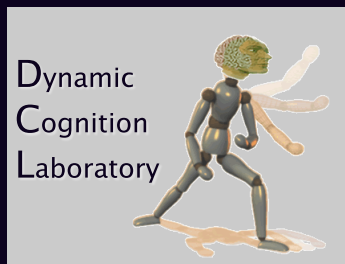


How people perceive and remember spatiotemporal events: From real-time toward geologic time

Jeffrey M. Zacks



Support:

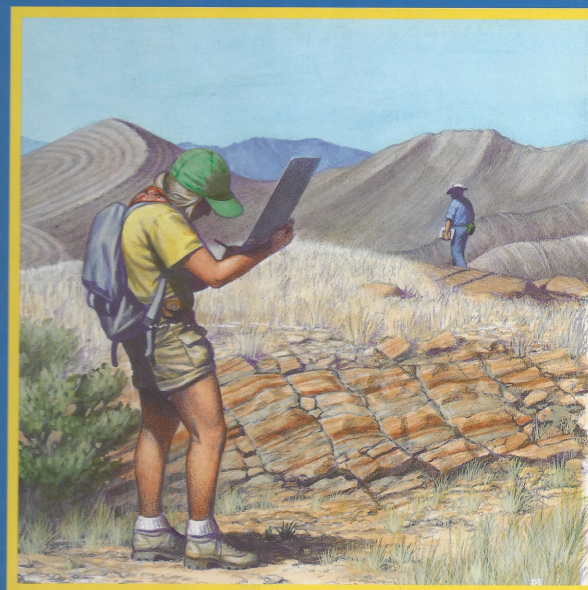
NIH R01MH070674, R01AG031150, P50AG05681
NSF BCS BCS-023665
McDonnell Center for Higher Brain Function





STRUCTURAL GEOLOGY

OF ROCKS AND REGIONS



SECOND EDITION

GEORGE H. DAVIS

STEPHEN J. REYNOLDS

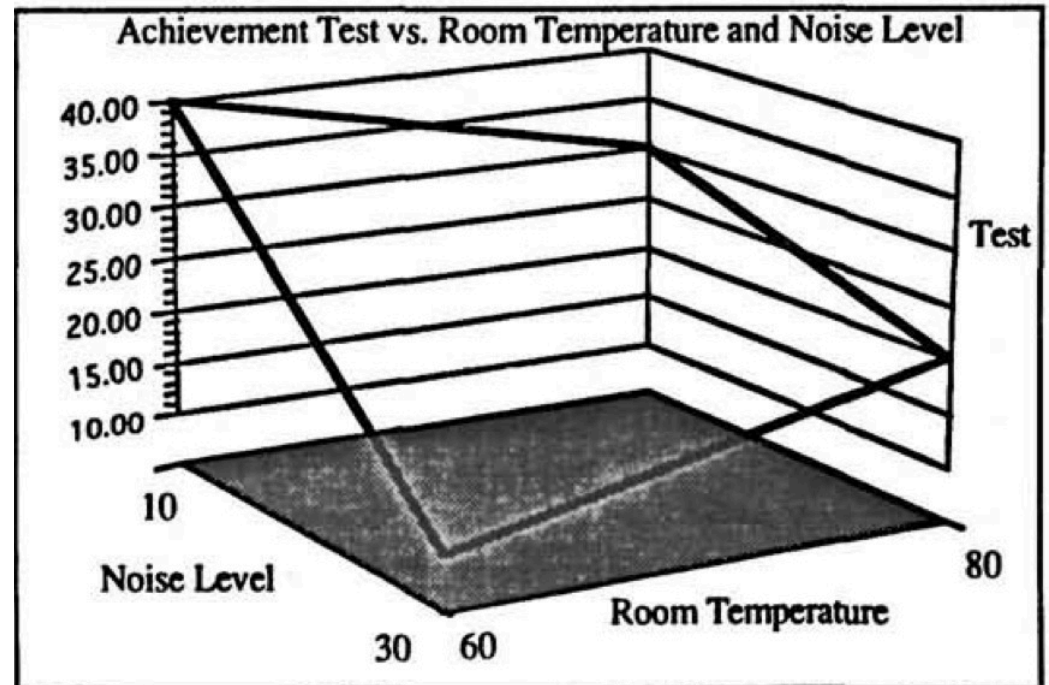
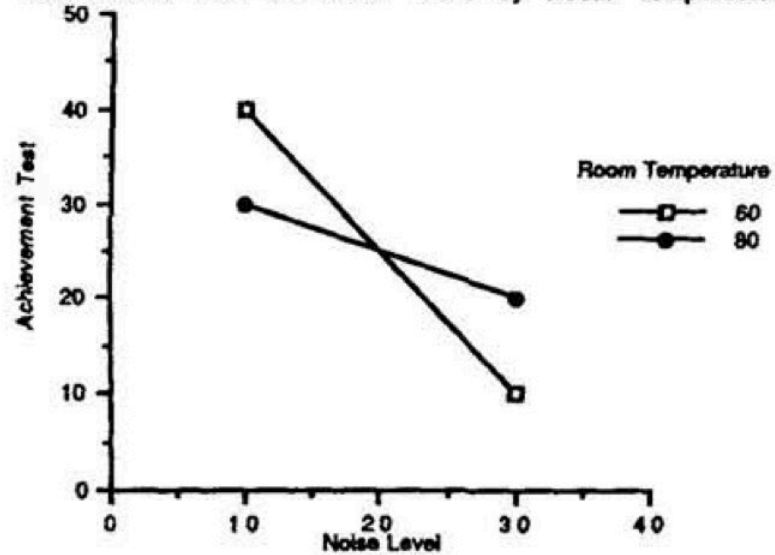
Road Map

- Spatial thinking is adapted for action planning.
 - “Simple” rotation, translation, dilation can be really hard.
 - Complex distortion can be easy.
- Temporal thinking is adapted for events on a human timescale.
 - We think of time as coming in “chunks.”
 - We think of quick and slow events analogically.

Spatial thinking is hard

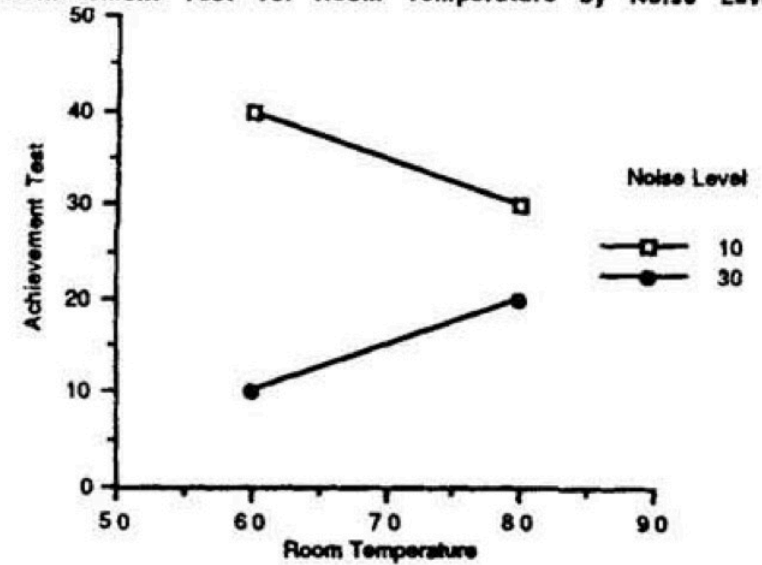
A. Cross-over

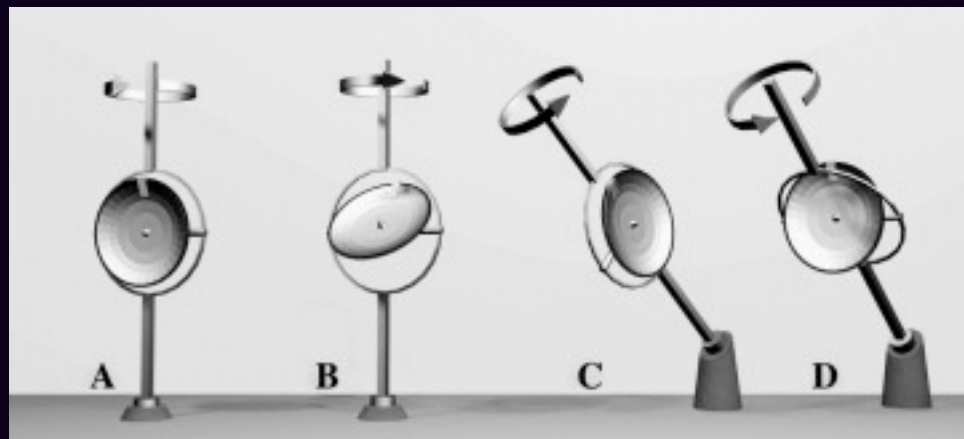
Achievement Test vs. Noise Level by Room Temperature



B. Non-cross-over

Achievement Test vs. Room Temperature by Noise Level



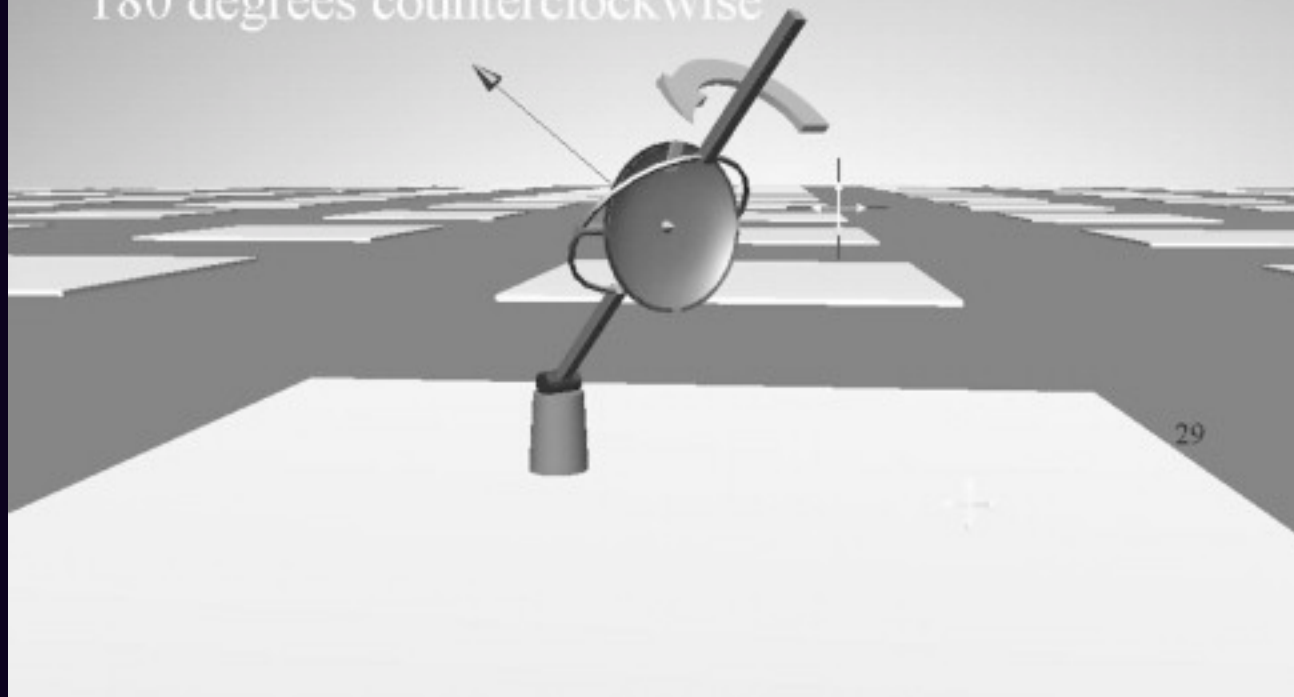


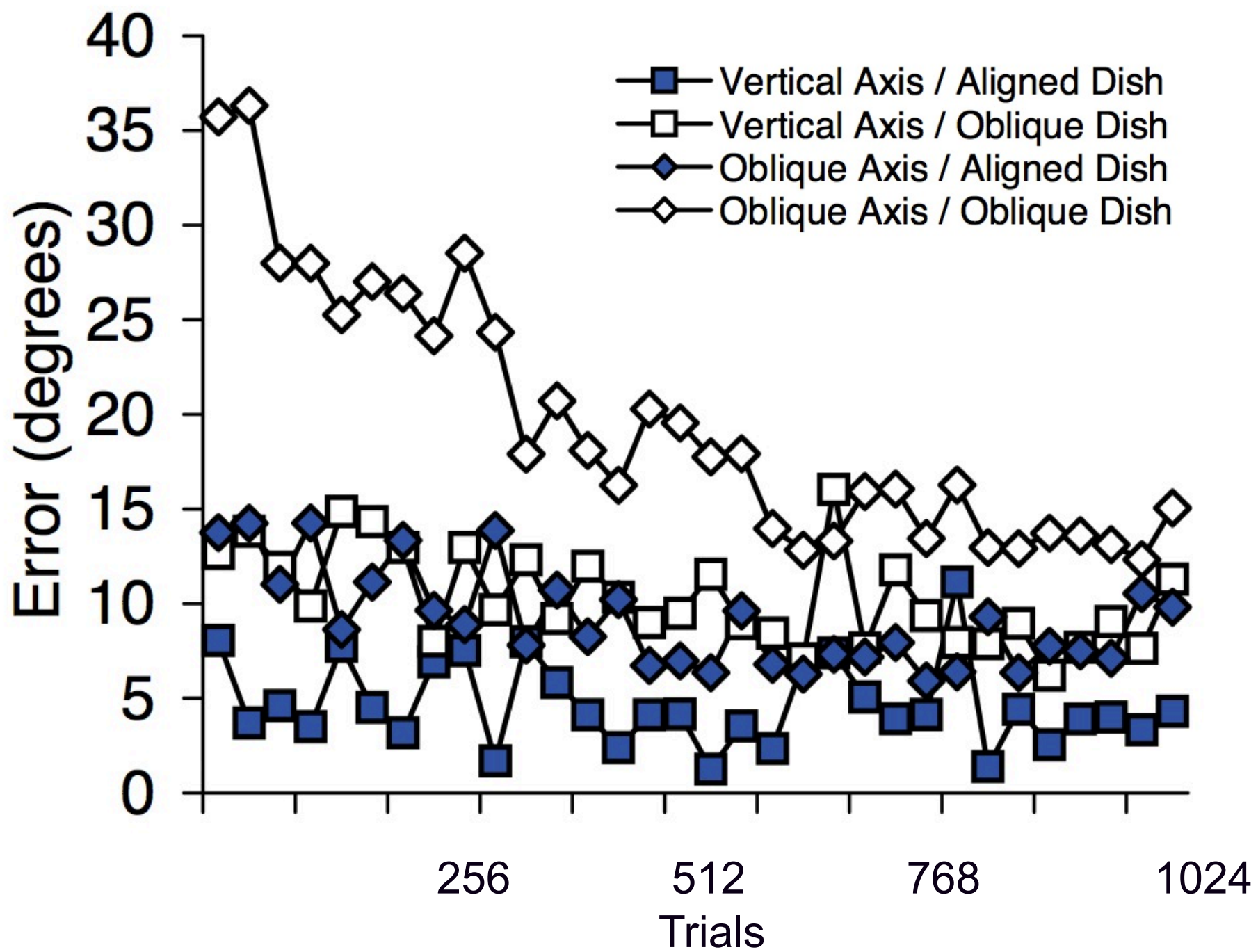
Pani et al., 2005

Use the controls to point the blue arrow where the dish will be facing after the described rotation.

Answer is complete.

180 degrees counterclockwise





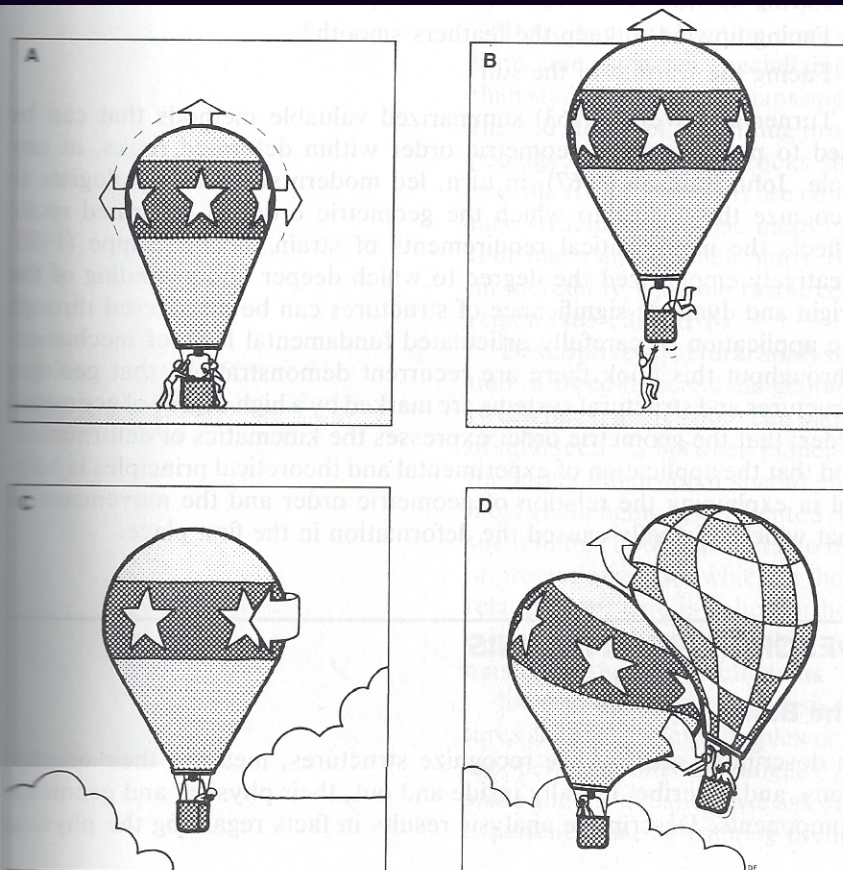


Figure 1.25 The basic movements of
 (A) **dilation** (change in volume),
 (B) **translation** (change in position),
 (C) **rotation** (change in orientation), and
 (D) **distortion** (change in shape). (Artwork
 by D. A. Fischer.)

Spatial thinking is easy









Reference Frame

Transformation

		Egocentric		
	Object-centered	Head-centered	Effector-centered	Environment-centered

Same-Different Judgments



Are the two figures
identical?
(Answer: yes)

Left-Right Judgments

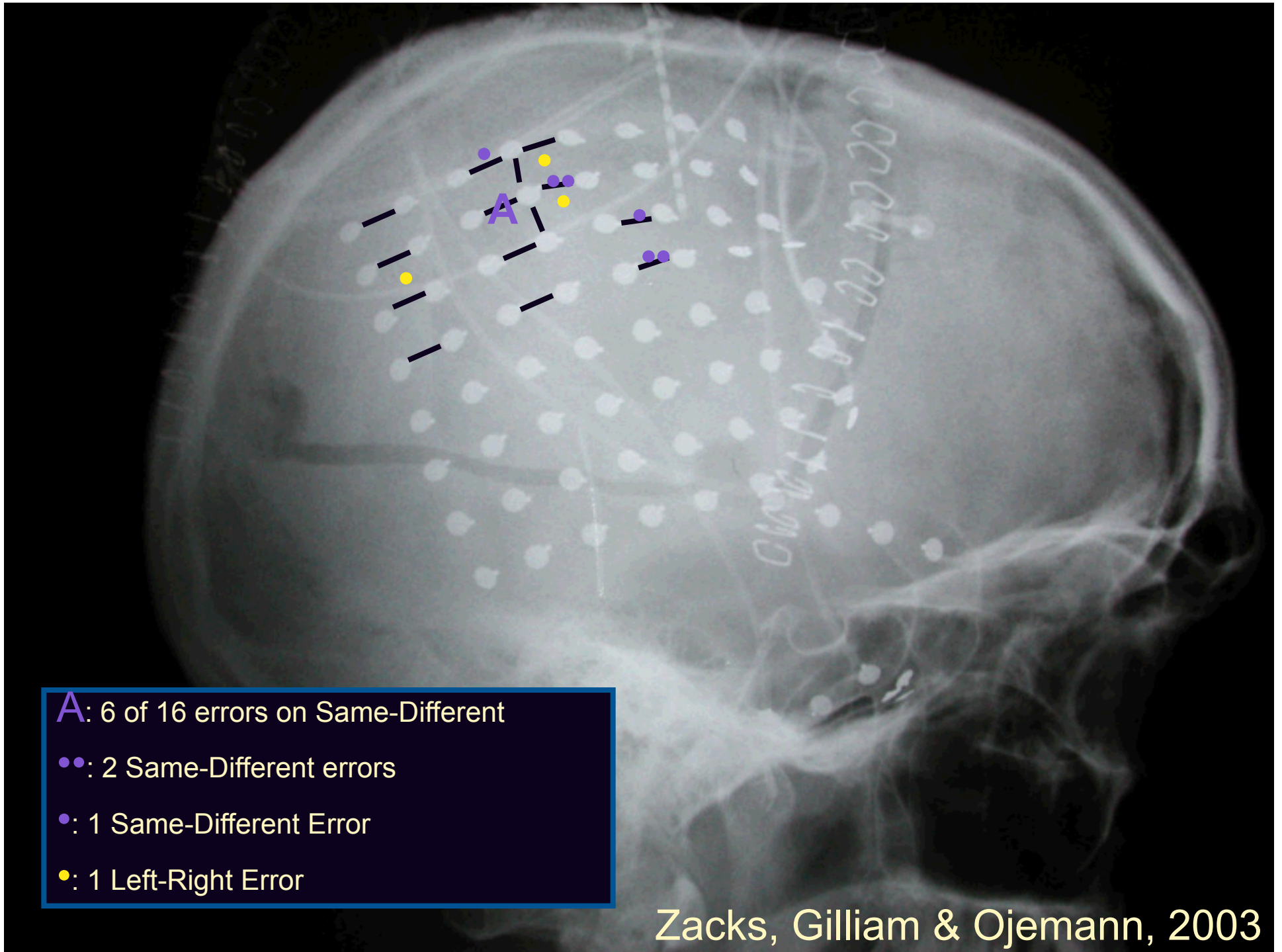


Is the figure's left or
right arm extended?
(Answer: right)

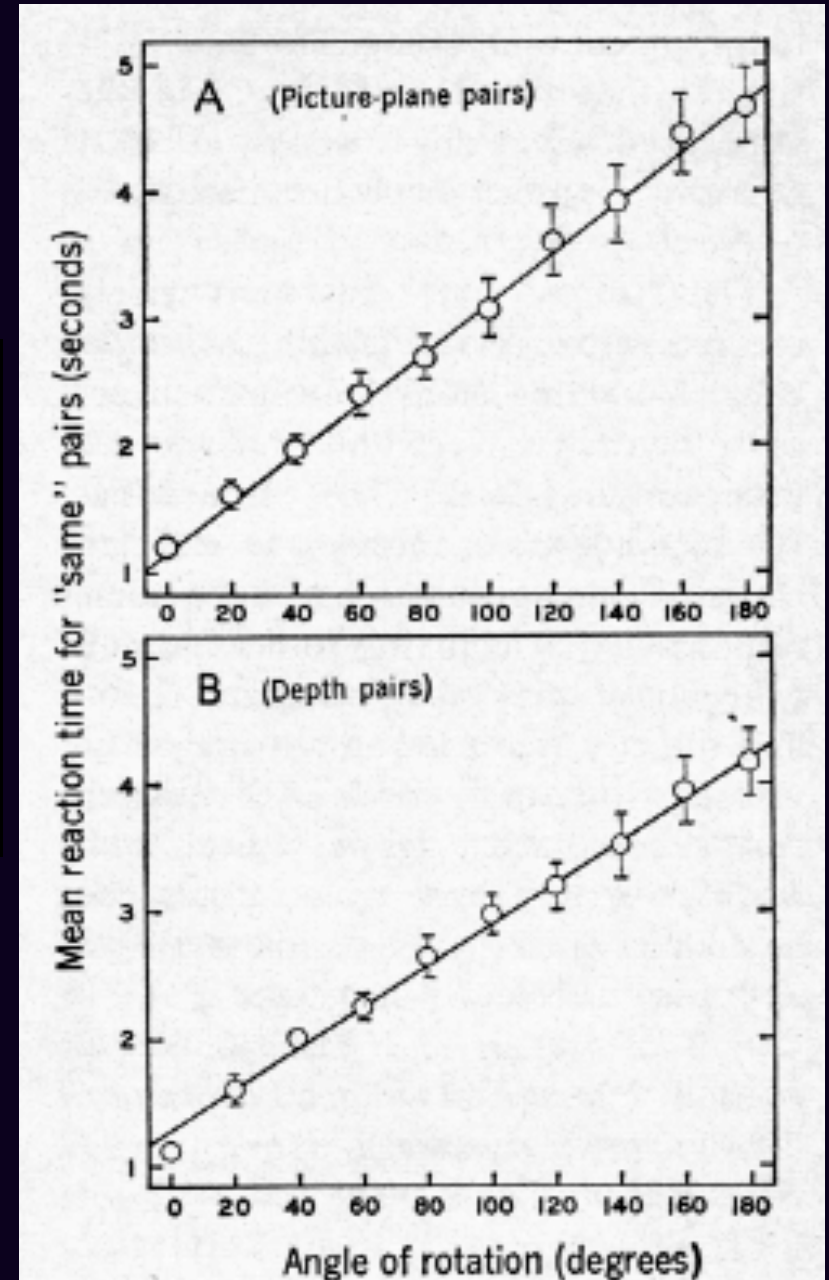
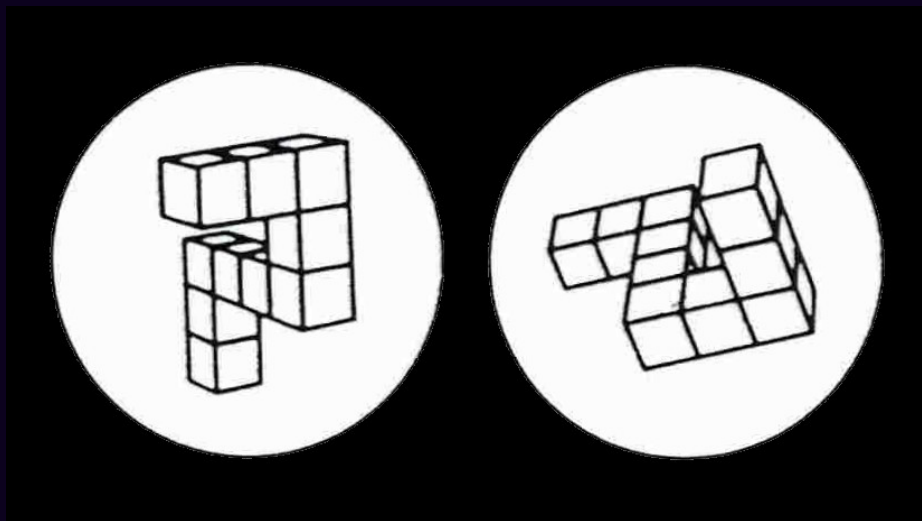
Which-Side Judgments



Is the figure's arm on
the left or right side of
the screen?
(Answer: right)

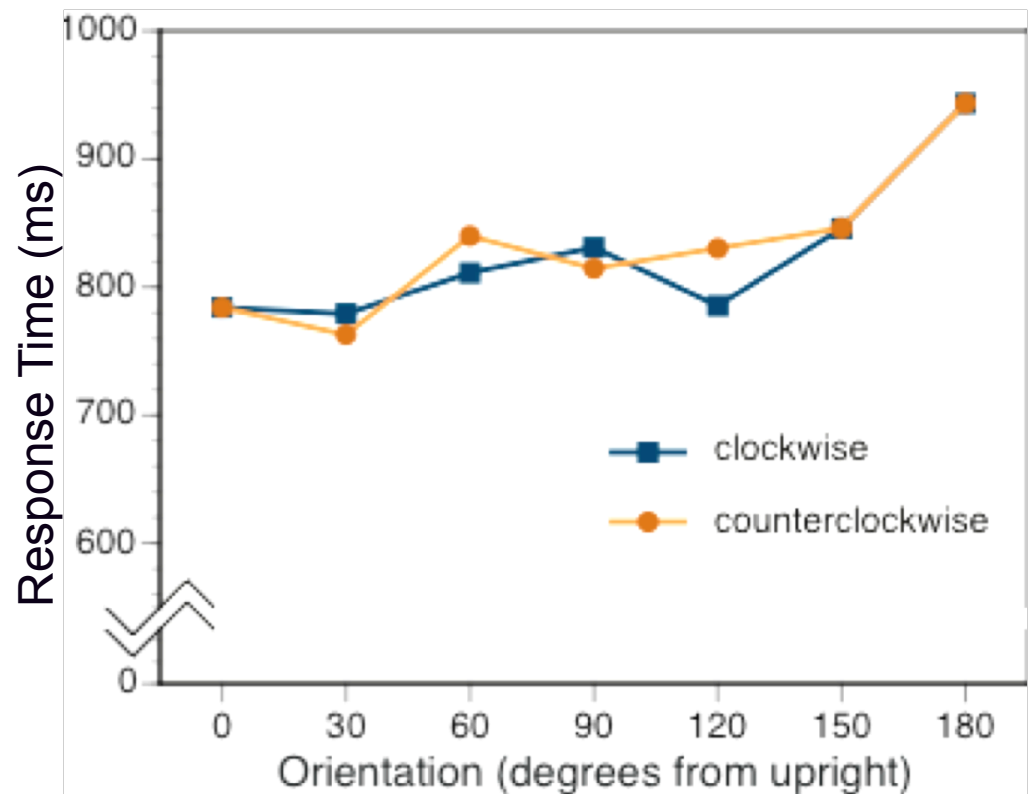
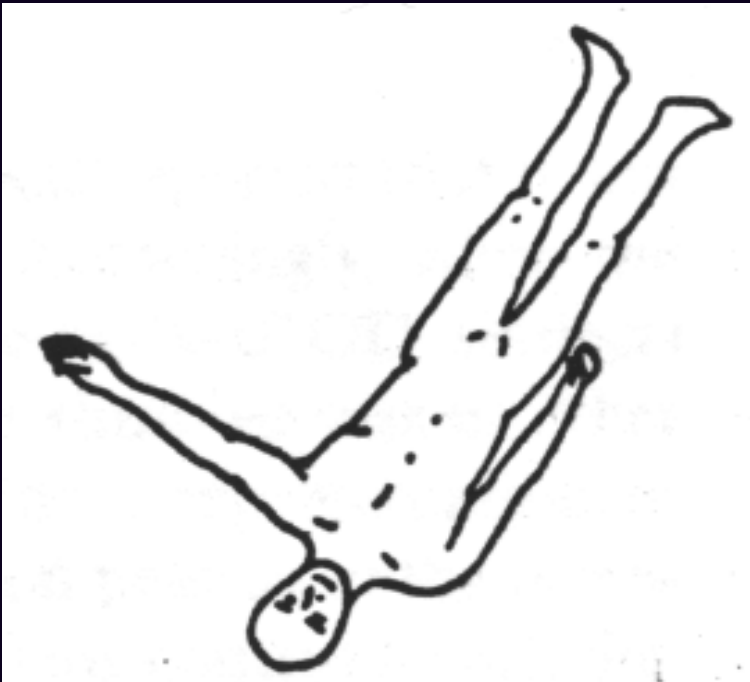


Zacks, Gilliam & Ojemann, 2003

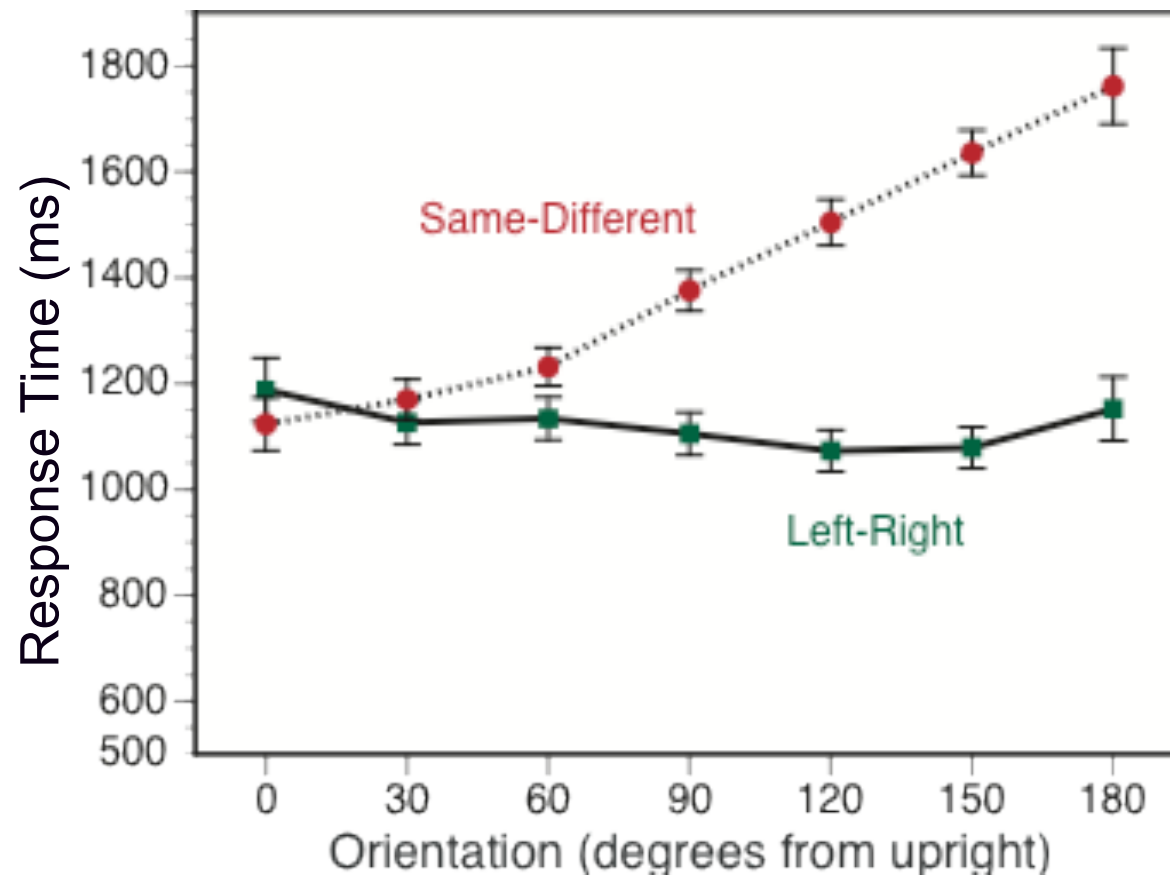


Shepard & Metzler, 1971

“Imagine yourself in the position of the figure”



Parsons, 1987



Zacks et al., 2002

Same-Different



Would the ball be in
the same hand of each
man?

(Correct: "no")

Left-Right



Is the ball in the boy's
left or right hand?

(Correct: "left")

Same-Different



Would the point of the iron be near the same hand?

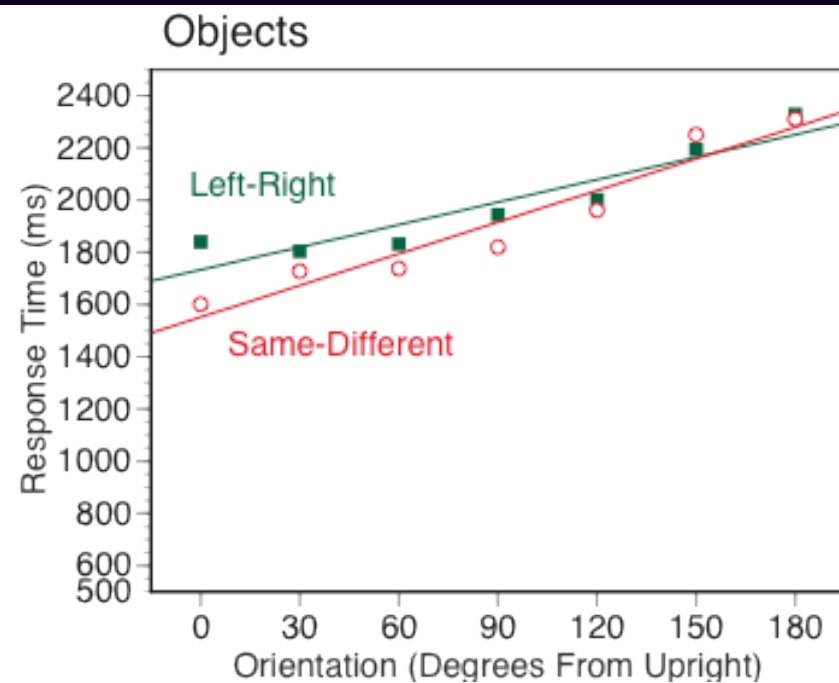
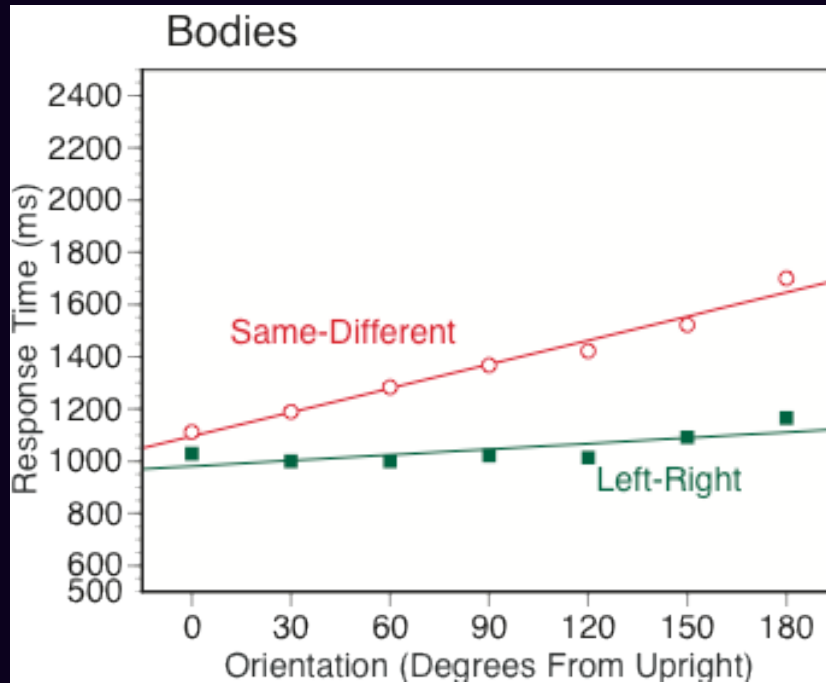
(Correct: "yes")

Left-Right



Would the bait on the mousetrap be near Leslie's left or right hand?

(Correct: "right")



Zacks & Tversky, 2005

(a) Human body



(b) Animal



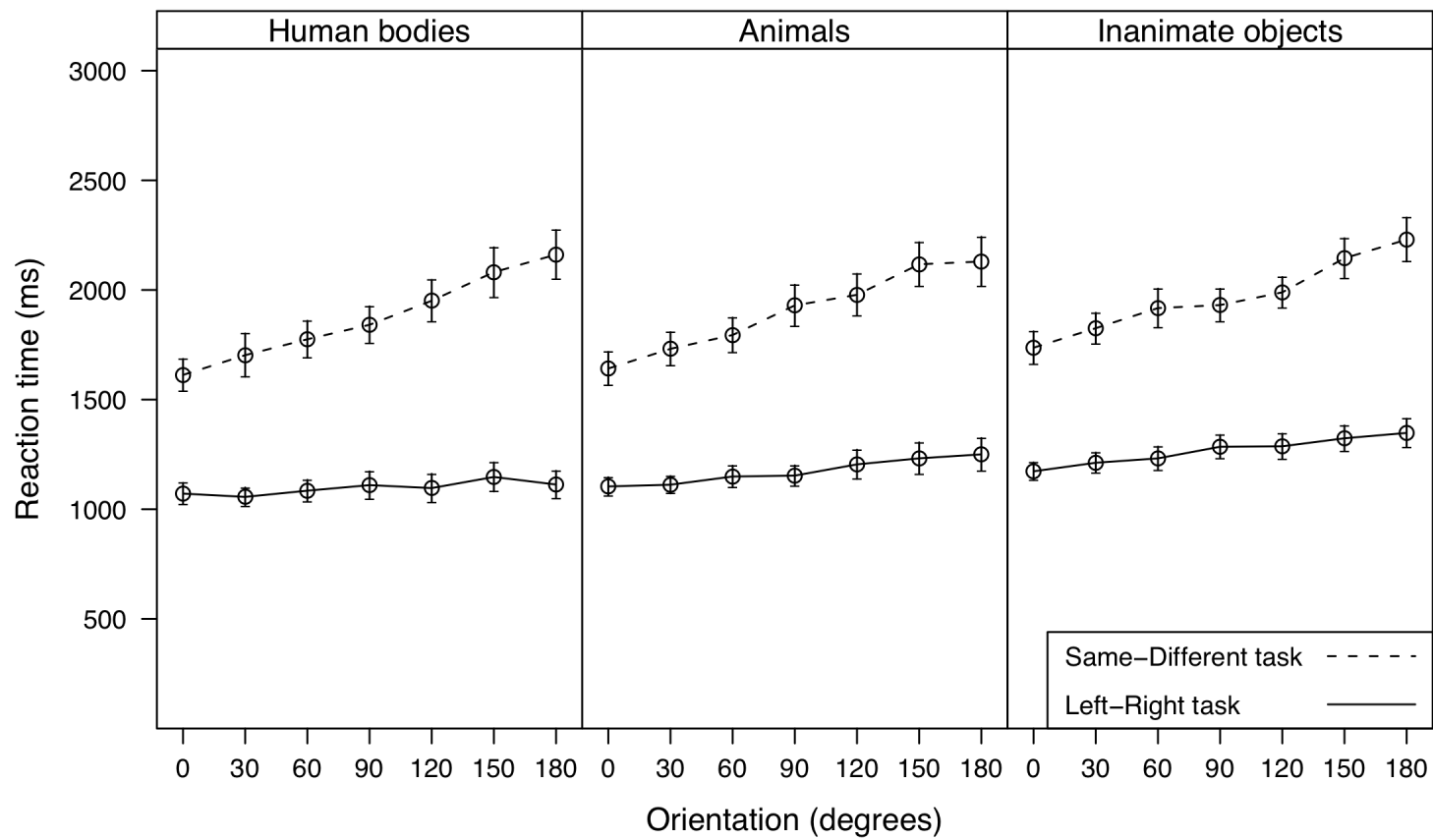
(c) Inanimate object

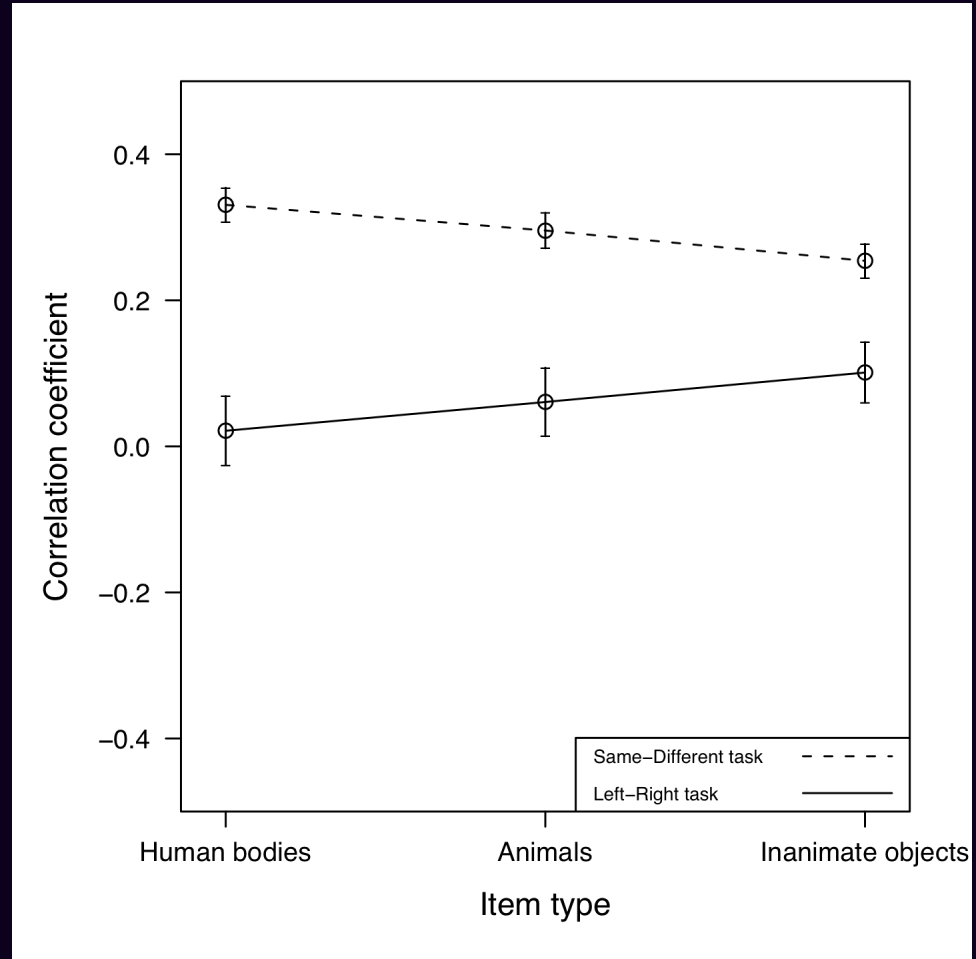




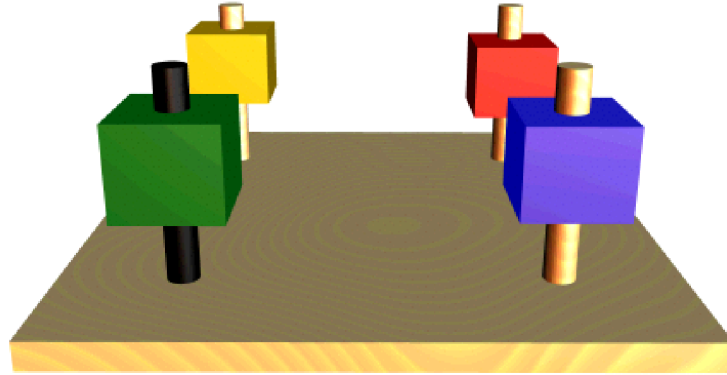






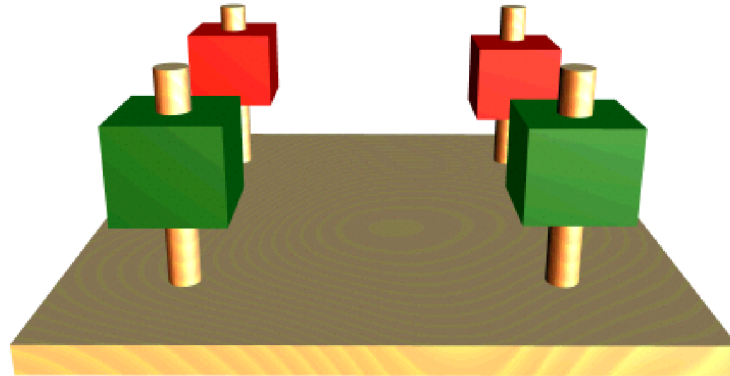


Direct instruction



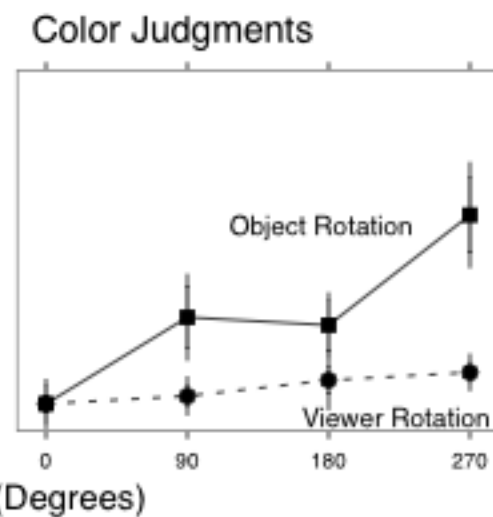
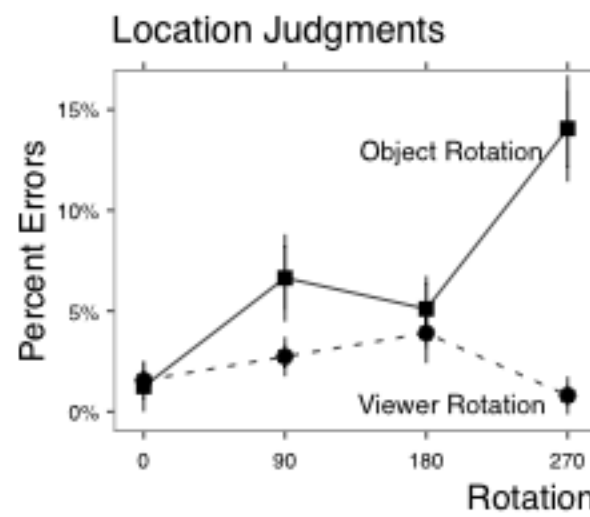
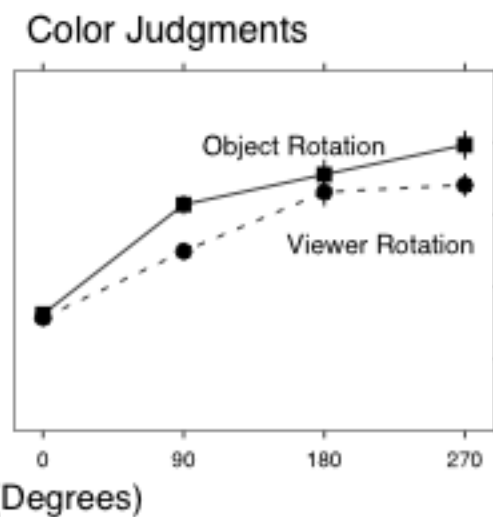
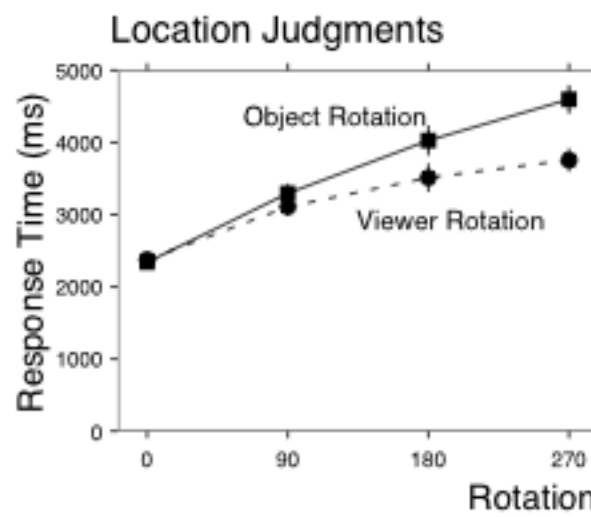
Self ↻ 270

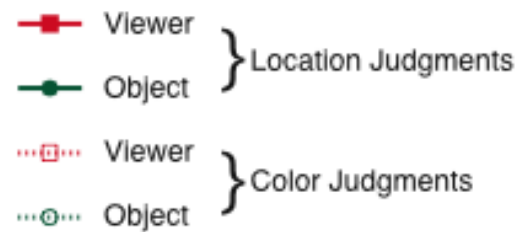
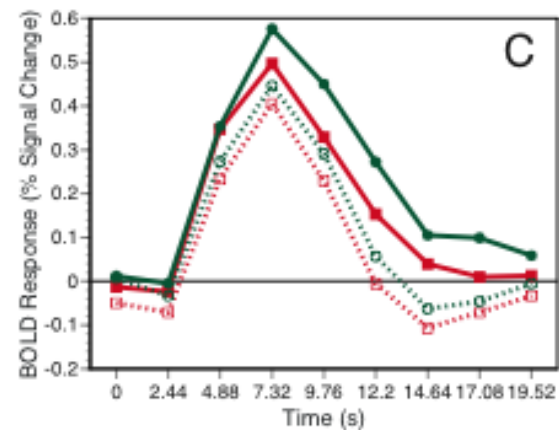
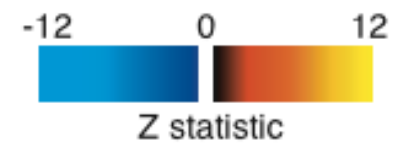
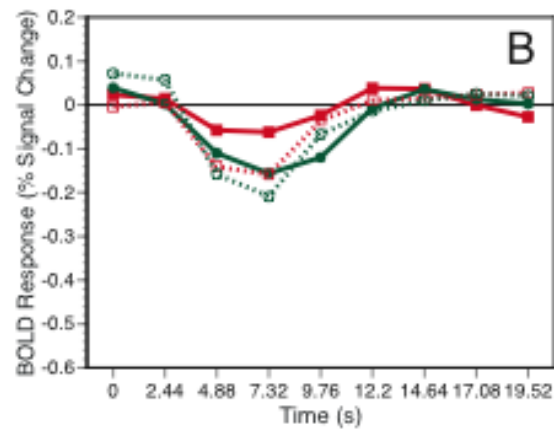
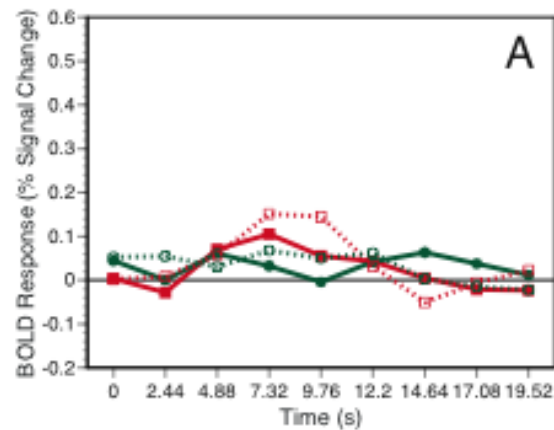
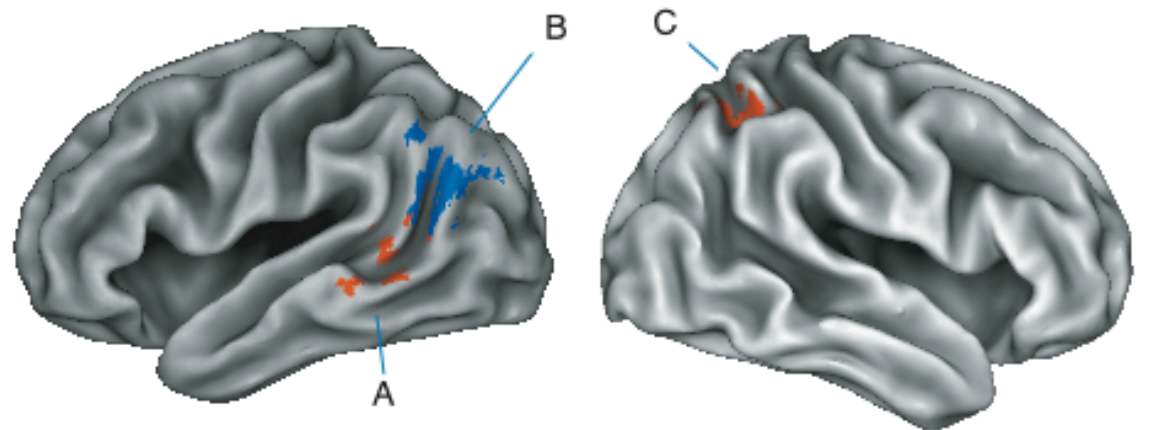
Color Judgment Task

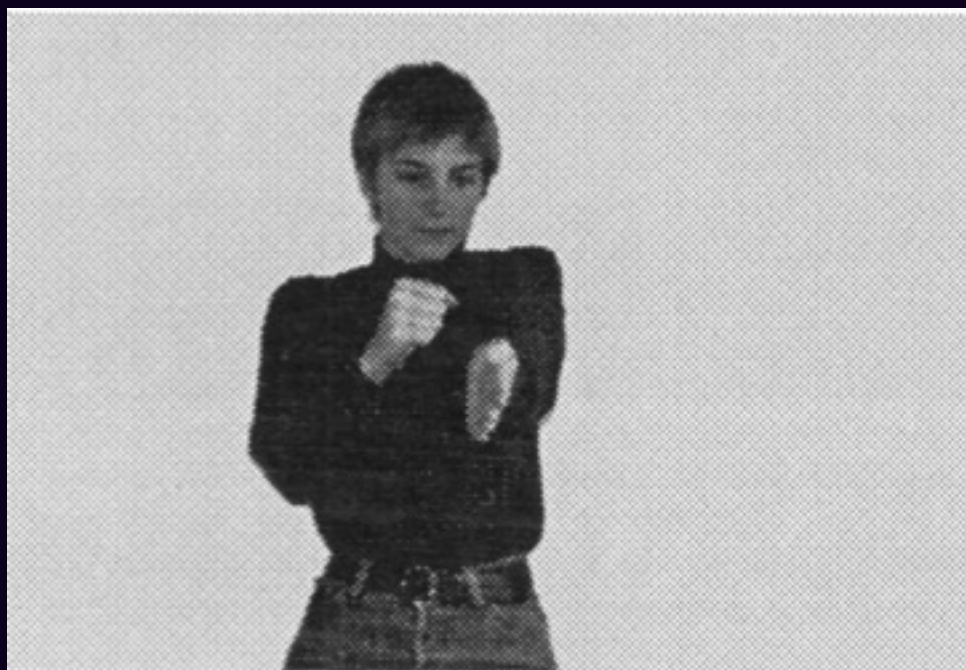


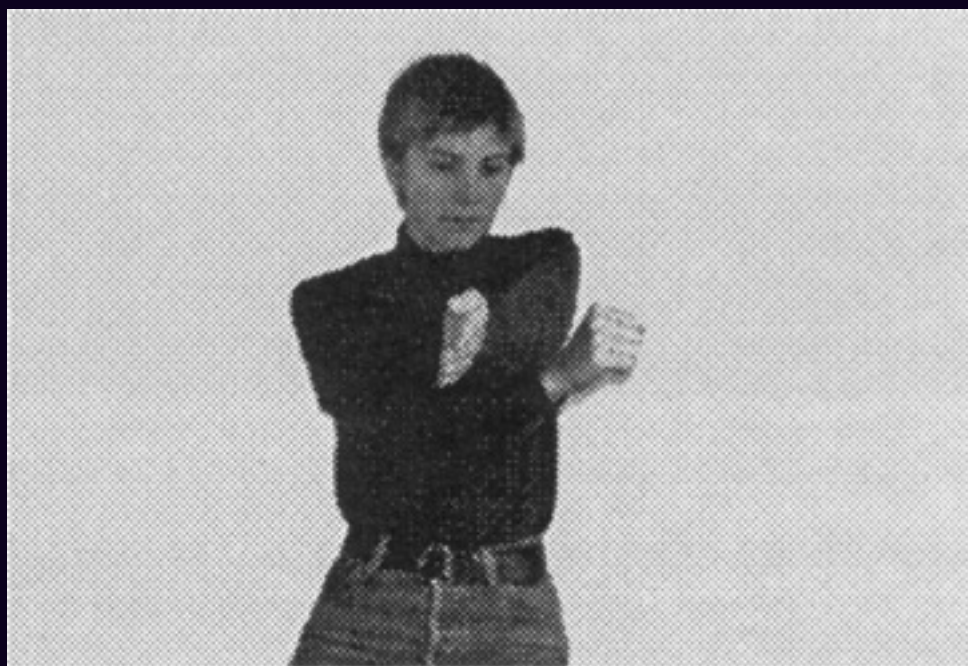
Self  180 Left













Motor transformations can be fast and automatic



Shiffrar & Freyd, 1993

Motor transformations can be fast and automatic



Shiffrar & Freyd, 1993

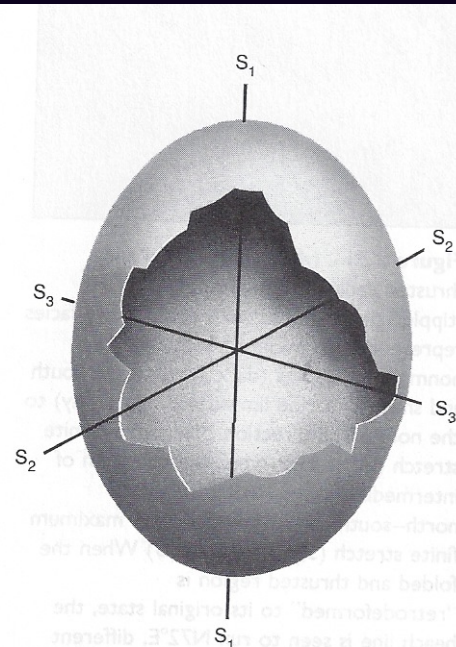
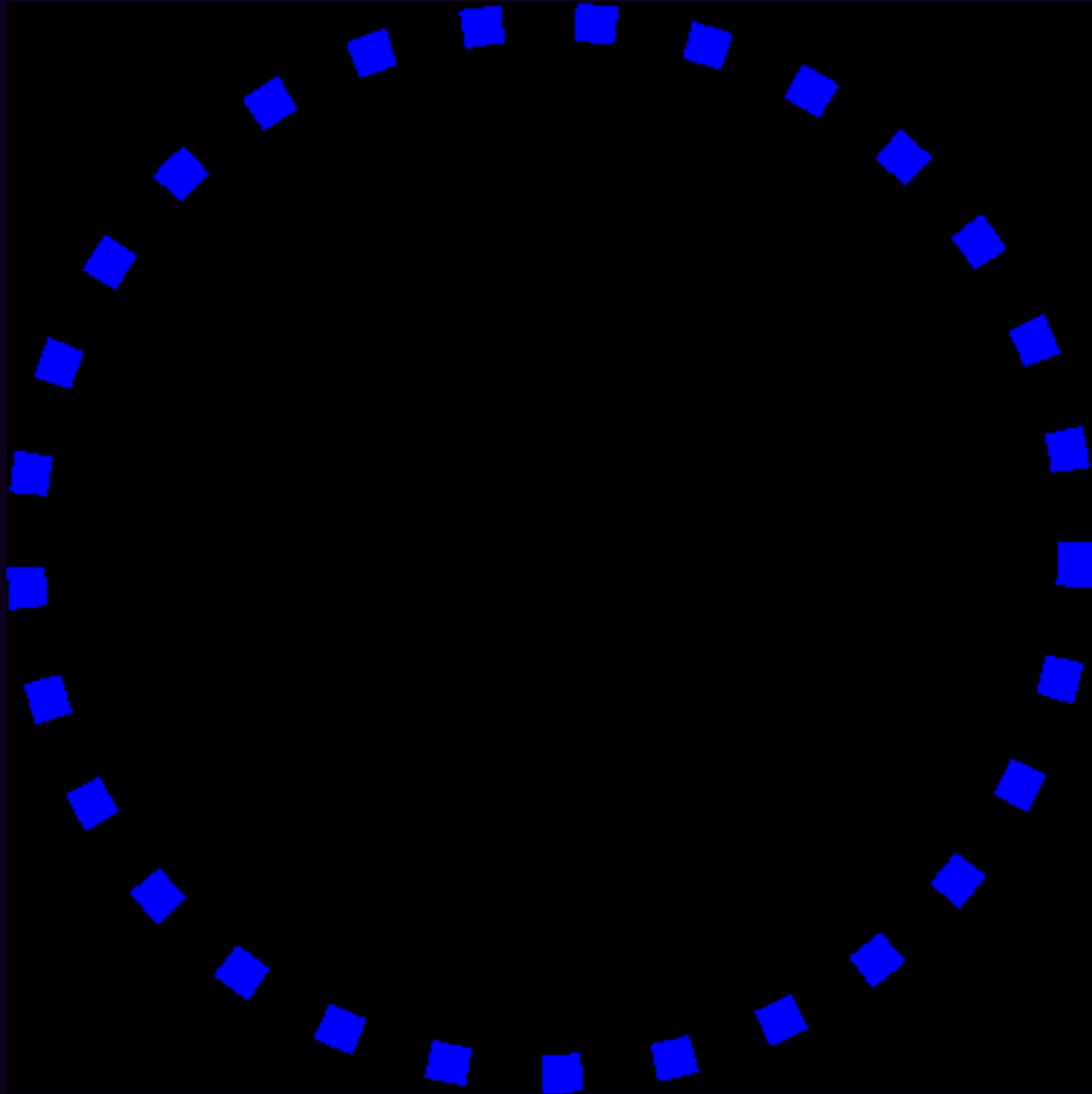


Figure 2.52 The strain ellipsoid: S_1 is the direction of maximum finite stretch, S_2 is the direction of intermediate finite stretch, and S_3 is the direction of minimum finite stretch.



Wohlschläger, 2000

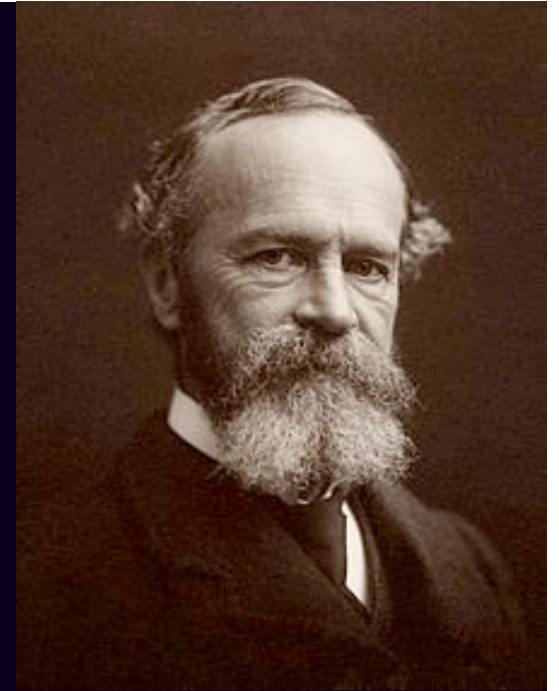
Spatial thinking: Take-away

- At least three ways to skin a cat:
 - Object-based transformations
 - Perspective transformations
 - Motor simulation
- Teaching tools can take advantage of this.
- Don't ask people to construct three-dimensional transformations in their heads.

Temporal thinking

- Cognition is scaled to everyday events
- Events are conceived as chunks
- Chunking is automatic
- Chunking determines memory

A 'river' or a 'stream' are the metaphors by which [consciousness] is most naturally described. *In talking of it hereafter, let us call it the stream of thought, of consciousness, or of subjective life.*



But now there appears... a kind of jointing and separateness among the parts, of which this statement seems to take no account. I refer to the breaks that are produced by sudden *contrasts in the quality* of the successive segments of the stream of thought.

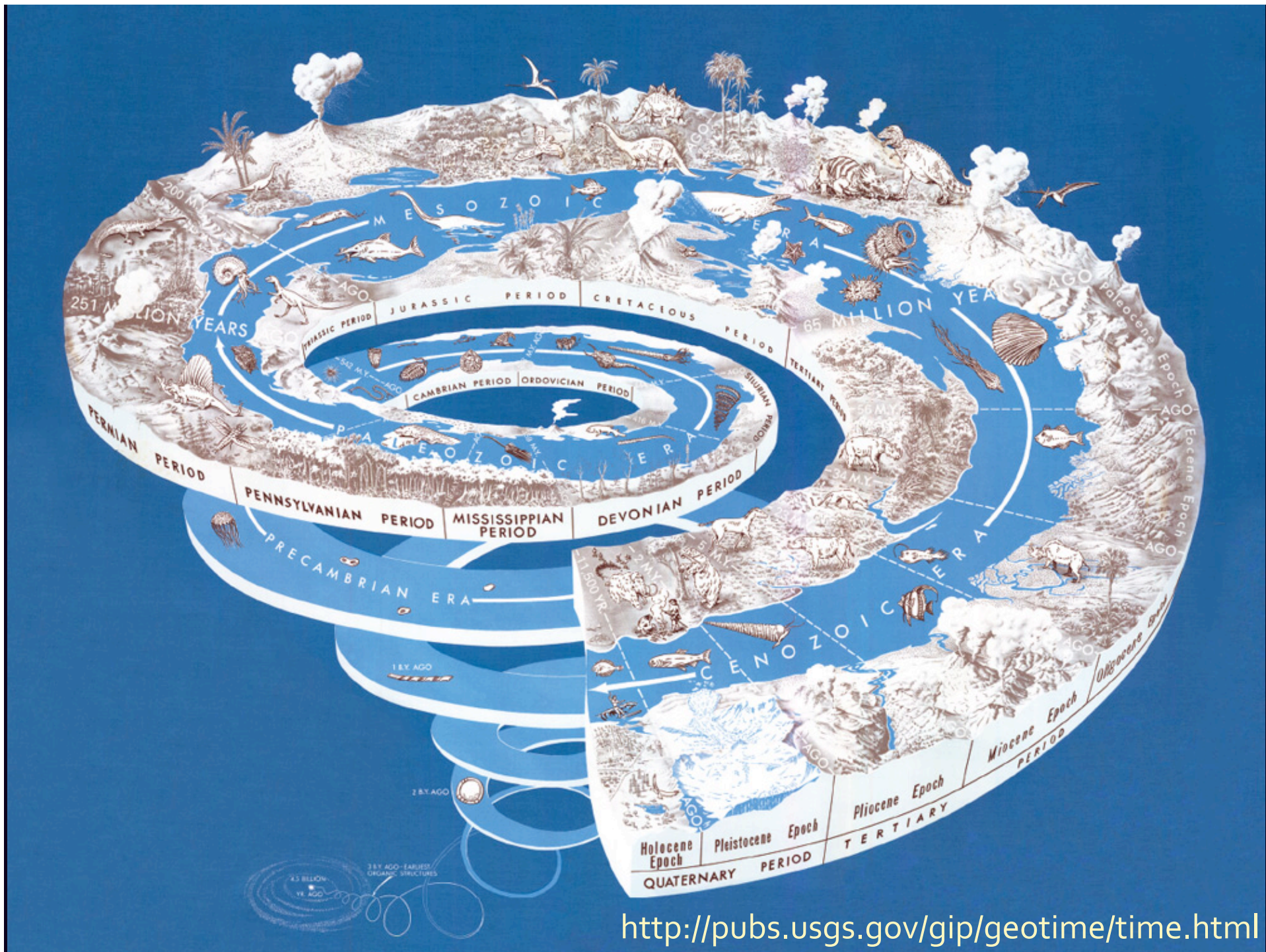
James, 1890, *Principles of Psychology*

ERA	PERIOD		EPOCH	M.Y.B.P.	
CENOZOIC	QUATERNARY (Q)		Holocene	.01	
			Pleistocene	2	
	TERTIARY (T)	NEOGENE	Pliocene	5	
			Miocene	25	
		PALEOGENE	Oligocene	55	
			Eocene	67	
			Paleocene	67	
	MESOZOIC	CRETACEOUS (K)		Upper	100
Lower				140	
JURASSIC (J)		Upper	160		
		Middle	180		
		Lower	200		
TRIASSIC (T)		Upper	205		
		Middle	215		
		Lower	250		
PALEOZOIC		PERMIAN (P)		Upper	270
				Lower	290
	PENNSYLVANIAN (P)		330		
	MISSISSIPPIAN (M)		365		
	DEVONIAN (D)	Upper	385		
		Middle	390		
		Lower	405		
	SILURIAN (S)	Upper	415		
		Lower	425		
	ORDOVICIAN (O)	Upper	460		
		Middle	485		
		Lower	500		
	CAMBRIAN	Upper	515		
Middle		540			
Lower		570			

Sorry, not enough room for 90% of Earth's time, i.e. PRECAMBRIAN

Sorry, not enough room for 90% of Earth's time, ie PRECAMBRIAN

- Chunks
- Hierarchy
- BUT totally different timescale



Continental Drift



Click on any of the four colored regions to the left for a paleontological history of each era.

The number in the lower right represents millions of years ago.

To see continental positions during a particular time, click on the STOP button of your browser as the red arrow reaches the era of interest.

Animation built from images provided by:

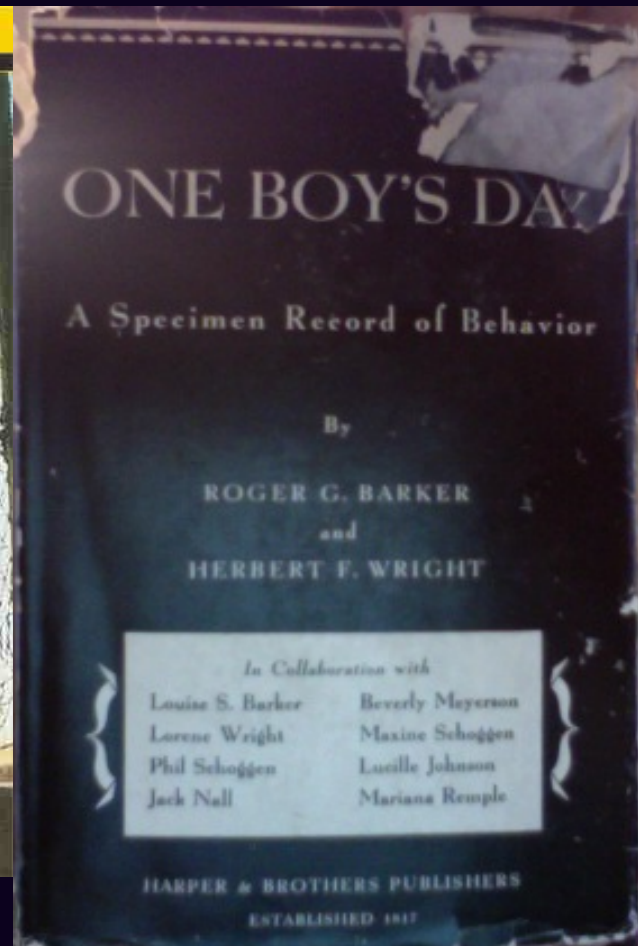
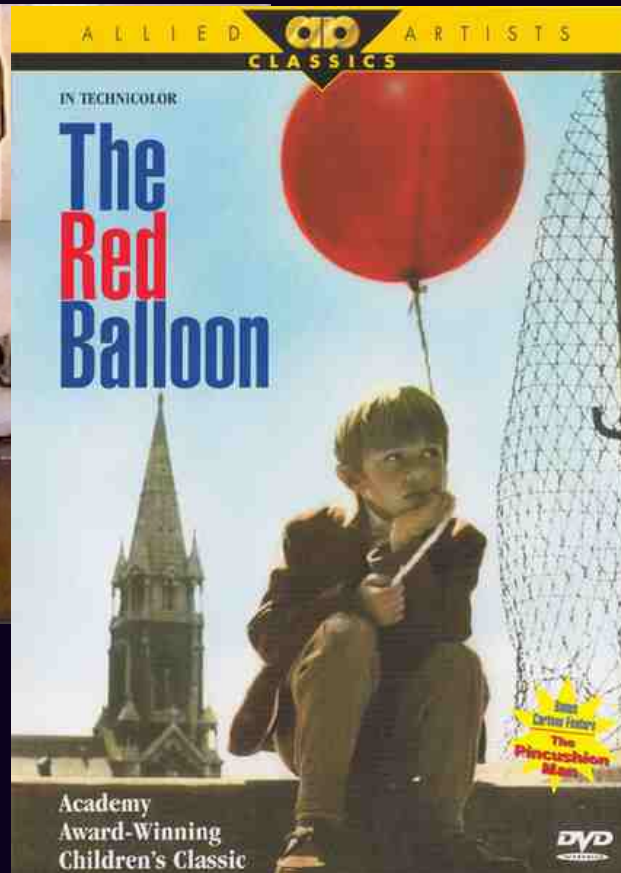
Christopher R. Scotese

PALEOMAP Project

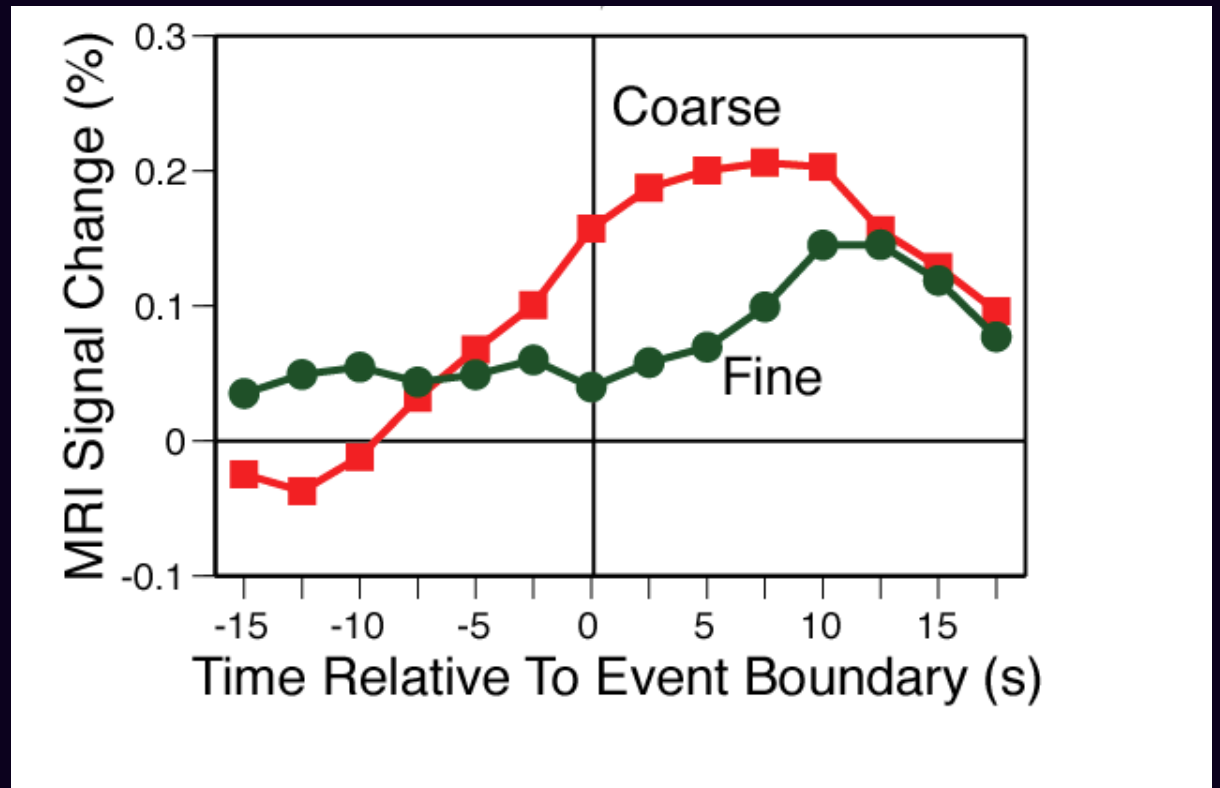
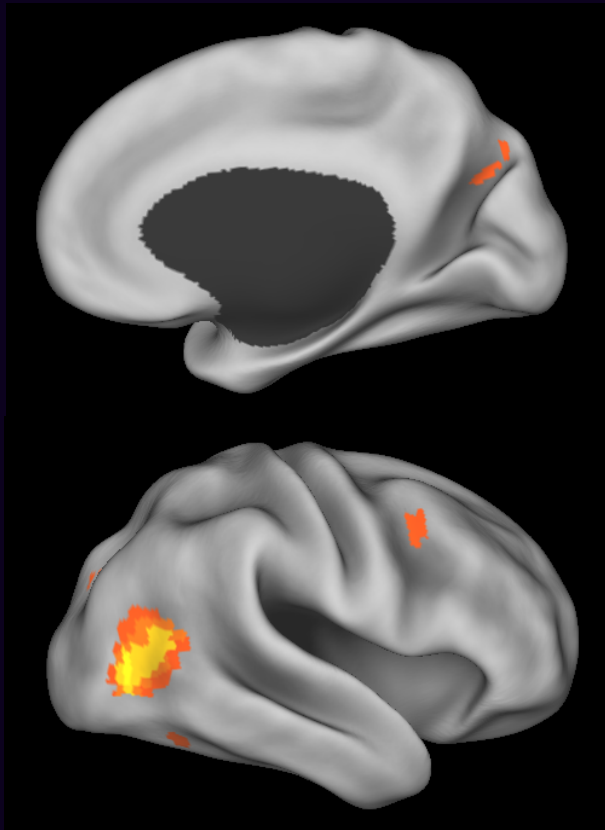
U. Texas at Arlington

<http://www.ucmp.berkeley.edu/geology/anim1.html>





- Passive viewing in the scanner
- Later, segment the movies
- Time-lock analysis to event boundaries

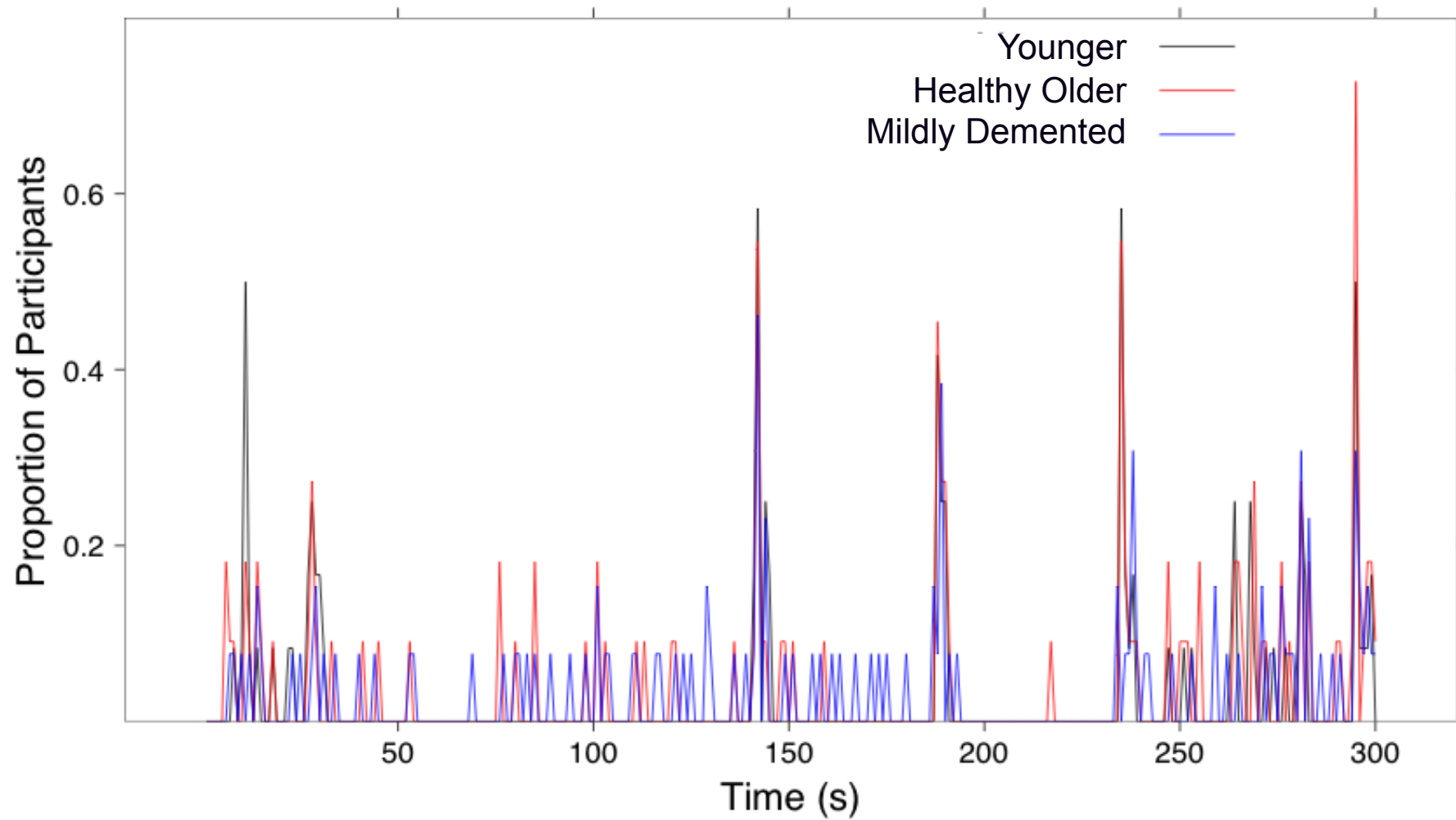


Everyday events

(Zacks et al., 2001, *Nat. Neuro.*)

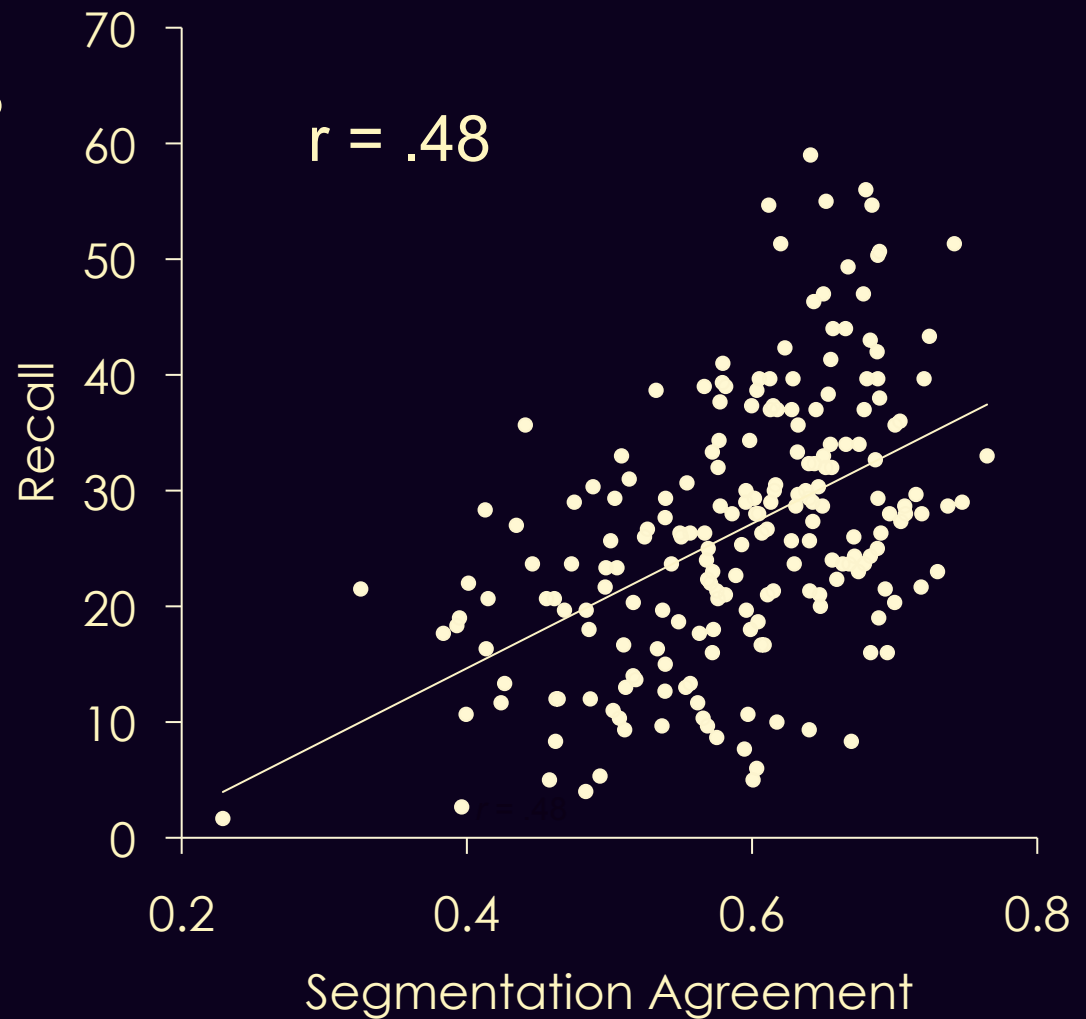
Individual differences in segmentation

- How normative is your segmentation?



- Older adults segment events less well than younger adults.
- They also remember these events less well.
- Does this matter?
- Yes. Segmentation predicts memory.

- 208 participants
- 20-79 years
- Event movies
- Psychometric testing



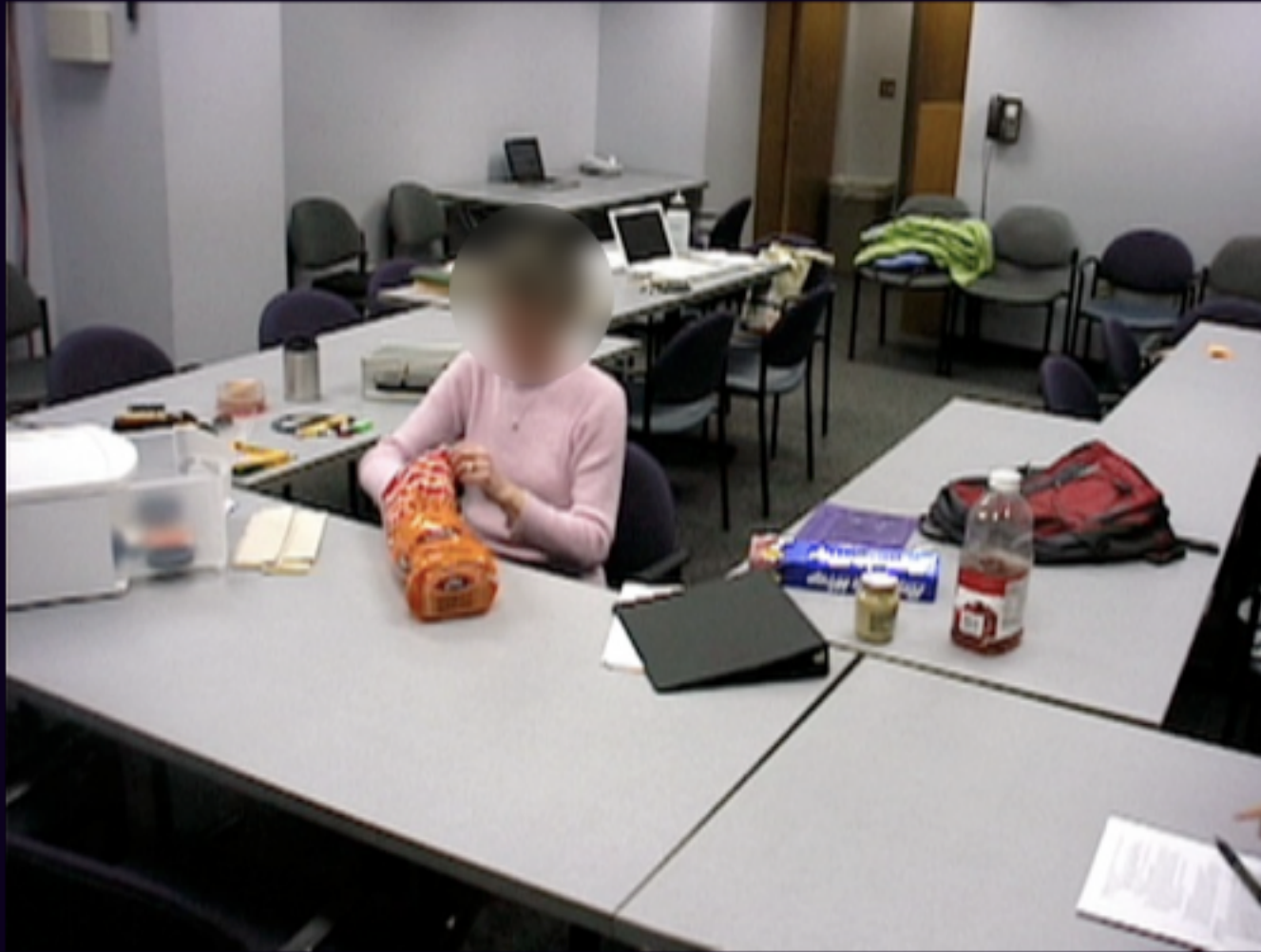
(Sargent et al., under review)

- Event segmentation predicts memory after controlling for
 - Age
 - Clinical dementia status
 - Working memory capacity, speed, general knowledge
 - Verbal episodic memory

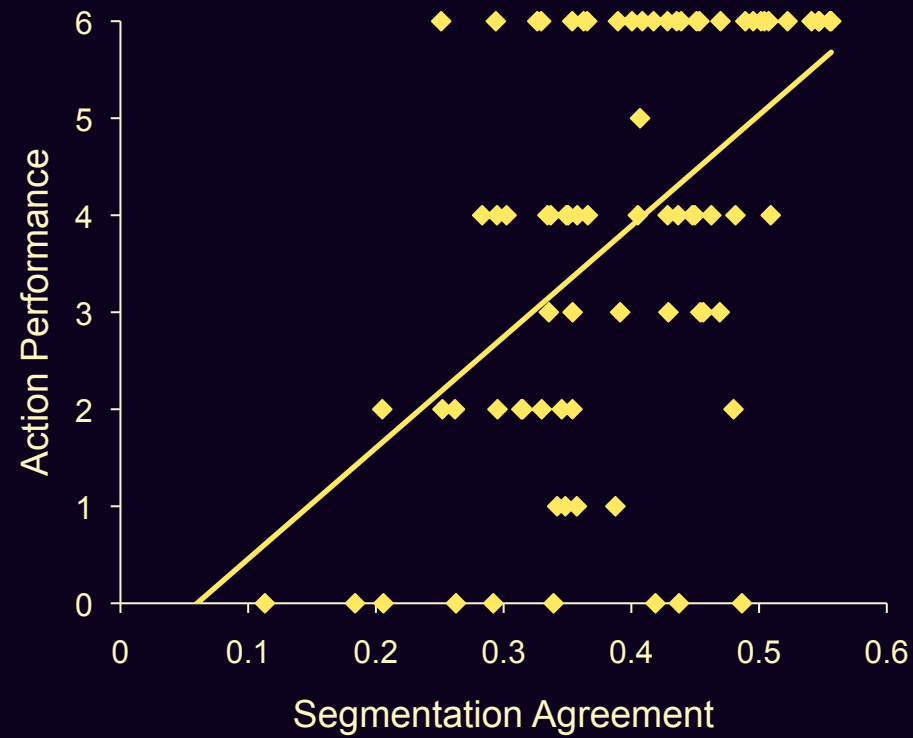
Are individual differences in event perception related to action?

- Older adults
 - Healthy, very mildly demented, mildly demented
- Event segmentation & memory
- Naturalistic Action Test (Schwartz et al. 2002)

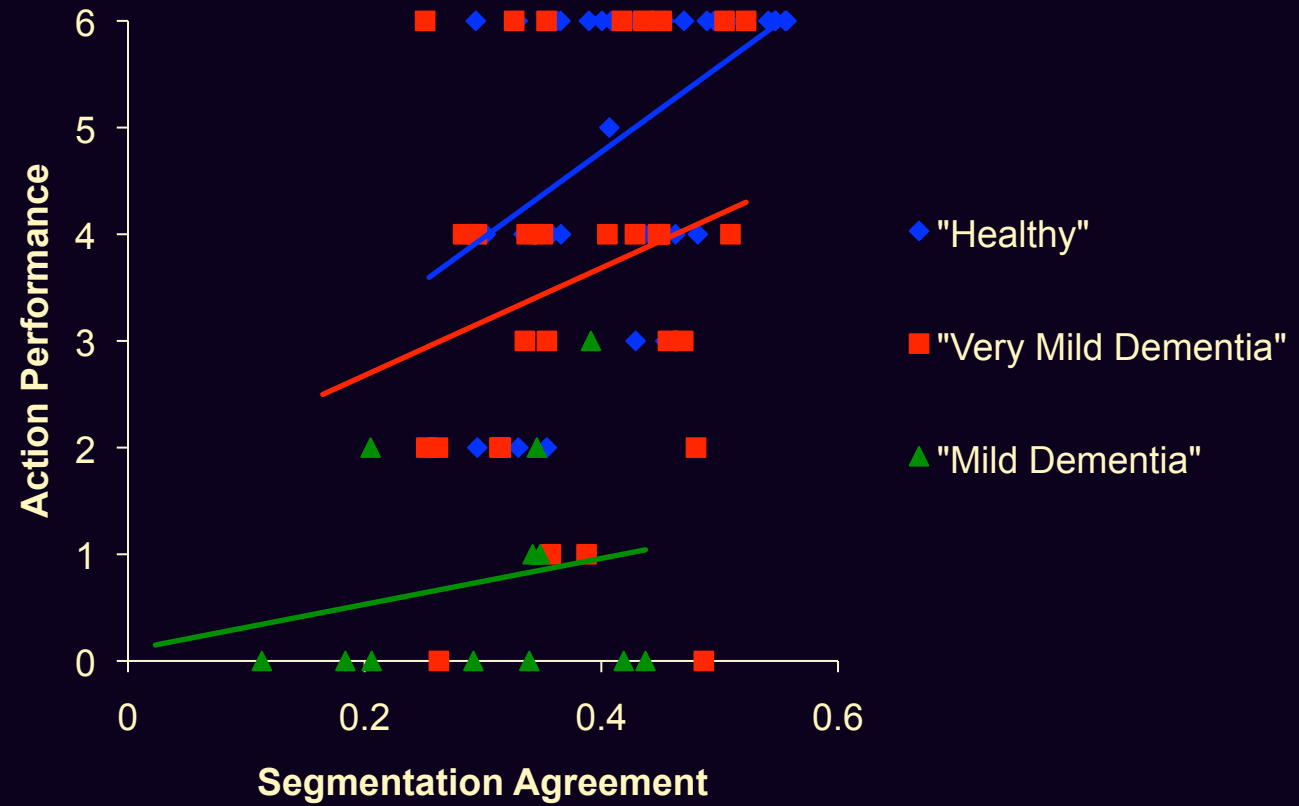
Naturalistic Action Test (NAT)



Schwartz et al. (2002)



Bailey et al., under review



- Across individuals, segmentation predicts memory and task performance.
- For a particular individual, can we provide a more effective segmentation to improve learning?

Teaching new procedures

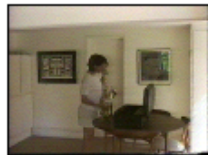
- Interface layout
 - Schema-structured
 - Unstructured
- Medium
 - Text
 - Text + still images
 - Text + video

(Zacks & Tversky, 2003, JEP: Applied)

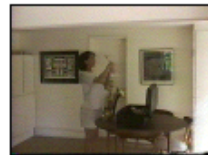
**An approach that worked:
Empirically identify event
structure**



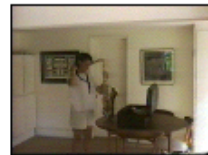
Open the saxophone case.



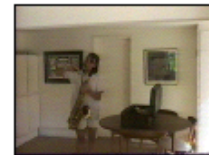
Pick up the cleaning cloth.



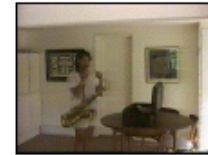
Pick up the neck.



Put on the saxophone neckstrap.



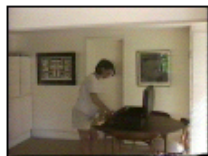
Pick up the saxophone mouthpiece.



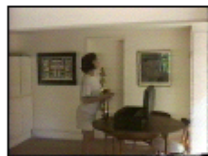
Wet the reed in your mouth.



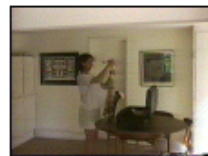
Close the saxophone case.



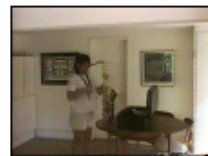
Take out the saxophone body.



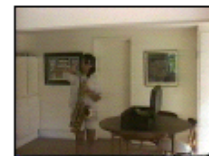
Wipe the saxophone body with the cleaning cloth.



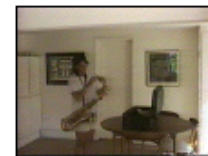
Insert the neck into the saxophone body.



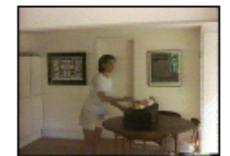
Adjust the fit of the neckstrap.



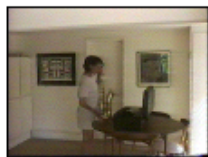
Attach the mouthpiece to the neck.



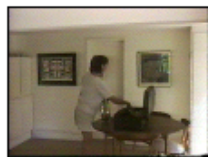
Place the reed on the flat part of the mouthpiece and slide the ligature over it.



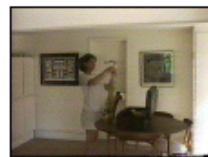
Put the saxophone down on the case.



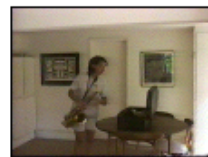
Take out the swab.



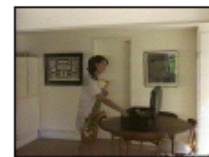
Put the cleaning cloth in the case.



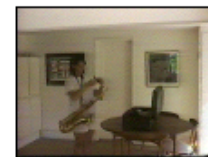
Tighten the neck screw.



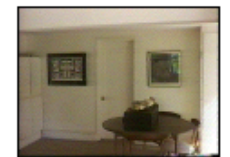
Attach the neckstrap to the saxophone.



Put the mouthpiece cover in the case.

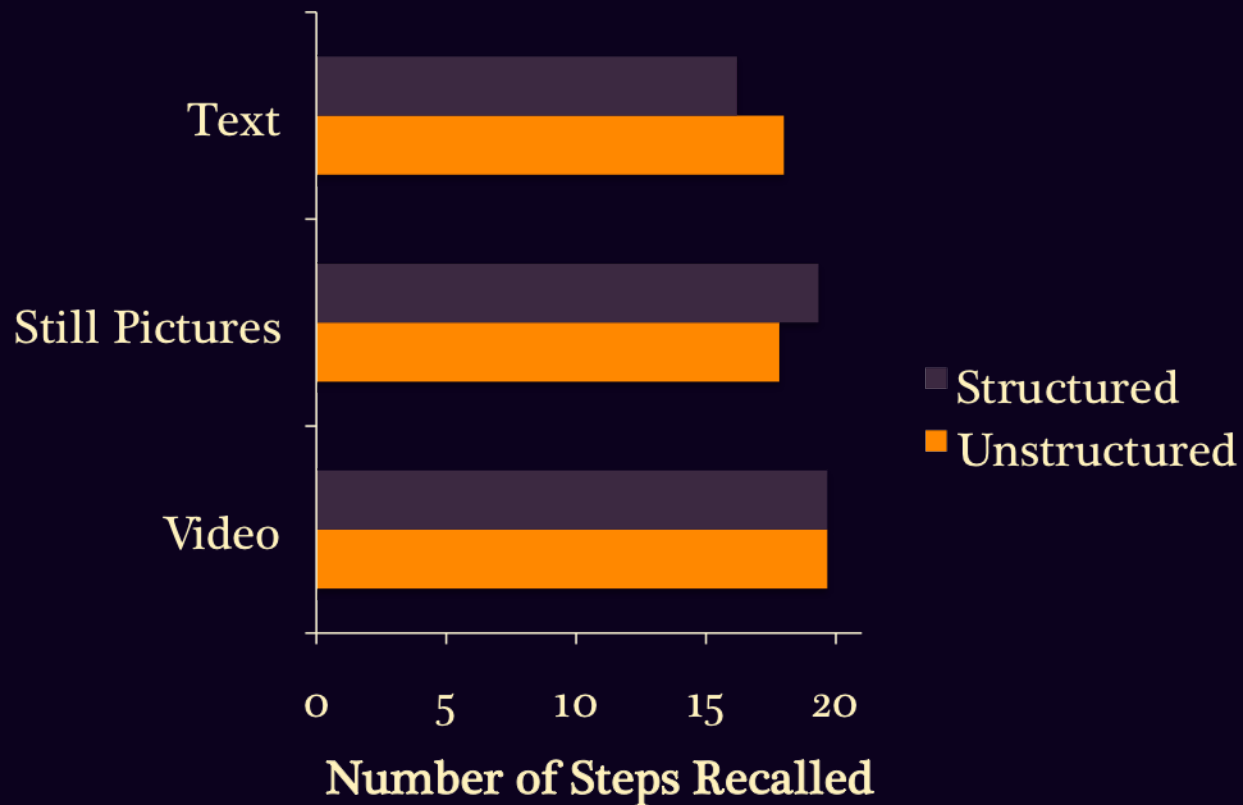


Tighten the ligature screws.

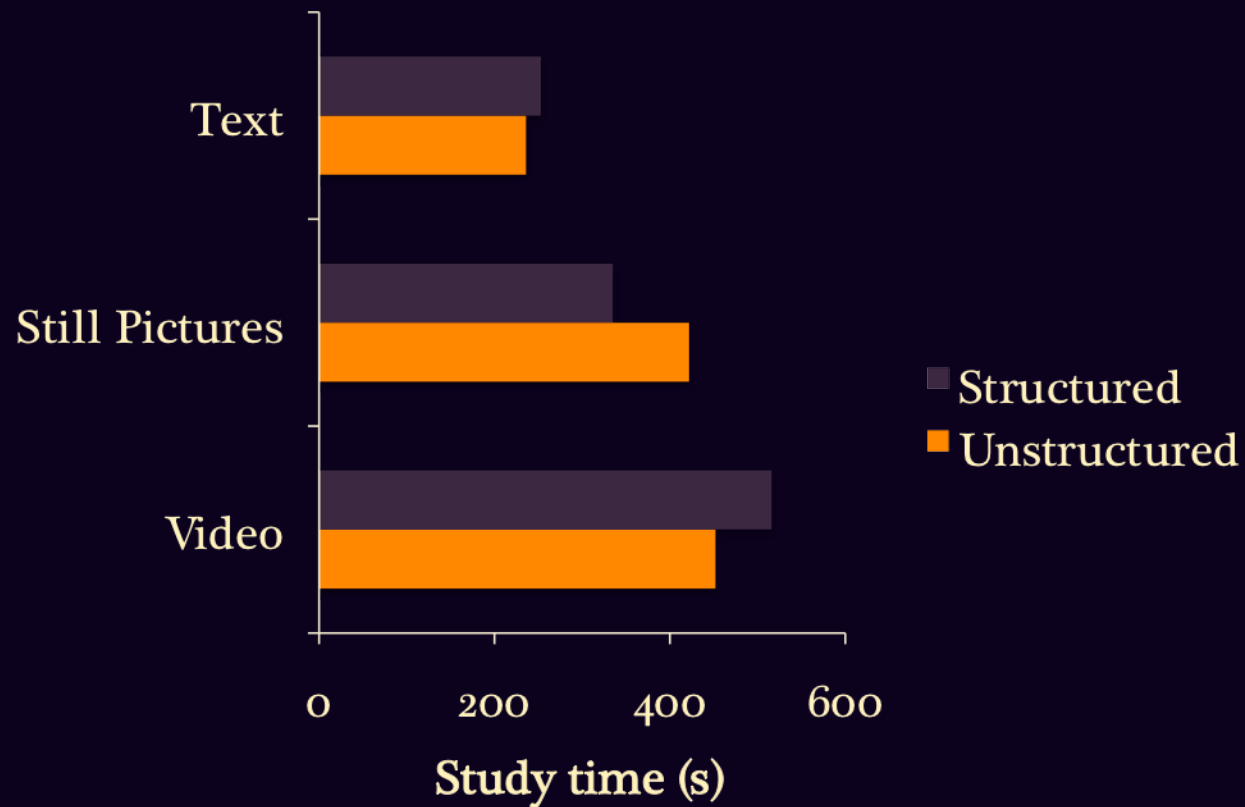


Leave the room.

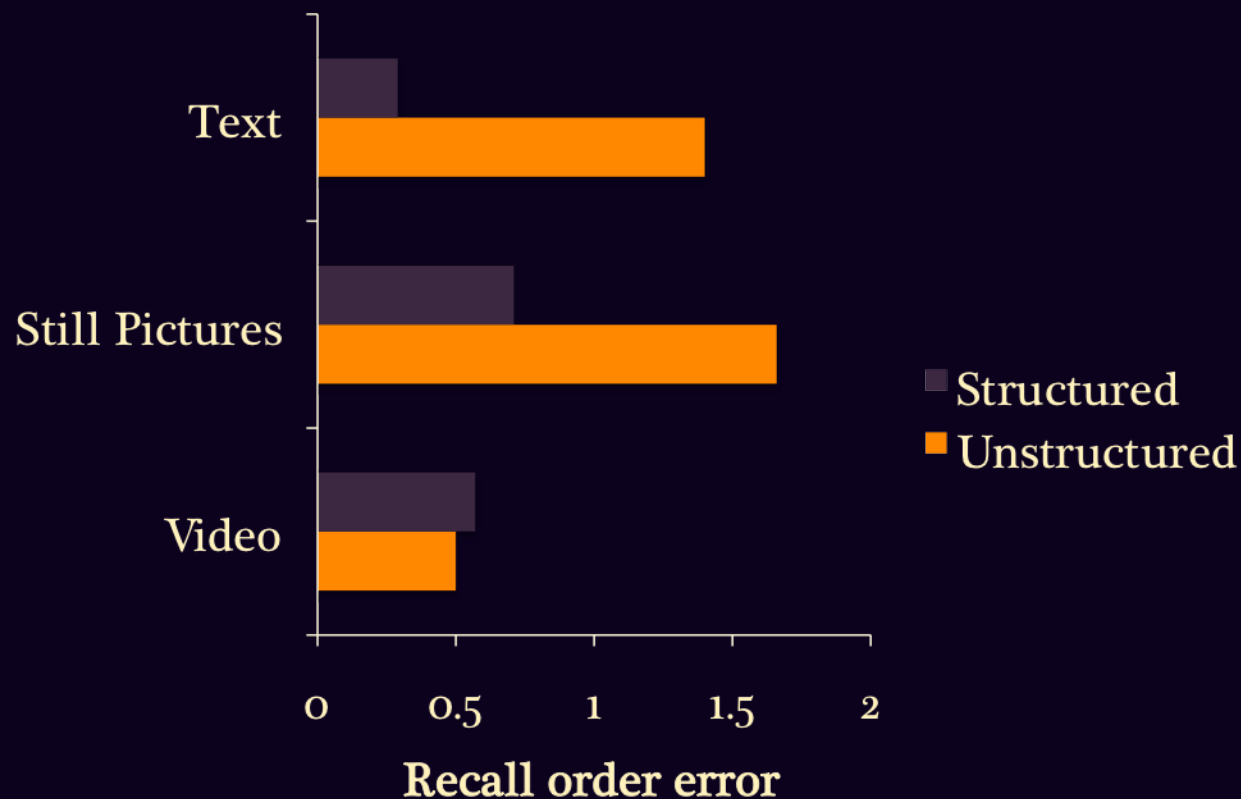
Video helped memory...



BUT this came at a cost of study time



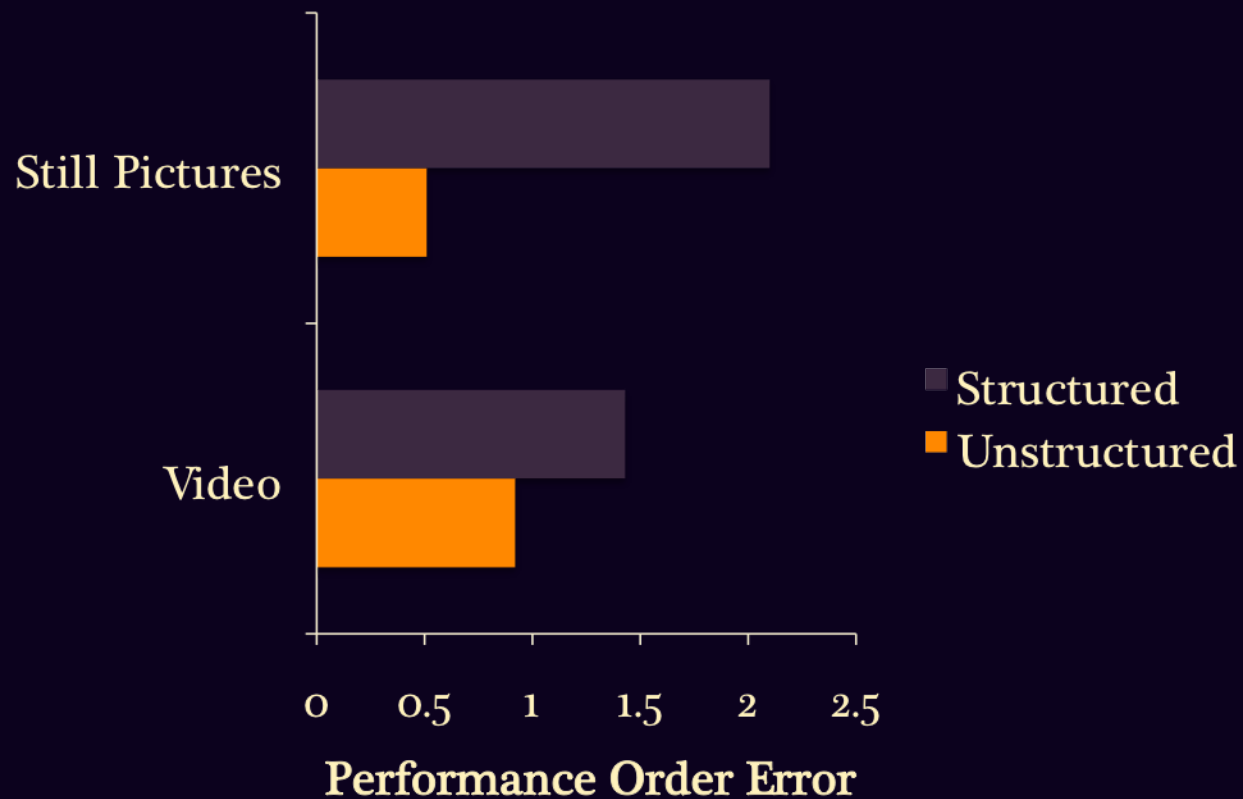
Video and event structure helped memory for order



Another approach: Event structure by fiat



Event structure hurt performance order



- If you get the event structure right, it may help learners build the right structured representations.
- There's a real danger of reinforcing the wrong structure.

Temporal thinking: Take-away

- Take advantage of real-time to depict geologic processes.
- Match structure of depiction to underlying conceptual structure

Final suggestion

- The virtues of quick cheap experiments.



Dynamic Cognition Laboratory

<http://dcl.wustl.edu>

dclweb@artsci.wustl.edu

Technical Acknowledgements

Statistical analysis: R

<http://www.r-project.org>

fMRI analysis: fidi

<http://www.nil.wustl.edu/~fidi/>

Surface mapping: CARET & PALS atlas

<http://brainmap.wustl.edu>