Aging & Cognition

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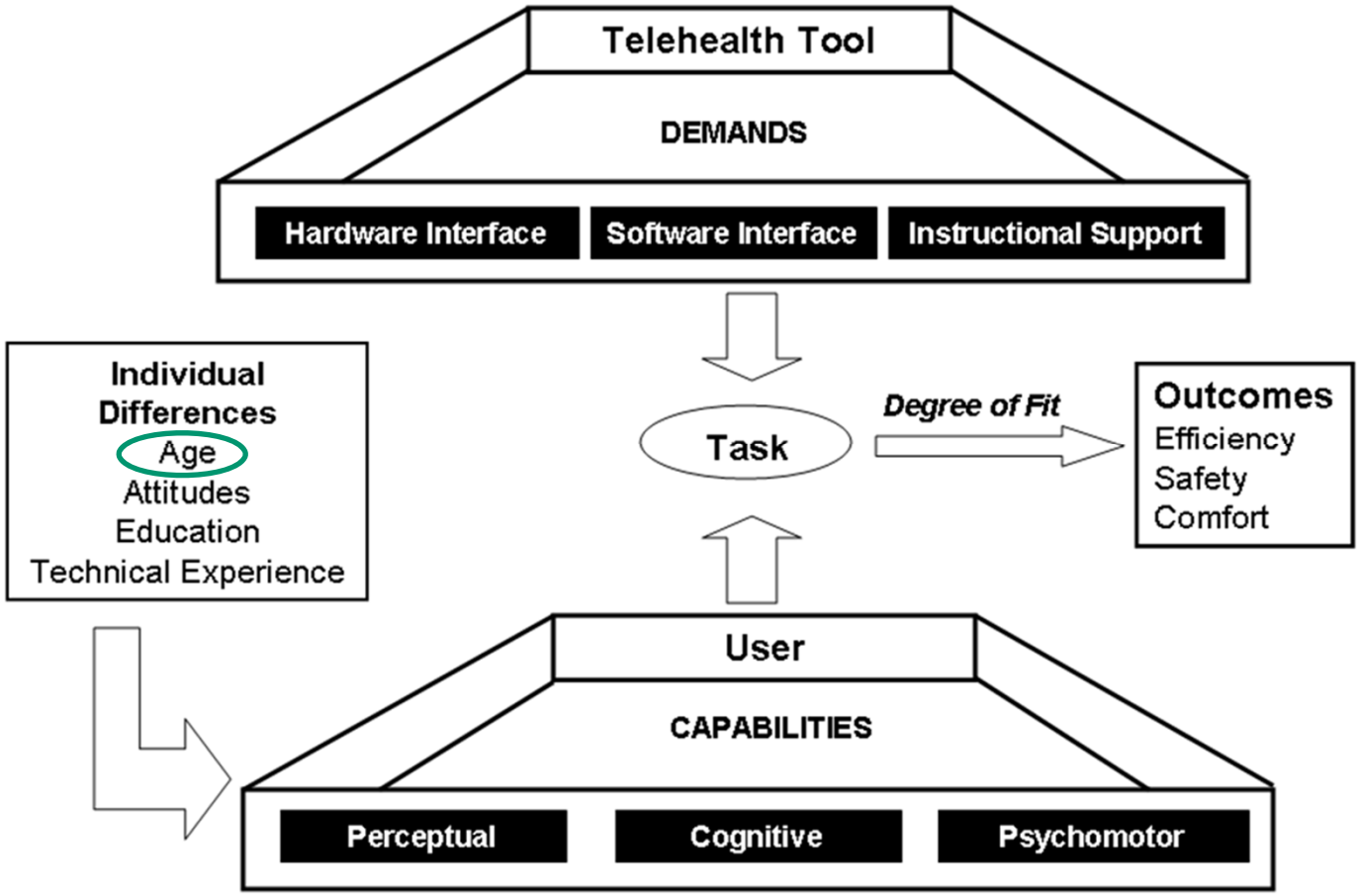
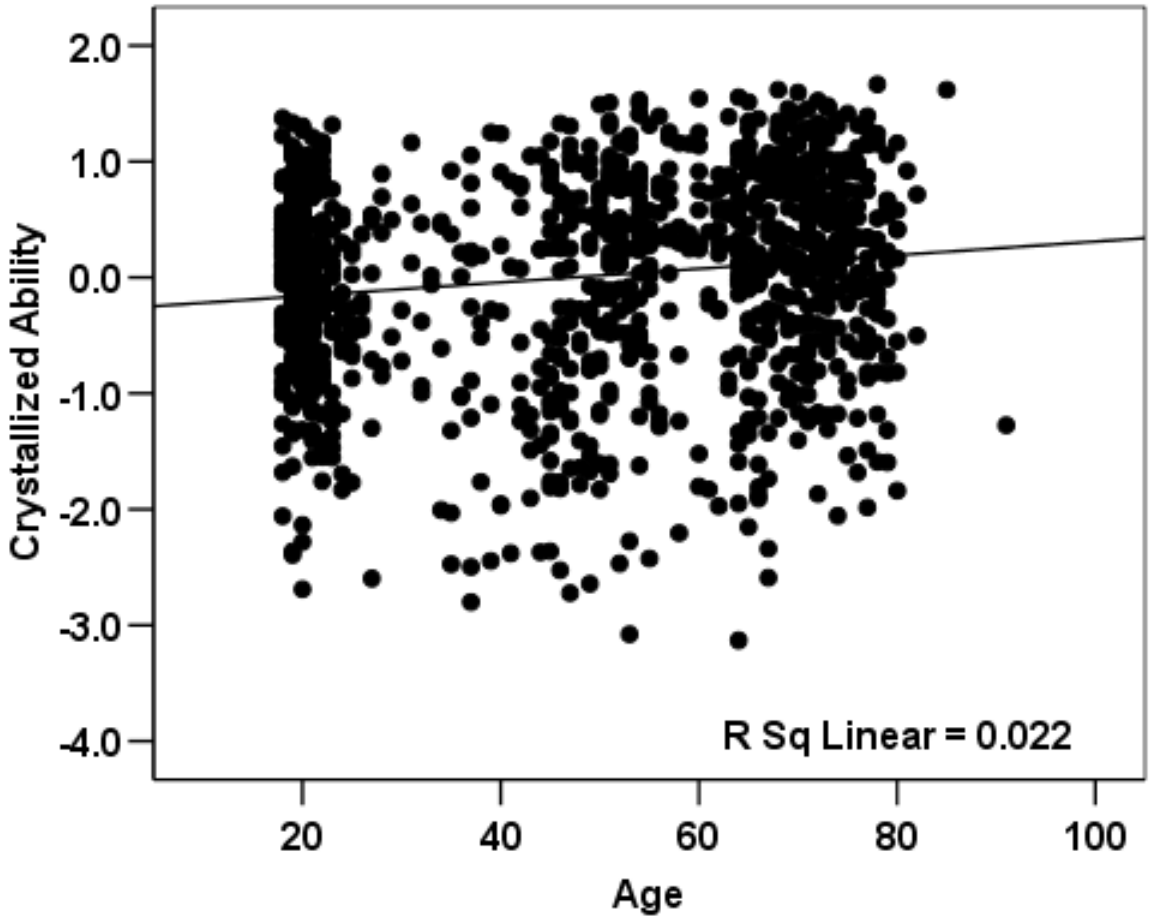
Person-Environment Fit



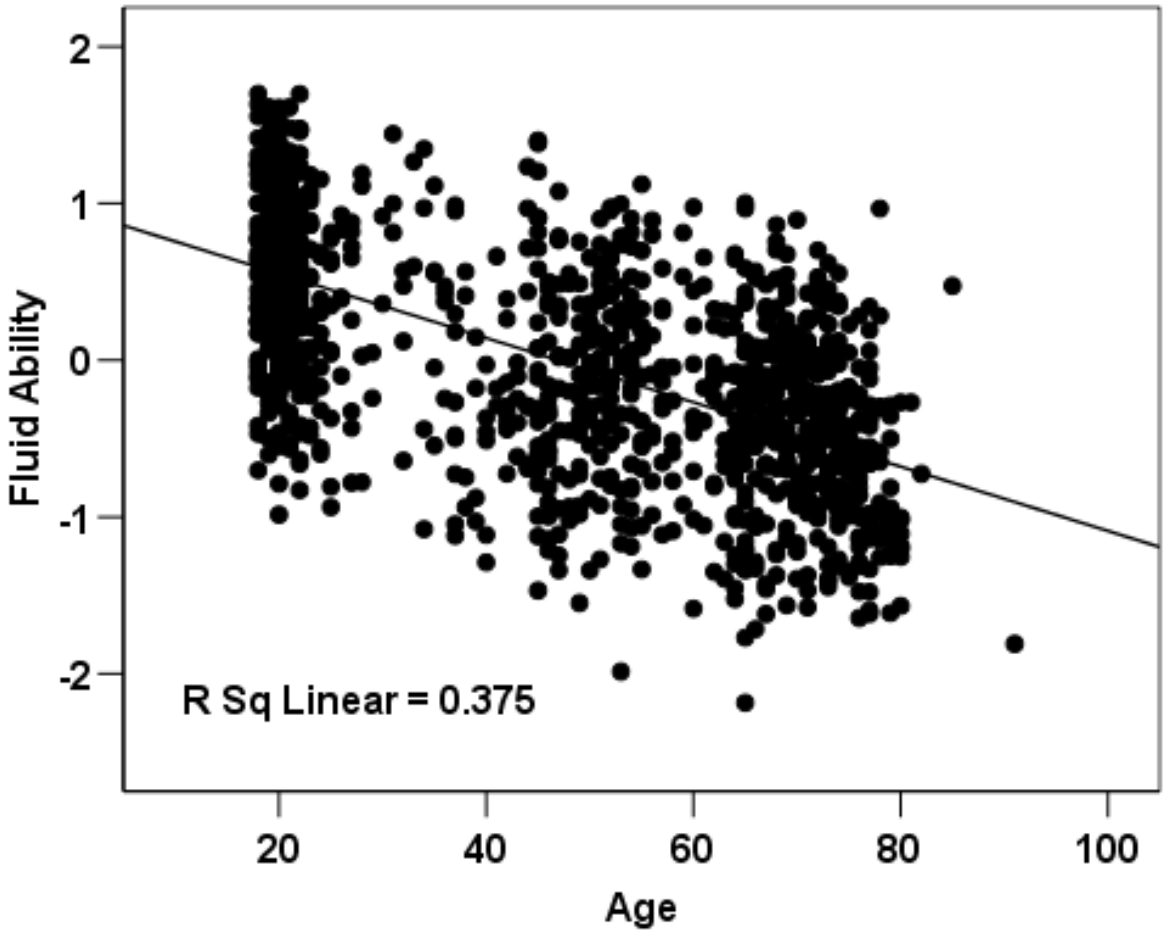
Characterizing Cognition as Cognitive Factors

- One approach is Factor Analysis
  - Give people short reliable tests that cover a broad range of cognitive operations and look for common variance across tests that define cognitive factors
    - Spearman, Thorndike, Guilford
  - Generally leads to two broad factors being found, though highly inter-correlated, termed crystallized and fluid abilities

CREATE Crystallized Ability (n=1197)

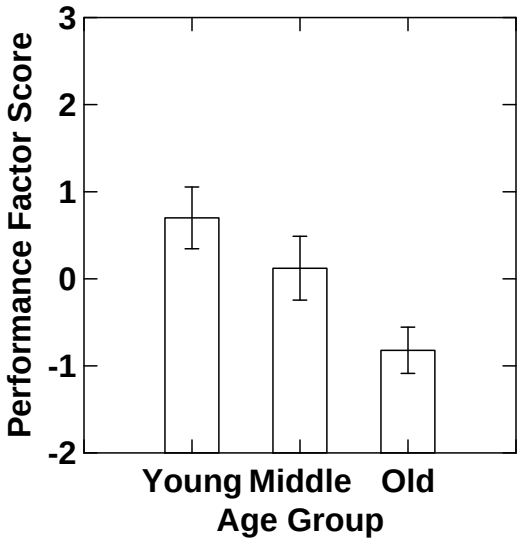


CREATE Fluid Ability (n=1174)

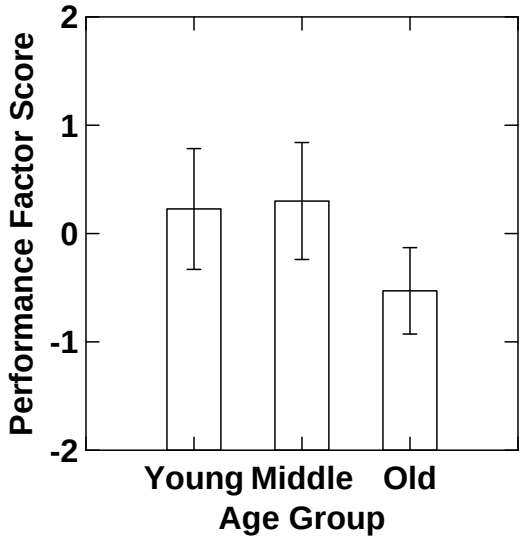


Joint Effects on Performance

Novice Word Processors



Experienced Word Processors



Caveats

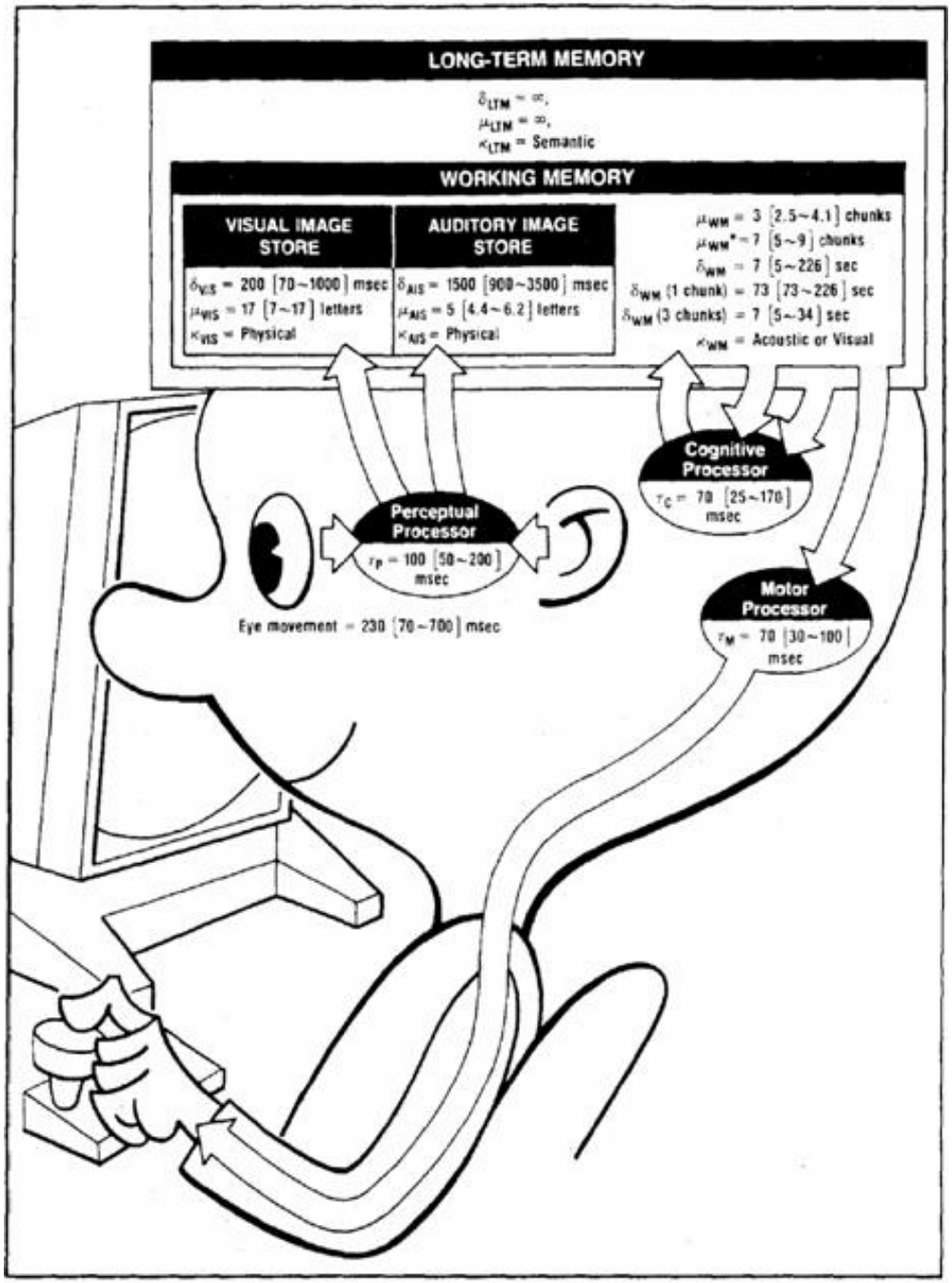
- Cross-sectional data conflates age & cohort effects
- Cohort effects can be powerful
  - Flynn Effect shows that fluid abilities have increased about 1 SD in many countries in the past 50 years

Characterizing Cognition as Information Processing

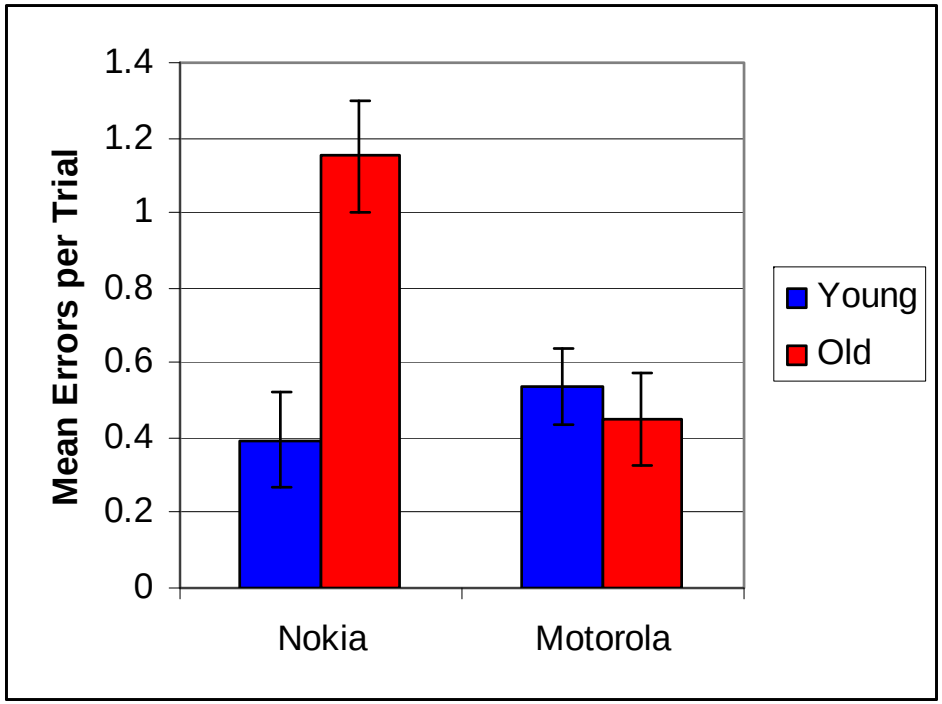
- With the introduction of computers, people began to see a deep connection between information processing in natural and artificial systems
  - Simon, Miller, Broadbent, Newell & Simon

GOMS

Parameter	Younger Adult (Card, Moran, & Newell, 1983)	Older Adult (Jastrzembski, 2006)	Ratio O/Y
Duration of eye fixation	230 ms	267 ms	1.2
Decay half-life of visual image store	200 ms	159 ms	0.8
Perceptual processor Cycle time	100 ms	178 ms	1.8
Motor processor Cycle time	70 ms	146 ms	2.1
Power Law of practice constant	0.4	0.49	1.2
Fitt's Law slope constant	100 ms/bit	175 ms/bit	1.8
Effective capacity of working memory	7 items)	5.4 items	0.77
Pure capacity of working memory	2.5 items	2.3 items	0.92
Cognitive processor Cycle time	70 ms	118 ms	1.7



Letter “S” errors: Why?



- GOMS modeling reveals that older adults need 759 ms to press the same button four times in a row on the Nokia phone, and need 792 ms for the Motorola phone.
- **Nokia times out after 1000 ms, so older adults have 241 ms of leeway before an error is committed, compared to 508 ms for the Motorola with a 1500 ms timeout.**
- Younger adults require 422 ms to complete the required cognitive, perceptual, and motor cycles with the Nokia phone, and 420 ms with the Motorola phone
  - error likely because of improper button press calculation (4 not 3).
  - Best performing older adults (upper half) resemble younger adults

GOMS for the Nokia

Steps 1-10

ASSUMPTIONS: In default mode for the Nokia – user holding cell phone in preferred hand, dialing with preferred thumb.	OPERATOR	TIME (Young)	TIME (Old)	TOTAL (Young)	TOTAL (Old)	Button Press Number
GOAL: Dial number (268-413-0734) and send call.						
METHOD: Press numbers and hit green call button.						
Step 1: Fixate 1st chunk of numbers on paper (1st 3 numbers)	F	230	267	230	267	
Step 2: Encode first 3 digits	3 C	3 (70)	3(118)	440	621	
Step 3: Fixate keypad	F	230	267	670	888	
Step 4: Decode first chunk	C	70	118	740	1006	
Step 5: Fixate first digit	F	230	267	970	1273	
Step 6: Dial 1st digit	M	70	146	1040	1419	1
Step 7: Fixate second digit	F	230	267	1270	1686	
Step 8: Dial 2nd digit	M Fitts	70 84.8	146 148	1424.8	1980	2
Step 9: Fixate third digit	F	230	267	1654.8	2247	
Step 10: Dial 3rd digit	M Fitts	70 100	146 175	1824.8	2568	3

GOMS for the Nokia

Steps 11-22

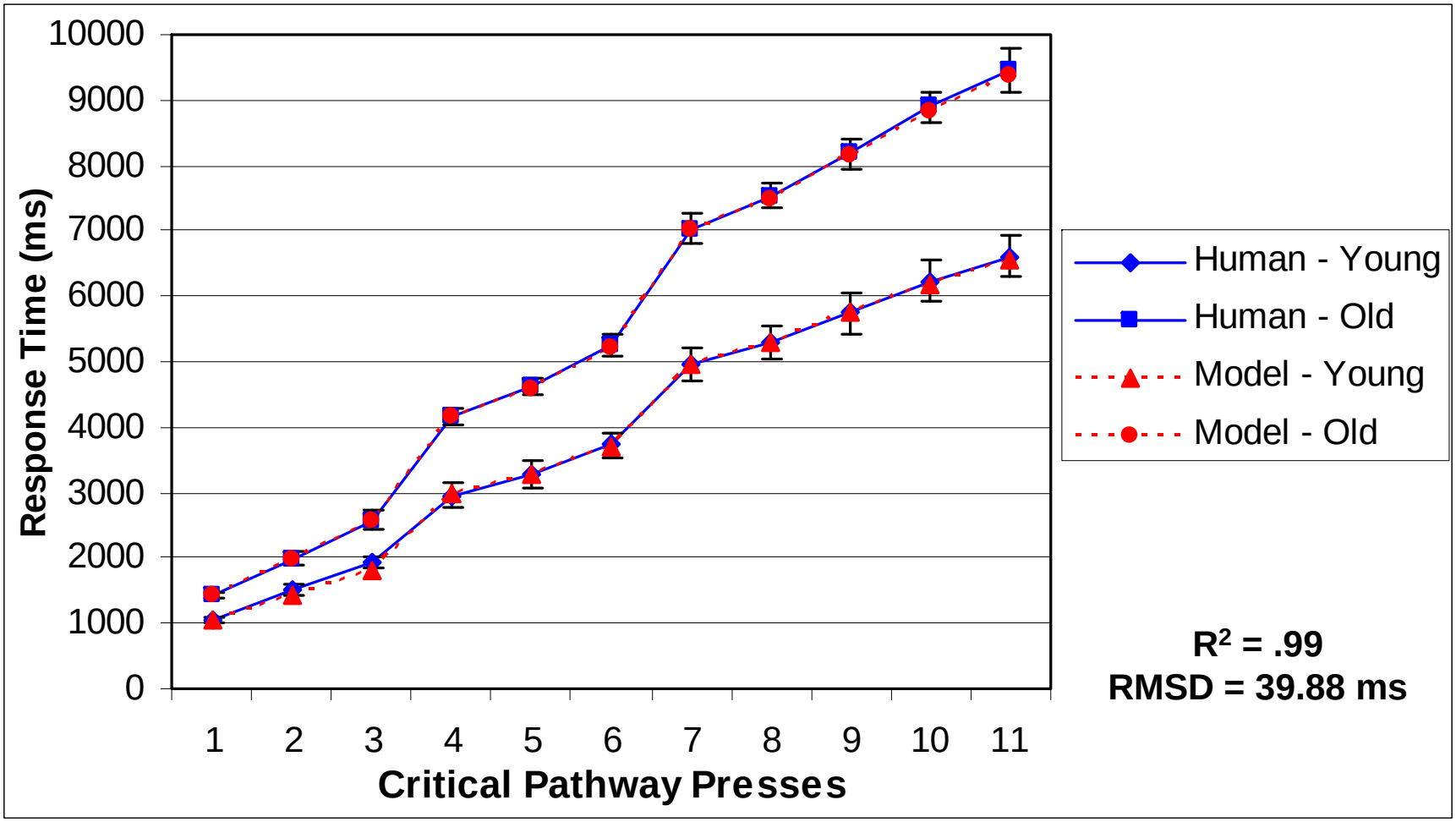
Step 11: Fixate 2nd chunk of numbers on paper (2nd 3 numbers)	F	230	267	2054.8	2835	
Step 12: Encode second 3 digits	3 C	3(70)	3(118)	2264.8	3189	
Step 13: Fixate keypad	F	230	267	2494.8	3456	
Step 14: Decode second chunk	C	70	118	2564.8	3574	
Step 15: Fixate first digit	F	230	267	2794.8	3841	
Step 16: Dial 1st digit	M Fitts	70 100	146 175	2964.8	4162	4
Step 17: Fixate second digit	F	230	267	3194.8	4429	
Step 18: Dial 2nd digit	M Fitts	70 0	146 0	3264.8	4575	5
Step 19: Fixate 3rd digit	F	230	267	3494.8	4842	
Step 20: Dial 3rd digit	M Fitts	70 132.2	146 231	3697	5219	6
Step 21: Fixate last chunk of numbers on paper (last 4 numbers)	F	230	267	3927	5486	
Step 22: Encode last 4 digits	4 C	4(70)	4(118)	4207	5958	

GOMS for the Nokia

Steps 23-35

Step 23: Fixate keypad	F	230	267	4437	6225	
Step 24: Decode last chunk	C	70	118	4507	6343	
Step 25: Fixate first digit	F	230	267	4737	6610	
Step 26: Dial 1st digit	M Fitts	70 148.5	146 260	4955.5	7016	7
Step 27: Fixate second digit	F	230	267	5185.5	7283	
Step 28: Dial 2nd digit	M Fitts	70 26.3	146 46	5281.3	7475	8
Step 29: Fixate third digit	F	230	267	5511.8	7742	
Step 30: Dial 3rd digit	M Fitts	70 158.5	146 277	5740.3	8165	9
Step 31: Fixate fourth digit	F	230	267	5970.3	8432	
Step 32: Dial 4th digit	M Fitts	70 148.5	146 260	6188.8	8838	10
Step 33: Return with goal accomplished	C	70	118	6258.8	8956	
Step 34: Fixate green send button	F	230	267	6488.8	9223	
Step 35: Press green send button	M	70	146	6558.8	9369	11
TOTAL TIME				6.59 sec	9.37 sec	

Model Fit for Nokia – Dial task



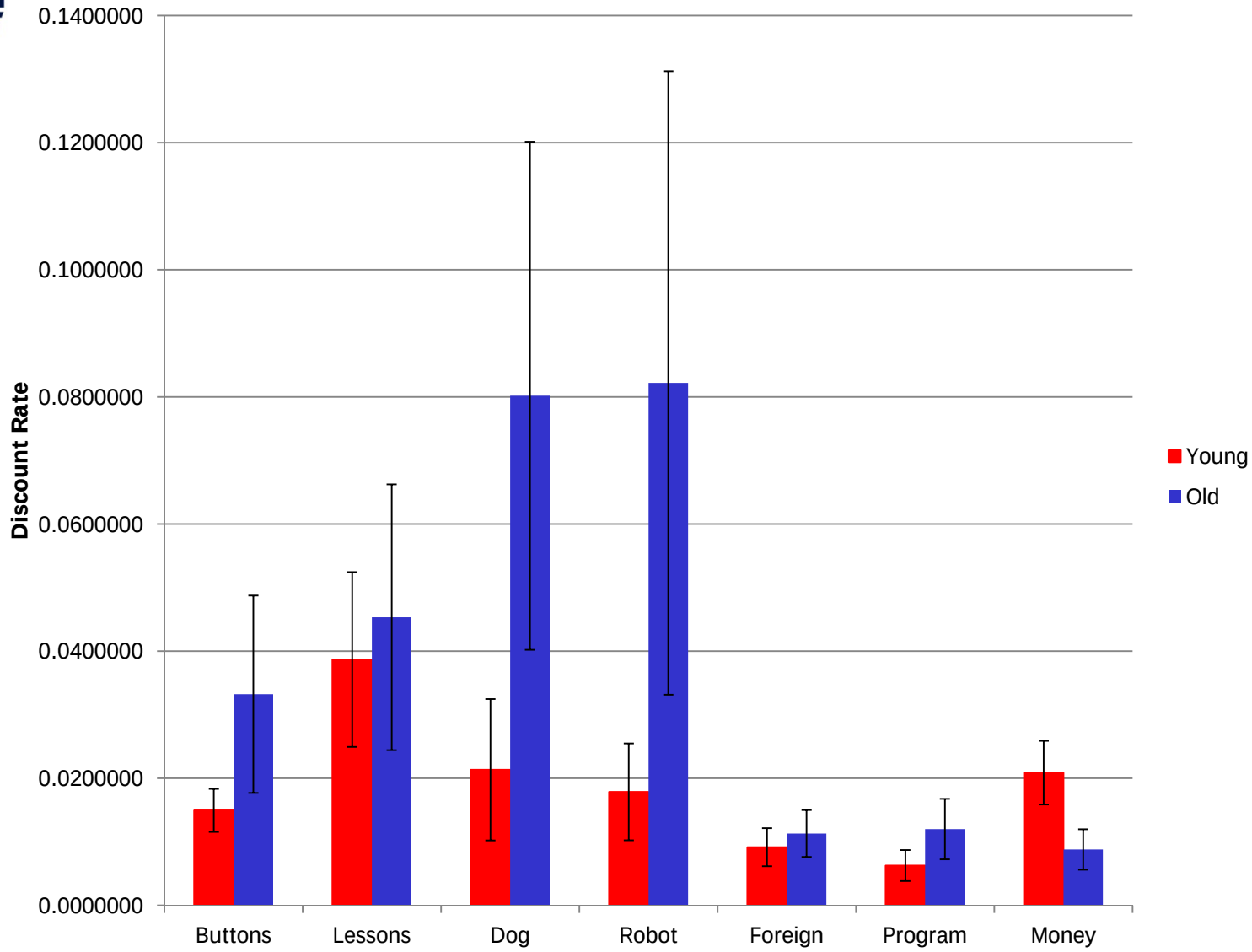
Discounting Phenomena

- Describes the change in value of any commodity when its acquisition is not immediate or guaranteed
- Perceived value is a fluid variable depending on factors such as
  - Risk ("a bird in the hand is worth 2 in the bush"
    - "$100 with p = 1.0 or $1000 with p=.1"?
  - Waiting time
    - "$100 now or $200 in 1 year"?
  - Effort
    - Train robot to do 79 household tasks in 1 session or 97 tasks in 14 sessions?

Age & Discount Rates

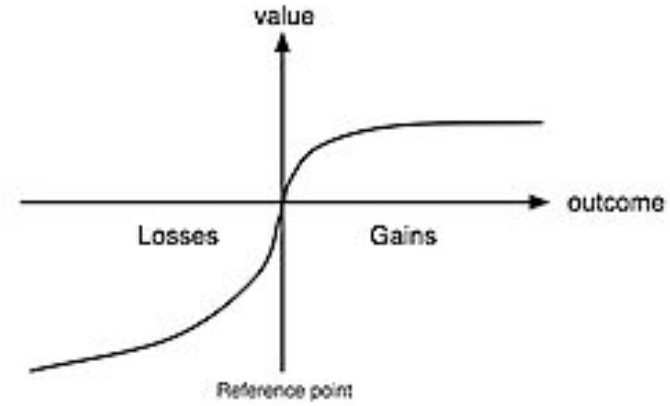
- US District Court Judge Wesley Brown
  - Age 103 (2010)
- “At this age, I’m not even buying green bananas.”
- The rationality principle suggests that older adults may discount the value of new learning more steeply

Discount Rate for Learning



Benefits and Costs

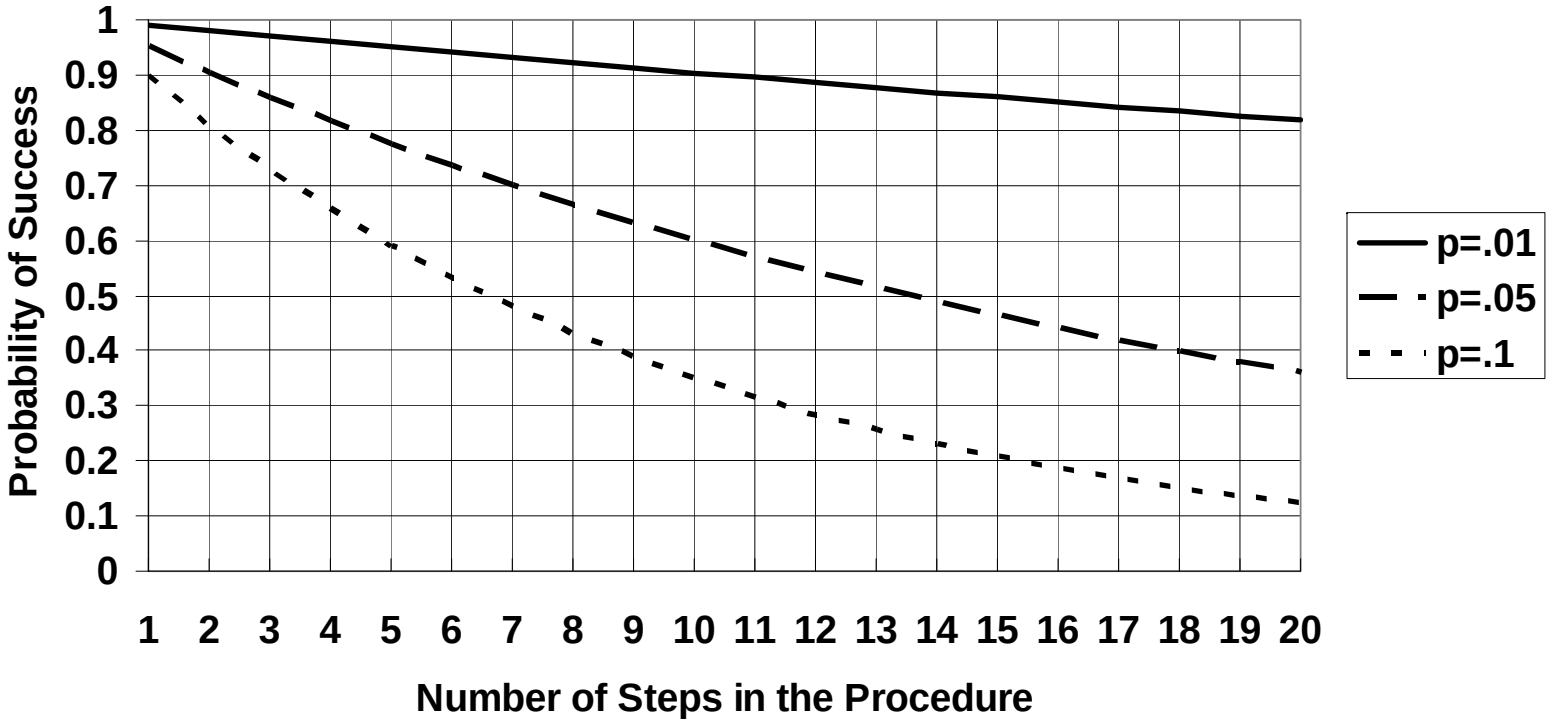
- Older adults appear to weight benefits more than costs when considering the adoption of new technology
  - Implies that for a Kahneman-Tversky prospect theory that losses slope less steeply with age for decision making under uncertainty



Implications for Consumer Product Design

- Try to match perceptual, cognitive, and psychomotor demands of the product to older consumer capabilities
- How? Do usability testing, simulation when designing
- Emphasize benefits when marketing and ensure perceived and actual ease of use
- Good design for older consumers often helps other groups including the young

Example: Working Memory Declines so Minimize Steps



Note. Assumes a constant probability of error per step (.01, .05, .1) and that failure at any step results in failure for the whole procedure.