

COGS 105

Research Methods for Cognitive Scientists

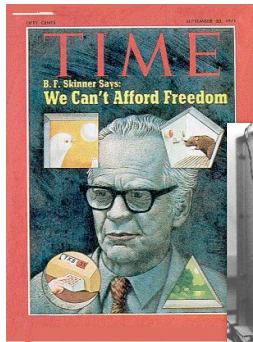


Week 4, Class 2:
Behavioral Methods II: Aging and Response Speed

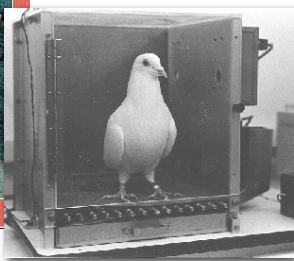
Reaction time as a
window into mental
processing...

Fundamental idea

History Recap: Behaviorism



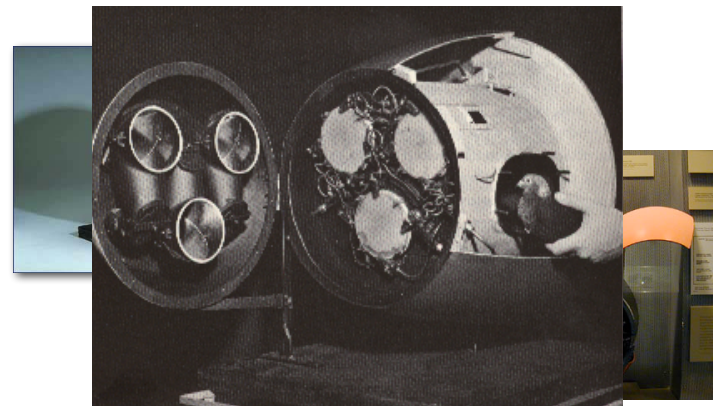
We study behavior and only behavior. We simply relate behavior to other behaviors, and the environment. Dominant: 1930's - 1960/70's



B.F. Skinner
WALDEN TWO

Including "Walden Two Revisited,"
a preface by B. F. Skinner on
the relevance of his novel 28
years after publication.

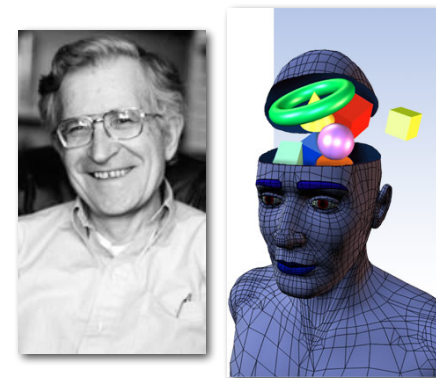
Some History: Behaviorism



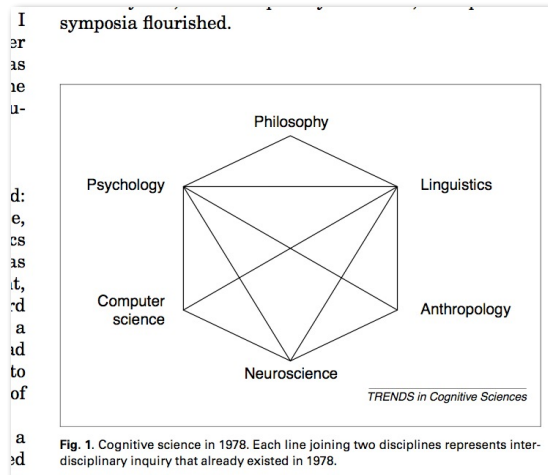
Application to Humans?



Chomsky's Review



Cognitive Revolution!



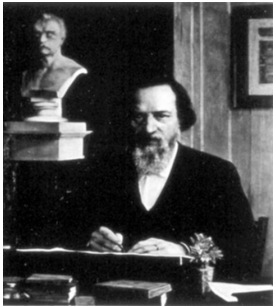
Step into a Time Machine...



Donders ...



Donders (1818-1889)



Reaction time as a window into mental processing...

Fundamental idea

Yesterday: Cognitive engineering (games)

Today: Clinical application (aging)



"40 photos in 40 years"
NYTimes



Biological Psychology 54 (2000) 35–54

BIOLOGICAL
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www.elsevier.com/locate/biopsycho

Aging and measures of processing speed

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Abstract

Many variables have been assumed to reflect speed of processing, and most are strongly related to age in the period of adulthood. One of the primary theoretical questions with respect to aging and speed concerns the relative roles of specific and general age-related effects on particular speed variables. Distinguishing between specific (or unique) and general (or shared) age-related influences on measures of speed has been complicated, in part because the issues are sometimes framed in terms of extreme all-or-none positions, and because few researchers have employed analytical procedures suitable for estimating the relative contributions of each type of influence. However, recent methods focusing on partitioning age-related variance have indicated that large proportions of the age-related effects on individual speed variables are shared with age-related effects on other variables. Although these theoretical ideas and analytical procedures are fairly new, they may be relevant to a variety of psychophysiological or neurobiological variables. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Aging; Speed; Working memory

At least six different types of variables have been used to assess the processing speed of an individual, with the particular variables varying according to the speed of the task. For example, psychomotor speed has been tested by requiring

very
dense
primary source
read; read
only for gist,
we will cover
some details
in these
slides

Today

- **Clinical application** of cognitive psychology methods, like reaction time
 - Basic procedures and some examples
- Relationship of RT to **age**
 - Methods and **controversies**
- Discussion of confounds and the importance of basic research

“Processing Speed”

- **Decision speed**
 - Time to respond in cognitive tests with moderately complex content.
- **Perceptual speed**
 - Time to respond in cognitive tests with very simple cognitive content; use a time limit.
- **Psychomotor speed**
 - Speed between processing and motor execution; e.g., finger tapping.
- **Psychophysical speed**
 - How much time is needed on a simple test to achieve some threshold of accuracy.

Psychometrics

Psychometrics

From Wikipedia, the free encyclopedia

Not to be confused with [psychrometrics](#), the m
vapor properties of air.

For other uses of this term and similar terms, s

Psychometrics is the field of study concerned with the theory and technique of [psychological measurement](#). One part of the field is concerned with the objective [measurement](#) of skills and knowledge, abilities, attitudes, [personality](#) traits, and [educational achievement](#). For example, psychometric research has concerned itself with the construction and validation of assessment instruments such as [questionnaires](#), [tests](#), [raters'](#) judgments,

education

aging

neuropsychology

...

Example: Perceptual Speed

- The **Woodcock-Johnson Psycho-Educational Battery**
- **Paper-and-pencil tests** (“battery of tests”)
- **“Visual Matching” Subtests** of the W-J:
 - Very simple requirements, everyone can do them perfectly, but you have a limited time to complete them.
 - Relationship to RT: Each decision is a “unit of RT,” and you see how many a person can fit into the time allotted.

Woodcock-Johnson



Selective Testing Table - Clusters

WJ III Tests of Cognitive Abilities

		Intellectual Ability		Cognitive Categories							
		Gen. Inver. Ability - Std	Gen. Inver. Ability - Exr	Bract Intellectual Ability	Verbal Ability - Std	Verbal Ability - Exr	Thinking Ability - Std	Thinking Ability - Exr	Cog. Efficiency - Std	Cog. Efficiency - Exr	Comp. Knowledge (Gc)
		Gen. Inver. Ability - Std	Gen. Inver. Ability - Exr	Bract Intellectual Ability	Verbal Ability - Std	Verbal Ability - Exr	Thinking Ability - Std	Thinking Ability - Exr	Cog. Efficiency - Std	Cog. Efficiency - Exr	Comp. Knowledge (Gc)
Standard Battery	1. Verbal Comprehension	♦	♦	♦							
	2. Visual-Auditory Learning	♦	♦				♦	♦			♦
	3. Spatial Relations	♦	♦				♦	♦			♦
	4. Sound Blending	♦	♦								
	5. Concept Formation	♦	♦				♦	♦			
	6. Visual Matching	♦	♦						♦	♦	
	7. Numbers Reversed	♦	♦						♦	♦	
	8. Incomplete Words										
	9. Auditory Working Mem.										
	10. Vis-Aud. Learn. - Delayed										
Extended Battery	11. General Information	♦	♦	♦							♦
	12. Retrieval Fluency	♦	♦				♦	♦			♦
	13. Picture Recognition	♦	♦								♦
	14. Auditory Attention	♦	♦				♦	♦			
	15. Analysis-Synthesis	♦	♦				♦	♦			
	16. Decision Speed	♦	♦								

Woodcock-Johnson

Student's Name _____

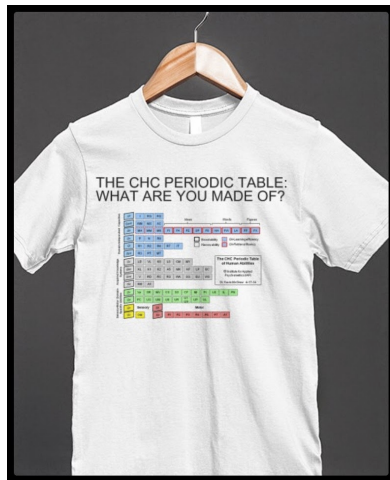
WOODCOCK-JOHNSON COGNITIVE BATTERY - REVISED (WJ-Cog) or BATERIA WOODCOCK-MUNOZ PRUEBAS DE HABILIDAD COGNITIVA - REVISADA (Bateria-R Cog)

A comprehensive measure of specific psycheducational processes as well as general cognitive ability.
Administration Information: Date: ____ By: ____ In: ____ English ____ Spanish ____ Other ____ Modifications: ____
Clinical Observations: _____

Test Results:	Significantly Below Average	Below Average	Low Average	AVERAGE	High Average	Above Average	Significantly Above Average
Percentile Scores	0-4th	5th-25th	25th-50th	50th-75th	75th-90th	90th-98th	98th-99.8th
Long-Term Memory							
Memory for Names							
Visual-Auditory Learning							
Memory for Names - Delayed							
Visual-Aud. Learning - Delayed							
Short-Term Memory							
Memory for Sentences							
Memory for Words							
Numbers Reversed							
Auditory Processing							
Counting Words							
Sound Blending							
Sound Patterns							
Processing Speed							
Visual Matching							
Concepts Old							
Fluid Reasoning							
Analysis-Synthesis							
Concept Formation							
Spatial Relations							
Verbal Analogies							
Comprehension							
Picture Vocabulary							
Class Vocabulary							
Listening Comprehension							
Visual Processing							
Visual Closure							
Picture Recognition							
OVERALL COGNITIVE							
Standard Score, 100							
Average							

Pattern Analysis and Interpretation:

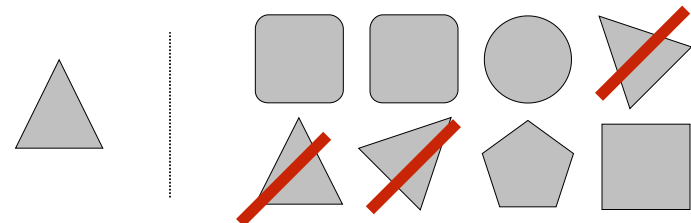
	Clusters/Factors	Strengths	Hypotheses Regarding Patterns
Normative (compared to peers)			
Relative (compared to own performance)			
	Clusters/Factors	Weaknesses	Hypotheses Regarding Patterns
Normative (compared to peers)			
Relative			

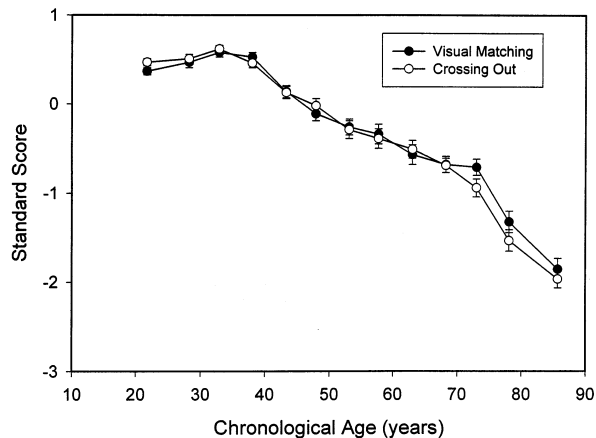


<http://www.iqscorner.com/>

Salthouse, 1998a

- Used two perceptual speed tests in the W-J III
- Visual matching: Circle numbers that are the same (from a set)
- Cross out: Mark out patterns that are the same to a comparison pattern.

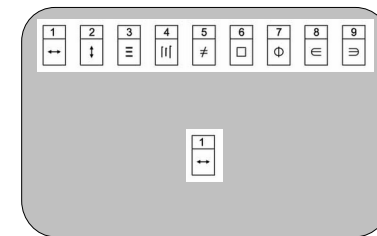




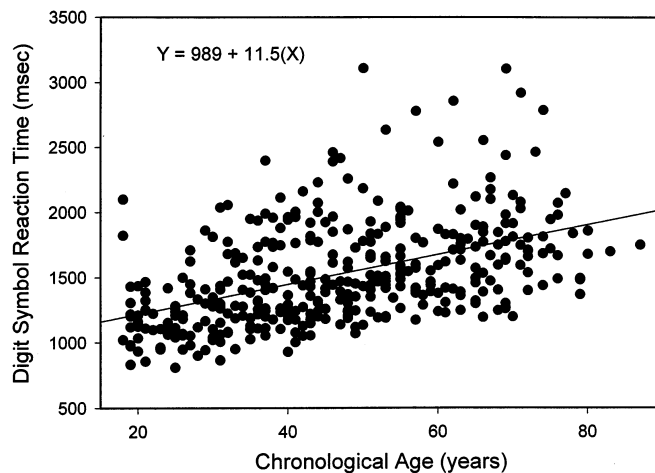
Standard scores by age on the two tests in a nationally representative sample from 18 to 90

Salthouse, 1998b

- E.g., digit symbol task: “This task involves the presentation of a code table containing pairs of digits and symbols at the top of the computer screen, and a series of probe pairs in the middle of the screen.”



Salthouse, 1998b



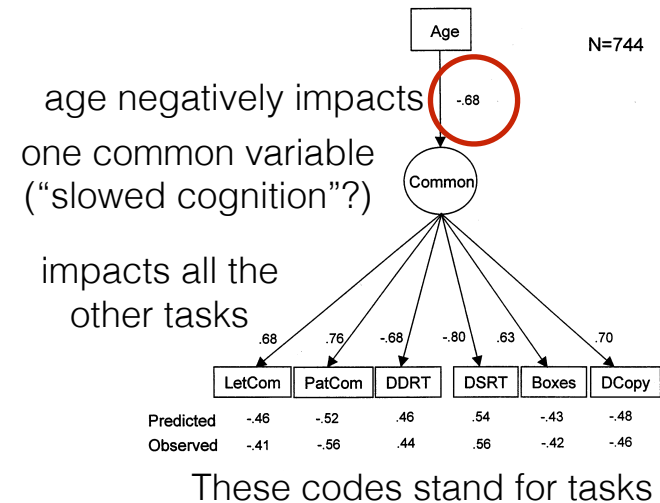
Big Questions

- How do these tasks relate to age, and, importantly, how do these tasks relate to each other?
 - Are they **different measures of the same “factor”**?
- They are certainly not independent. E.g., perceptual speed can obviously impact decision speed.
 - The Salthouse paper talks a lot about the relationship among these measures; there is ongoing debate. Just know that psychometric tests involve much discussion about **“how many factors”** underlie a set of tests.

One Hypothesis

- Using “multivariate statistical methods,” researchers can see if the tasks behave differently, and might have a different effect with age.
- This is what Salthouse means by an “interaction.”
- The task “interacts” with age in the sense that, aging slowness on a task depends on the task (“age interacts with the nature of the task”).

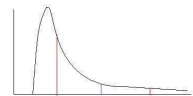
Example Statistical Model



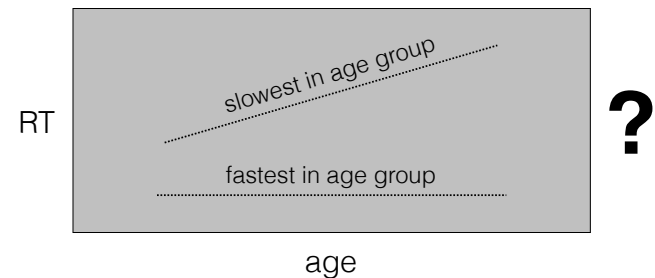
Why Aging Effect?

- Health status
 - Health explains “20% of the aging effect,” based on an analysis using self-report measures. However, being healthy does not preclude your likelihood to slow as you age (i.e., age brings the same trends in slowness).
- Practice?
 - Practice can diminish the aging effect, but cannot make it go away.
- Interactions with task
 - Maybe it matters what the task is, and on some the aging effect holds, and others not? In general, Salthouse argues that the aging effect is consistent across all tasks.

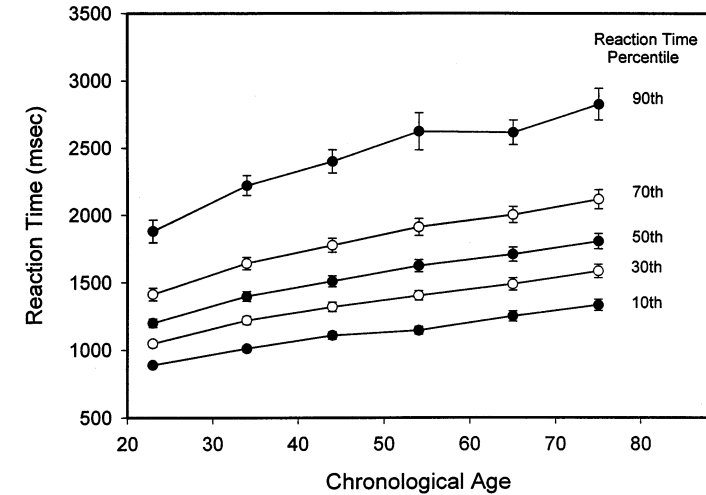
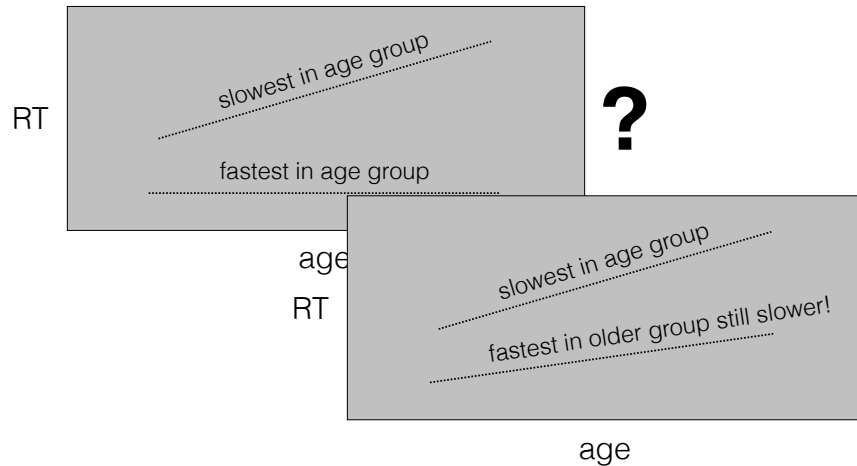
But...



- Could it be that the **tail of the distribution** just gets longer because of all these factors? In other words, maybe the aging effect would look like this kind of distribution?



But...



Outstanding Questions

fundamental than others in terms of mediating age-related effects on other types of variables.

Ultimately, of course, we would like to know why increased age during the adult years is associated with decreased levels of speed, and this is another area where psychophysiological and neurobiological research can be expected to make important contributions. Among the speculations proposed to account for age-related slowing are that because of diffuse cell loss the transmission of neural impulses must traverse lengthier and more circuitous pathways to reach the same end state (Salthouse, 1985; Cerella, 1990), that a slower propagation of neural impulses with increased age is attributable to a reduction of dendritic branching, a decrease in the number of active synapses, or a loss of myelin (Miller, 1994), and that age-related slowing may be a consequence of a loss of synchronization of neural impulses, possibly due to a reduction of particular neurotransmitters such as dopamine. It seems unlikely that these possibilities can be distinguished with only behavioral research, and thus research with various types of psychophysiological or neurobiological variables may be necessary to help resolve the fundamental issue of the causes of age-related slowing.

Salthouse reading



No one denies that aging is associated with a slowing of RT. The real controversy is from explaining **why it occurs**. The answer is both theoretically relevant, but may also have important clinical implications.



Recent Critique

- Michael Ramscar and his colleagues have been questioning the entire “aging” paradigm in an intriguing set of papers (see optional readings).
- I'd like to cover some of that here.
- **General idea:** Older people have **more information to wrestle with**, and so you'd expect some slowing!

Playful Science Writing

People are clearly living longer; it is less clear that this is a blessing. In Greek mythology, Tithonus was the mortal lover of Eos, goddess of the dawn. While asking Zeus to make Tithonus immortal, Eos forgot to mention “eternal youth,” dooming Tithonus to an eternity of decrepit babbling. The psychological and brain-sciences endorse the Tithonean view of aging, portraying adulthood as an extended period of mental decline: memories dim; thoughts slow; problem-solving abilities diminish (Naveh-Benjamin & Old, 2008; Deary et al, 2009); and each year, the onset of cognitive decrepitude is set ever younger (Salthouse, 2009;

Singh-Manoux et al., 2012). One crumb of comfort is that older adults are, on average, happier (Charles & Carstensen, 2010), although in the circumstances, this might be taken as further evidence of their declining mental prowess.

Ramscar et al., optional reading

fraction of its total vocabulary, and that vocabularies grow steadily across the lifespan. However, the tests used to measure cognitive decline assume that vocabulary size is age-invariant in adults (Spearman, 1927; Carroll, 1993;

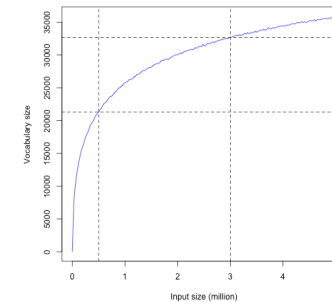
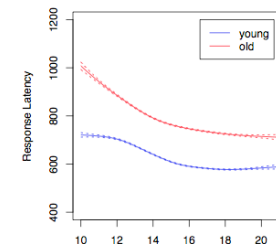
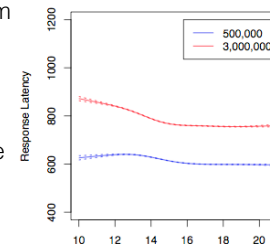


Figure 2. Empirically observed vocabulary growth after sampling from the Google Trigrams Corpus.

Model of vocabulary over time

results from a model that assumes the more words, the more difficulty



real data!

These results suggest that older and younger adults' performance in psychometric testing largely reflects the same cognitive mechanisms, confronted with the task of processing different quantities of information. The performance of older adults on these tests is evidence of increased knowledge, not declining processing capacity.



CogSci Is Young

- Psychoeducational assessment, despite being several decades old, is always under constant development.
- Theoretical developments in cognitive science can inform this development.
- Basic knowledge of RT experiments and principles can be applied in these domains.

Reaction time as a window into mental processing...

Fundamental idea

Yesterday: Cognitive engineering (games)

Today: Clinical application (aging)

Next week...

- We will talk about one last cognitive psychological method: "priming" (Tuesday)
- We will also discuss research ethics (Thursday)
- **Important:** Due to the Monday holiday, and keeping sections in parity, **no section next week.**