Embodiment (2)

SS16 - (Embodied) Language Comprehension

Ross Macdonald
20.05.16

Overview

Last week

Traditional cognition

Cognition for action
- Theoretical basis
- Supporting evidence
- Problems with this concept

Body-based cognition
- Symbol grounding problem
- Perceptual symbol systems

- **This week:**
- Body-based cognition
    - Behavioural evidence
    - Brain imaging evidence
    - Evidence from clinical populations
- Problems with embodiment
- Middle ground approaches

Embodied Language Processing

Body-based Cognition

This strict embodied view suggests that sensorimotor experiences are essential to meaning

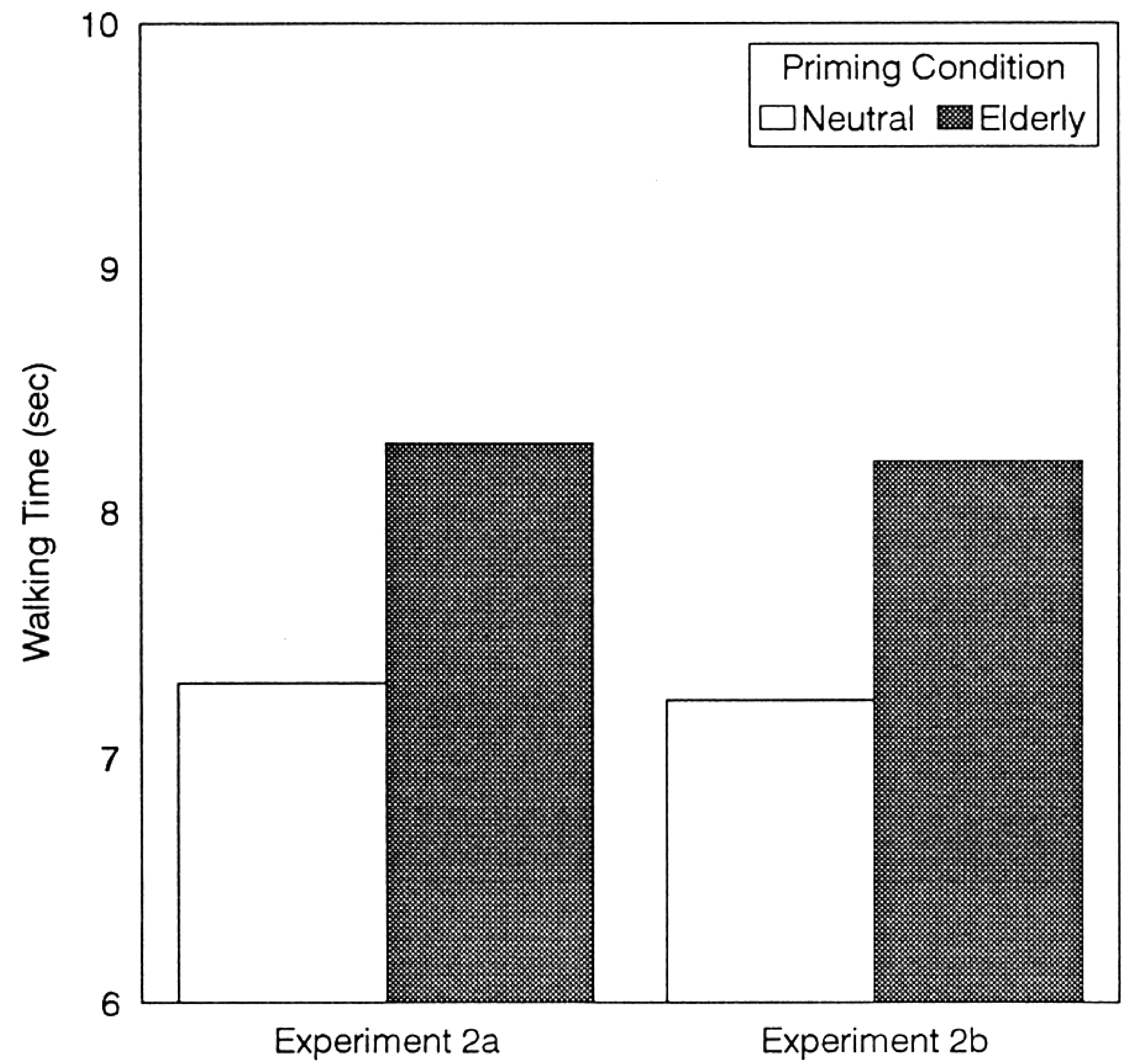
So, we are looking for evidence of sensorimotor and language processing influencing each other

Embodied Language Processing

Behavioural Evidence

Words priming motor behaviour

- Participants unscrambled words to make sentences
- Either lots of words linked to elderly or neutral words
- Crucially, no words linked to speed
- Experimenters timed how long it took people to walk away



Bargh et al (1996)

Embodied Language Processing

Behavioural Evidence

Shimuhuru word reading test *Vs* *Schumacher word reading test*

- Participants read out words from one of these lists
- They were secretly timed doing so

MacRae et al. (1998)

Embodied Language Processing

Behavioural Evidence

- **Schumacher was the quickest!**
- **Concept of “speed”, quickened language production**

MacRae et al. (1998)

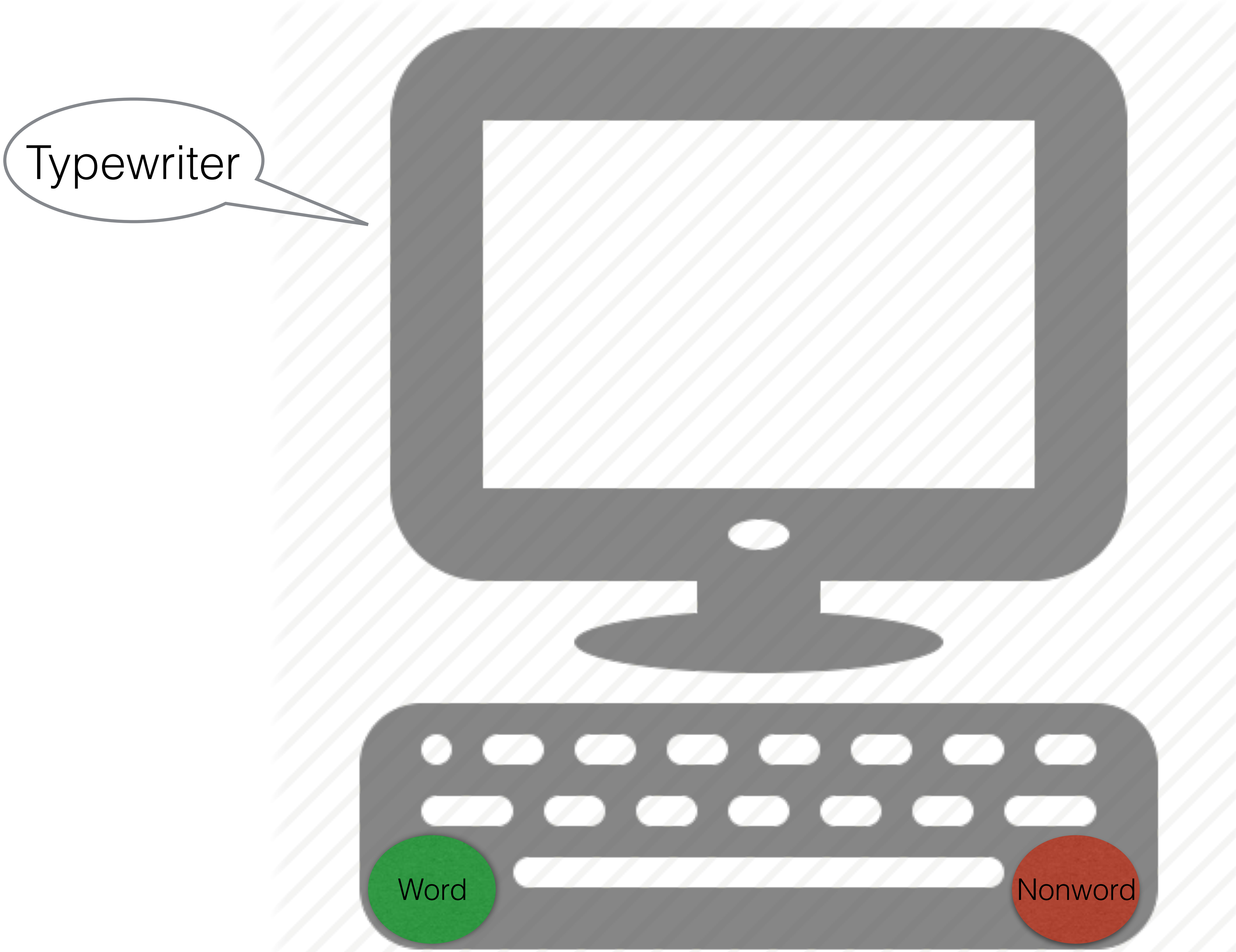
Embodied Language Processing

Behavioural Evidence

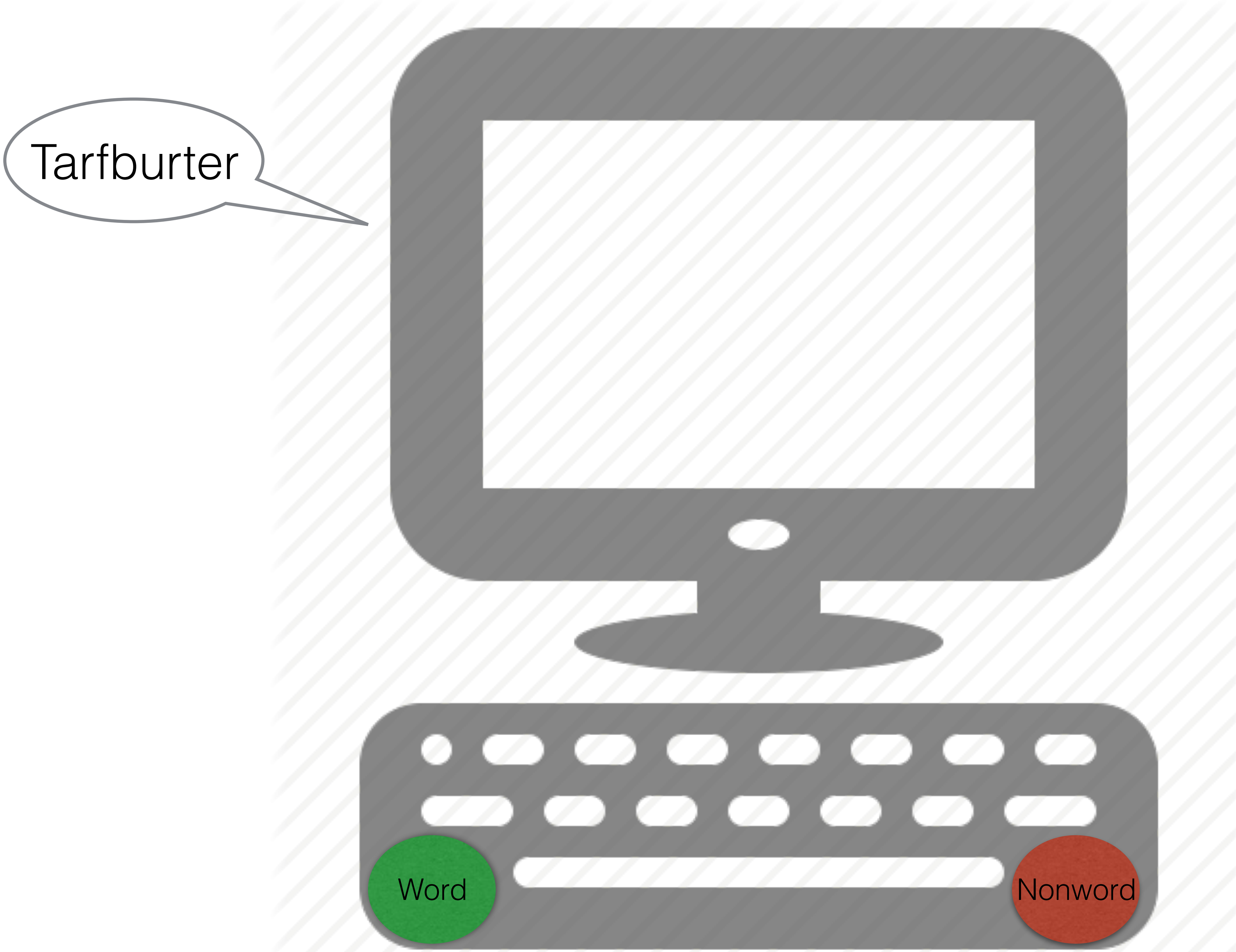
- Auditory lexical decision task

Myung et al. (2006)

Lexical Decision task



Lexical Decision task



Embodied Language Processing

Behavioural Evidence

- Auditory lexical decision task
- e.g. On “Typewriter” after the prime of “Piano” or “Blanket”
- Note typewriter is orthographically, phonetically and semantically different than both
- But the motor associations are more similar to “Piano”

Myung et al. (2006)

Embodied Language Processing

Behavioural Evidence

- Auditory lexical decision task
- e.g. On "Typewriter" after the prime of "Piano" or "Blanket"
- **Participants were quicker to respond after "Piano"**
- **Similar sensory-motor area activated, thus accessing "typewriter" easier**

Myung et al. (2006)

Embodied Language Processing

Behavioural Evidence

- Action-sentence compatibility effect (**ACE**)

Participants asked if sentences make sense

For example:

“Open the cupboard”

or

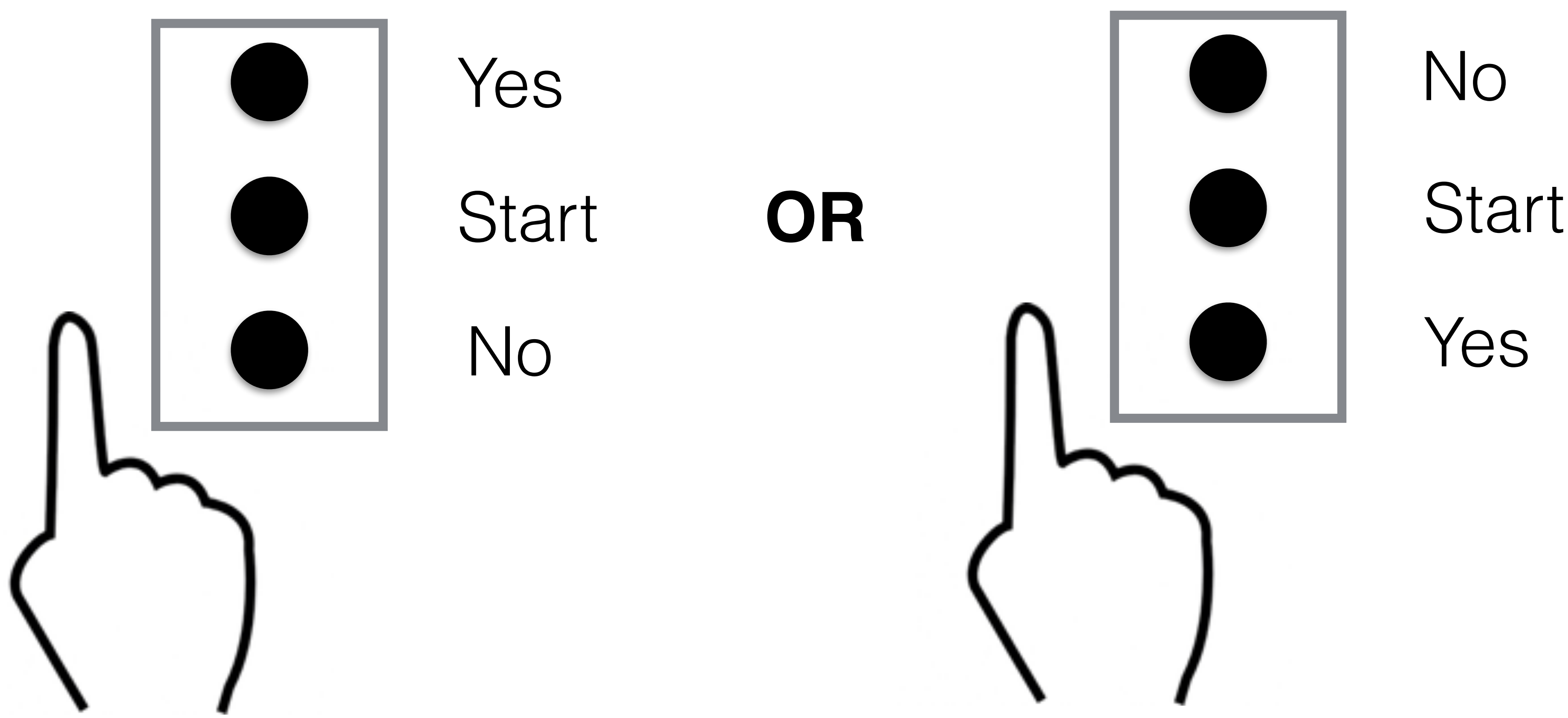
“Close the cupboard”

Glenberg & Kaschak (1998)

Embodied Language Processing

Behavioural Evidence

- Action-sentence compatibility effect (**ACE**)

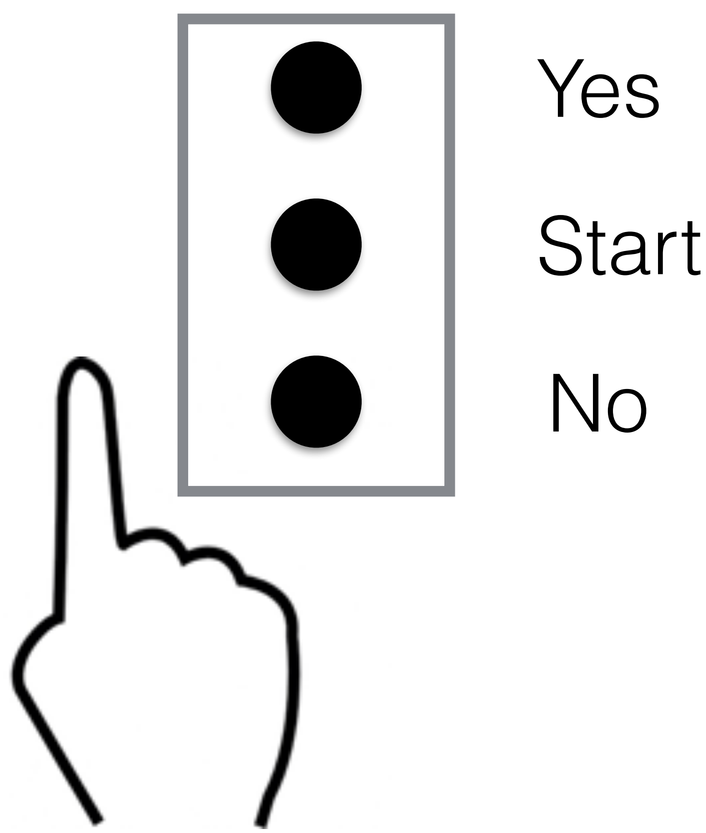


Glenberg & Kaschak (1998)

Embodied Language Processing

Behavioural Evidence

- Action-sentence compatibility effect (**ACE**)



Faster with:

“Close the cupboard”

than

“Open the cupboard”

Glenberg & Kaschak (1998)

Embodied Language Processing

Behavioural Evidence

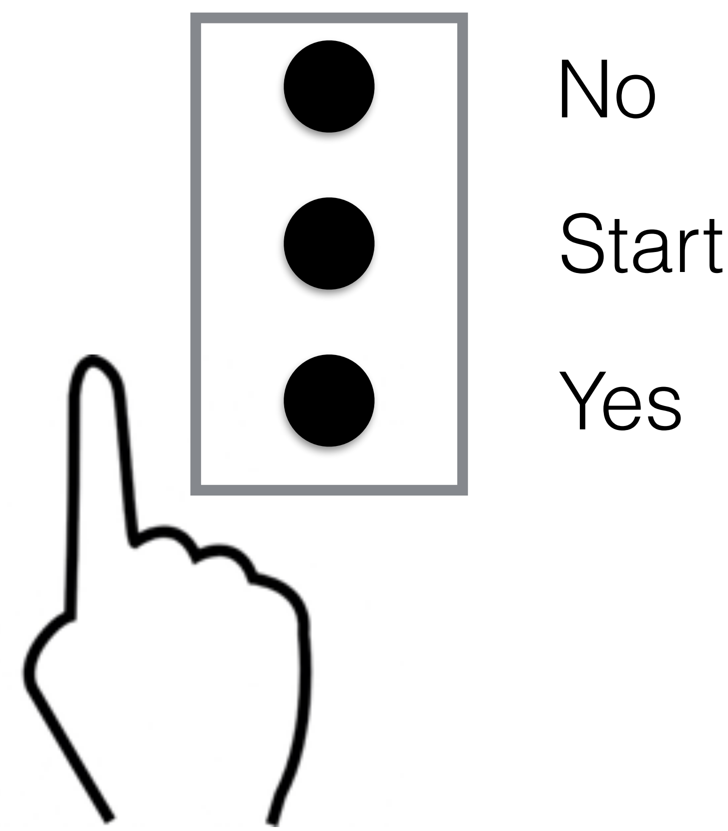
- Action-sentence compatibility effect (**ACE**)

Faster with:

“Open the cupboard”

than

“Close the cupboard”



Glenberg & Kaschak (1998)

Embodied Language Processing

Behavioural Evidence

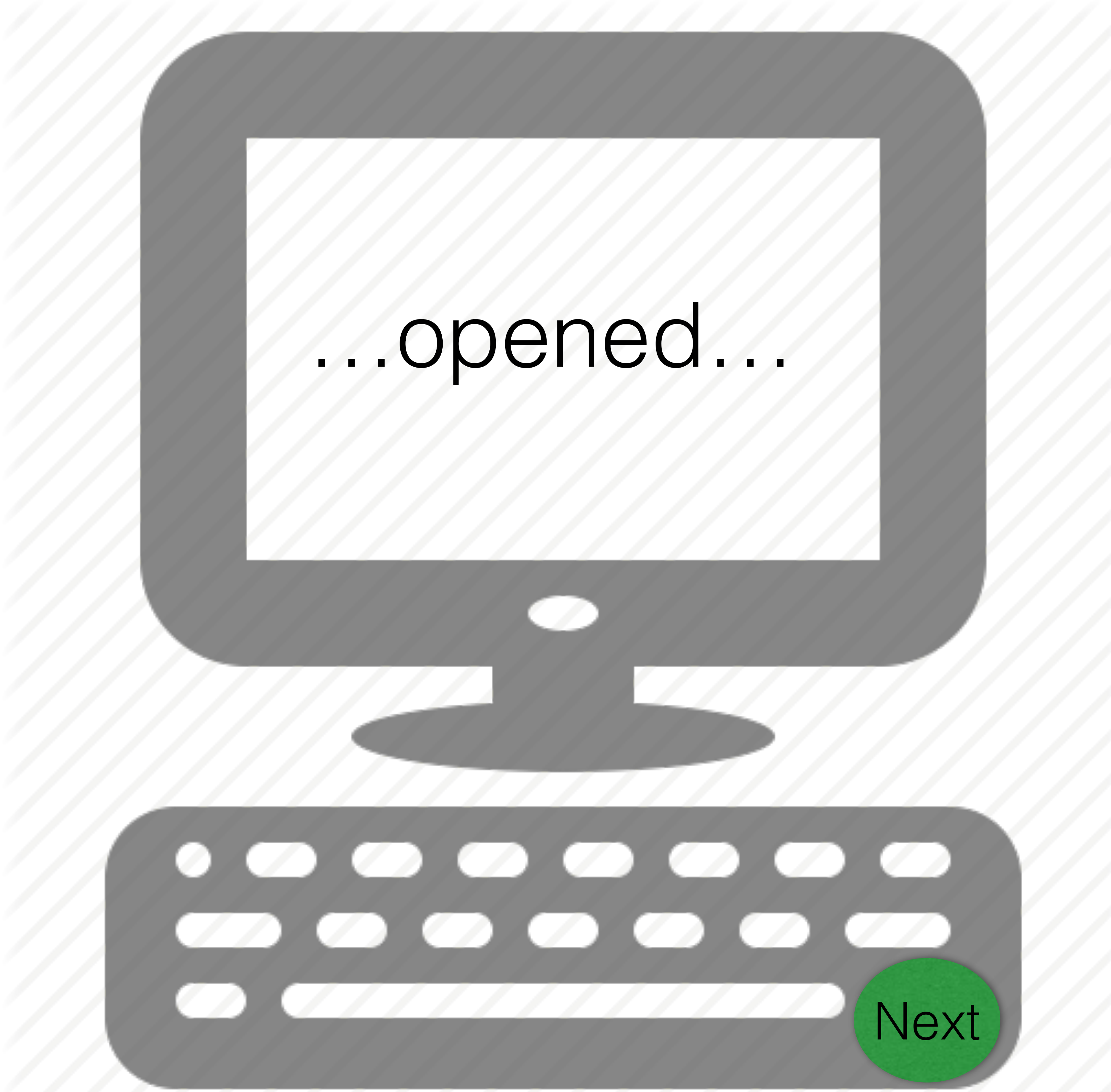
- Action-sentence compatibility effect (**ACE**)

    - Self-paced reading
    - More of an “online” measure

Zwann and Taylor (2006)

Self-paced Reading

Self-paced Reading



Self-paced Reading

Self-paced Reading

Embodied Language Processing

Behavioural Evidence

- Action-sentence compatibility effect (**ACE**)
  - Self-paced reading
  - More of an "online" measure
  - Used a volume dial

Zwann and Taylor (2006)

Embodied Language Processing

"Opened"

Zwann and Taylor (2006)

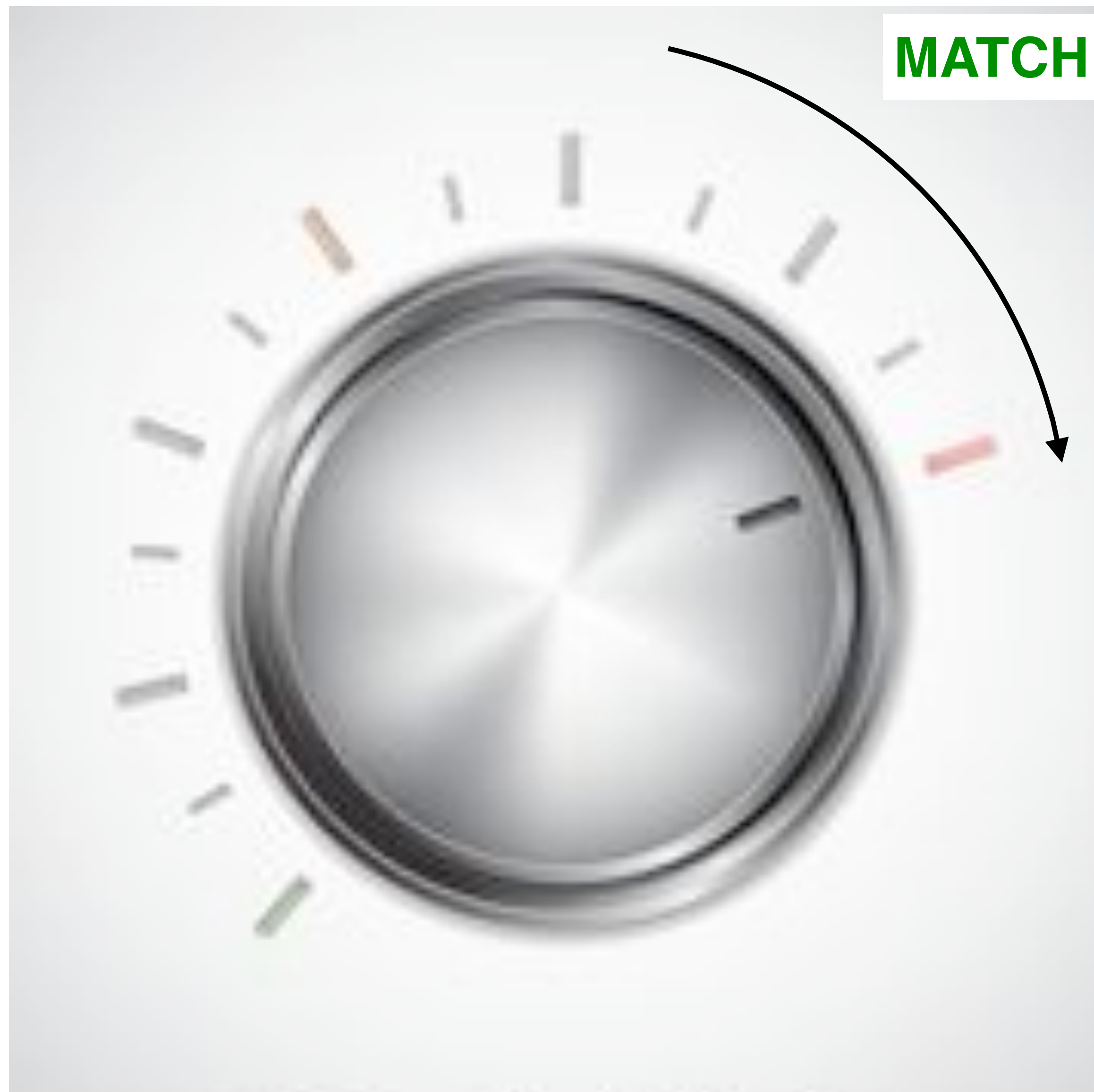
Embodied Language Processing

"Opened"

Zwann and Taylor (2006)

Embodied Language Processing

"Opened"



Zwann and Taylor (2006)

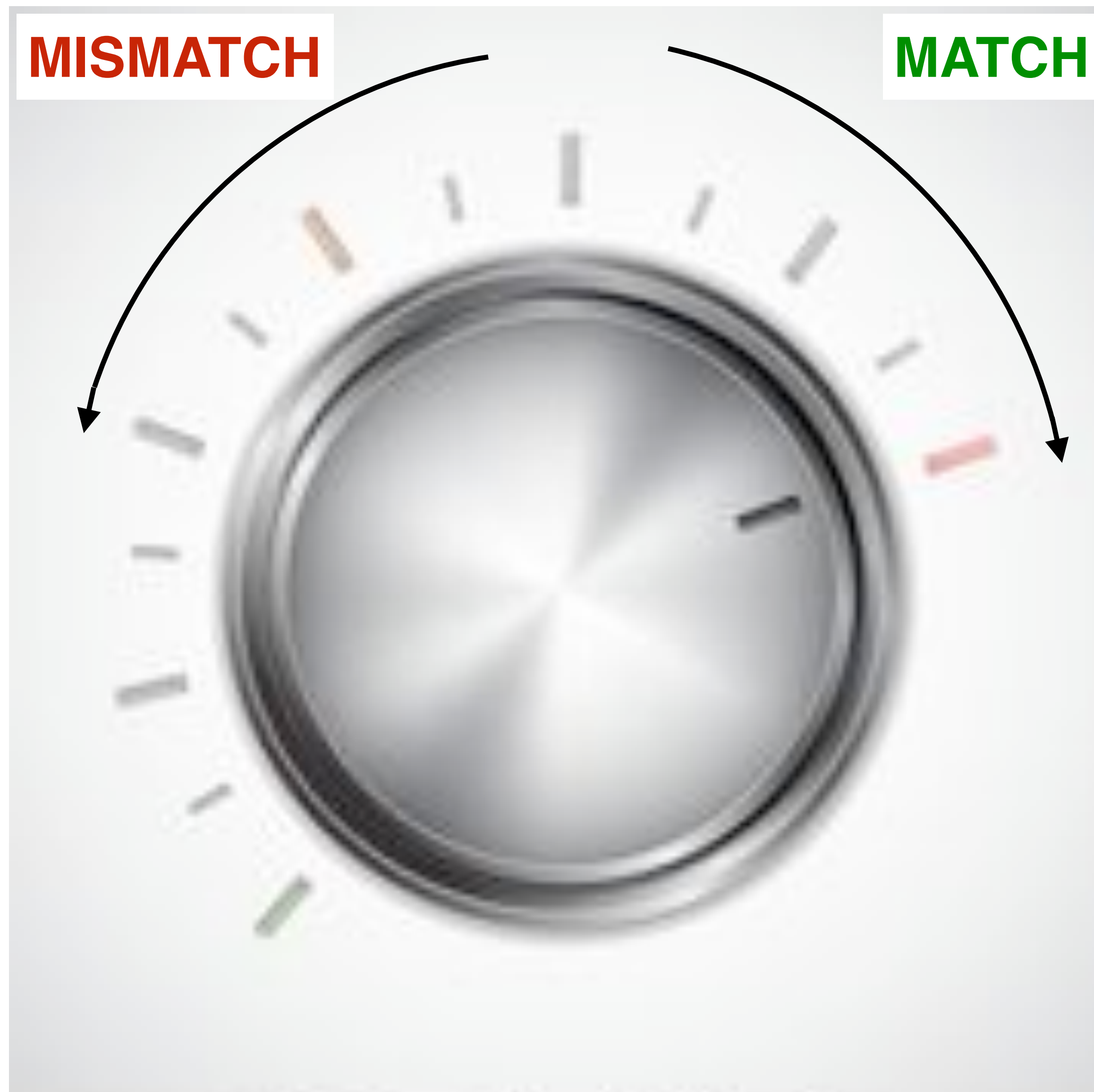
Embodied Language Processing

"Opened"

Zwann and Taylor (2006)

Embodied Language Processing

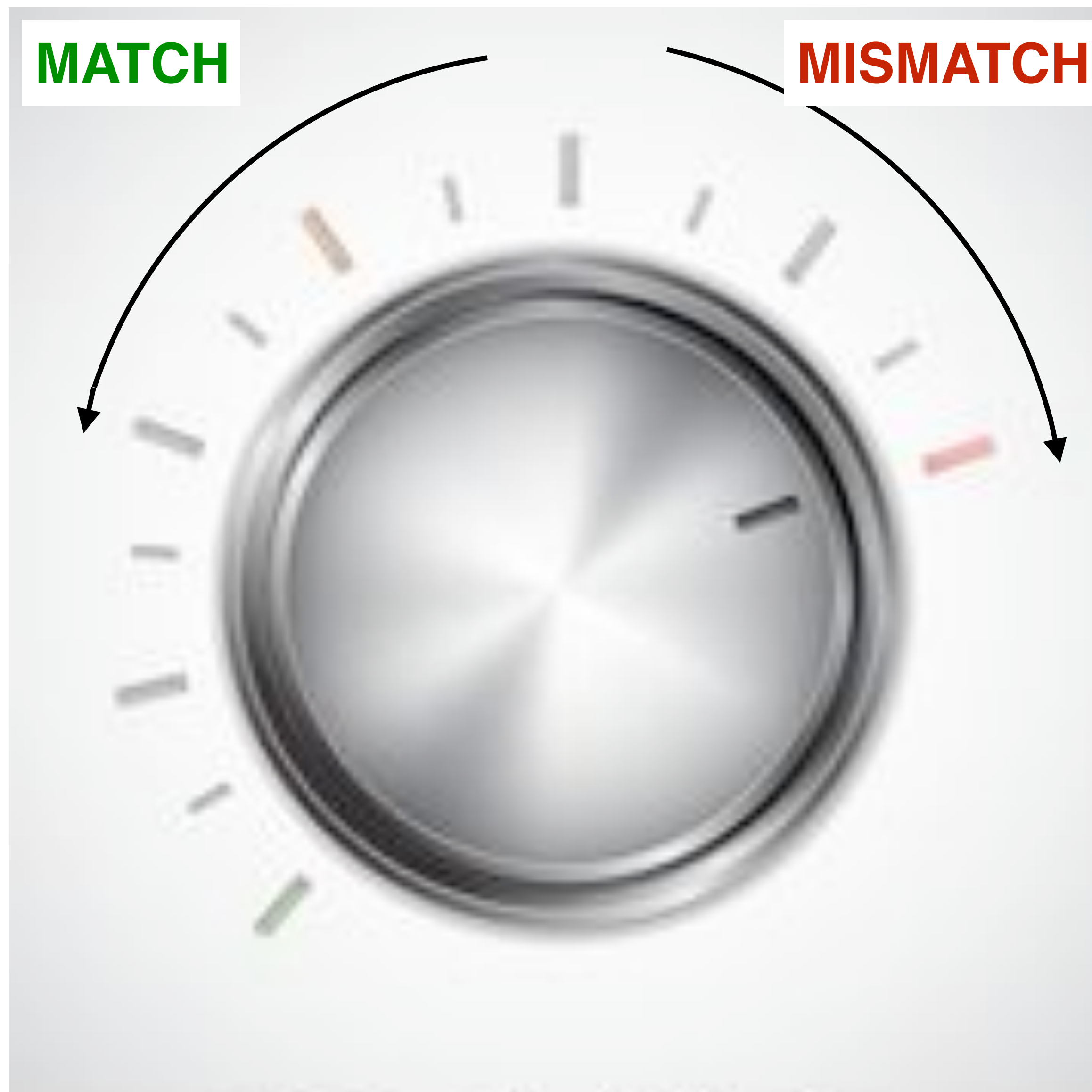
"Opened"



Zwann and Taylor (2006)

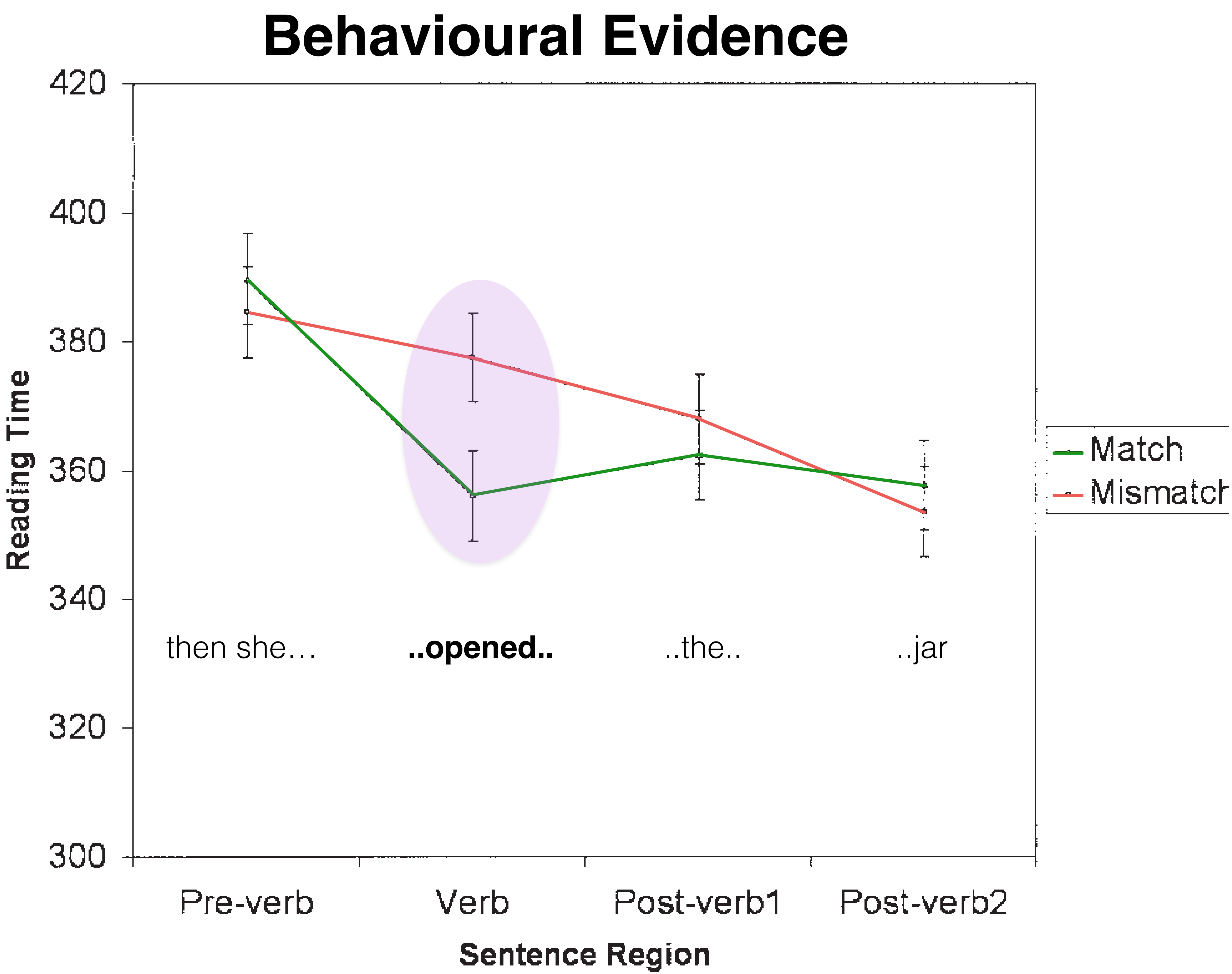
Embodied Language Processing

“Closed”



Zwann and Taylor (2006)

Embodied Language Processing



Embodied Language Processing

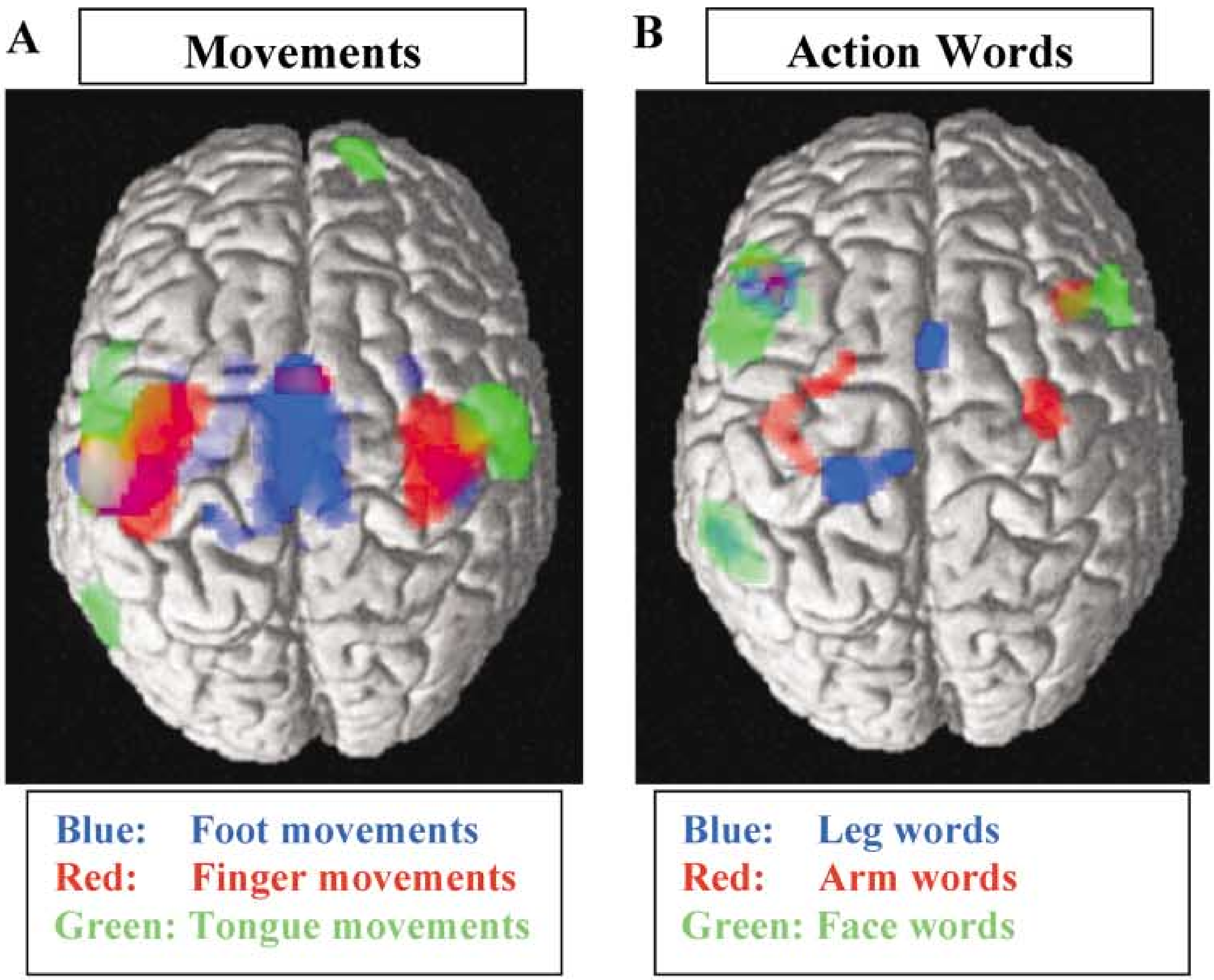
Brain imaging evidence

- fMRI study looking at haemodynamic activation
- Carried out scans during leg, arm and face movements
- Also during silent reading of leg, arm and face related words

Hauk, Johnsrude and Pulvermuller (2004)

Embodied Language Processing

Brain imaging evidence



Hauk, Johnsrude and Pulvermuller (2004)

Embodied Language Processing

Clinical population evidence

- Evidence from clinical populations can be very useful in understanding cognition and the brain
- We can infer things about function from deficits
- When considering embodiment, you should see how individuals with perceptual or motor deficits may be useful

Bak et al. (2001)

Embodied Language Processing

Clinical population evidence

- Patients with Motor Neurone Disease
- Test of the Reception of Grammar
  - Participants identify picture from word/sentence
  - Followed by reverse

Bak et al. (2001)

Embodied Language Processing

Clinical population evidence

	MND	
	Mean (SD)	Range
TROG		
Total score	54.7 (20)	30–86
Naming		
Nouns	57.5 (15.5)	35–70
Verbs	31.3 (22.9)	5–55
Comprehension		
Nouns	86.1 (12)	60–100
Verbs	62.6 (12)	50–83

All results show the percentage of correct answers.

Big deficit overall compared to Alzheimer's (95%) and control (98%) group

Bak et al. (2001)

Embodied Language Processing

Clinical population evidence

- Patients with Parkinson’s disease
- Motor disease, associated with loss of dopamine-generating cells
- Control group, Parkinson’s patients on ON phase and OFF phase of L-DOPA (dopaminergic treatment)
- Lexical Decision Task with either same-word of consonant string prime

Boulenger et al. (2008)

Embodied Language Processing

Clinical population evidence

Consonants		*Identical*	
GHSDFB	50ms	**MONKEY**	50ms
↓	150ms	↓	150ms
MONKEY	timed	**MONKEY**	timed

Boulenger et al. (2008)

Embodied Language Processing

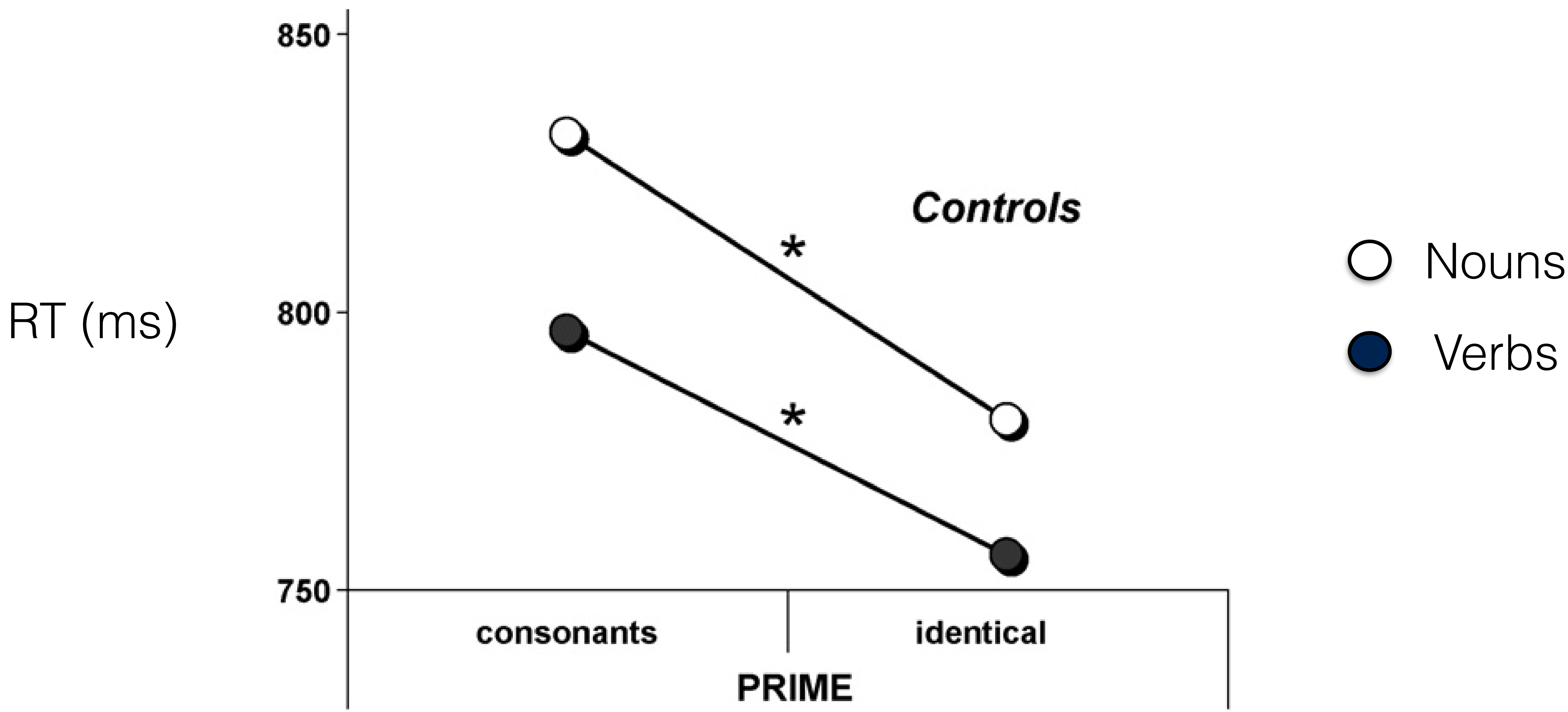
Clinical population evidence

Consonants		*Identical*	
YGSJPV	50ms	**JUMPED**	50ms
↓	150ms	↓	150ms
JUMPED	timed	**JUMPED**	timed

Boulenger et al. (2008)

Embodied Language Processing

Clinical population evidence



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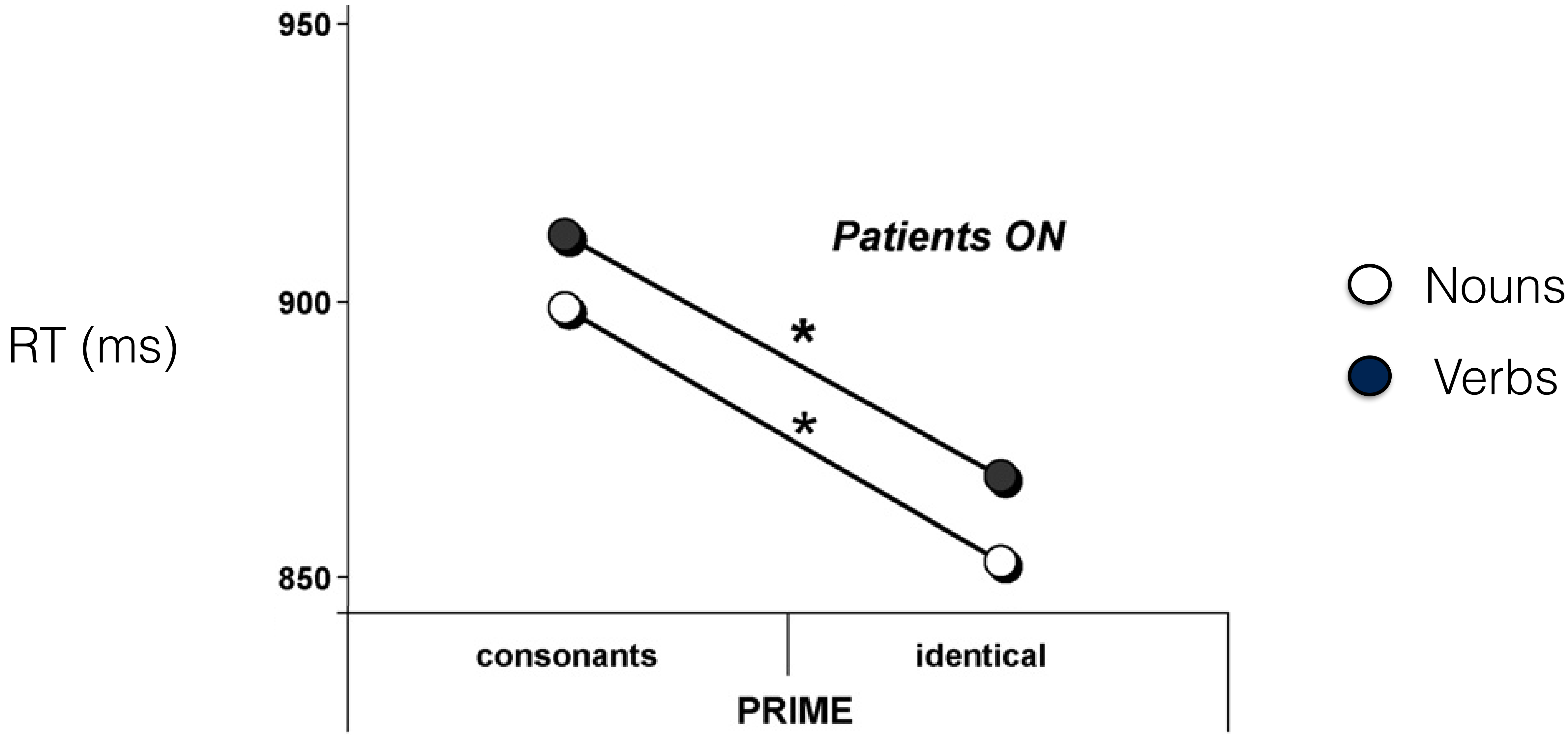
Embodied Language Processing

Clinical population evidence

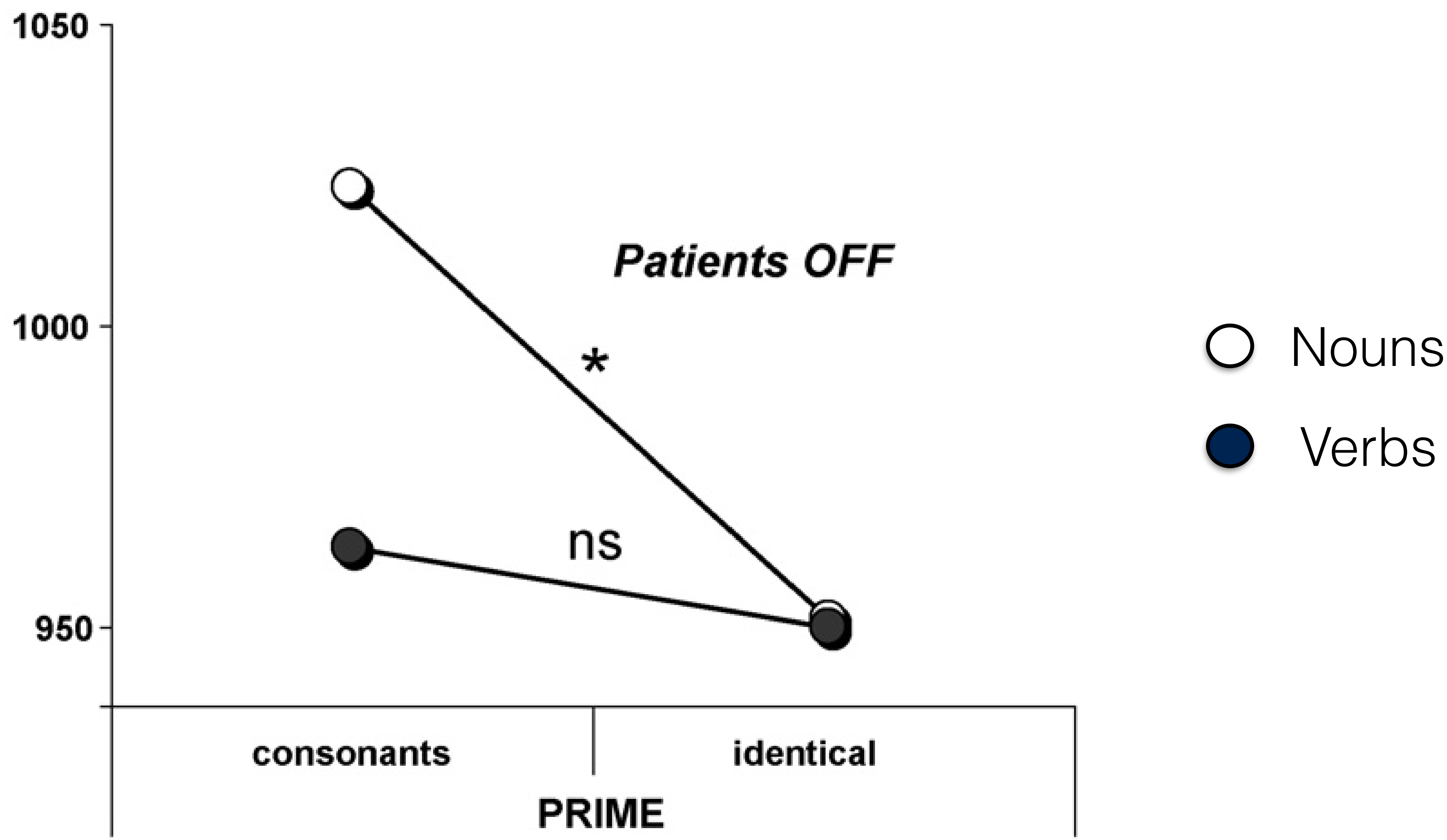


Boulenger et al. (2008)

Embodied Language Processing

Clinical population evidence

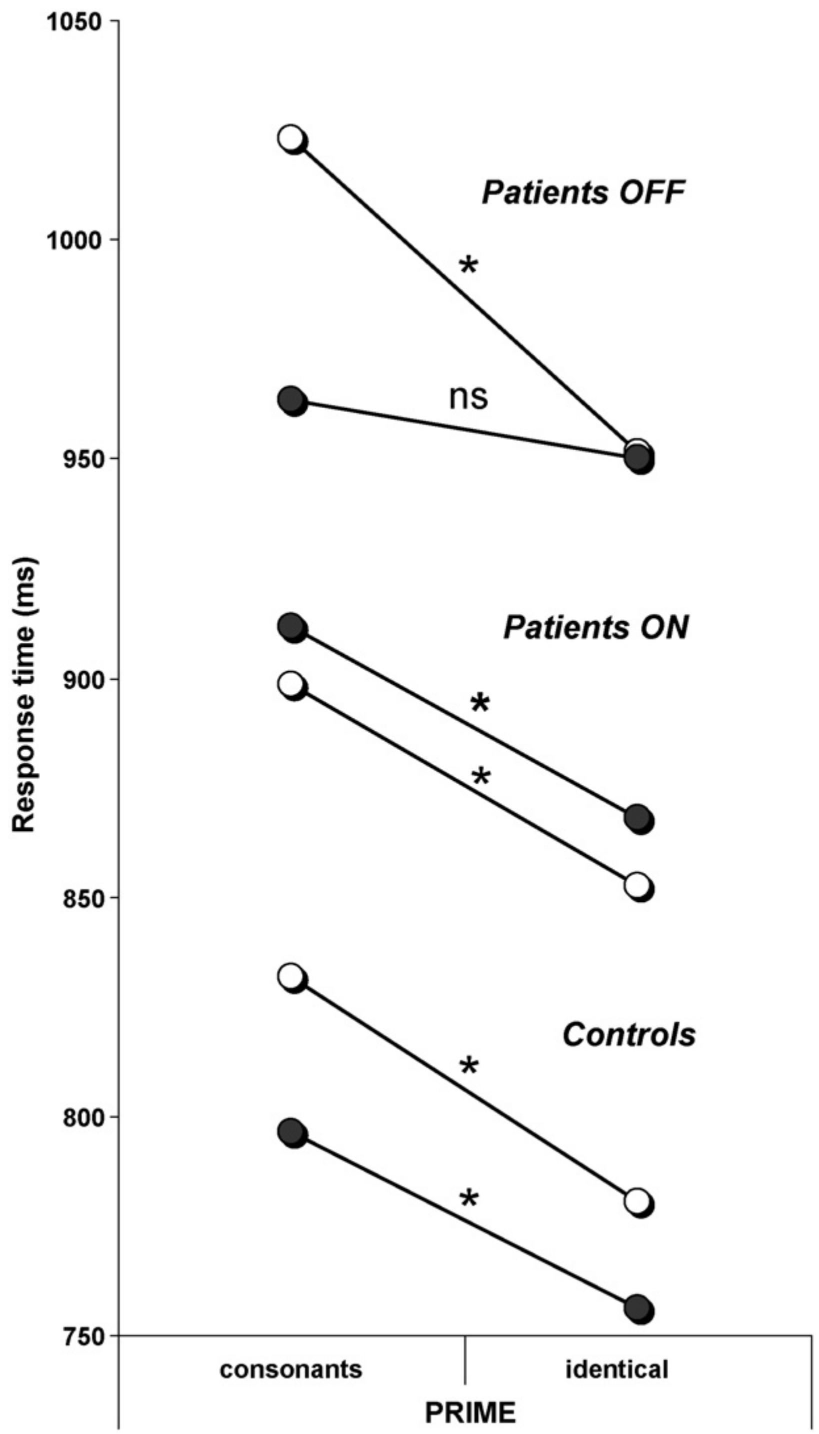
RT (ms)



Boulenger et al. (2008)

Embodied Language Processing

Clinical population evidence



- Good evidence that activation of dopamine receptors influenced word processing
- Embodied theories of language processing make sense of this
- lack of dopamine leads to problem with motor system which causes problem integrated sensorimotor factors into word recognition
- This is evident for verbs in particular, supporting MND findings
- Action words more embodied?

Boulanger et al. (2008)

Embodied Language Processing

Clinical population evidence

Production task

Control and Parkinson's groups

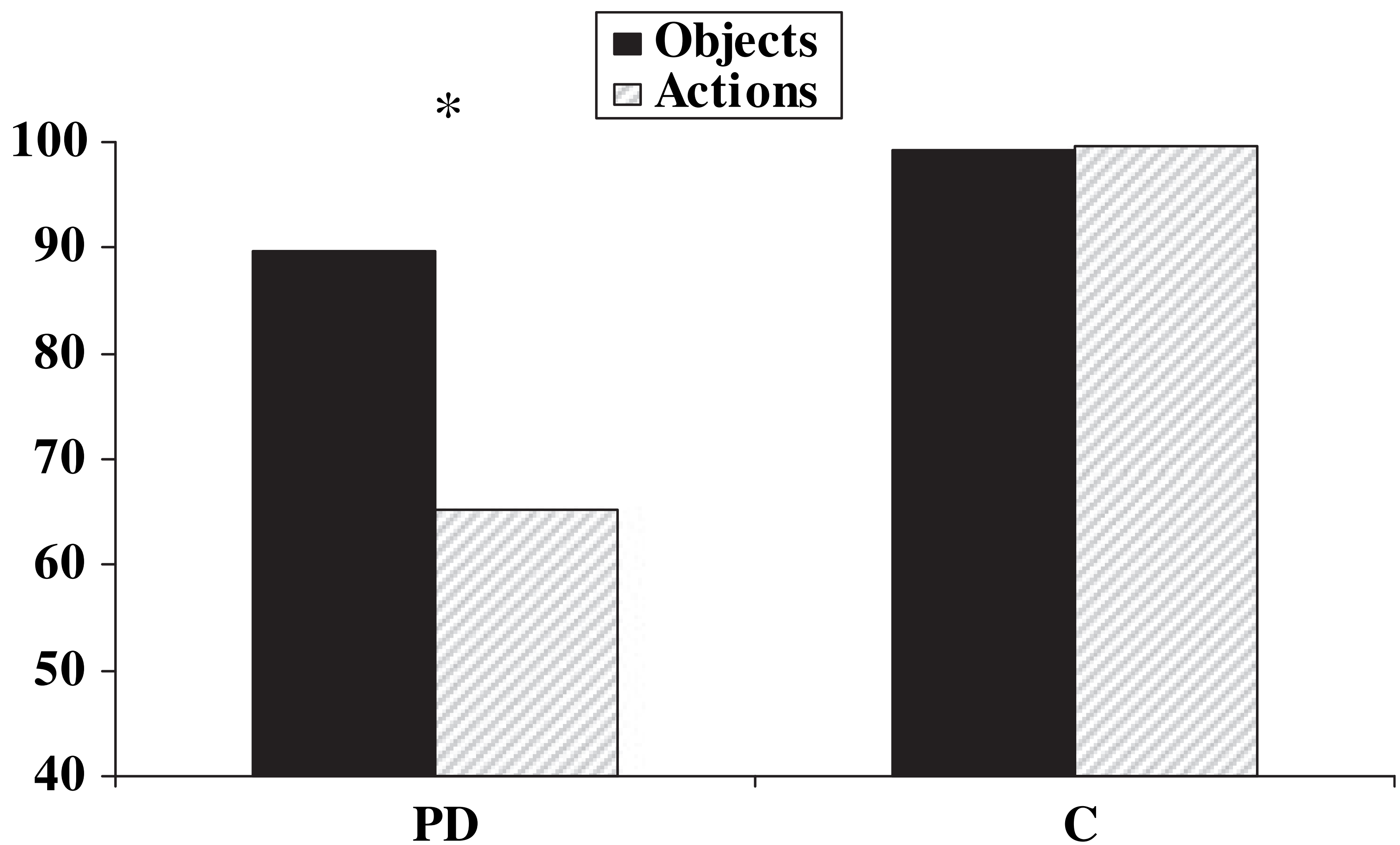
Had to name pictures of either objects or actions

Cotelli et al. (2007)

Embodied Language Processing

Clinical population evidence

Production task



Cotelli et al. (2007)

Embodied Language Processing

Clinical population evidence

Production task

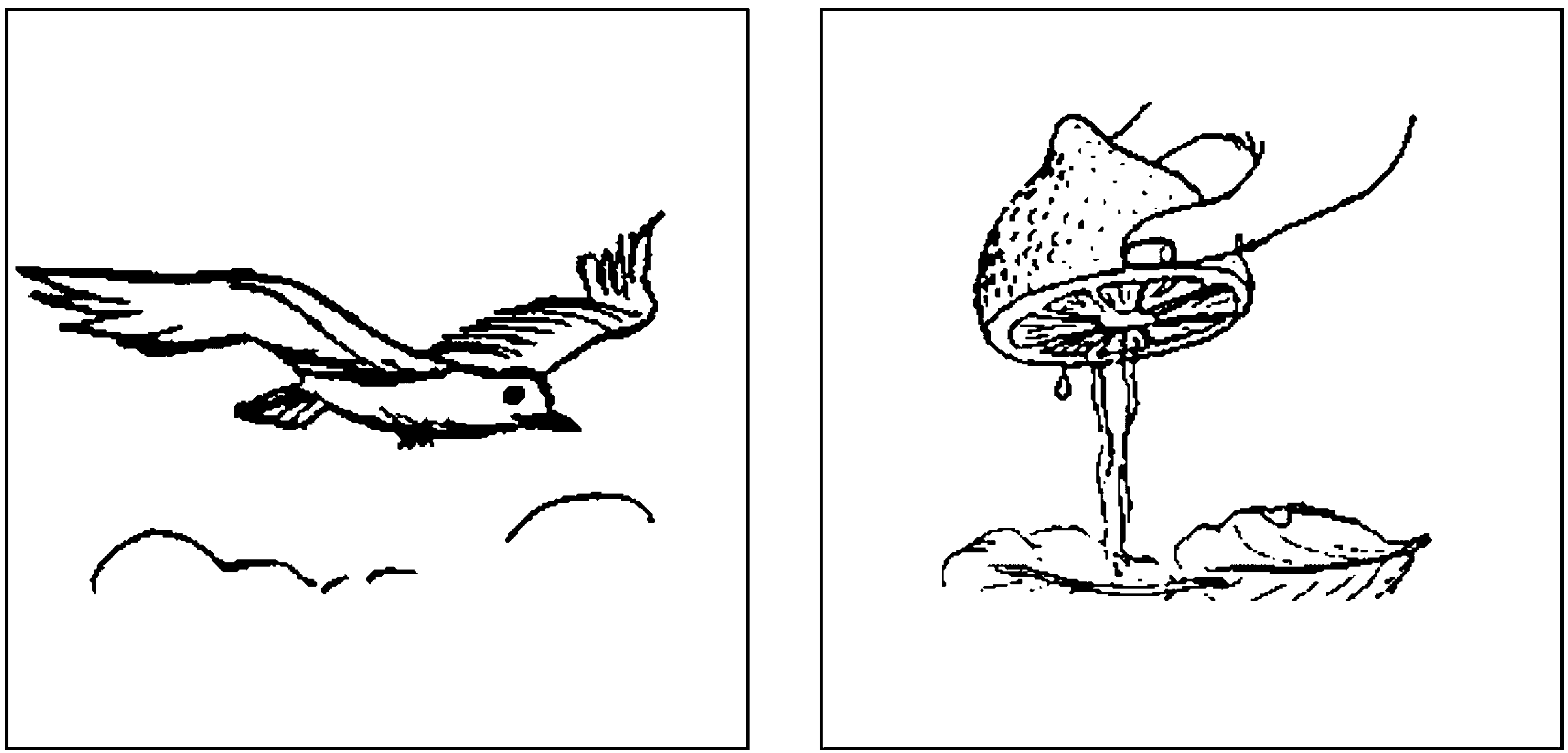


Figure 1 Examples of manipulable and non-manipulable actions.

Cotelli et al. (2007)

Embodied Language Processing

Clinical population evidence

We have evidence here of motor involvement in language processing

But if cognition (and hence language) are body-based, shouldn't we also see effects on nouns?

or are some more embodied than others?

Against Embodiment

We talked about this last time:

- What do push and hammer make you think of?

- What about contemplate and sophisticated?

If sensorimotor factors are required for grounding to work, how do abstract concepts work?

Against Embodiment

If sensorimotor factors are required for grounding to work, how do abstract concepts work?

Some argue that is is where embodied theories fall down (Mahon & Caramazza, 2008)

A theory that can't account for a huge number of words would require two mechanisms for word processing, one with sensorimotor, one without.

Dealing with abstract terms

Theoretically, abstract concepts could be “grounded” in concrete concepts.

Lakoff’s (1992) theory of metaphor argues for this approach to metaphors.

Something that can’t be handled, such as “time” is conceptualised (and hence verbalised) as if it had properties of something concrete (like distance).

“Christmas is so **far away**!”

Could this help with embodied theories?

Dealing with abstract terms

Could this help with embodied theories?

Examples:

More is up, less is down
Linear scales are paths
Passing time is motion
Mental/emotional states as locations
Awareness/Knowledge is light
Confusion/ignorance is dark
Happiness/excitement is bright
sadness/boredom is dull
Love is warmth

Could what we'd normally call associations actually be vital sensorimotor aspects of understanding?

Dealing with abstract terms

Could this help with embodied theories?

Could what we'd normally call associations actually be vital sensorimotor aspects of understanding?

Little evidence in favour of these abstract terms - perhaps future research

Then again, no real evidence of a mechanism for transduction from perceptual to amodal representations in the classic view of cognition

But, it is perhaps clear to many of you, that some associations and weaker than others

And some may have none

Dealing with abstract terms

Could this help with embodied theories?

A theory that can't account for a huge number of words would require two mechanisms for word processing, one with sensorimotor, one without.

Dealing with abstract terms

Concrete VS Abstract?

Or could it be more of a continuum?

Connell & Lynott (2009, 2012)

Dealing with abstract terms

Perceptual strength

Distinct from concreteness

Connell & Lynott (2009, 2012)

Dealing with abstract terms

Perceptual strength

“to what extent do you experience something being WORD?”

‘‘to what extent do you experience WORD?”

Rating out of 5 for all senses

Connell & Lynott (2009, 2012)

Dealing with abstract terms

Perceptual strength

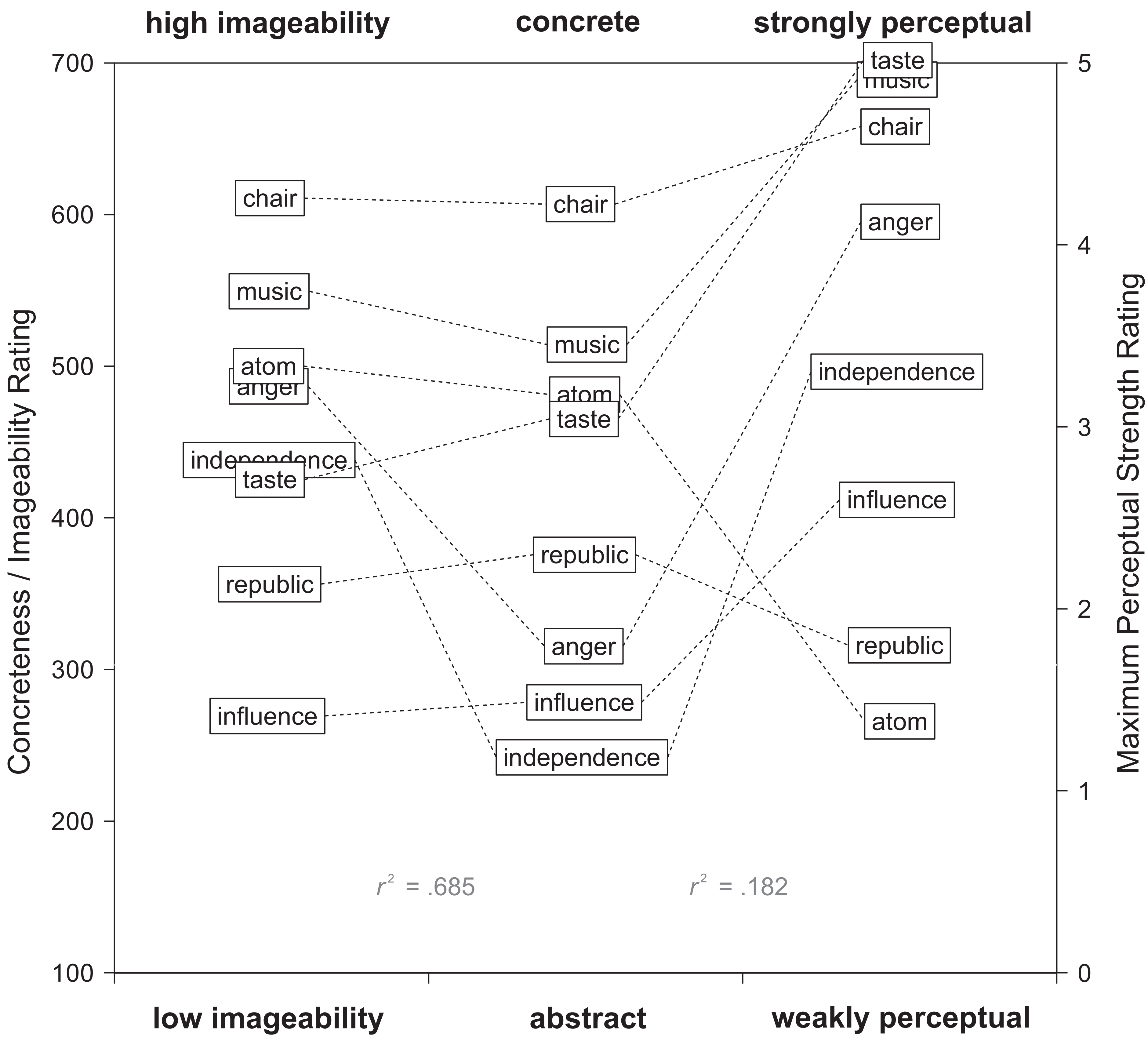
Table 1
Sample words, used in Studies 1 and 2, for which perceptual strength matches or mismatches ratings of concreteness and imageability.

Word	Perceptual strength					Concreteness	Imageability
	Auditory	Gustatory	Haptic	Olfactory	Visual		
Strongly perceptual, high concreteness/imageability							
Hen	3.53	1.12	2.35	1.47	3.82	631	597
Soap	0.35	1.29	4.12	4.00	4.06	589	600
Yellow	0.15	0.05	0.00	0.05	4.90	518	597
Strongly perceptual, low concreteness/imageability							
Fear	2.18	0.71	1.88	0.82	3.47	326	394
Noisy	4.95	0.05	0.29	0.05	1.67	293	138
Quality	3.06	3.41	4.06	3.12	4.29	274	349
Weakly perceptual, high concreteness/imageability							
Air	1.06	1.47	2.12	2.53	1.35	581	450
Atom	1.00	0.63	0.94	0.50	1.38	481	499
Hell	2.47	0.24	1.06	0.71	1.24	355	519
Weakly perceptual, low concreteness/imageability							
Aspect	1.88	0.50	0.80	1.00	2.38	217	233
Factor	1.31	0.38	0.31	0.06	1.88	328	269
Republic	0.53	0.67	0.27	0.07	1.79	376	356

Note: perceptual strength ratings range from 0 to 5, concreteness and imageability ratings range from 100 to 700.

Connell & Lynott (2009, 2012)

Dealing with abstract terms



Dealing with abstract terms

Perceptual strength

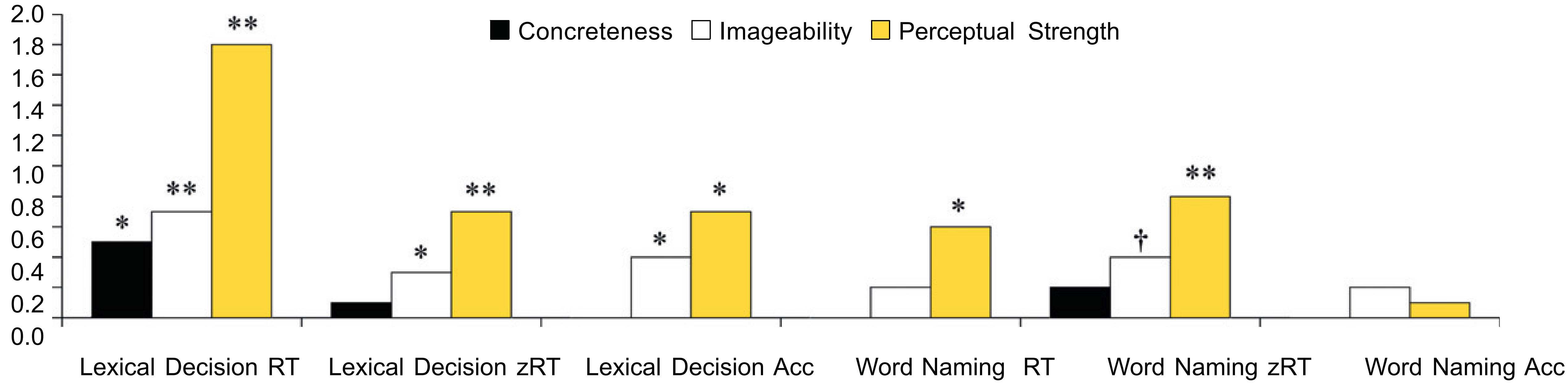


Fig. 4. Simple effects of each predictor in Study 2, showing proportion of explained variance (R^2 change in %) of Elexicon reaction time and accuracy data, over and above a basic model of contextual diversity, word length in letters, and number of syllables ($^{\dagger}p < .1$, $^{*}p < .05$, $^{**}p < .01$). Flatline bars (e.g., concreteness in naming RT) represent 0% contribution.

Connell & Lynott (2009, 2012)

Dealing with abstract terms

Perceptual strength

So, perceptual strength seems a better indicator of speed and accuracy than "concreteness"

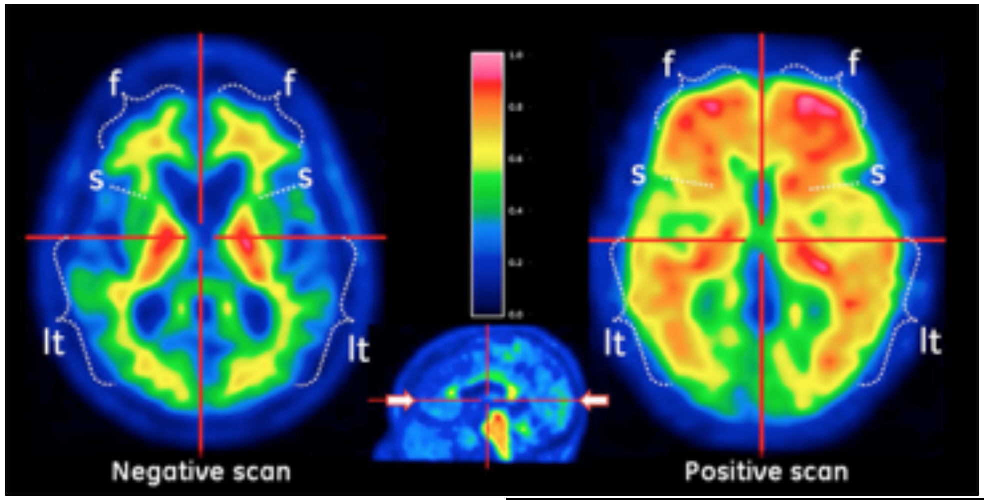
A sign that perceptual embodiment is influencing processing across all words, but to varying degrees.

Not essential, but always a factor.

Connell & Lynott (2009, 2012)

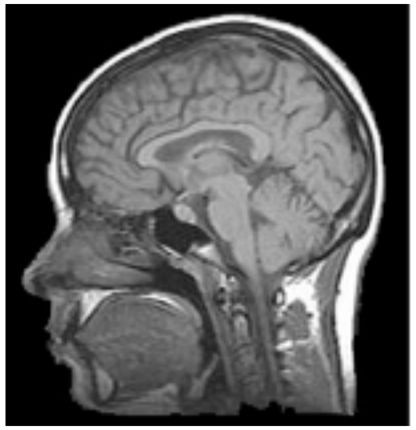
Against Embodiment

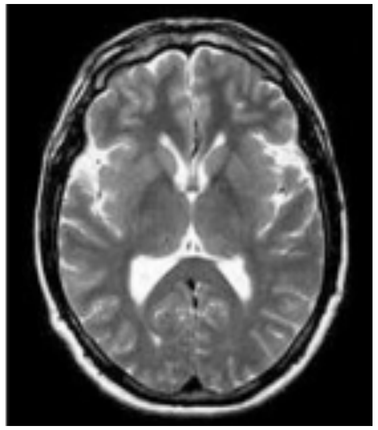
Is the brain imaging evidence all it's cracked up to be?

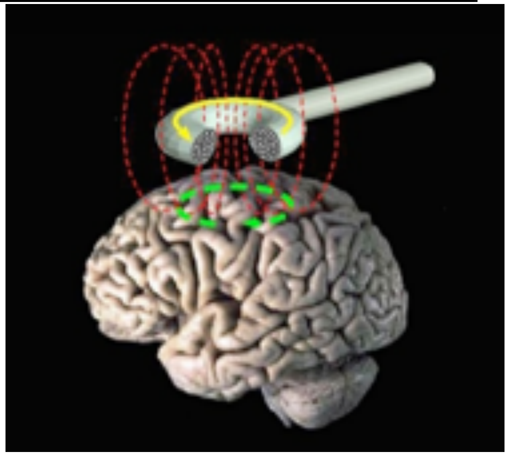


I've shown some intriguing examples so far

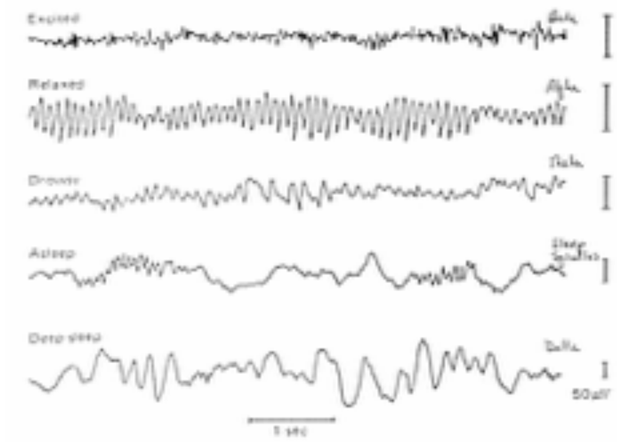
But there are varying methods, measures and standards used in brain imaging







Add to that variance in conclusions (Watson et al. 2013; Bedny et al., 2008)



Against Embodiment

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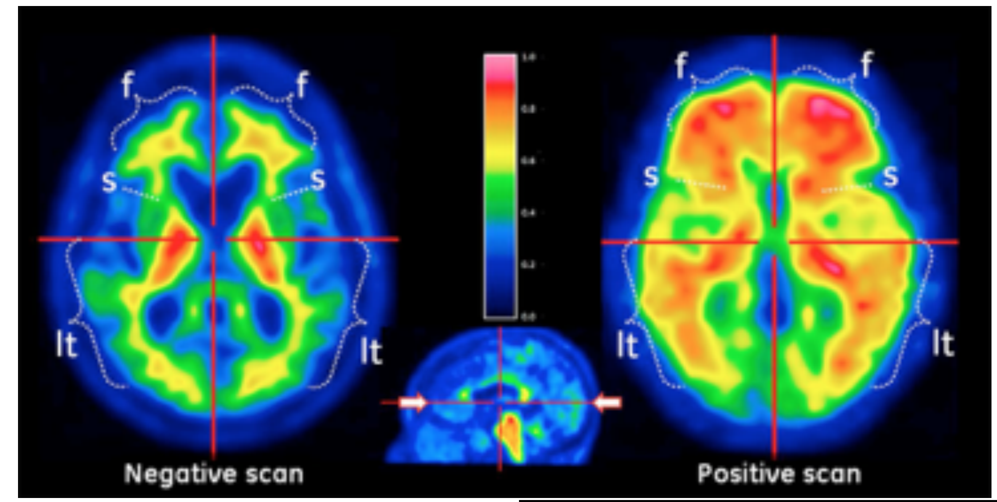
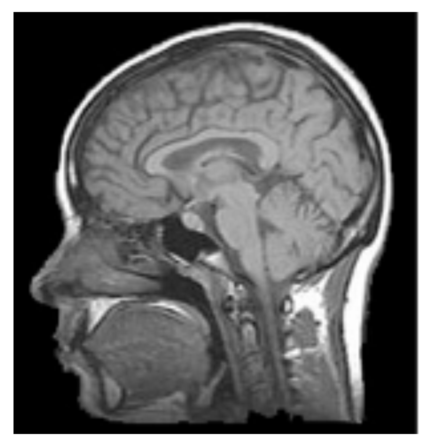
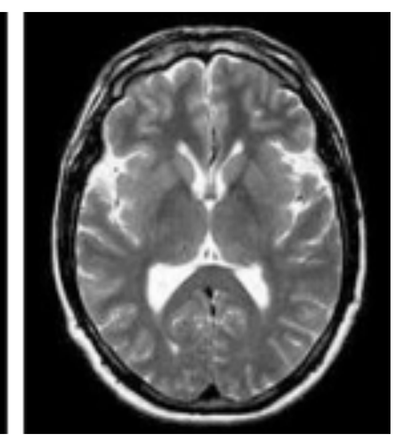
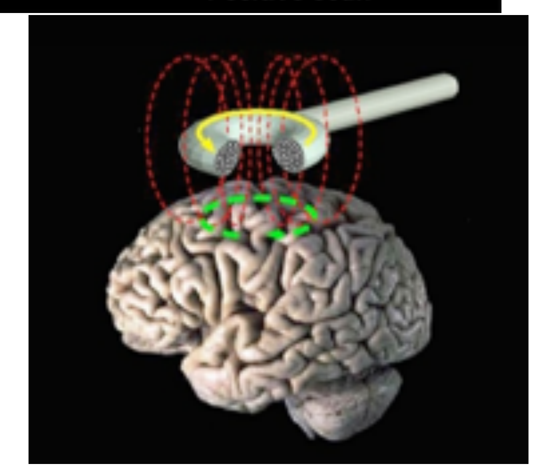


BUT

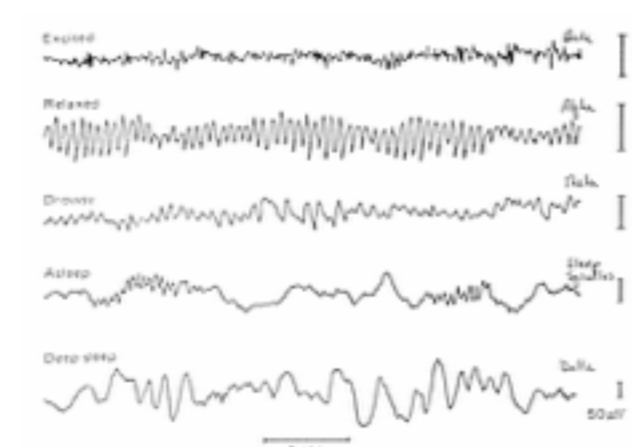






The behavioural evidence of sensorimotor and language is strong

Add to that the clinical populations studies



Against Embodiment

So, do the behavioural findings mean what we think?

We have seen lots of behavioural evidence for embodied language processing

But can these be accounted for by disembodied theories (amodal theories)?

Some argue (Caramazza, 2014) that an amodal concept could have associative sensorimotor influences after the concept is retrieved

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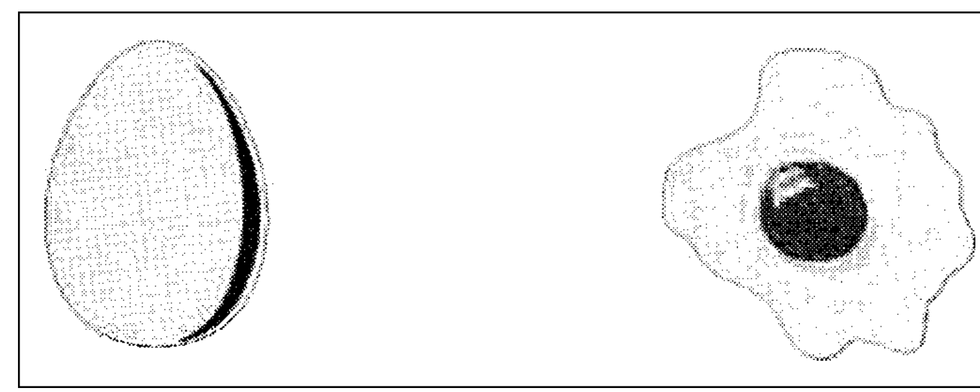
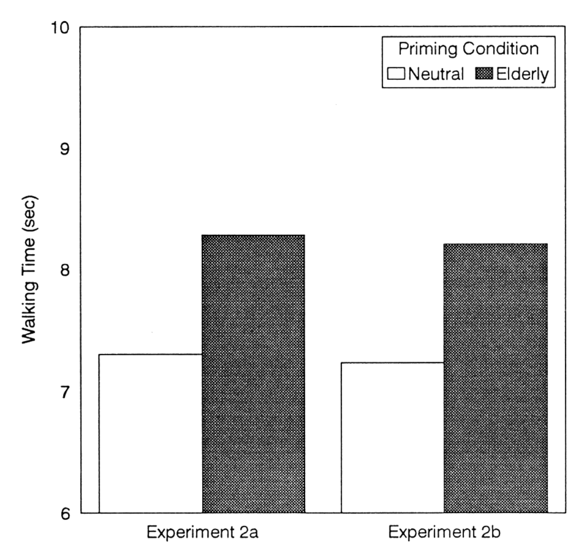
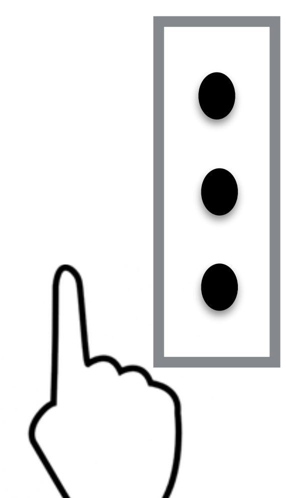
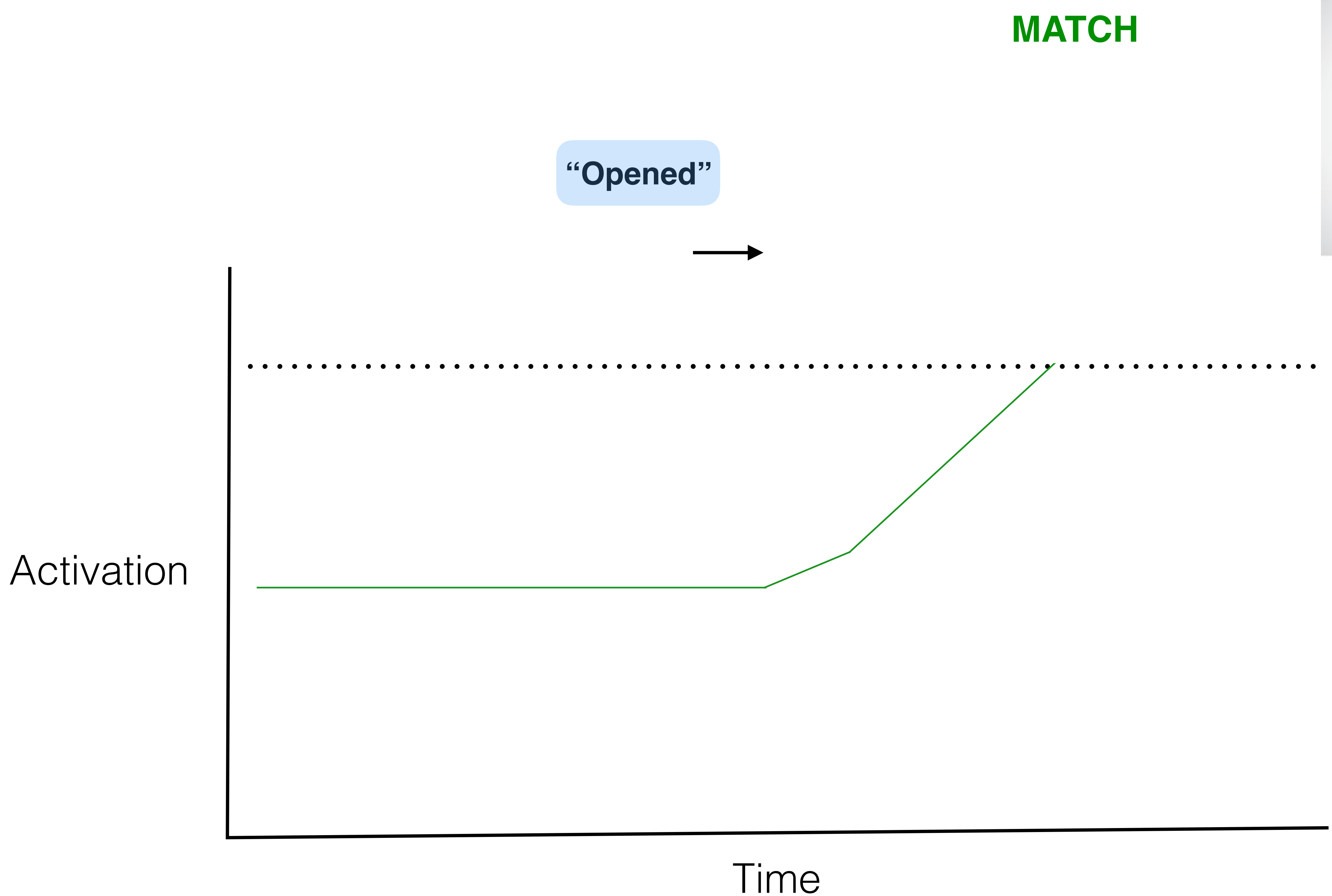






Against Embodiment

So, do the associations mean what we think?



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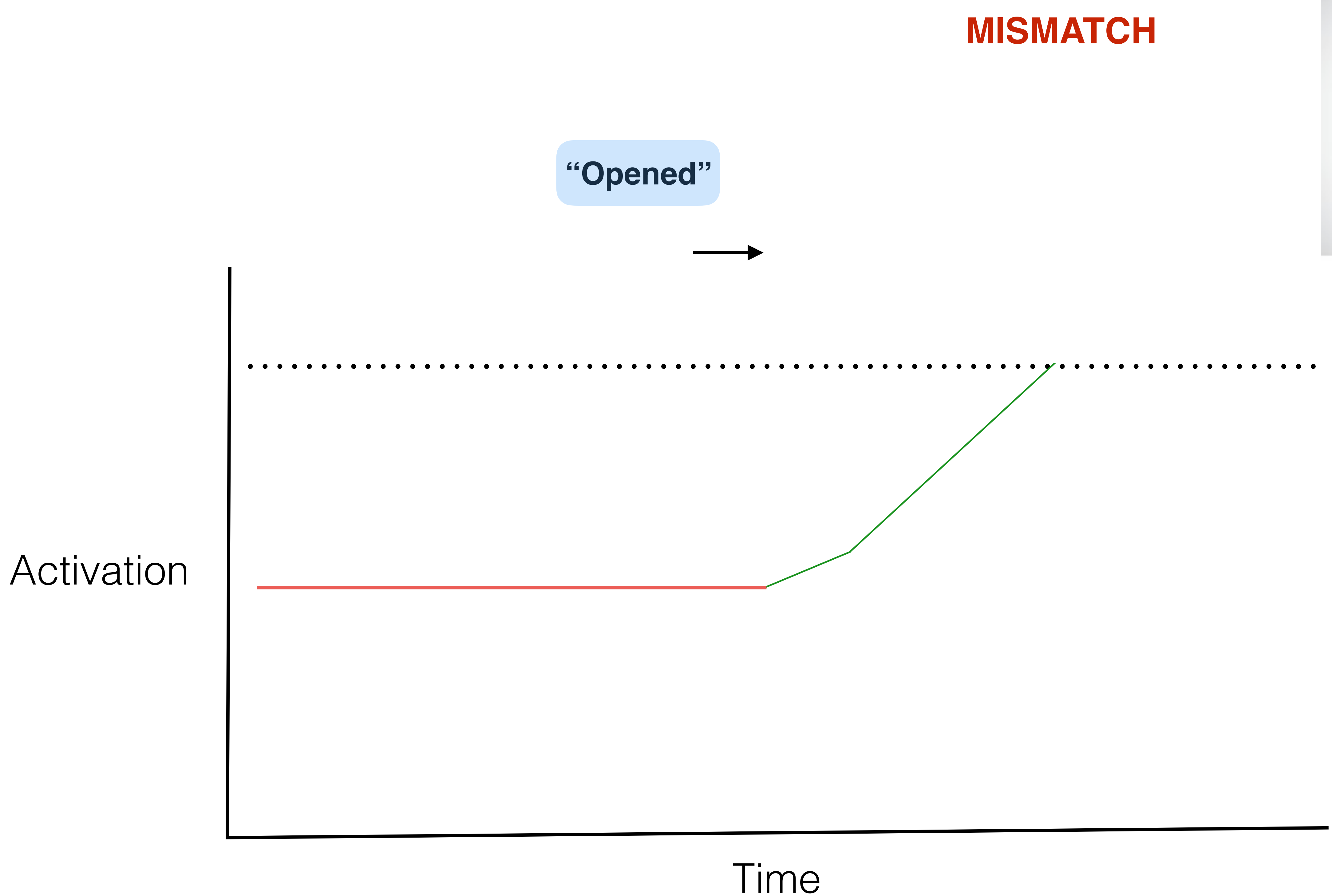

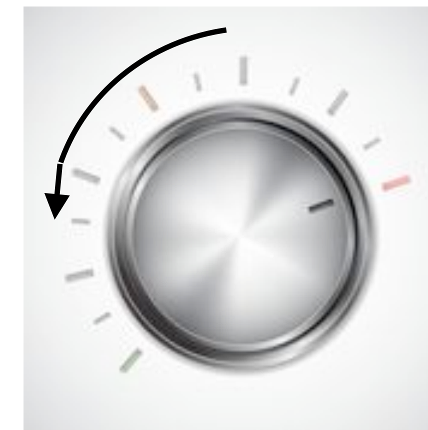

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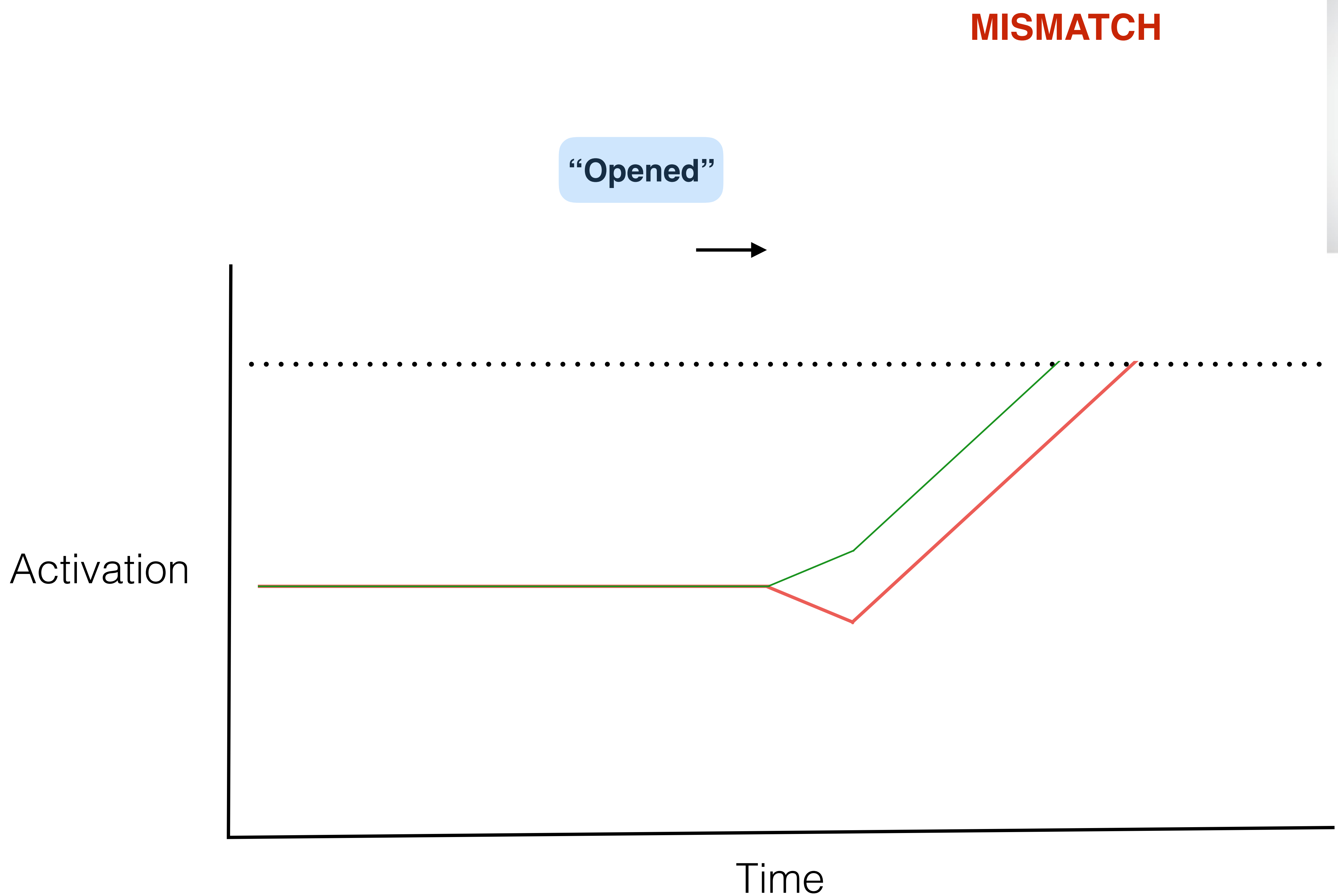
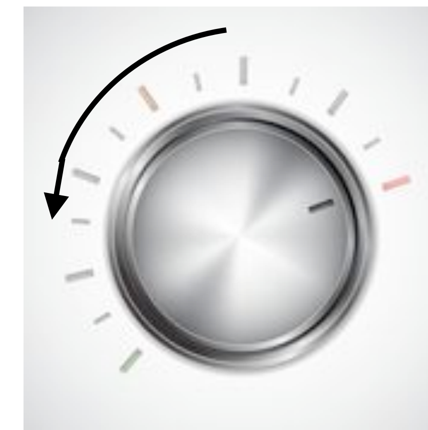
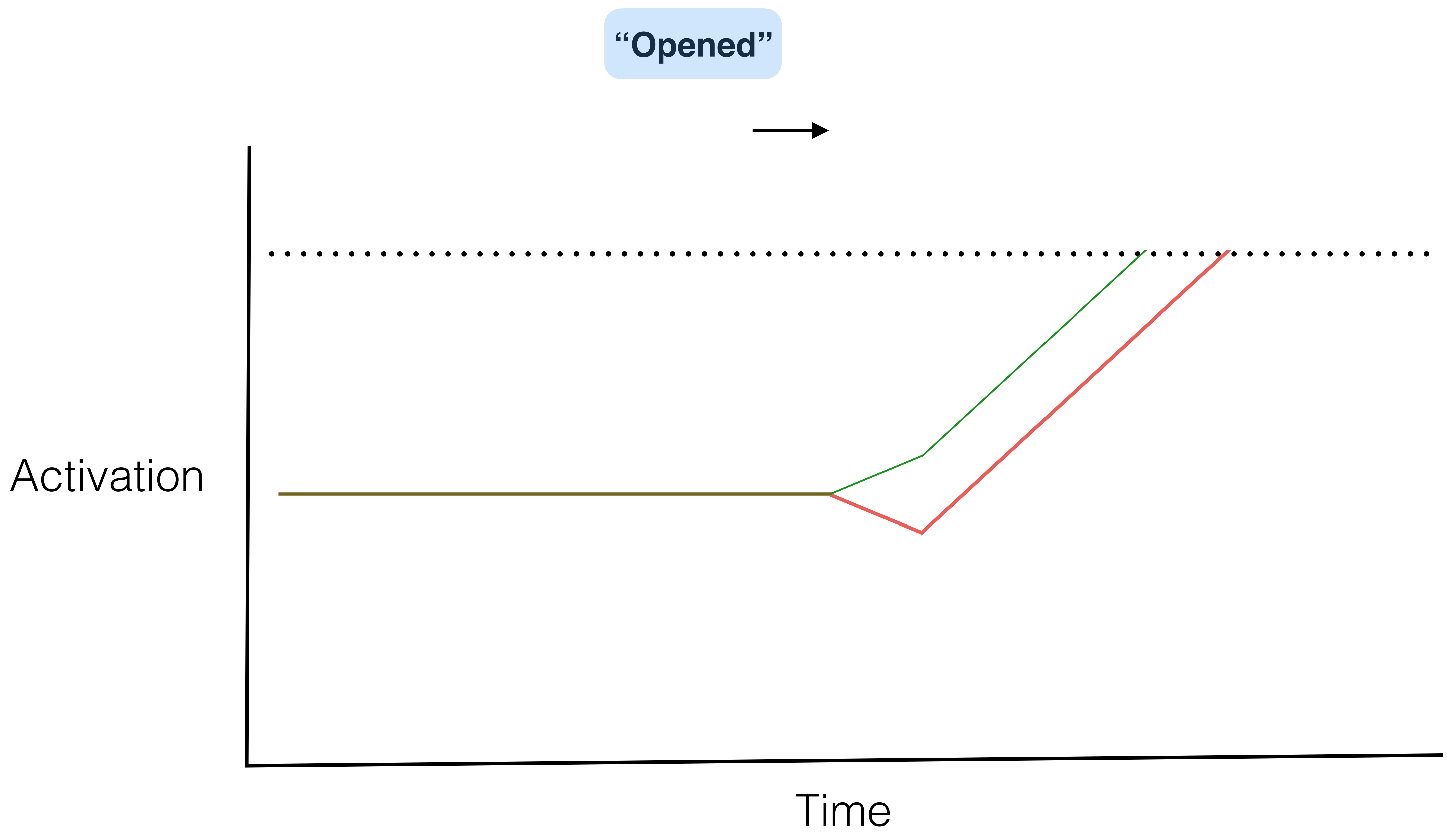




Against Embodiment



Cognition for Action and Amodal account

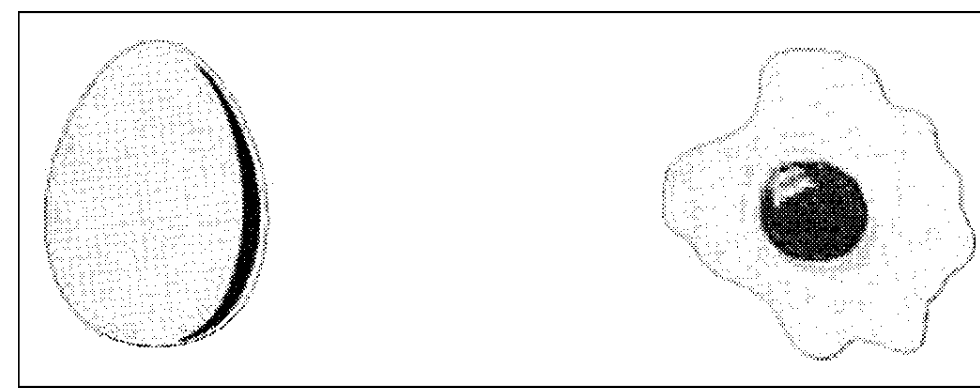
Against Embodiment

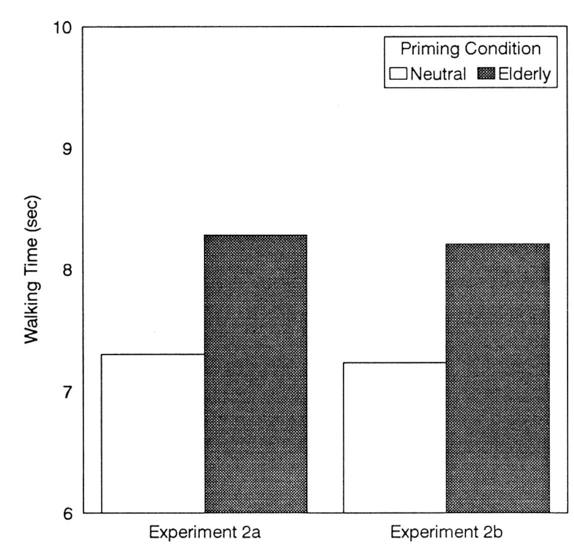
So, do the associations mean what we think?

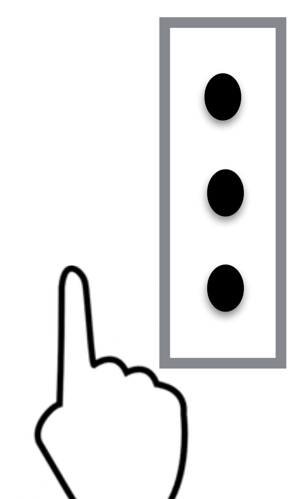
Perhaps a stronger threshold of evidence required

But even if we decided on amodal - why?

Symbol grounding problem still an issue







Amodal Vs. Embodied

Is there middle ground?

Most researchers don’t go “full embodied”

Supporters of amodal processing mostly accept sensorimotor influence - just not at conceptual level.

Danger of arguing against extremes

Amodal Vs. Embodied

Is there middle ground?

Barsalou (2008),
Lowers & Connell (2011)

Two streams for concepts: superficial linguistic (amodal) and simulation (embodied)

Taylor & Zwann, (2009)

Sensorimotor important, but non sensorimotor system also can make up for this

Barsalou (2016)
Solve abstraction by:
Multimodal compression

Mahon & Carramazza (2008)

Core concepts are amodal and (arbitrarily) symbolic

sensorimotor used to enrich and facilitate meaning

It looks like these ideas are converging

Amodal Vs. Embodied

Is there middle ground?

It looks like these ideas are converging

- Sensorimotor factors are clearly important in language processing
- Are they a core component of our concepts?
- or are they supportive?

Overview

- Traditional Cognition
- Cognition for action
    - Theoretical basis
    - Supporting evidence
    - Problems with this concept
- Body-based cognition
    - Symbol grounding problem
    - Perceptual symbol systems
    - Behavioural evidence
    - Brain imaging evidence
    - Evidence from clinical populations
- Problems with embodiment
    - Abstract concepts
    - brain imaging data
    - Alternative explanations of phenomena
- Middle ground approaches
    - sensorimotor important
    - but one of a number of factors
    - helpful or core to forming concepts?

References

Bak, T. H., O'Donovan, D. G., Xuereb, J. H., Boniface, S., & Hodges, J. R. (2001). Selective impairment of verb processing associated with pathological changes in Brodmann areas 44 and 45 in the motor neurone-dementia-aphasia syndrome, *Brain*, **124**, 103-120

Barsalou, L.W. (2008). Grounded cognition. *Annual Review of Psychology*, **59**, 617-645.

Barsalou, L.W. (2016). On staying grounded and avoiding Quixotic dead ends, *Psychonomic Bulletin & Review* **[e-publication ahead of print]**

Bedny M., Caramazza A., Grossman E, Pascual-Leone A., Saxe R. (2008). Concepts are more than percepts: the case of action verbs. *The Journal of Neuroscience : the Official Journal of the Society For Neuroscience*, **28**, 11347-53.

Boulenger, V., Mechtouff, L.. Thobois, S., Broussolle, E., Jeannerod, M., & Nazir, T. A. (2008). Word processing in Parkinson's disease is impaired for action verbs but not for concrete nouns, *Neuropsychologia,* **46**, 743-756.

Bargh J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behaviour: Direct effects of trait construct and stereotype activation on action

Caramazza, A. Anzellotti, S., Strand, L, & Lingnau, A. (2014) Embodied Cognition and Mirror Neurons: A critical assessment, *The Annual Review of Neuroscience,* **37,** 1-15

References

Connell , L. & Lynott, D. (2012). Strength of perceptual experience predicts word processing performance better than concreteness of imageability, *Cognition*, 125. 452-465.

Cotelli, M., Bottoni, B., Manenti, R., Zanetti, M., Arévalo, A., Cappa, S. F., & Padovani, A. Action and object naming in Parkinson's disease without dementia, *European Journal of Neurology*, **14**, 632-637.

Glenberg AM, Kaschak MP. Grounding language in action. *Psychonomic Bulletin & Review*. **9**: 558-65.

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in human Motor and Premotor Cortex

Lakoff, G. The Contemporary Theory of Metaphor. (1992). In *Metaphor and Thought (2nd edition).* Cambridge University Press.

Macrae, C. N., Bodenhausen, G. V., Milne, A. B., Castelli, L., Schloerscheidt, A. M. (1998). On activating exemplars, *Journal of Experimental Social Psychology*, **34** (4), 330-354.