring capability**
 - Real-time data transmission allows continuous compliance monitoring and data processing
- **Cognitive performance assessment in naturalistic environments, including assessments of accuracy & speed**
- **Potential for enhanced sense of 'privacy' of responses or performance data**



ELECTRONIC EXPERIENCE SAMPLING

- **Capture activity, experiences, associated emotions, perceptions and biomarkers/function *in vivo* – life as it is lived**
 - Capture the “experiencing” or “momentary” self
 - Minimize error associated with recall over long periods and reconstruction biases
 - Allows estimation of between- and within-person contributions to variation in an outcome of interest
 - Electronic ES increasingly utilized in study of stress and other psychosocial factors, but not in older adult populations
 - **May provide opportunity for more focused elucidation of links between activity, affect and cognition**
 - Clues as to targets of intervention
- 

POTENTIAL DISADVANTAGES

○ Design issues:

- Time-consuming and/or expensive start-up
- Lack of readily-available assessment tools; multiple operating systems and devices
- Expensive deployment (if employing real-time data collection)

○ Unknown territory:

- Lack of data on implementation feasibility & best practices
- Lack of data on concurrent and predictive validity
- Feasible with digital non-natives, including older adults?
 - Older individuals have greater difficulty in using technological devices (Slegers et al., 2009)
 - However, increasing adoption in those 65+: 77% have cell phones (but only 18% smartphones), 59% are online (but only 47% have broadband – although a 5-year doubling); varies by SES (2013 Pew Survey)



AIMS

- **Feasibility of implementing an electronic daily activity, affect, and cognitive function sampling tool in older adults**
 - Compliance
 - User experience
- **Examination of activity, affect, and cognitive performance characteristics**



METHODS

Two pilot samples:

○ Recording Everyday Activities, Cognition and Health (REACH) Pilot Study



- Convenience sample (n=51; age 55+) used to pilot implementation feasibility and examine collected data
- 1 week of experience sampling embedded in between two in-person lab visits

○ Art Through the Ages (ATTA) Pilot Study

- Pilot study (n = 20; age 65+) of an intergenerational art education intervention over a 7-month period
- 3 experience sampling waves (1 week each) prior to program and at months 1 and 4 of the program



	Combined	REACH	ATTA
Demographic characteristic:	Mean (SD) or %	Mean (SD) or %	Mean (SD) or %
Age (55-91 years)	68.8 (8.2)	67.3 (8.4)	72.5 (6.1)
55-64	29.7%	42.6%	0.0%
65-74	46.0%	40.4%	66.7%
75+	24.3%	17.0%	33.3%
Sex (% female)	59.5%	50.9%	81.0%
Race			
Asian/Pacific Islander	12.2%	11.3%	14.3%
Black/African-American	31.1%	43.4%	0.0%
White/Caucasian	51.4%	37.7%	85.7%
Other	5.5%	7.6%	0.0%
Education (years)	15.7 (4.0)	15.5 (4.6)	16.2 (2.0)
≤high school	17.6%	20.8%	9.5%

METHODS

- **The experience sampling protocol consisted of 4 surveys per day over a 7-day period:**
 - A brief morning survey upon waking
 - (4 questions; approximately 1 min.)
 - Three lengthier surveys at ~11:30 a.m., ~4:30 p.m., and right before bedtime
 - (40 survey questions and 3 brief cognitive assessments)
 - Surveys/assessments completed with a 7" Android-based tablet with a live data (cellular) connection
 - Device alarms served as reminders to take each survey at the specified time
 - \$35 incentive for completion of 28 surveys (pro-rated for partial completion)



This evening (since the last survey),
how much time did you spend in
each of the following activities?

Watching TV

- 0 minutes (none)
- 30 minutes or less
- 31 to 60 minutes
- 61 to 90 minutes
- 91 to 120 minutes
- greater than 120 minutes

Next

19 activities:

- Housework/chores*†
- Watching TV*†
- Exercising*
- Napping/resting†
- Using computer or Internet*
- Reading*
- Socializing*
- Running errands†
- Engaging in a hobby*
- Praying, worshipping, or meditating
- Church-related activity†
- Working for pay*†
- Unpaid care to: adult relative, adult non-relative, child/children†
- Volunteer work: at home, outside of home*†
- Giving help/support to others
- Receiving help/support from others

*HRS DRM; †ATUS Missing: HRS (play puzzles/games); ATUS (grooming, meal prep, eating, paying bills, specific chores)

19 COGNITIVE/AFFECTIVE STATES:

- Frustrated/annoyed*
- Depressed/blue
- Worried/anxious
- Stressed*†
- Happy*†
- Content/relaxed
- Tired†
- Active/energetic
- Like you were using your mind
- Supported
- Bonding/connecting with others
- Competent/capable
- In control
- Making progress on an important goal
- Proud
- Activities were worthwhile/meaningful†
- Useful
- Making important contributions to others
- Making a difference

Missing:

HRS (bored, interested, impatient, sad, angry); ATUS Well-Being Module (sad, pain)

Thinking about this evening (since the last survey), how much did you generally feel each of the following?

Happy

60

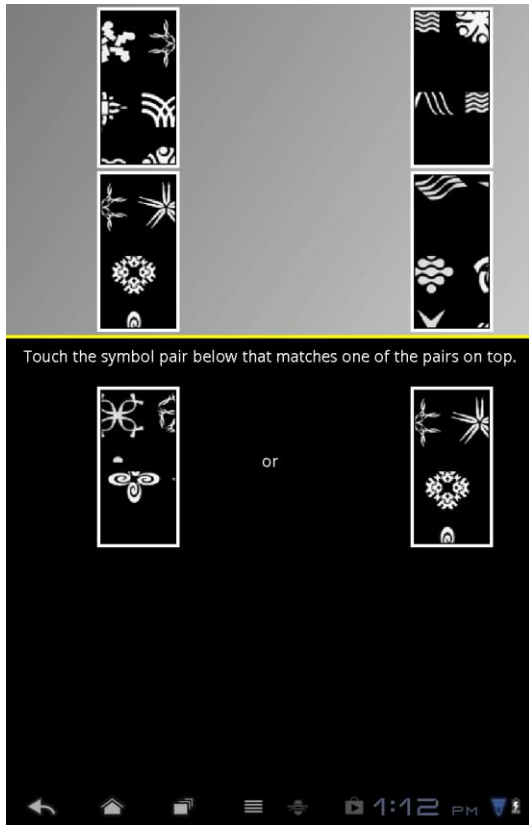
Not at all

Very much

Next

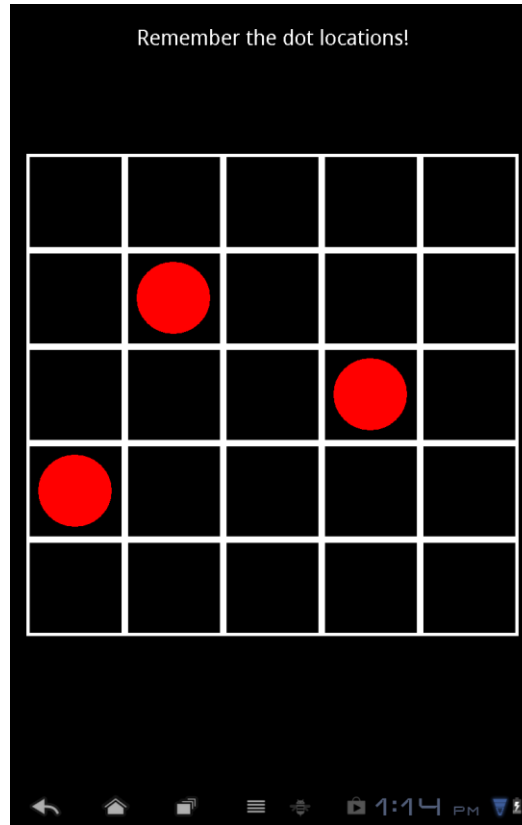


COGNITIVE ASSESSMENTS



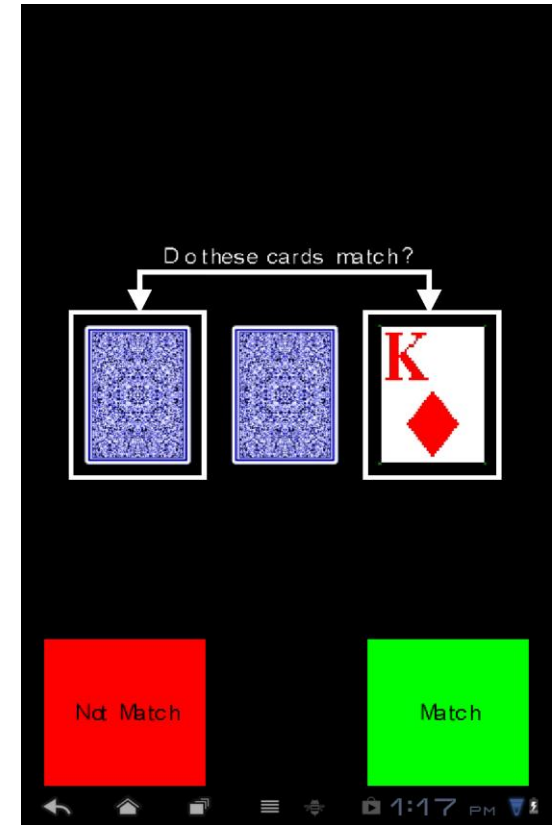
Symbol Search pattern matching

- Accuracy
- Reaction time (RT)



Spatial location memory task

- Error (Euclidean distance)



N-back working memory task

- Accuracy
- Reaction time (RT)

Developed by M. Sliwinski & J. Mogle, Penn State Center on Aging

-ESCAPE Study (NIA R01 AG39409)

~3.5 minutes to complete in older adults

TRAINING

- Participants received **one-on-one instruction** in the operation of the device and completed a brief morning and full length practice survey during training.
- They received a **34-page instruction manual** with screenshots of surveys/assessments and instructions regarding device operation and how to contact the support team.
- They **practiced contacting the support team** via the device using Google Talk's text and voice (VOIP) functions. They were also given phone and email contact information.



IMPLEMENTATION FEASIBILITY

- **Compliance** (# of completed surveys)
- **Burden** (survey and cognitive assessment completion times)
- **User experience**: Administered a 28-item user experience survey after weeklong sampling period
 - The survey assessed ease of completion of assessments, burden, appropriateness of length, whether questions adequately captured daily activity, concerns with privacy, whether tasks were challenging, etc.
 - Favorability of user experience ranked on a 5-point scale (1 = “*Definitely Disagree*” to 5 = “*Definitely Agree*”)



COMPLIANCE

REACH Study

ATTA Study

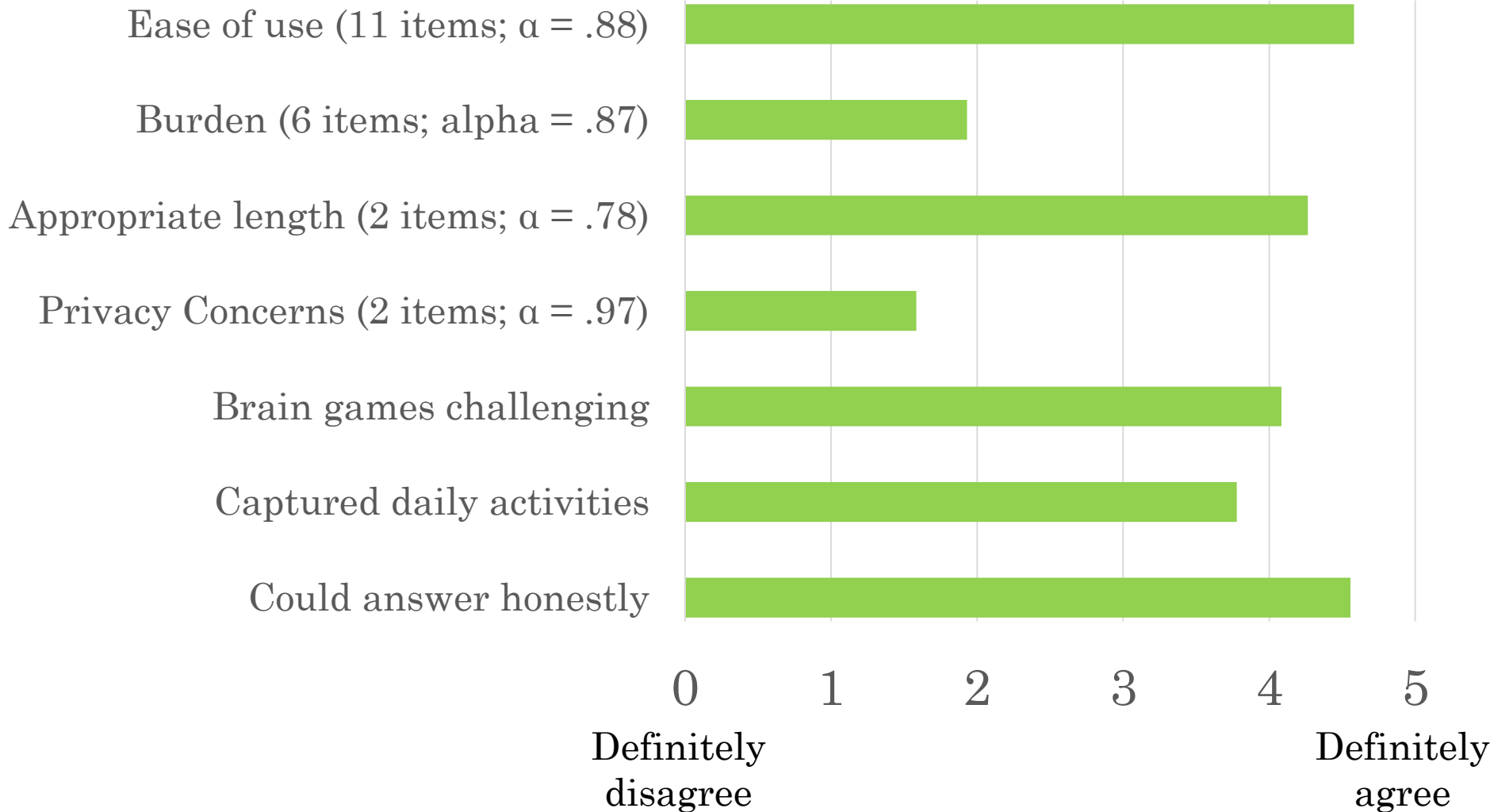
Survey completion rate	n	%	n	%
100%	28	54.9%	13	68.4%
90-99%	12	23.5%	5	26.4
80-89%	5	9.8%	1	5.3%
70-79%	1	2.0%		
60-69%	1	2.0%		
50-59%	1	2.0%		
40-49%	1	2.0%		
<10%	2	3.9%		
	51		19	

BURDEN (COMPLETION TIME)

Activity and Affect Survey	Average Time (min.)	SD	Range
Combined	3.68	1.16	1.66 – 8.80
REACH Study	3.80	1.28	1.66 – 8.80
ATTA Study	3.38	0.68	2.25 – 4.40

Survey: 19 activity items, 19 affect items, 2 social interaction items

USER EXPERIENCE RATINGS



PREDICTORS OF COMPLIANCE

Variable	B	<i>p</i>
Age	-0.03	0.606
Race (non-white)	-0.83	0.373
Sex (male)	-0.10	0.913
Education (years)	0.04	0.709
Baseline verbal memory (RAVLT)	0.05	0.333

DV: Number of surveys out of 21 possible completed.

No significant variations in compliance as a function of demographic characteristics or baseline memory ability.



PREDICTORS OF COMPLIANCE

Variable	B	<i>p</i>
Ease of use/completion	1.65	0.074
Burden	-0.024	0.973
Felt privacy safeguarded	0.285	0.604
Appropriateness of length	-0.827	0.219
Would recommend to a friend	0.953	0.202
Alarm reminders helpful	-0.242	0.519
Brain games challenging	0.447	0.443
Surveys captured daily activities	-0.667	0.286
Felt could answer honestly	0.127	0.857

Hint that perceived ease of use/completion of assessments associated with variations in compliance.



PREDICTORS OF BURDEN (TIME)

Variable	B	<i>p</i>
Age	0.02	0.318
Race (non-white)	0.74	0.015
Sex (male)	-0.18	0.543
Education (years)	0.00	0.935
Baseline verbal memory (RAVLT)	-0.04	0.031

DV: Time taken to complete survey (minutes).

Non-white race and lower baseline memory performance associated with slower completion time.



PREDICTORS OF BURDEN (TIME)

Variable	B	<i>p</i>
Ease of use/completion	-0.550	0.059
Burden	0.162	0.484
Felt privacy safeguarded	0.088	0.610
Appropriateness of length	0.042	0.841
Would recommend to a friend	-0.188	0.421
Alarm reminders helpful	0.079	0.504
Brain games challenging	-0.103	0.574
Surveys captured daily activities	0.135	0.491
Felt could answer honestly	-0.118	0.596

Hint that perceived ease of use/completion of assessments associated with slower completion time.



ACTIVITY CHARACTERISTICS

	Avg. Daily Sum	SD	Minimum	Maximum
exercised	33.64	31.18	0.00	119.29
napped	27.43	25.25	0.00	96.75
used internet	58.52	58.37	0.00	262.14
read	52.59	41.14	0.00	160.71
socialized	99.84	57.21	0.00	251.43
ran errands	39.83	32.46	0.00	209.75
hobbies	25.65	34.70	0.00	140.71
meditated	19.26	24.55	0.00	96.43
church	10.92	16.99	0.00	72.86
paid work	16.25	37.07	0.00	209.29
care for adult relative	8.03	20.27	0.00	115.50
care for child	5.75	13.14	0.00	62.25

ACTIVITY CHARACTERISTICS

	Avg. Daily Sum	SD	Minimum	Maximum
volunteered (home)	9.02	15.10	0.00	72.86
volunteered (out)	9.11	20.13	0.00	99.75
gave help	27.87	30.97	0.00	119.25
received help	16.29	21.93	0.00	105.00
chores	68.20	37.27	10.71	170.00
watched TV	92.84	63.60	0.00	278.00



AFFECT CHARACTERISTICS

	Mean (SD)	Range	ICC
Bad mood	1.6 (1.5)	0 – 5.5	.38
Tired	3.0 (1.8)	0 – 7.0	.41
Happy	7.5 (1.8)	3.0 – 10.0	.76
Engaged	7.3 (1.9)	3.0 – 10.0	.67
Generative	7.4 (2.0)	1.1 – 10.0	.71
Achieving	7.4 (1.9)	2.1 – 10.0	.81
Socially connected	7.3 (1.7)	2.7 – 10.0	.55

Bad mood: worry, stressed, annoyed, blue ($\alpha = .91$)

Happy: happy, relaxed, content ($\alpha = .82$)

Engaged: active, using your mind ($\alpha = .79$)

Generative: useful, doing something meaningful, making a difference ($\alpha = .92$)

Achieving: achieving a goal, proud, competent, in control ($\alpha = .85$)

Socially connected: feel supported, bonding with others ($\alpha = .73$)

ICCs (estimate of variation due to between-person differences)

COGNITIVE TASK CHARACTERISTICS

	Age 55-84 (REACH)		Age 25-65 (ESCAPE)
	Mean (SD)	Range	Mean (SD)
Dot Location Error (Euclidean distance = error)	2.13 (0.90)	0.31 – 4.77	1.79 (0.91)
Symbol Search Accuracy	0.95 (0.60)	0.67 – 1.00	
Flipback Accuracy	0.75 (0.14)	0.39 - 0.92	0.82 (0.13)
Symbol Search RT (sec)	5.42 (1.63)	3.33 – 11.47	2.70 (0.70)
Flipback RT (sec)	1.73 (0.57)	0.99 – 3.48	

ICCs (estimate of variation due to between-person differences) range from .22 - .54; thus, substantial within-person variation to predict.

COGNITIVE TASK ASSOCIATIONS

	Education (years)	Age	Memory (RAVLT Sum)	Memory (RAVLT LD)	Gait Speed
Dot location (Euclidean distance; error level)	-.053	.096	-.277	-.456**	.469**
SS accuracy	.152	-.077	.434**	.363*	-.470**
SS reaction time	-.177	.062	-.211	-.118	.065
FB accuracy	.187	-.209	.230	.432**	-.333*
FB reaction time	.335*	.353*	-.090	-.134	.043

SS = symbol search task; FB = flipback (n-back) task

SUMMARY

- **Completion of electronic surveys and cognitive assessments a generally favorable experience**
- **Compliance is generally high for multi-assessment, multi-day protocol**
 - Compliance did not significantly vary by demographic factors or cognitive ability
 - Hint that perceptions of ease of use are associated with compliance



SUMMARY

- **Sufficient within-person variability in affective and cognitive measures**
- **Cognitive task characteristics for pilot sample similar to that of more diverse younger sample, albeit poorer average performance**
 - Brief, daily cognitive assessment scores associated with other measures of cognitive and physical performance



FUTURE DIRECTIONS

- **Links between specific activities, affective states, and cognitive performance**
- **Alternative assessment protocols**
 - One-time assessments
 - Cross-mode reliabilities
 - Training alternatives
- **Assessment in larger, representative samples**



THANK YOU

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- **Southern California Clinical Translational Science Institute**
- **USC Davis School of Gerontology**
- **USC Healthy Aging Lab**

- **Collaborators:**
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 - Jacqui Mogle
 - Teresa Seeman
 - Elizabeth Hagood

