

Lecture 3: Embodiment

COGS 153

Thought experiment:

- Imagine learning a language with only access to a dictionary in that language:
 - You look up a word, and you get its definition in the same language...
 - You look up the words in the definition, and you get more unfamiliar words...
- “the symbol/symbol merry-go-round”



The “Chinese Room” Thought Experiment



If you see this shape,
"什麼"
followed by this shape,
"帶來"
followed by this shape,
"快樂"

then produce this shape,
"爲天"
followed by this shape,
"下式".



Searle's motivation:

Can a computer executing a program have a “mind” or “conscious understanding”?
What do you think?

The Symbol Grounding Problem

- How can the meaning of intrinsically meaningless and arbitrary symbols (e.g., the sound of words) be grounded in other intrinsically meaningless symbols?
 - (Like trying to learn a foreign language by reading a dictionary in that language)
- What's an alternative to traditional/amodal meaning approaches?
 - How do we connect arbitrary symbols to the world?
 - Are symbolic representations grounded in non-symbolic representations?

Embodied cognition/mental simulation

- The idea: concepts activated by language are grounded in perceptual and motor experience & language should activate some perceptual/motor information
- This theory hypothesizes that meaning is built up from experiences people have had *in their bodies* and *in the world*
 - The brain doesn't exist in a vat
 - In the real world, people act, perceive, and experience emotions
 - They create mental traces of these experiences
- And in turn, words evoke this meaning (that is grounded in experiences)

how does the brain 'do language'?

Traditional Views

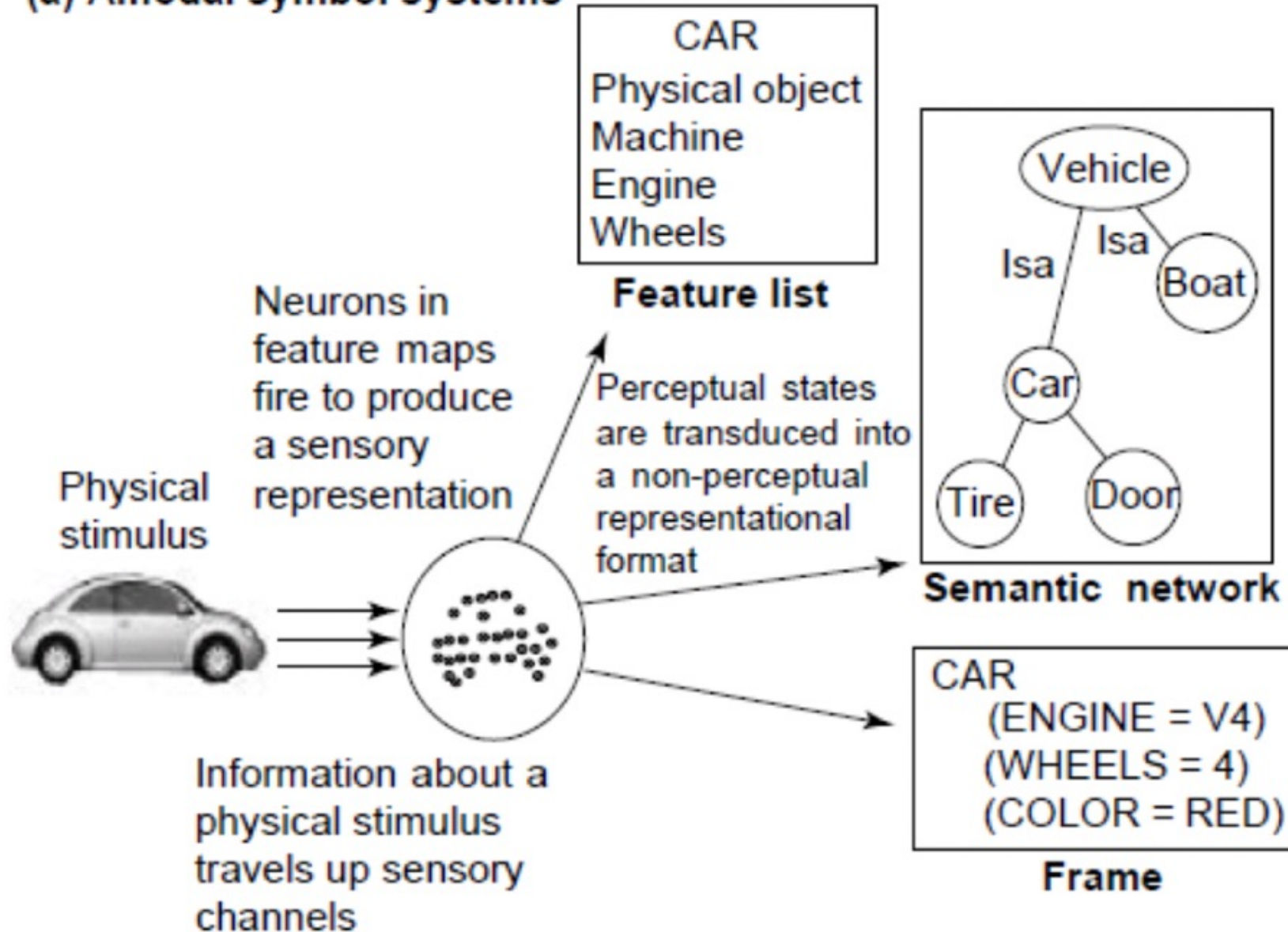
- "Language Organ"- evolved, domain-specific capacity for language
- Amodal symbol systems
- The mind is like a computer

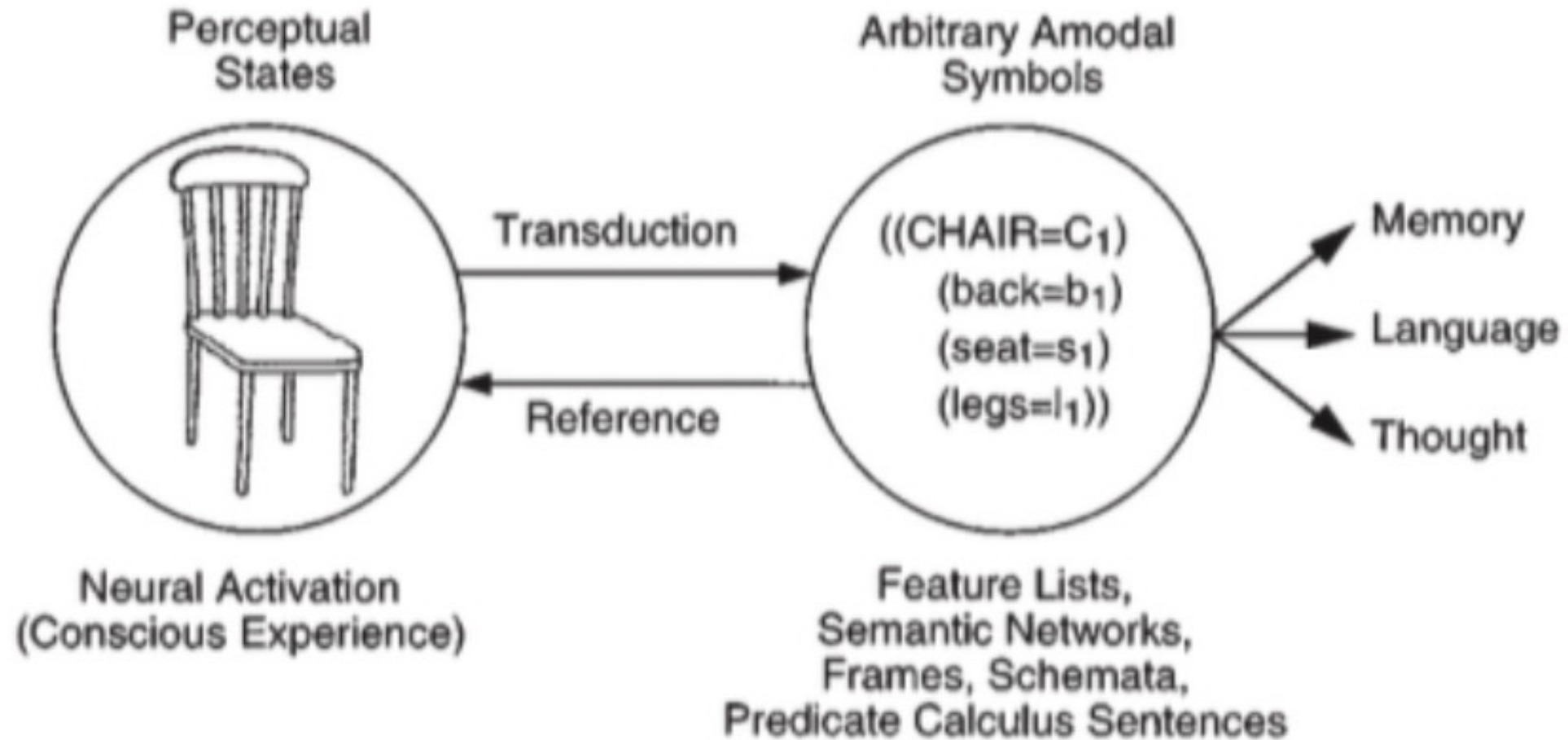
Simulation/Embodied Views

- "New machine, old parts"- use neural systems that evolved for other things, like perception + action
- Domain-general
- Perceptual symbol systems
- The mind is embodied

Traditional view of meaning:

(a) Amodal symbol systems





Perceptual
Input

See
Smell
Hear
Feel
Taste?



Cognition
the idea /dog/ is
abstract symbol
“platonic ideal”



Motor
Output

Pet
The
Dog

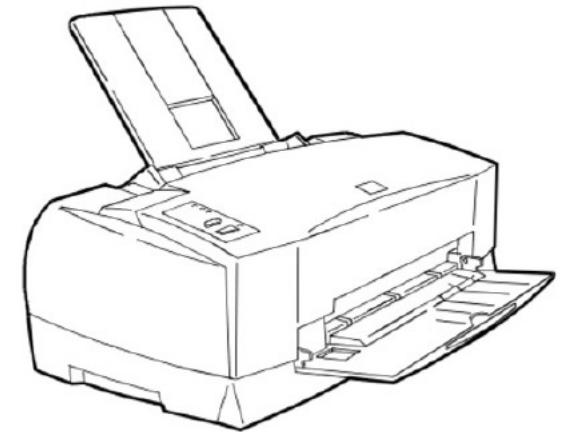


Classical View of Cognition

Sensory Input



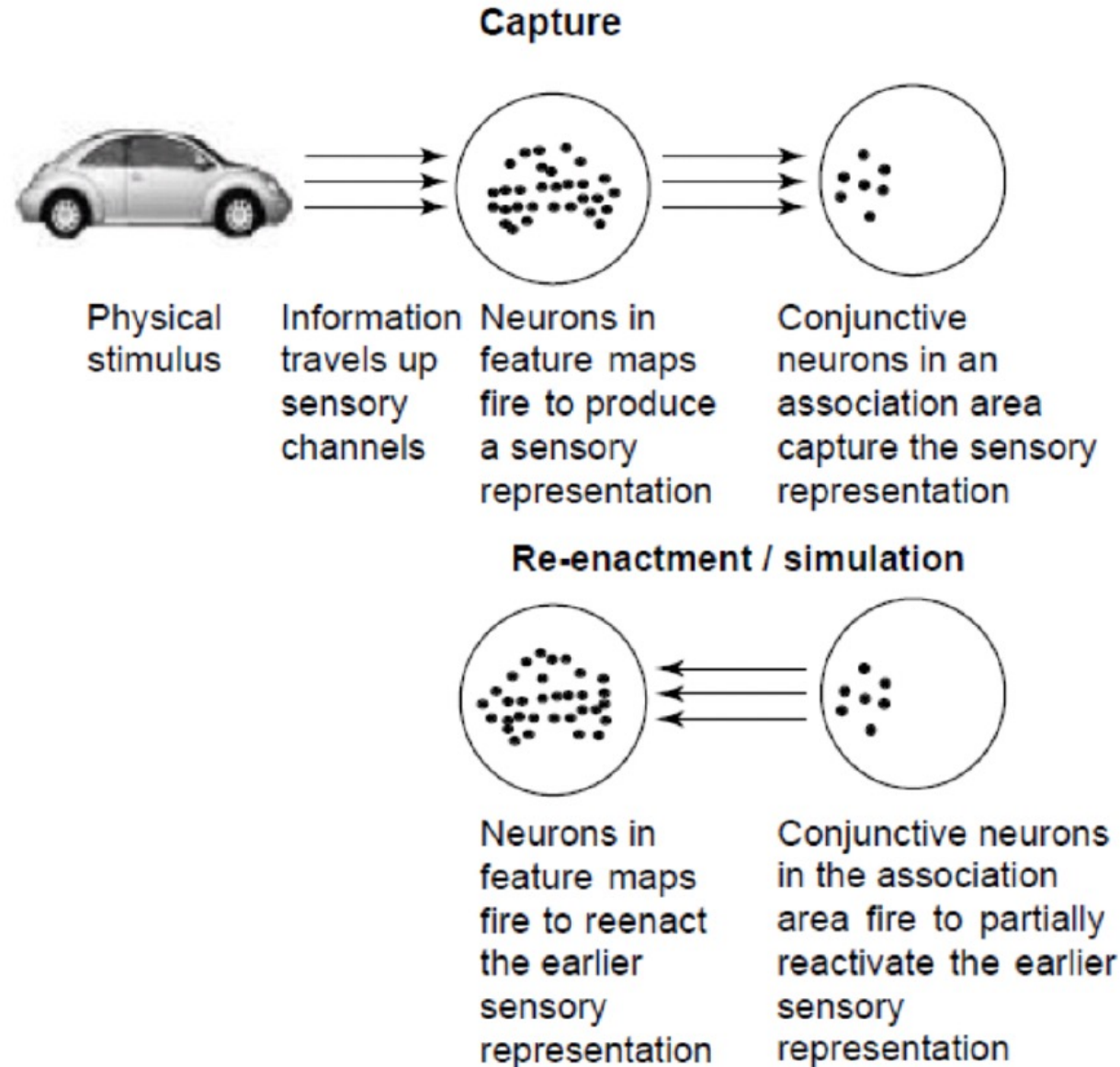
Cognition



Motor Output

Embodied view of meaning:

(b) Perceptual symbol systems

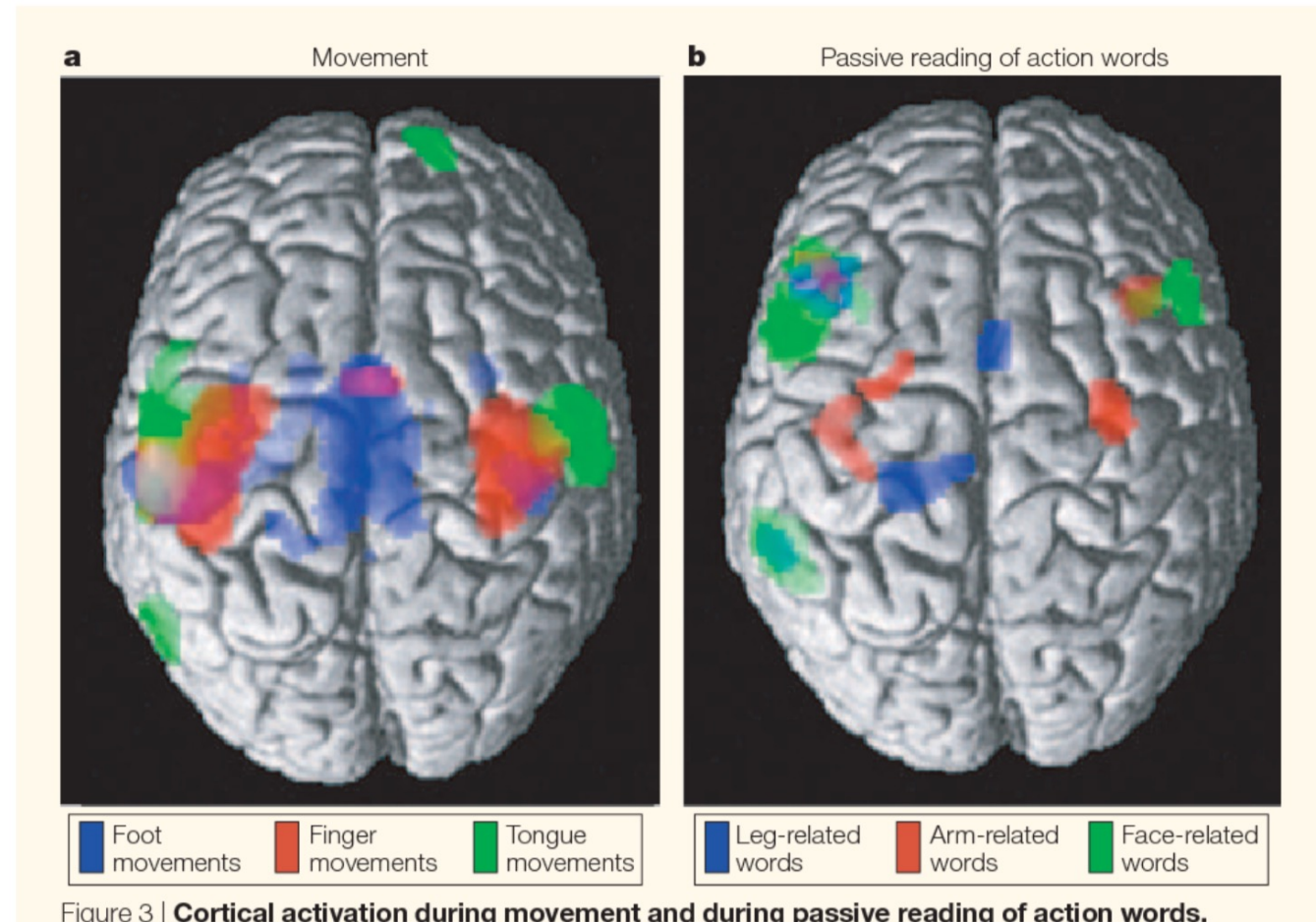


What predictions does this theory make?

- Language tasks **will recruit perceptual and/or motor systems** in the brain
- Language and perception/action **will interact**
 - If perceiving language about some perceptual/motor events recruits similar brain systems, performance on perceptual/action tasks that share resources will be affected (e.g. facilitation effects)
 - “If some language behavior, say understanding a sentence, involves activating a simulation that includes certain perceptual or motor content, then language on the one hand and perception or action on the other should interact.” (Bergen, 2015)

Activation of sensorimotor areas

- Sensorimotor systems are involved in more than perception or movement, they are activated during the comprehension of word meaning
 - Activation in moving foot, fingers, and tongue
 - And activation in reading action words like KICK, PICK, and LICK



Simulation of motion

- fMRI study
- Saygin et al. (2010) compared the following types of sentences:

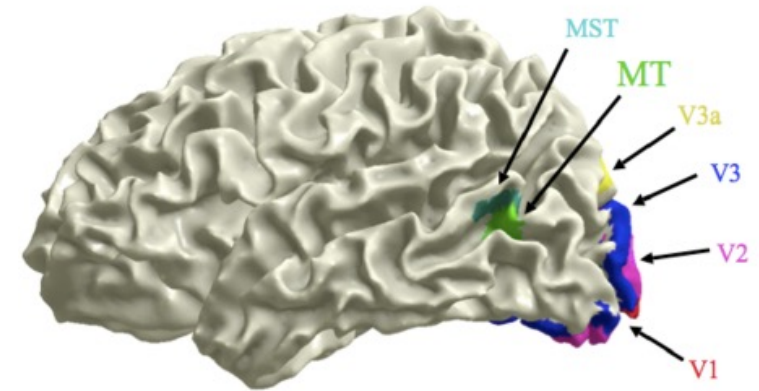
Motion: *I drove from Modesto to Fresno.*

Fictive motion: *The highway runs from Modesto to Fresno.*

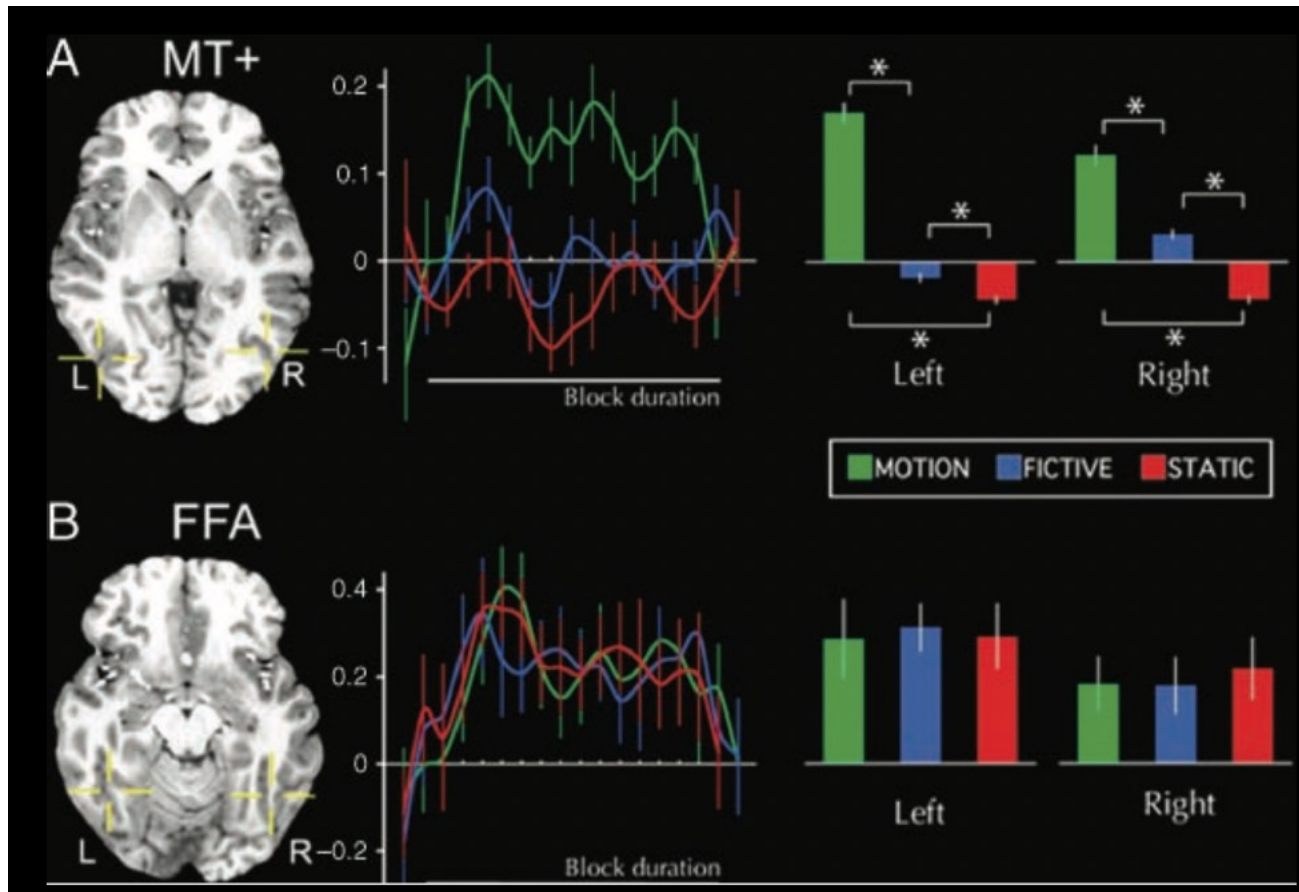
Static: *Modesto and Fresno are in California.*

Simulation of motion

- **Region of interest: V5/MT+**
 - Area of the brain known to be involved in processing visual motion
- **Control region: FFA**
 - Area of the brain known to be involved in processing complex visual objects, especially faces



Simulation of motion



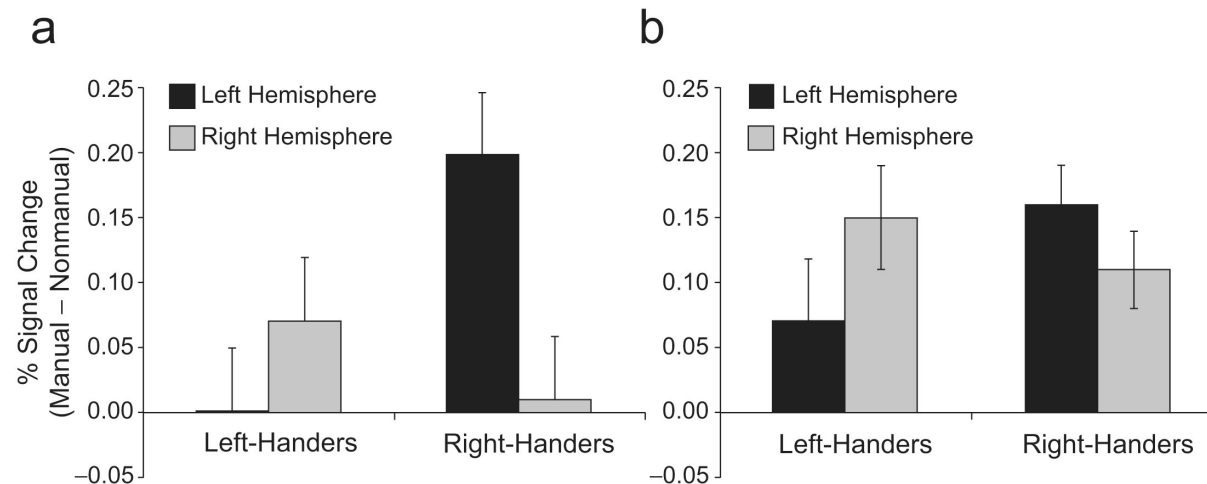
Results:

- V5/MT+ responded most to sentences that were about literal motion
- V5/MT+ responded in an intermediate way to sentences that described static events using fictive motion language
- V5/MT+ responded least to sentences that described static/motionless scenarios
- No differences in activation between conditions for FFA control

Effect of body specificity

Prediction: If language comprehension involves sensorimotor simulation, then left handers and right handers should simulate verbs like “throw” in different hemispheres.

Lexical decision task: Word or nonword?



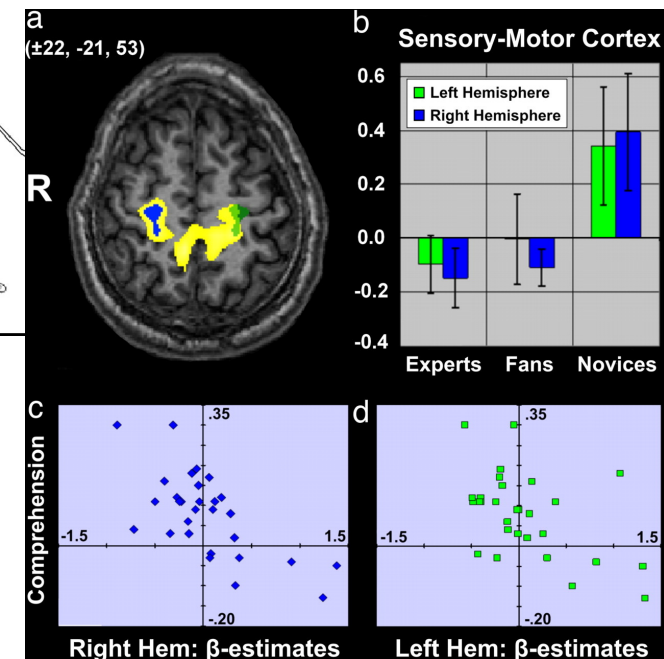
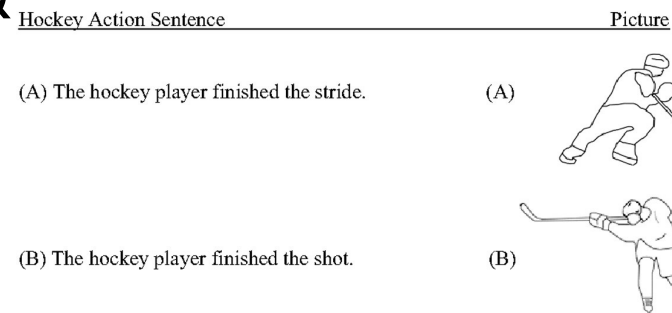
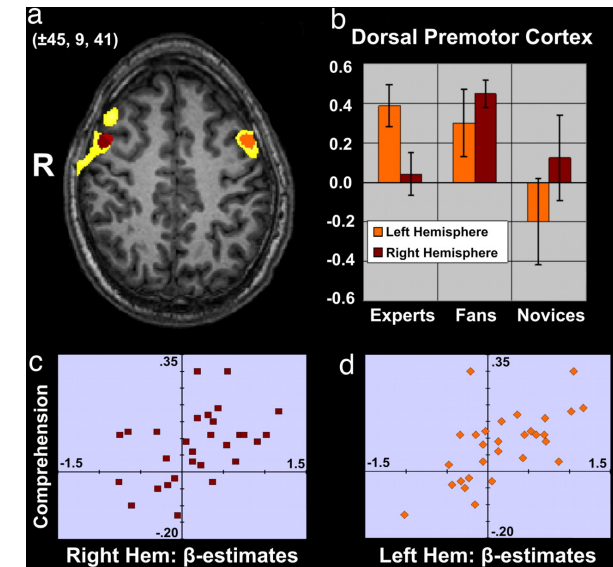
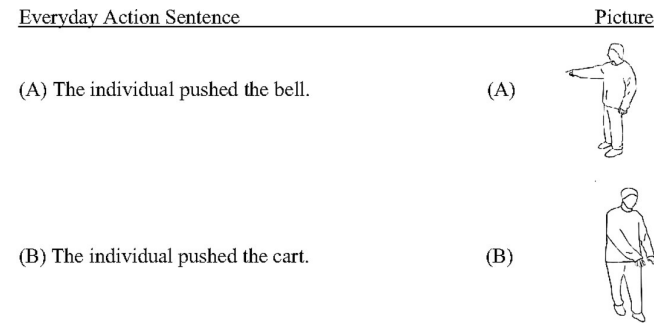
Effect of action expertise

Question: Does motor expertise influence the recruitment of the motor system during language comprehension?

Participants: Hockey experts, fans, & novices (all right-handed)

Task: Listen to sentences about hockey & everyday actions while being scanned in fMRI

Manipulation check: Take a post-scan comprehension test



Simulation of object orientation

- Procedure: read sentences involving simple actions

“The carpenter hammered the nail into the floor.”
(implied vertical orientation)

Or

“The carpenter hammered the nail into the wall.”
(implied horizontal orientation)

Simulation of object orientation

- Procedure: ask participant "Was this mentioned in the sentence?"

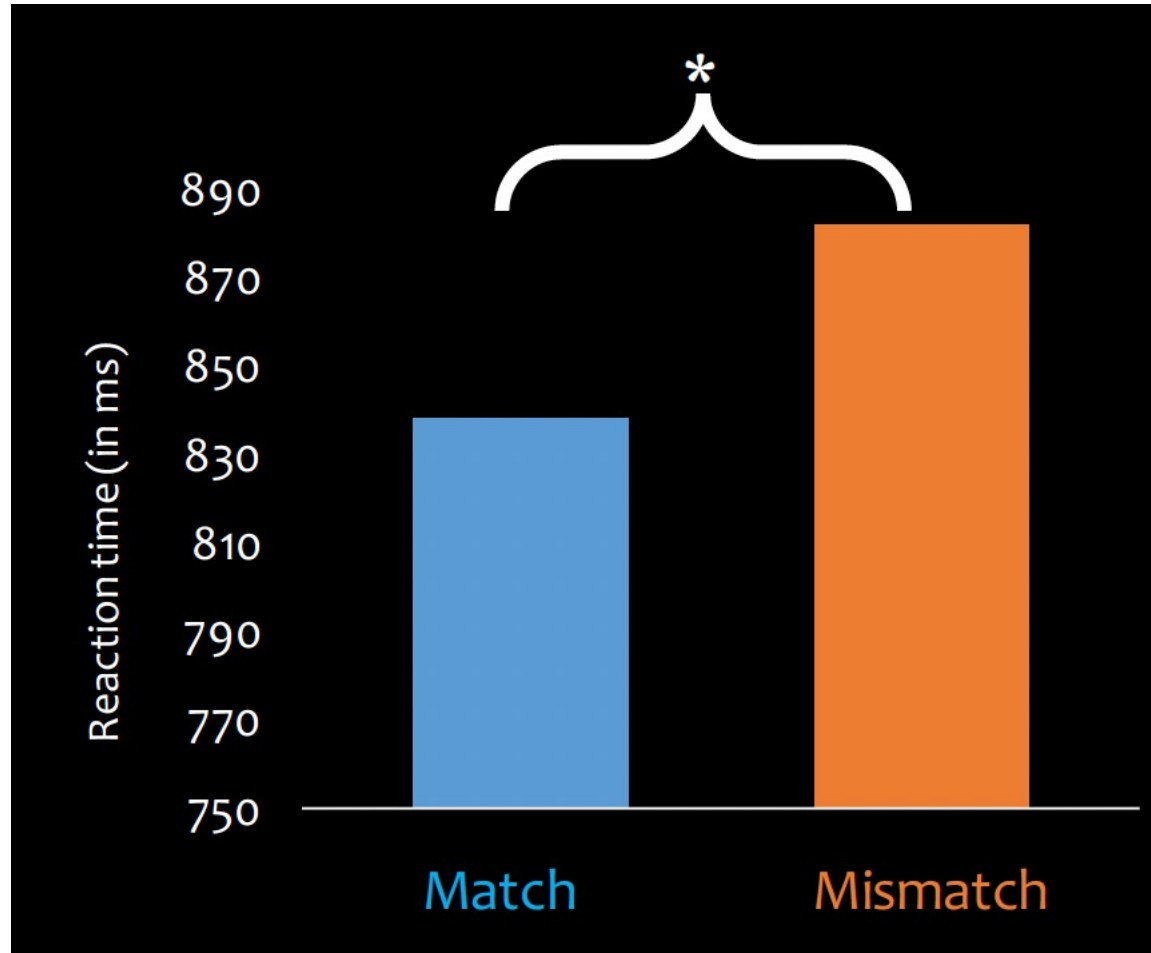


vertical orientation



horizontal orientation

Simulation of object orientation



Results:

- Participants were faster to recognize images when they matched the orientation implied by the sentence
- Facilitation effect

Implied shape

- **Procedure:** read sentences involving an object that could have two shape configurations

“The ranger saw the eagle in the sky.”
(implied: spread wings)

Or

“The ranger saw the eagle in the nest.”
(implied: closed wings)

Results: responses were faster when the pictured object's shape matched the shape implied by the sentence than when there was a mismatch

Procedure: ask participant "Was this mentioned in the sentence?"



Pronouns and perspective taking

- **Procedure:** read sentences involving simple actions completed by you or someone else. Participants then verified whether a displayed picture matched or mismatched the described event.

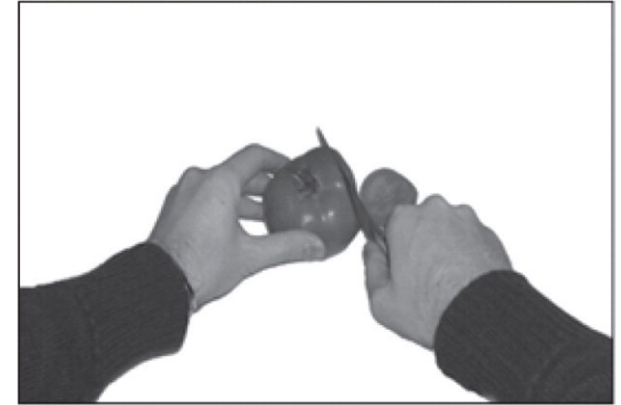
“I am slicing the tomato.”

vs

“You are slicing the tomato.”

vs

“He is slicing the tomato.”



Internal/Performing



External/Performing

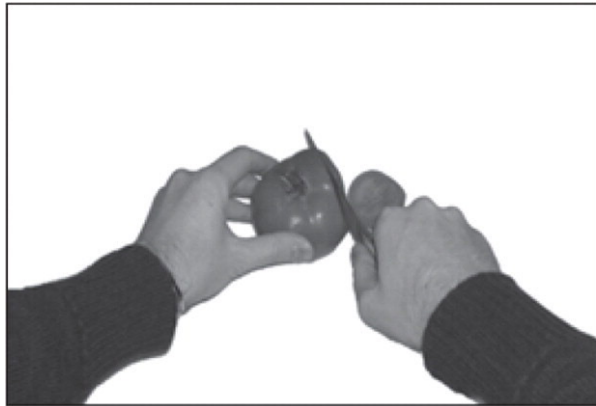
“I am slicing the tomato.”

vs

“You are slicing the tomato.”

vs

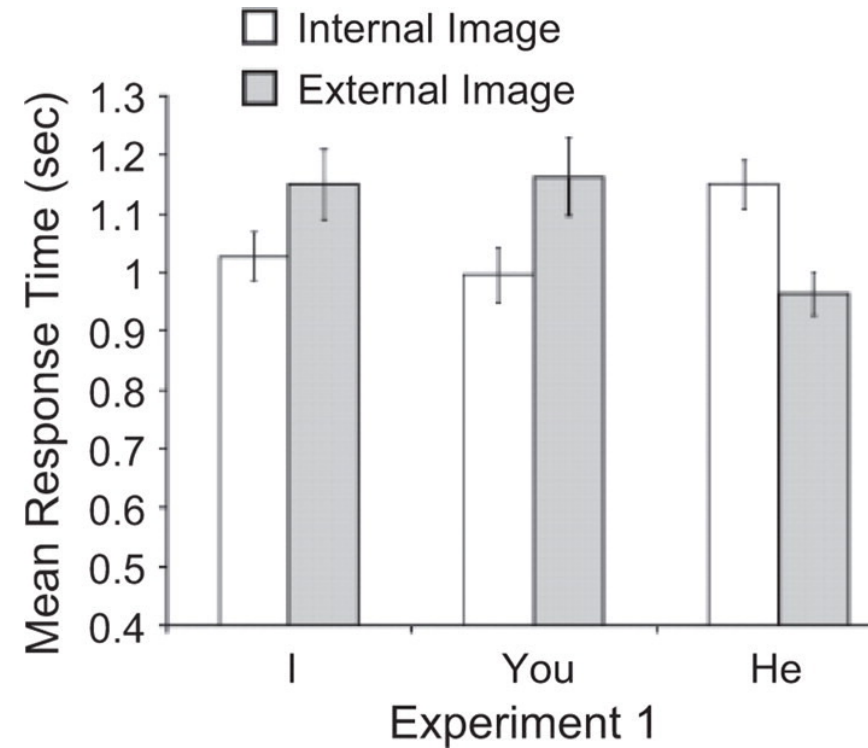
“He is slicing the tomato.”



Internal/Performing



External/Performing



Results: Readers took on an internal perspective when the pronoun *you* or *I* is used, but take an external perspective when *he* is used

- pronoun variation mediate degree of embodiment experienced
- “readers mentally simulate objects and events, but they embody an actor's perspective only when directly addressed as the subject of a sentence.”

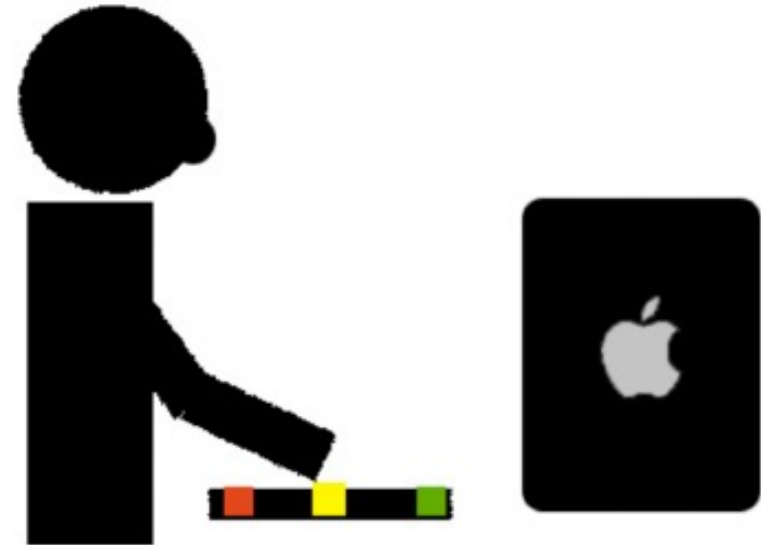
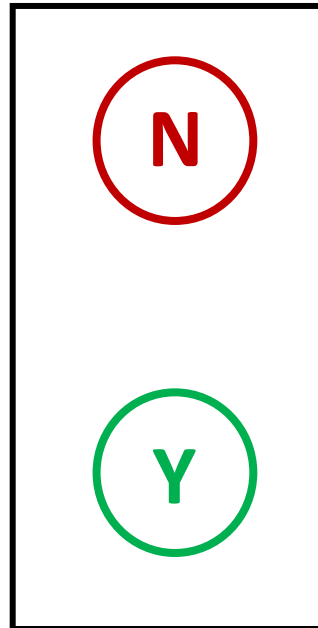
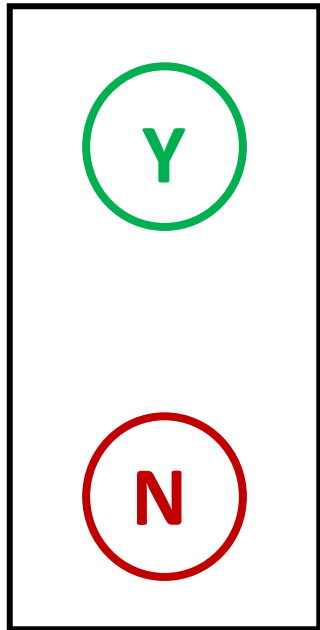
Action Compatibility Effect (ACE)

- **Procedure:** participants read sentences that implied motion towards/away from them:

	Towards motion implied	Away motion implied
Imperative:	<i>Open the drawer.</i>	<i>Close the drawer.</i>
Concrete Transfer:	<i>Andy delivered the pizza to you.</i>	<i>You delivered the pizza to Andy.</i>
Nonsense:	<i>Boil the air.</i> (no motion towards/away implied)	

Action Compatibility Effect (ACE)

- Then ask participant “Does this sentence make sense?”
 - Participant responds by pressing a yes or no button
 - **Yes** buttons are oriented either as *far* or *near* (away or towards!)



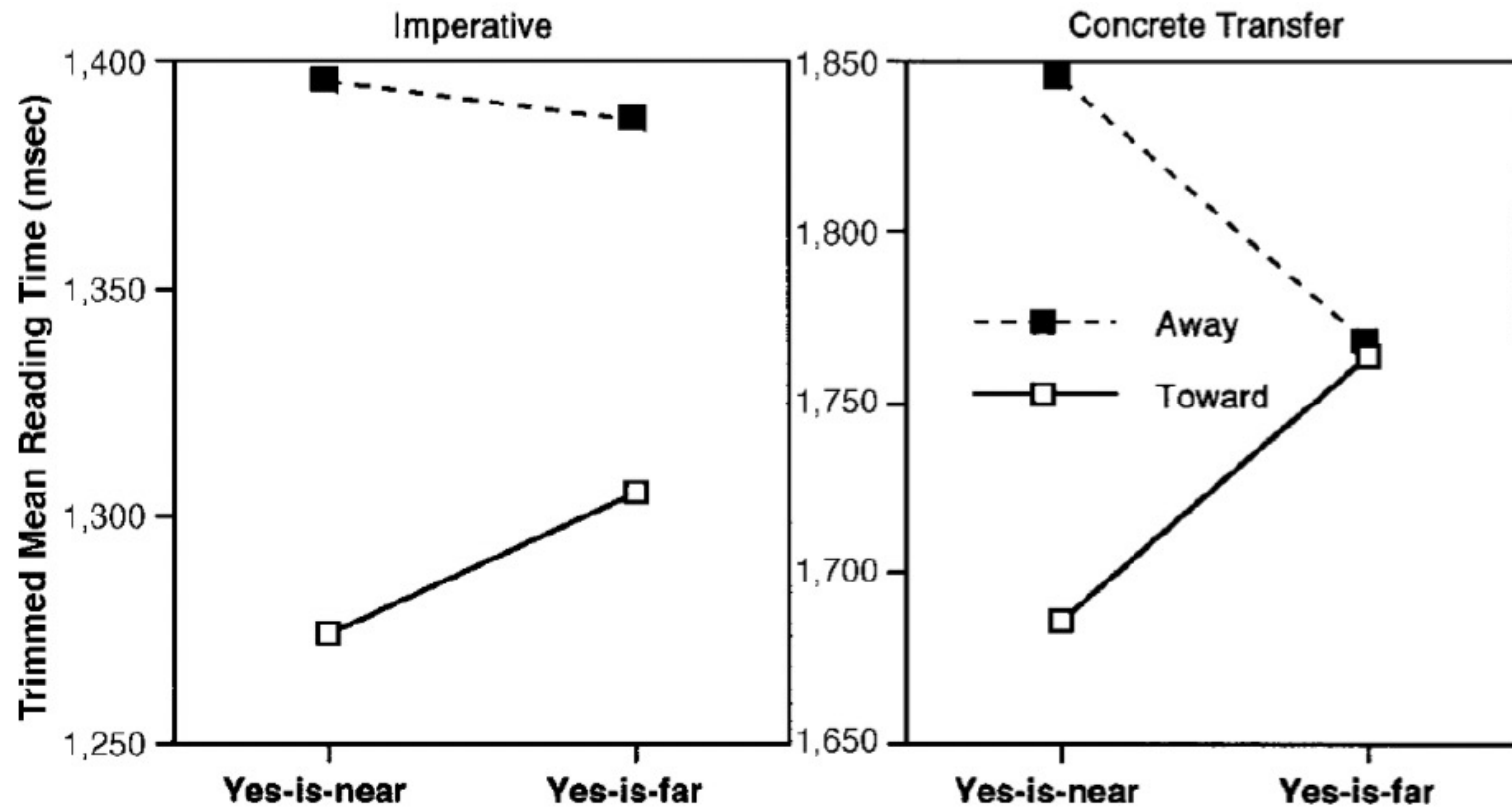
Towards motion implied

Away motion implied

Imperative: *Open the drawer.*

Close the drawer.

Concrete Transfer: *Andy delivered the pizza to you.* *You delivered the pizza to Andy.*



- **Results:**

- Participants are faster when the location of the button matches implied motion
- Facilitation of movement based on language

The ACE Method

- Highly influential and productive paradigm
 - Original paper by Glenberg & Kaschak (2002) cited almost 3k times.
- Replicated and extended in different studies
 - Different languages
 - SVO languages (e.g., English John grabbed the pizza)
 - SOV languages (e.g., Japanese, Awazu, 2011)
 - sign language (ASL, Secora & Emmory, 2014)
- Different body movements
 - hand vs foot button presses (Awazu, 2011)
- Words from different grammatical categories
 - nouns (Masson et al., 2008) and verbs (Zwaan & Taylor, 2006)
- The time course and temporal dynamics have been studied
 - occurs shortly after target word, disappears, then reappears at the end of the sentence (Kaschak & Borreggine, 2008)

Failure to replicate ACE...

- Run in 18 labs, by
prominent embodiment
researchers

Brief Report | [Open Access](#) | [Published: 09 November 2021](#)

A pre-registered, multi-lab non-replication of the action-sentence compatibility effect (ACE)

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Abstract

The Action-sentence Compatibility Effect (ACE) is a well-known demonstration of the role of motor activity in the comprehension of language. Participants are asked to make sensibility judgments on sentences by producing movements toward the body or away from the body. The ACE is the finding that movements are faster when the direction of the movement (e.g., *toward*) matches the direction of the action in the to-be-judged sentence (e.g., *Art gave you the pen* describes action toward you). We report on a pre-registered, multi-lab replication of one version of the ACE. The results show that none of the 18 labs involved in the study observed a reliable ACE, and that the meta-analytic estimate of the size of the ACE was essentially zero.

Testing embodied representations: Priming

- Priming studies
 - Present one related stimulus shortly before the other
 - If information has recently been accessed, you are faster to access it again
 - The same is true for associated information
 - Occurs when using verbal and/or nonverbal content
 - **Faster RTs for related content** (compared to unrelated content)
 - Facilitation effect

Testing embodied representations: Interference

- Interference paradigm logic
 - Testing if a part of the brain is involved in the *same process* for two *unrelated tasks*
- If a brain region is being used for one task and its resources need to be used for another task at the same time, it will cause interference
 - **Slower response times to the test stimuli**

Manipulating spatial location

Procedure:

- Listen to a sentence while looking at the screen.
 - spatial location implied sentence (up/down)
- A shape will appear on the screen.
 - spatial location is either top or bottom
- Make a speeded response to indicate if it is a circle or a square.

Results:

- Slower in the congruent condition
- Interference b/c same resources used for different things at the same time (simulating UP when listening to the ceiling sentence + viewing circle at top of screen)

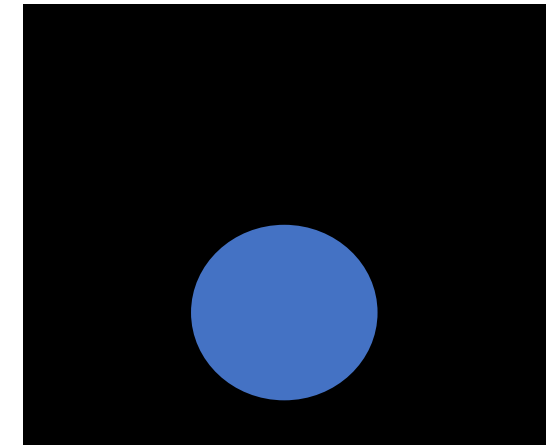
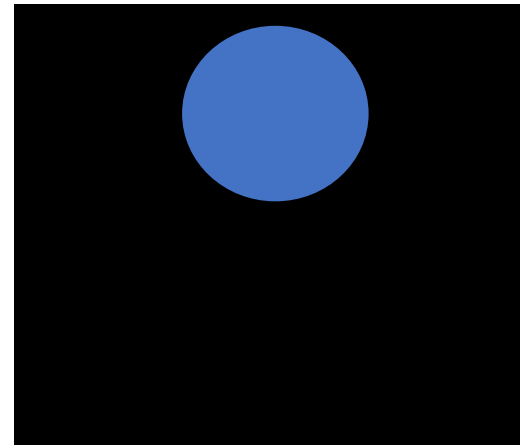
Sentences

Noun Down

The Cellar Flooded.
The Grass Glistened.
The Ground Shook.
The Shoe Smelled.
The Submarine Fired.

Noun Up

The Ceiling Cracked.
The Rainbow Faded.
The Roof Creaked.
The Sky Darkened.
The Tree Swayed.



Does mental simulation play a functional role?

- Does the mental simulation documented in prior studies play an important functional role, or is it epiphenomenal?
 - epiphenomenon: a secondary phenomenon that occurs alongside or in parallel to a primary phenomenon (like side effects or by-products)

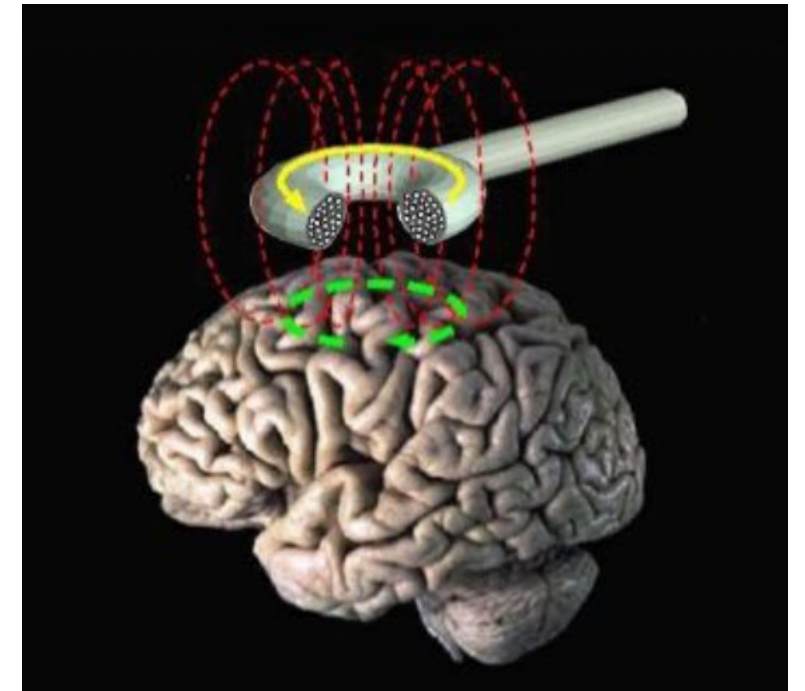


Does mental simulation play a functional role?

- *Transcranial magnetic stimulation* (TMS): application of a strong electromagnet to the scalp and depending on the exact method, can either:
 - induce "transient lesions" in target regions
 - increase excitability in target regions

Procedure:

- TMS was applied over the left hand area (in one session) and the right hand area (in a separate session)
- Then, right-handed participants performed a lexical decision task on manual and non-manual verbs (e.g. *throw*, *write* vs *earn*, *wander*)



Willems et al., 2011

Does mental simulation play a functional role?

Results:

- TMS over left hand areas sped up lexical decision responses to manual action verbs (but not non-manual action verbs)
- This suggests that activity the activity observed in these areas during mental simulation is not epiphenomenal

