

# GERONTECHNOLOGY

## Research Methods

- ### What is good research?
- How do I know this article is methodological sound?
    - Are the findings clinically meaningful
      - Statistical versus clinical significance
  - Design of research is a compromise
    - Use best possible methods
    - Avoid as many confound or other interpretations of you data
  - Look for convergence among research methods

- ### Research Methods
- What approaches do scientists use to measure behavior in aging research?
  - What specific designs are unique to aging research?
  - What are general designs for doing research?

- ### Conducting Research Ethically
- Collaborative Research Training Initiative (CITI training)
  - Institutional Review Board
  - Informed Consent

- ### Reliability & Validity of Measures
- Choice of outcome measures is important
  - Reliability of a measure: extent to which it provides a consistent index of the behavior of interest (measurement error).
    - Repeatedly over items (internal consistency), over time (test-retest), over judges (inter-rater)
  - Validity of a measure: extent to which it measures what researchers think it measures.
    - Content (representativeness of sample of items), construct (assessing what suppose to be measuring; convergent & discriminant validity), criterion-related (relationship with an outcome; concurrent & predictive validity)

### Development of a questionnaire to capture difficulties with everyday activities

Item	Mean	SD	Alpha
<b>FUNCTIONAL DIFFICULTY INDEX</b>	2.0	1.0	.80
1. I have trouble remembering things	2.0	1.0	
2. I have trouble staying organized	2.0	1.0	
3. I have trouble keeping track of things	2.0	1.0	
4. I have trouble remembering names	2.0	1.0	
5. I have trouble remembering faces	2.0	1.0	
6. I have trouble remembering where things are	2.0	1.0	
7. I have trouble remembering what I have done	2.0	1.0	
8. I have trouble remembering what I have said	2.0	1.0	
9. I have trouble remembering what I have written	2.0	1.0	
10. I have trouble remembering what I have read	2.0	1.0	
11. I have trouble remembering what I have heard	2.0	1.0	
12. I have trouble remembering what I have seen	2.0	1.0	
13. I have trouble remembering what I have touched	2.0	1.0	
14. I have trouble remembering what I have smelled	2.0	1.0	
15. I have trouble remembering what I have tasted	2.0	1.0	
16. I have trouble remembering what I have felt	2.0	1.0	
17. I have trouble remembering what I have thought	2.0	1.0	
18. I have trouble remembering what I have dreamed	2.0	1.0	
19. I have trouble remembering what I have imagined	2.0	1.0	
20. I have trouble remembering what I have fantasized	2.0	1.0	
21. I have trouble remembering what I have planned	2.0	1.0	
22. I have trouble remembering what I have intended	2.0	1.0	
23. I have trouble remembering what I have promised	2.0	1.0	
24. I have trouble remembering what I have agreed	2.0	1.0	
25. I have trouble remembering what I have accepted	2.0	1.0	
26. I have trouble remembering what I have approved	2.0	1.0	
27. I have trouble remembering what I have authorized	2.0	1.0	
28. I have trouble remembering what I have consented	2.0	1.0	
29. I have trouble remembering what I have assented	2.0	1.0	
30. I have trouble remembering what I have acquiesced	2.0	1.0	
31. I have trouble remembering what I have complied	2.0	1.0	
32. I have trouble remembering what I have conformed	2.0	1.0	
33. I have trouble remembering what I have adhered	2.0	1.0	
34. I have trouble remembering what I have abided	2.0	1.0	
35. I have trouble remembering what I have followed	2.0	1.0	
36. I have trouble remembering what I have obeyed	2.0	1.0	
37. I have trouble remembering what I have listened	2.0	1.0	
38. I have trouble remembering what I have attended	2.0	1.0	
39. I have trouble remembering what I have participated	2.0	1.0	
40. I have trouble remembering what I have cooperated	2.0	1.0	
41. I have trouble remembering what I have assisted	2.0	1.0	
42. I have trouble remembering what I have helped	2.0	1.0	
43. I have trouble remembering what I have aided	2.0	1.0	
44. I have trouble remembering what I have supported	2.0	1.0	
45. I have trouble remembering what I have backed	2.0	1.0	
46. I have trouble remembering what I have upheld	2.0	1.0	
47. I have trouble remembering what I have sustained	2.0	1.0	
48. I have trouble remembering what I have maintained	2.0	1.0	
49. I have trouble remembering what I have preserved	2.0	1.0	
50. I have trouble remembering what I have protected	2.0	1.0	
51. I have trouble remembering what I have defended	2.0	1.0	
52. I have trouble remembering what I have supported	2.0	1.0	
53. I have trouble remembering what I have upheld	2.0	1.0	
54. I have trouble remembering what I have sustained	2.0	1.0	
55. I have trouble remembering what I have maintained	2.0	1.0	
56. I have trouble remembering what I have preserved	2.0	1.0	
57. I have trouble remembering what I have protected	2.0	1.0	
58. I have trouble remembering what I have defended	2.0	1.0	
59. I have trouble remembering what I have supported	2.0	1.0	
60. I have trouble remembering what I have upheld	2.0	1.0	
61. I have trouble remembering what I have sustained	2.0	1.0	
62. I have trouble remembering what I have maintained	2.0	1.0	
63. I have trouble remembering what I have preserved	2.0	1.0	
64. I have trouble remembering what I have protected	2.0	1.0	
65. I have trouble remembering what I have defended	2.0	1.0	
66. I have trouble remembering what I have supported	2.0	1.0	
67. I have trouble remembering what I have upheld	2.0	1.0	
68. I have trouble remembering what I have sustained	2.0	1.0	
69. I have trouble remembering what I have maintained	2.0	1.0	
70. I have trouble remembering what I have preserved	2.0	1.0	
71. I have trouble remembering what I have protected	2.0	1.0	
72. I have trouble remembering what I have defended	2.0	1.0	
73. I have trouble remembering what I have supported	2.0	1.0	
74. I have trouble remembering what I have upheld	2.0	1.0	
75. I have trouble remembering what I have sustained	2.0	1.0	
76. I have trouble remembering what I have maintained	2.0	1.0	
77. I have trouble remembering what I have preserved	2.0	1.0	
78. I have trouble remembering what I have protected	2.0	1.0	
79. I have trouble remembering what I have defended	2.0	1.0	
80. I have trouble remembering what I have supported	2.0	1.0	
81. I have trouble remembering what I have upheld	2.0	1.0	
82. I have trouble remembering what I have sustained	2.0	1.0	
83. I have trouble remembering what I have maintained	2.0	1.0	
84. I have trouble remembering what I have preserved	2.0	1.0	
85. I have trouble remembering what I have protected	2.0	1.0	
86. I have trouble remembering what I have defended	2.0	1.0	
87. I have trouble remembering what I have supported	2.0	1.0	
88. I have trouble remembering what I have upheld	2.0	1.0	
89. I have trouble remembering what I have sustained	2.0	1.0	
90. I have trouble remembering what I have maintained	2.0	1.0	
91. I have trouble remembering what I have preserved	2.0	1.0	
92. I have trouble remembering what I have protected	2.0	1.0	
93. I have trouble remembering what I have defended	2.0	1.0	
94. I have trouble remembering what I have supported	2.0	1.0	
95. I have trouble remembering what I have upheld	2.0	1.0	
96. I have trouble remembering what I have sustained	2.0	1.0	
97. I have trouble remembering what I have maintained	2.0	1.0	
98. I have trouble remembering what I have preserved	2.0	1.0	
99. I have trouble remembering what I have protected	2.0	1.0	
100. I have trouble remembering what I have defended	2.0	1.0	

## Internal Consistency Reliability

Rasch Model Statistics for the IADL-C

Factor	Rasch Reliability	Separation	$\chi^2$ Model Fit	p-value
1	.93	3.6	944.53	.078
2	.87	2.6	968.16	.071
3	.79	1.9	106.79	.663
4	.93	3.5	100.75	.663

- 27 item IADL-C, 4 factors accounted for 75.3% of variance
- Each of 4 scales also showed adequate fit to Rasch model supporting model unidimensionality

## Test-Retest Reliability

- Healthy OA (N = 10) and MCI (N = 31)
- Interval avg 4.03 months (range 2-6)
- Spearman Correlation Coefficients
  - IADL-C total score ( $r_s = .91$ )
  - money and self-management subscale ( $r_s = .91$ )
  - home daily living ( $r_s = .76$ )
  - travel and event memory ( $r_s = .70$ )
  - social skills ( $r_s = .70$ )

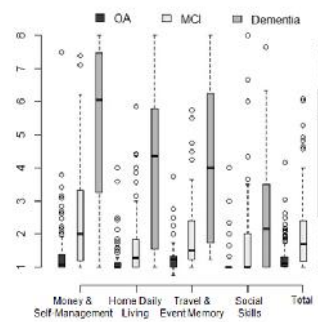
Spearman Correlation between Total and Rasch IADL-C Scores and Measures of Everyday Functioning, Cognitive Status, Psychosocial Functioning, and Demographics

	Total Score	Money and Self-Management	Home Daily Living	Travel and Event Memory	Social Skills	Total Scale
<b>Demographic Information</b>						
AGE, n=174	.35**	.23**	.41**	.45**	.45**	.45**
AGE, n=143	.35**	.23**	.41**	.45**	.45**	.45**
AGE, n=41	.35**	.23**	.41**	.45**	.45**	.45**
<b>Cognitive Function</b>						
MMSE, n=232	-.13**	-.12**	-.12**	-.12**	-.12**	-.12**
MMSE, n=102	-.13**	-.12**	-.12**	-.12**	-.12**	-.12**
<b>Psychosocial Function</b>						
GHQ-12, n=237	.21**	.21**	.17**	.22**	.22**	.22**
GHQ-12, n=102	.24**	.24**	.22**	.22**	.22**	.22**
<b>Diagnoses</b>						
Healthy, n=109	.36**	.35**	.35**	.35**	.35**	.35**
MCI, n=229	.24**	.24**	.24**	.24**	.24**	.24**

## Convergent & Discriminant Validity

### Hypothesized:

- 0.5-0.8: Moderate to High (everyday functioning)
- 0.4-0.6: Moderate (global cognitive status)
- 0.0-0.3: Low (psychosocial & Demographics)



Ability to Distinguish between Diagnostic Groups

Figure 2. Box and whisker plots of the IADL-C total and subscale scores for the healthy older adults (OA), mild cognitive impairment (MCI) and dementia groups.

## Representative Sampling

- Generalizability – across people, environment etc.
- Most aging research conducted on:
  - White
  - Middle-class
  - Well-educated
- Most research conducted in a laboratory environment
- Effects external validity

## Aging Assistive Technologies Programs

- Video intervention to increase awareness & knowledge about ASTs, promote more positive attitudes and reduce stigma among users, caregivers and professionals.
- AST phone intervention to help promote AST use
- AST Lending Program



## The Meaning of Age

- How old are you?
  - Calendar years?
  - How old you feel at this time?
  - How old you look?
  - Your cognitive competence?
  - Your social role?



Ernestine Shepherd, at age 74, said she's up at 3 a.m. every morning: runs, lifts weights and works out with other senior citizens at a local church in Baltimore. "I feel better than I did at 40"



## The Meaning of Age

- Chronological age or calendar age = surrogate variable
  - Individual differences
  - Intra-individual differences
- Everyone does not grow old in the same way



## How Older Age Defined in Research

- When does late adulthood or older age begin?
  - Most developed countries use age 60/65+
- Some gerontologist differentiate between
  - Young-old (60/65 - 74)
  - Old-old (75 - 84)
  - Oldest-old (age 85+)
  - Centurions (age 100+)

## Research Design

- Nondevelopmental research
  - Examine relationships between factors that might apply regardless of age
- Developmental research

## Developmental Research Design

- Age Effects
  - Differences due to underlying aging processes (biological, psychological or social)
  - Variable in cross-sectional & longitudinal designs
- Cohort Effects (generation)
  - Differences due to experiences and circumstances unique to the generation to which one belongs
  - Possible confound in cross-sectional designs
- Time-of-Measurement Effects
  - Differences stemming from social, environmental, historical, or other events at time data collected
  - Possible confound in longitudinal designs

## Developmental Research

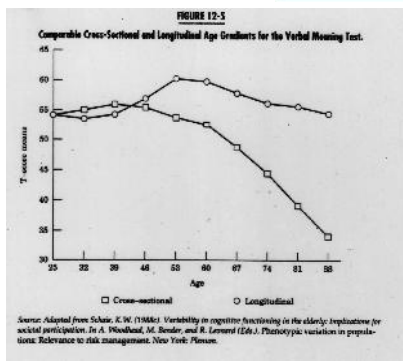
- Cross-Sectional Research Design
  - Involves comparing groups of people varying in age
  - Does not take long to complete
  - Cannot disentangle aging process from cohort effects
  - Allows us to make statements about Age Differences but not Age Changes



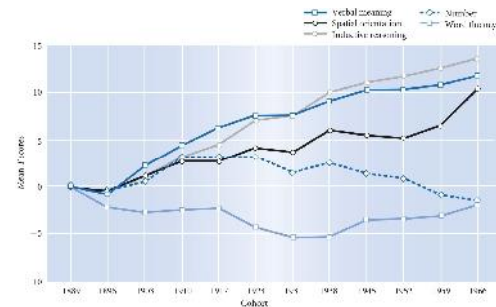
## Developmental Research

### Longitudinal Research Designs

- Involves observations of the same person at two or more different points in time
- Time consuming and expensive to complete
- Shifts in personnel, subject attrition, practice effects
- Allows us to record Age Changes
- Cannot disentangle age changes from time of measurement effects

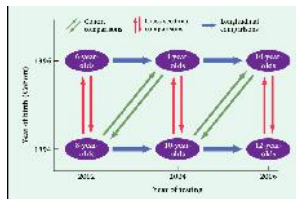


Cohort gradient showing cumulative cohort difference on 5 primary mental abilities for cohorts born in 1889 to 1996. (Source: Schaie, 1994)



## Developmental Research Design

- Sequences
  - More than one cross sectional or longitudinal design used simultaneously



## Research Methods

- Controlled experiments
- Quasi-experimental & Non-experimental designs
- Correlational studies
- Observational methods
- Psychobiological studies
- Survey and questionnaire measures
- Standardized test
- Qualitative methods: Interviews and focus groups
- Case studies
- Computer simulations and artificial intelligence

## In an Experiment...

- Random sample of participants
- Manipulate the Independent Variable (IV)
  - Create experimental group
  - Create control group
  - Randomly assign participants
- Measure the Dependent Variable(s) (DV)
  - Same for all groups
- Control all other variables
  - Prevent confounds

## Experimental design

Amap task  
 Participants: older adults  
 randomly assigned to condition  
 IV: planning condition  
 (planning versus no planning)  
 DV: task accuracy & efficiency  
 measures



Questions: (Please use the answer to each question on level)

1. How many plants are located in the apartment? 2 3 4 8
2. What Brand is the Microwave? Philips Sharp Kenmore Hoover
3. Is there a container of frozen sugar located in cupboard "A"? Yes No
4. Is there a lemon in the kitchen supply closet? Yes No
5. Is there a mouse and trapping in the hallway closet? Yes No
6. Is there a clock sitting on the dining room table? Yes No

Task List

7. Retrieve T.V. remote from the kitchen counter and place on top of T.V.
8. Retrieve pill holder from dining room table and place in kitchen cupboard labeled "Cupboard A"
9. Retrieve water pitcher from hallway "kitchen" closet, fill with water from faucet and place in refrigerator
10. Bring the following items to the front door: reiki, two plastic cups, dharma (see map to determine location of items)

Possible confounds?

## Experimental Methods

- Age cannot be manipulated or randomly assigned
- Quasi-experimental design
  - No random assignment
  - Manipulate the Independent Variable
- Non-experimental design
  - No random assignment
  - No variable manipulated

## Quasi-Experimental design

Amap task  
 Participants: older & younger  
 adults  
 IV: planning condition  
 (planning versus no planning)  
 DV: task accuracy & efficiency  
 measures



Questions: (Please use the answer to each question on level)

1. How many plants are located in the apartment? 2 3 4 8
2. What Brand is the Microwave? Philips Sharp Kenmore Hoover
3. Is there a container of frozen sugar located in cupboard "A"? Yes No
4. Is there a lemon in the kitchen supply closet? Yes No
5. Is there a mouse and trapping in the hallway closet? Yes No
6. Is there a clock sitting on the dining room table? Yes No

Task List

7. Retrieve T.V. remote from the kitchen counter and place on top of T.V.
8. Retrieve pill holder from dining room table and place in kitchen cupboard labeled "Cupboard A"
9. Retrieve water pitcher from hallway "kitchen" closet, fill with water from faucet and place in refrigerator
10. Bring the following items to the front door: reiki, two plastic cups, dharma (see map to determine location of items)

## Non-Experimental design

Amap task  
 Participants: older adults &  
 individuals with mild cognitive  
 impairment  
 IV: none: all perform Amap  
 task with planning  
 DV: record task accuracy &  
 efficiency measures



Questions: (Please use the answer to each question on level)

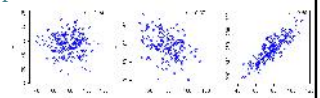
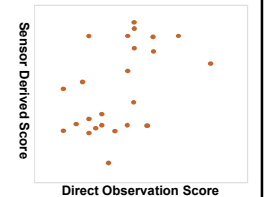
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2. What Brand is the Microwave? Philips Sharp Kenmore Hoover
3. Is there a container of frozen sugar located in cupboard "A"? Yes No
4. Is there a lemon in the kitchen supply closet? Yes No
5. Is there a mouse and trapping in the hallway closet? Yes No
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## Correlational Studies

- Cannot infer causation
- Simply measure variables of interest
- Nature of relationship
  - Positive Correlation
  - Negative Correlation
- Strength of relationship
  - Determined by size of "r"
  - -1.0 to 1.0;
  - r of 0 = unrelated



## What Factors Are Associated With the Reduction of Risk of Alzheimer's Disease?

• Causation cannot yet be drawn about the association of any modifiable risk factor with AD (all data correlational)

Linked to Decreased Risk of AD	Linked to Increased risk of AD
Adequate folic acid intake	Diabetes
Low saturated fat consumption	Elevated blood cholesterol (midlife)
High fruit & veggie consumption	Depression
Use of statins	Current smoking
Light to moderate alcohol use	Never been married
Educational attainment	Low social support
Cognitive engagement	
Participation in physical exercise	

## Observational Methods

- **Naturalistic Observation:** Observation of performance in everyday situations outside of the lab without any attempt to intervene; the situation is not initiated, manipulated or controlled by the investigator
  - Less experimental control
  - Presence of an observer could affect performance (reactivity)
  - High ecological validity

## Community Activities: Compensatory Strategy Study

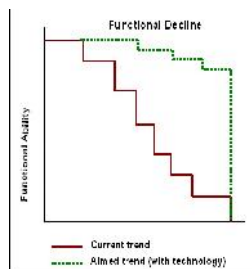
1. **Banking:** Please deposit the provided \$20 check in your bank. Please save the receipt from the transaction and save it where you would put important documents.
  2. **Shopping:** Please purchase items for a light lunch and a dessert you can serve guests at a party. Please purchase items as you normally would and as part of an already planned shopping trip to avoid making a separate trip. You will be using the items during your next session. Please put purchased items away where you normally would put such items.
- Because I want you to complete the shopping task in as natural of a way as possible I will not be accompanying you on this trip. Rather, if you agree, I would like you to wear a small, lightweight camera while you shop and put away grocery items. You can attach the camera to your shirt or the provided bag. Feel free to remove the camera if it provides you any discomfort. You do not need to wear the camera for the banking task. Furthermore, please remove and turn off the camera when you are waiting in line to respect the privacy of others. If someone were to approach in the store please let them read the backside of this page, let them know you are a part of a research study, and ask their verbal permission to continue recording. If they decline, please turn off the camera. If you go to a location that has a sign indicating they do not allow video recording, or if an employee requests that you not film, please turn off the camera.

## Psychobiological Studies

- **Postmortem studies**
  - Examining the cortex of persons with AD after death to see if count of plaques and tangles relates to degree of cognitive and functional deficits
- **Brain damaged individuals and their deficits**
  - Study functional difficulties that individuals with MCI have as they progress to dementia
- **Monitor brain function of a participant doing a task (fMRI)**
  - Measure brain activity while healthy older adults and individuals with MCI and AD are performing a working memory task
  - limited accessibility, expensive, small samples
  - Networks of researchers working together to create large datasets: ADNI, TBI Model networks, CART

## Neurodegenerative decline - longitudinal study

- > 40 resident homes turned into smart homes
- Primary collection sites: Horizon House, Seattle, WA; Rockwood, Spokane WA
- Individuals age 75+; healthy and individuals with MCI
- Bi-yearly clinical evaluations
- Monthly health calls
- Medical records review

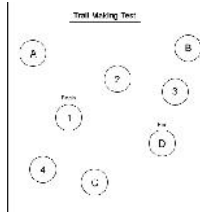


## Survey and Questionnaire Methods

- **Self-Report:** Obtain participants' report in progress or as recollected
  - Questionnaires
  - Diary
  - Ecological Momentary Assessment
  - Interviews
  - Think Aloud
    - Participants describe their conscious thoughts while working with a new prompting interface
- **Informant Report:** Obtain report about participants from someone who knows participant (e.g. spouse, clinician)
- Subject to reporter bias
- Cannot be assumed to be a mirror into objective status
- Context effects (wording, social)

## Standardized Tests

- A tests that is administered and scored in a standardized manner (e.g., neuropsychological test)



Trail Making Test: time to complete; errors

## Continuous Data

- Wearable sensors
  - Sleep wake, activity levels etc.
- Smart home sensors
  - Activity recognition

## Qualitative Methods

- Allow for exploration of a phenomenon of interest in an open-ended fashion
- Data typically organized on basis of themes
  - Interviews
  - Focus Groups
    - ✦ Discuss a topic with a group of respondents
- ✦ Interviewer bias
- ✦ Group dynamics

## Focus Groups

### Group TX Study - memory notebook

- **Themes:**
  - **Support:** Not feeling isolated/social support/other people are going through this too
  - **Empowerment:** Feeling empowered by a “game plan”/having tools to compensate for memory problems/ psychoeducation to understand the process

## Other Methods

- **Case Study:** Intensive studies of individuals
  - May examine archival records, interviews, direct observation, or participant-observations
  - Teaching an individual with memory deficits to use an electronic memory notebook paired with a smart home
  - Phineas Gage or HM
- **Meta-analysis**
  - A statistical technique for combining the findings from independent studies



## Meta-analysis

*Functional status domains and subdomains*

Functional status domains and subdomains	k	R	R <sup>2</sup>	LCI of R <sup>2</sup>	UCI of R <sup>2</sup>	I <sup>2</sup>	Heterogeneity	
							Q <sup>*</sup>	P
Performance-based	31	.50	25%	14%	35%	0.06	310.83	91.10%
Behavioral assessment	20	.40	22%	10%	30%	0.12	247.88	93.22%
Questionnaire	115	.49	24%	20%	27%	20.17	2282.77	91.03%
Self-report	15	.46	21%	14%	28%	9.49	114.47	88.90%
Informant report	72	.52	28%	21%	32%	18.86	1334.75	91.48%
Both self and informant	14	.59	33%	19%	34%	1.00	107.12	91.81%
IADL	105	.50	25%	21%	29%	20.12	1797.97	91.08%
ADL	35	.51	26%	18%	36%	7.9	1068.04	94.71%
Both IADL and ADL	61	.47	23%	16%	27%	12.06	2144.1	96.87%

Note: \*all significant at < .01. LCI = lower confidence interval, UCI = upper confidence interval, IADL = instrumental activities of daily living, ADL = activities of daily living.

## Computers in Research

- **Computer Simulations**
  - Attempt to make computers simulate human performance on various tasks
- **Artificial Intelligence**
  - Attempt to make computers demonstrate intelligent cognitive performance, regardless of whether the process resembles human cognitive processing
- Limitation imposed by hardware and the programs written by researchers

## Model for solving volume conservation task

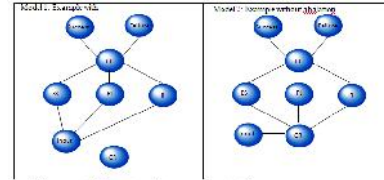


Figure 2. Comparison of a basic and a human computational model.

