Lecture 4:
Understanding Abstract Concepts

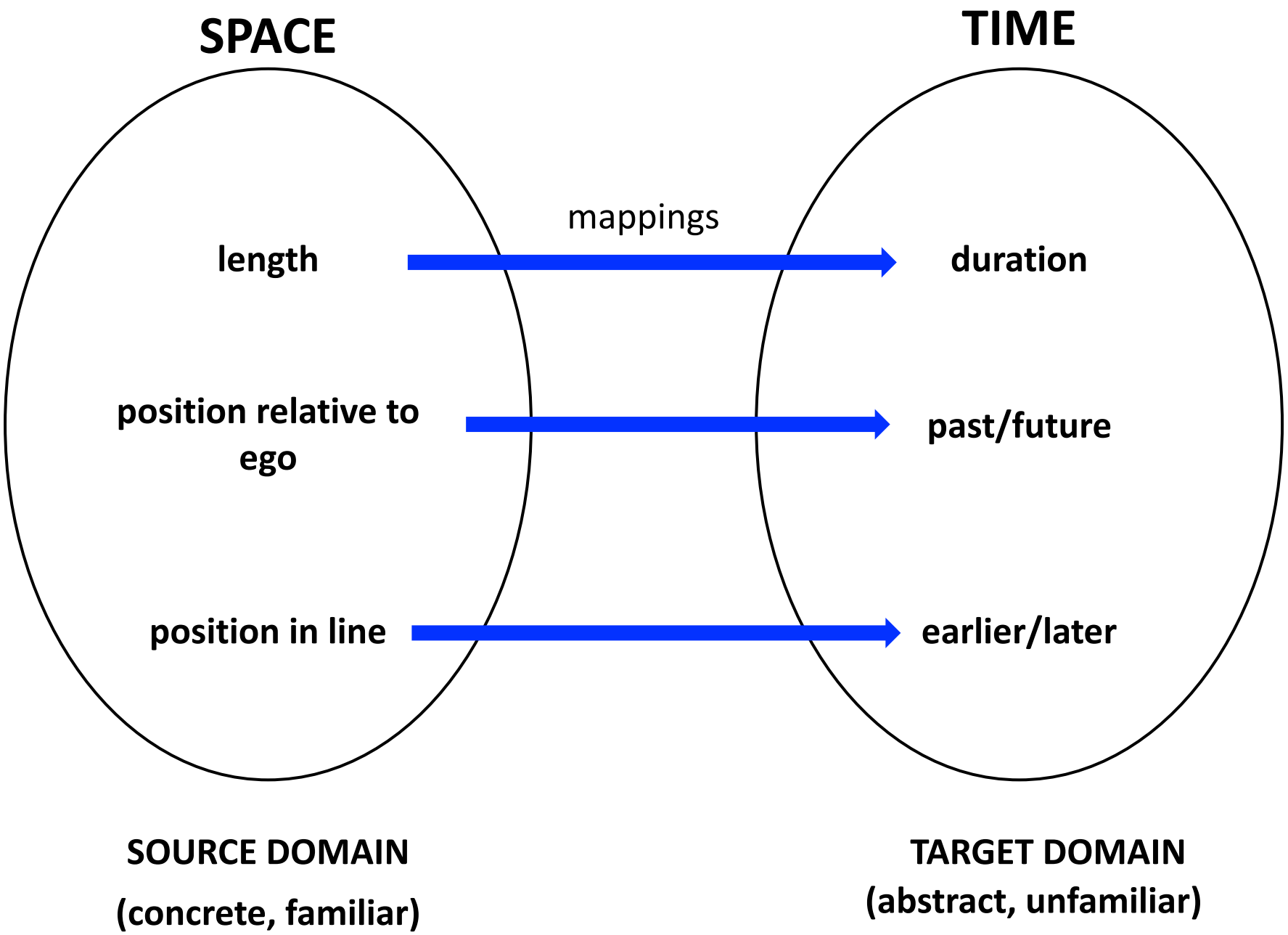
COGS 153

Simulation and abstract concepts

- We just covered evidence of mental simulation for content words that convey concrete visual/ motor information
- … but there's more to language than these kinds of words! What about abstract concepts?
  - How do people understand understand abstract language?
  - Could mental simulation still be involved?

Time & spatial metaphors

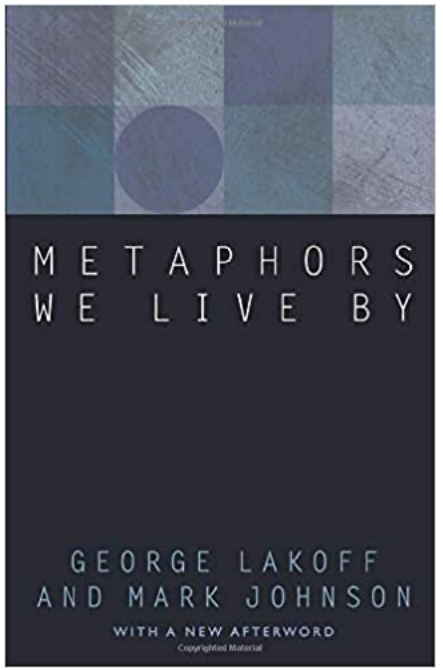
- It has been a **long** time since this town's future has looked so bright.
- Search millions of photographs from the LIFE photo archive, **stretching** from the 1750s to today.
- As I look **back**, I am proud of our ongoing success...
- Americans must resolve to be smarter **going forward** than we have been for the past several years.
- **Ahead** of election, D.C. Metro searches bags.
- Customers wait patiently for folding phone **following** reports of problems


SPACE
TIME
mappings
length
duration
position relative to ego
past/future
position in line
earlier/later
SOURCE DOMAIN
(concrete, familiar)
TARGET DOMAIN
(abstract, unfamiliar)

Conceptual Metaphor Theory

- Metaphors reflect how *we think and understand concepts*, not just linguistic usage

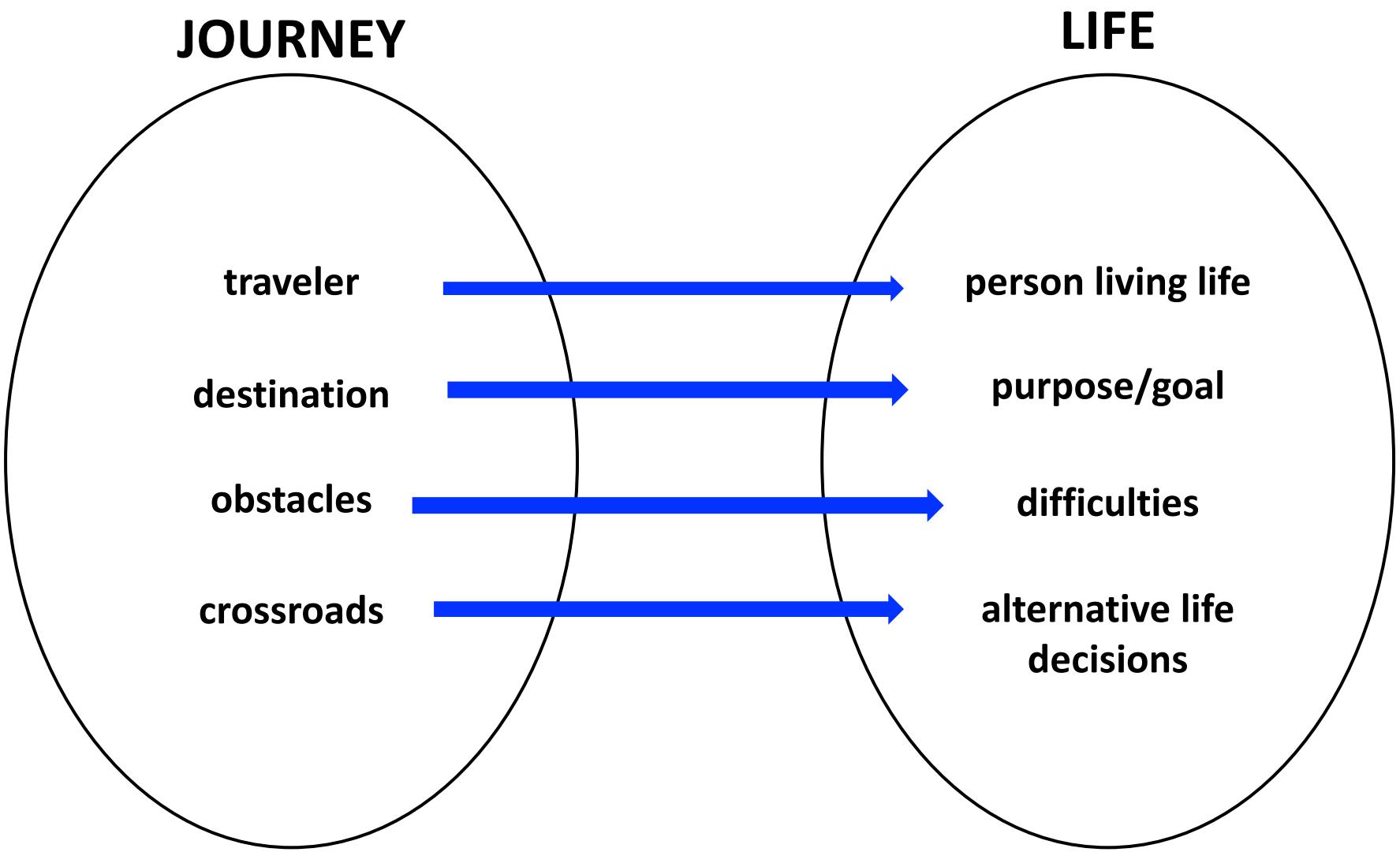
- Conceptual metaphors <u>ground abstract concepts in embodied experiences</u>
  - Mapping from source domain to target domain



Lakoff & Johnson (1980)

Not only relevant to time and space!

- LOVE IS A JOURNEY (note the convention: TARGET IS SOURCE)
  - Look how far we've come.
  - We're at a crossroads.
  - We need to go our separate ways.
  - We've come so far.
  - We can't turn back.
  - This relationship is going somewhere
  - It's been a long and bumpy road.
  - We have gotten off track.
  - Our relationship is a dead-end street.
  - We need to keep going.
  - (related metaphor: LIFE IS A JOURNEY)


JOURNEY
LIFE
traveler
destination
obstacles
crossroads
person living life
purpose/goal
difficulties
alternative life decisions
SOURCE DOMAIN
(concrete, familiar)
TARGET DOMAIN
(abstract, unfamiliar)

Other examples:

- AFFECTION IS WARMTH
  - She's warming up to her new brother-in-law.
- EMOTIONAL INTIMACY IS PHYSICAL PROXIMITY
  - They're very close.
- IDEAS ARE FOOD
  - His idea was half-baked.
  - Let me chew on that for a while.
  - He insisted on sugar-coating his warnings.
  - We have to regurgitate everything we learned on the final.
- HAPPY IS UP (SAD IS DOWN)
  - I'm soaring with joy. / His spirits fell.
- ARGUMENT IS WAR
  - He bombarded them with clever arguments.
  - His criticisms were right on target.

More examples…

- IMPORTANCE IS SIZE (or IMPORTANCE IS WEIGHT)
  - A big part of our goal has been met.
  - The responsibility is almost too much to bear.
  - This problem has weighed heavy on my mind.
- BUSINESESS ARE PLANTS
  - Our R&D branch has grown rapidly.
- ANGER IS PRESSURE IN A CONTAINER
  - He was about to burst with rage.

These metaphors are incredibly pervasive in language! But do they actually reflect how we think about the world?

Are conceptual metaphors cognitively real?

- **Procedure**: Participants had to categorize words (e.g., tomorrow) as related to the past or future by stepping forward (congruent block) or by stepping backward (incongruent block)

Rinaldi et al., 2016

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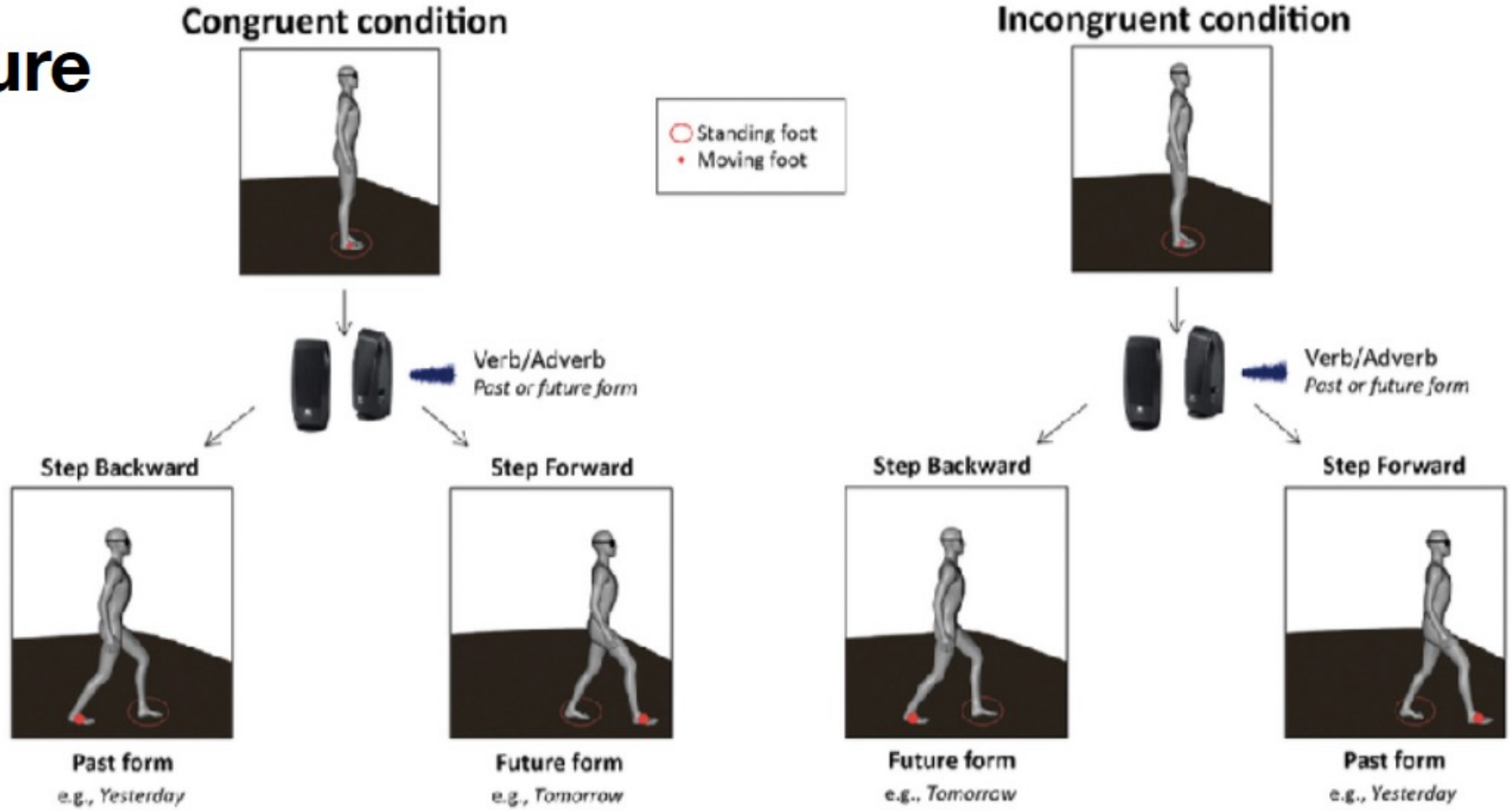
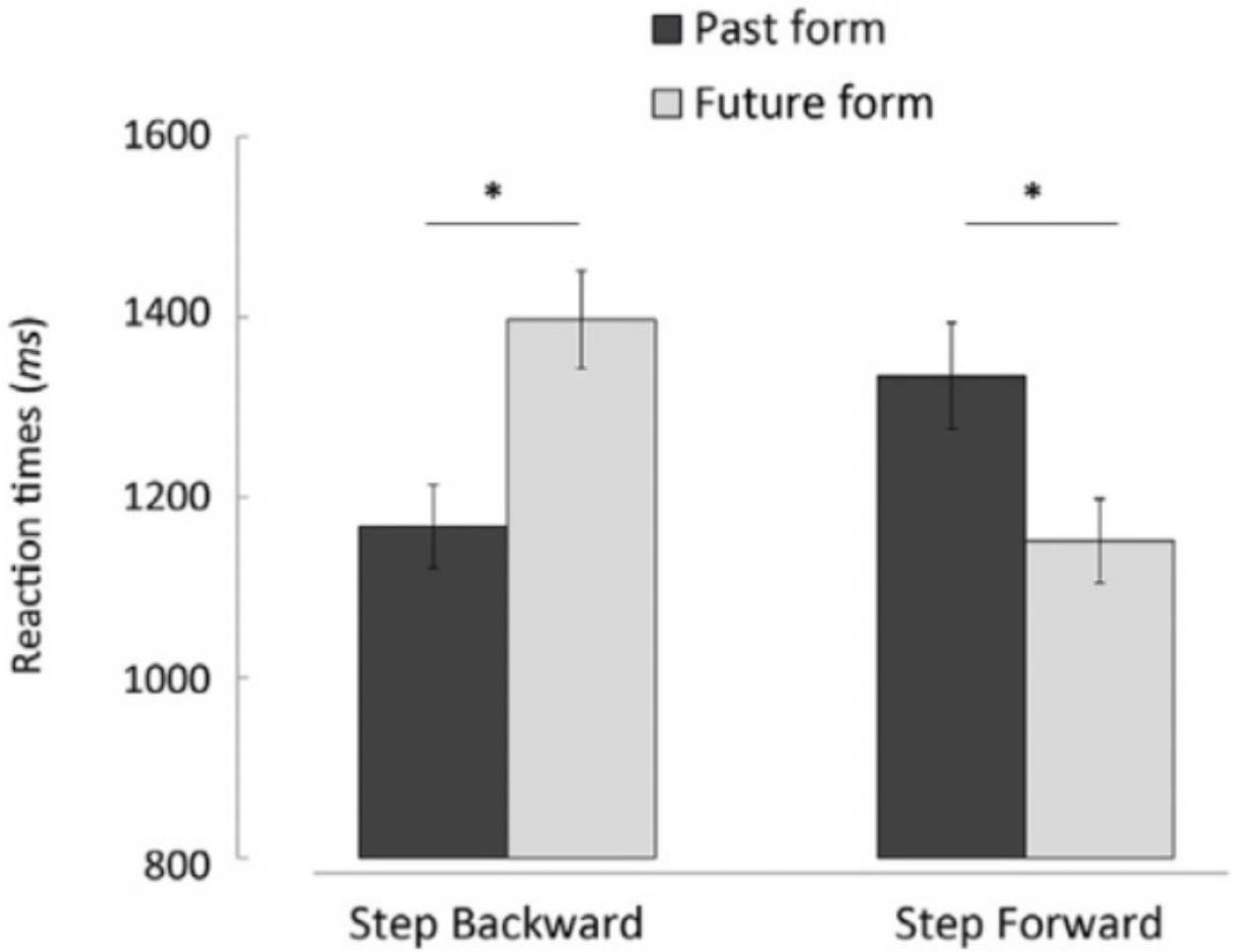
Procedure



Rinaldi et al., 2016

Simulation and metaphor: time

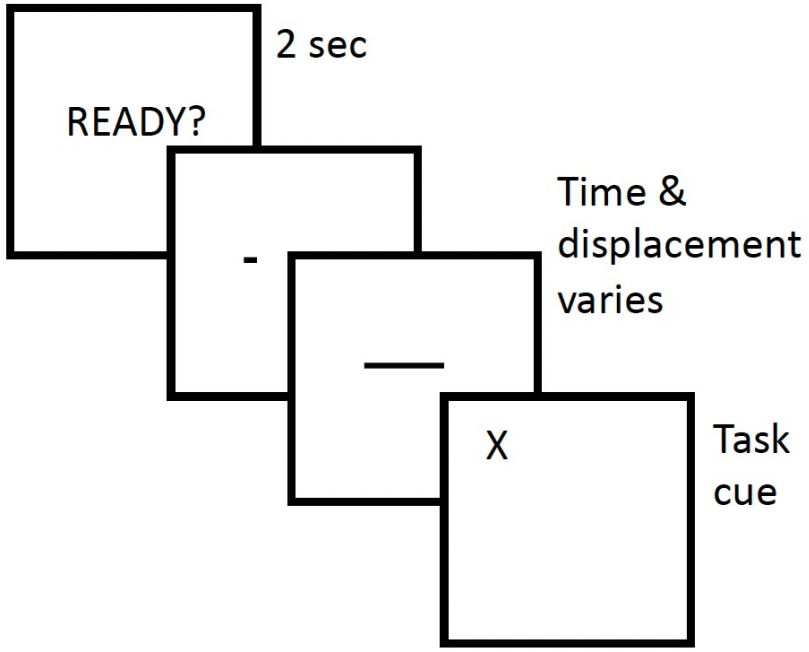
- Reaction times were faster in the congruent conditions
- Errors were more common in the incongruent conditions
- Simulation still appears to be involved when understanding language about abstract concepts that are understood via spatial metaphors



Rinaldi et al., 2016

Are mappings symmetric or asymmetric?

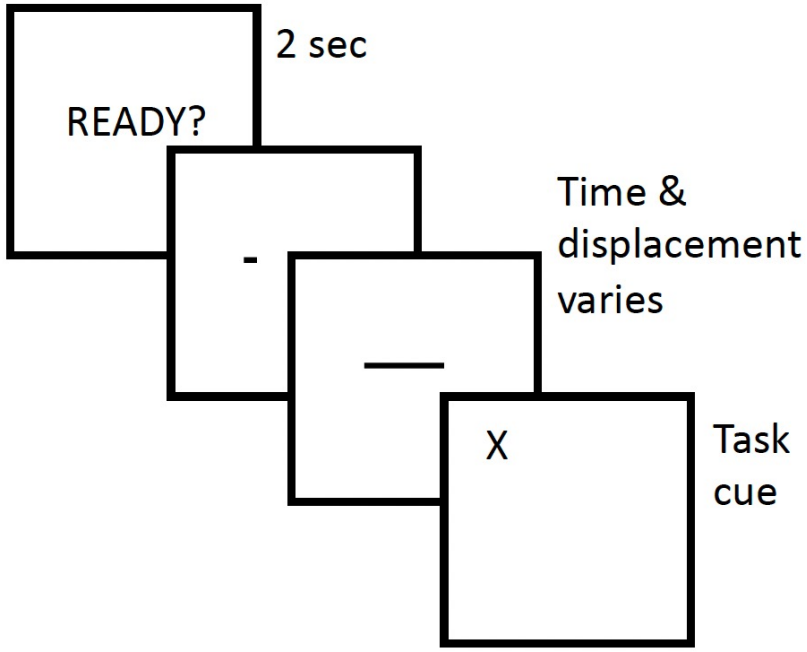
- Does spatial displacement influence time perception?
- Does duration influence spatial perception?
- Do people think about time using spatial representations, even when not using language?
- **Task**: Participants watch a line grow, and then click mouse twice to indicate line displacement or temporal duration of line growing
- Independent Variables (what is manipulated):
  - length of line displacement
  - duration it took for line to grow
- Dependent Variable (what is measured):
  - Displacement – space between clicks
  - Duration – time between clicks



Cassasanto & Boroditsky, 2008

Are mappings symmetric or asymmetric?

- Participants viewed growing lines, one line at a time
  - 'Length' of line and duration line takes to grow varies across trials
- After each line was shown, participants had to indicate either the displacement or its duration of the line growth
  - To estimate **displacement**:
    - Participants clicked the mouse once in the center, moved the mouse to the right in a straight line, and clicked the mouse again to indicate that they had moved a distance equal to the line
  - To estimate **duration**:
    - Participants clicked the mouse once in the center, waited the appropriate amount of time, and clicked again in the same spot



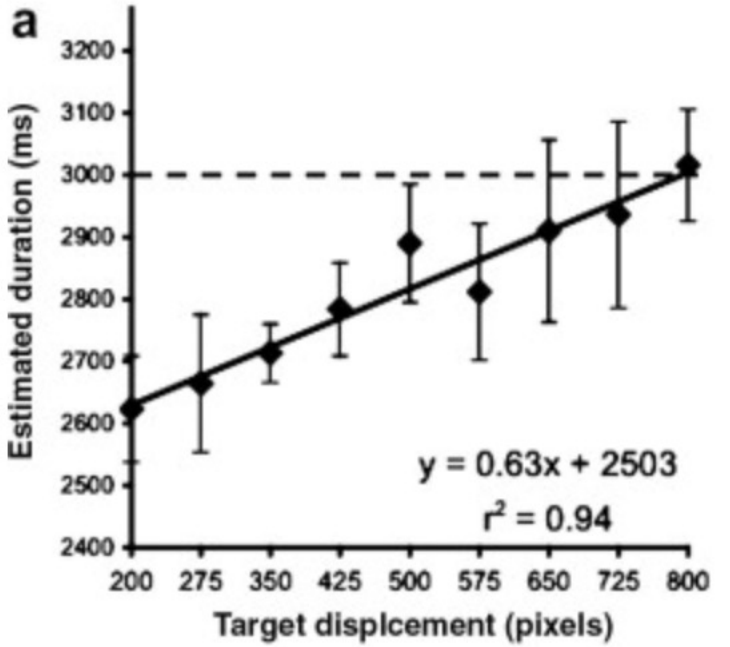
Cassasanto & Boroditsky, 2008

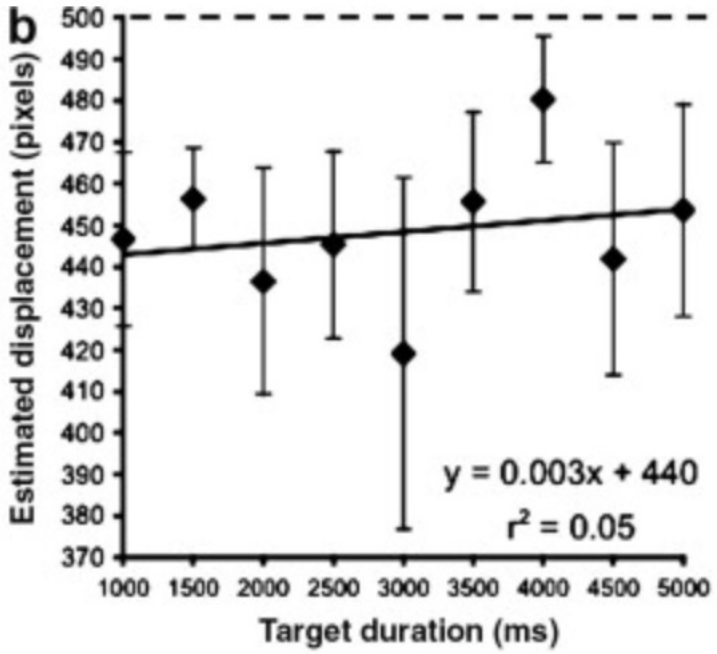
a) Effect of **line displacement** on **estimated duration**

- True duration is held constant and line length is varied
- When line length was longer, participants estimated longer duration
- Length of the line influenced estimations of time
  - Space influenced time perception

b) Effect of **duration** on **estimated displacement**

- True length is held constant and duration of growth is varied
- No significant different when it took longer for the line to grow
- Time it took to move that distance did not influence estimations of length
  - time did not influence spatial perception

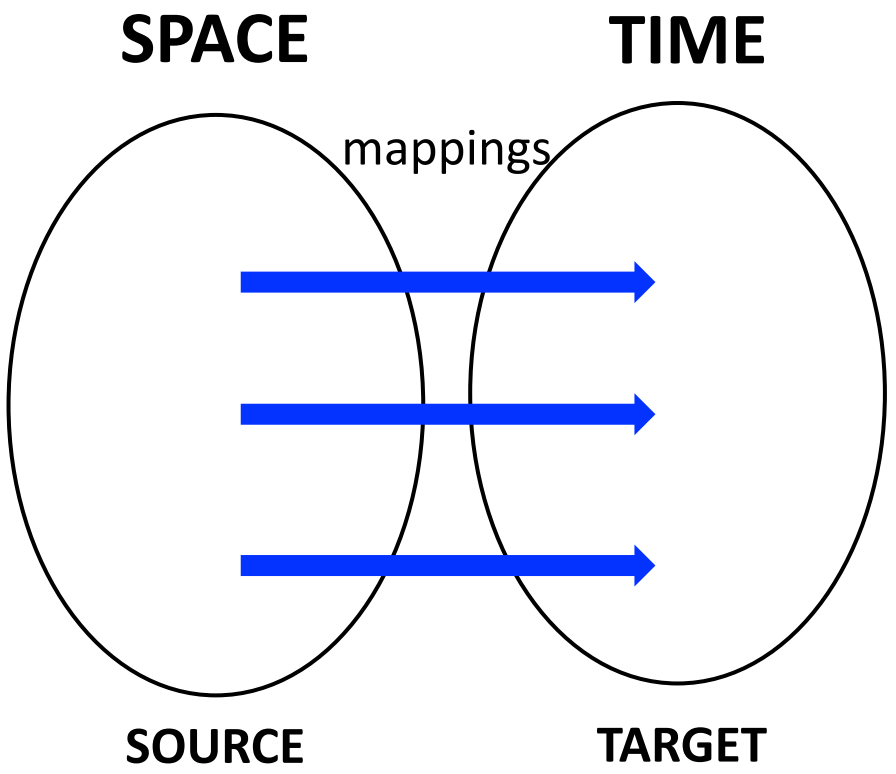




Cassasanto & Boroditsky, 2008

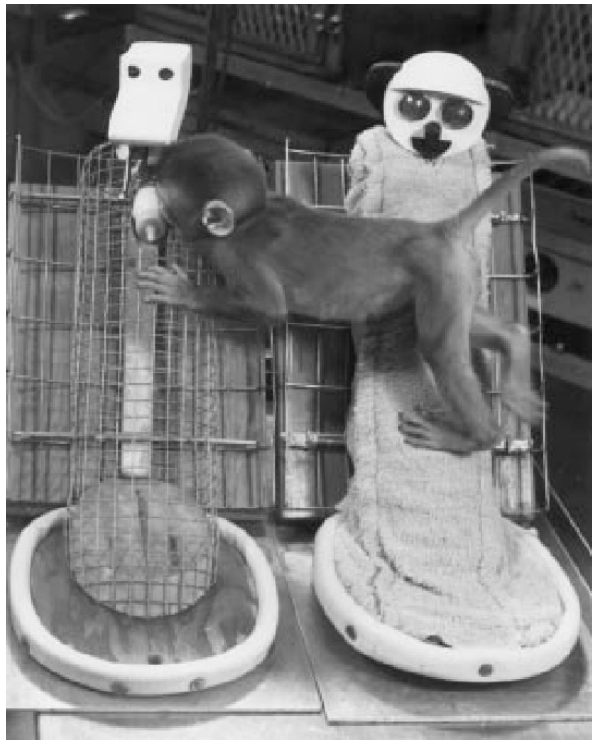
Conceptual Metaphors:

- Mappings between features of source and target domain are <u>ASYMMETRIC</u>
  - Thinking about space affects how you reason about time, but not the reverse
  - Links between source and target domains are not bidirectional



Harlow's Monkeys

- Harlow took infant monkeys from their biological mothers and gave them two inanimate surrogate mothers:
  - Mother 1: wire + milk bottle
  - Mother 2: warm light blub inside wire, with soft terry cloth covering it
  - The infants were assigned to one of two conditions
- **Results**: Infant monkeys preferred to stay close to a warm, cloth surrogate mother rather than a wire mother with food.
  - Comfort more important than nourishment needs
  - Monkeys "raised" by the warm cloth surrogate showed relatively normal social development compared to the infants left alone wire surrogate



Harlow, Dodsworth, & Harlow (1965)

Could some metaphors be motivated by correlations in experience?

- **Conflation Hypothesis**: Children hypothesize an early meaning for a source domain word that *conflates* meanings in both the literal and metaphorical senses
  - e.g. experiencing warmth and affection when being held as a child
  - e.g. observing a higher water level when there's more water in a cup
  - Idea: Perhaps these metaphors are the most *grounded*

- Because of such frequent early life experiences with a trustworthy caregiver, a close mental association could develop between the concepts of physical warmth and psychological 'warmth'...
  - Remember the conceptual metaphor "AFFECTION IS WARMTH"

Physical warmth and interpersonal ‘warmth’

- Participants met in lobby of building and rode elevator up to fourth floor with experimenter
- Experimenter asked them to hold coffee while they recorded their name on a clipboard
  - Either hot coffee or iced coffee
- Participants read description of “Person A” and rated them on traits related and unrelated to warm-cold dimension
- **Results**: Related (but not unrelated) traits *rated significantly warmer* by those who held hot than cold coffee (1=cold; 7=warm)
  - Hot Coffee: 4.71
  - Cold Coffee: 4.25
- Physical warmth promoted feelings of interpersonal warm

Williams & Bargh (2008)

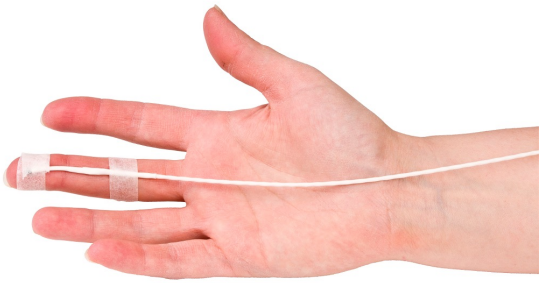
Physical warmth and interpersonal ‘warmth’

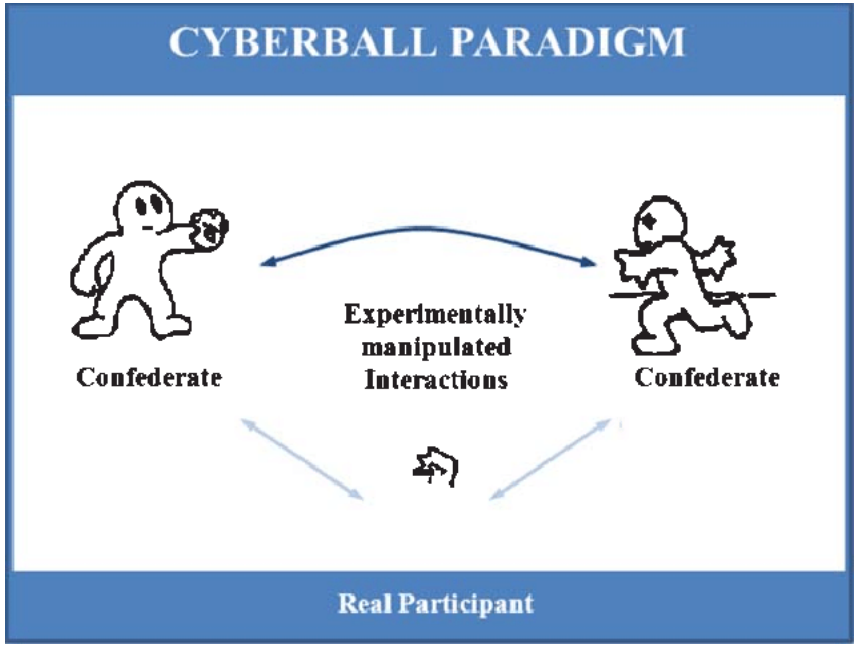
- Participants held either hot or cold thermapak and did a product evaluation
- Asked to choose their reward for participating
  - Snapple or $1 ice cream coupon
  - “For Yourself” or “To Treat a Friend”
- Participants more likely to ‘treat a friend’ after warm than cold thermapak
  - Cold (75% Self vs 25% Friend)
  - Warm (46% Self vs 54% Friend)
- Physical warmth promoted feelings of pro-social behaviour

Williams & Bargh (2008)

Physical warmth and interpersonal 'warmth'

- Participants' skin temperature was continuously monitored while they played cyberball
  - Inclusion Condition: other players included participant in game
  - Exclusion Condition: other players avoided including participant in game
- Results:
  - Those in inclusion condition showed relatively constant temperature
  - Those in exclusion condition showed *decreases* in skin temperature
- Social exclusion lowered skin temperature





Ijzerman et al. (2012)

What about *emotion* concepts?

- Could emotion concepts be **grounded in sensorimotor experience**, like facial expressions and bodily actions?
  - Smiles, frowns, scowls
  - Vocalizations
  - Tone of voice
  - Laughter, sighs, screams
- Emotional states are associated with facial expressions

Davis et al., 2021

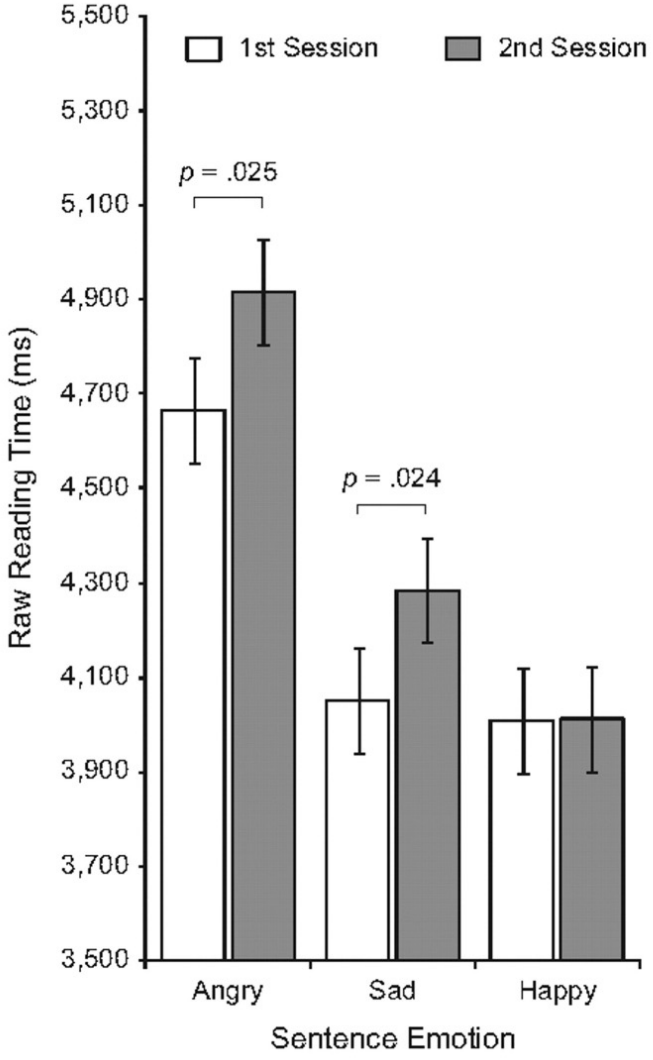
Inferring internal emotional state from actions

- When experiencing an emotion, you have your internal feelings and your external behaviors
  - You could be associating your internal and external emotional patterns during those experiences
- Any evidence for this idea?
  - Emotional contagion (Hatfield et al., 1993)
  - Spontaneous facial mimicry (Dimberg, 1982)
  - Mirror neurons (Rizzolatti & Craighero, 2004)
  - Pain empathy (Cheng et al., 2010)

Interference: paralyzing facial muscles

- Botox injections to corrugator muscle (brow furrower) slowed comprehension of sentences about sad and angry situations, but not in happy situations

Sentence type	Example sentences
Angry	Reeling from the fight with that stubborn bigot, you slam the car door.
	The pushy telemarketer won't let you return to your dinner.
	The workload from your pompous professor is unreasonable.
Happy	The water park is refreshing on the hot summer day.
	Finally, you reach the summit of the tall mountain.
	You spring up the stairs to your lover's apartment.
Sad	You hold back your tears as you enter the funeral home.
	You open your email in-box on your birthday to find no new emails.
	Your closest friend has just been hospitalized for a mental illness.



Havas et al. (2010)

But how could more complex emotion concepts come from sensorimotor experience?

- Immorality & its relationship to disgust
  - Similar facial expressions
    - Chapman et al., 2009
  - Similar language used: bad taste in the mouth, nasty, gross, stomach-churning...
  - People sensitive to physical disgust tend to be more sensitive to moral disgust
    - Moll et al., 2005
  - Inducing disgust increases feelings of moral injustice
    - Inbar et al., 2009

Davis et al., 2021

The multifaceted abstract brain: meta-analysis

- Meta-analysis of 4 types of abstract concepts: numbers, emotions, morality, & Theory of Mind
  - Widespread representations
  - Each category activated some unique areas (especially numbers!)
  - Some commonly activated areas (overlap between ToM, morality, and emotions)

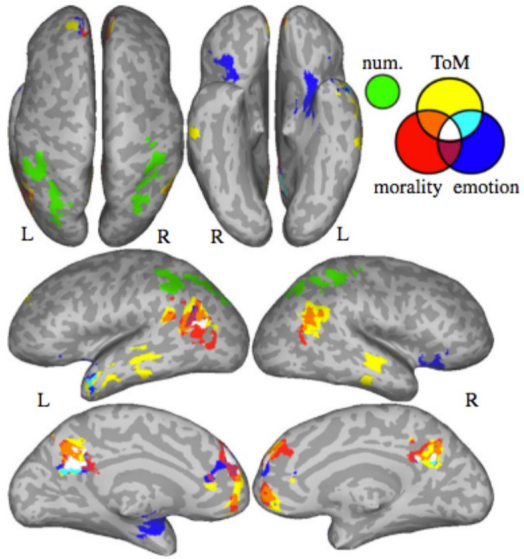


Figure 2. Results of the meta-analysis showing significant ALE values within each domain, and overlap.

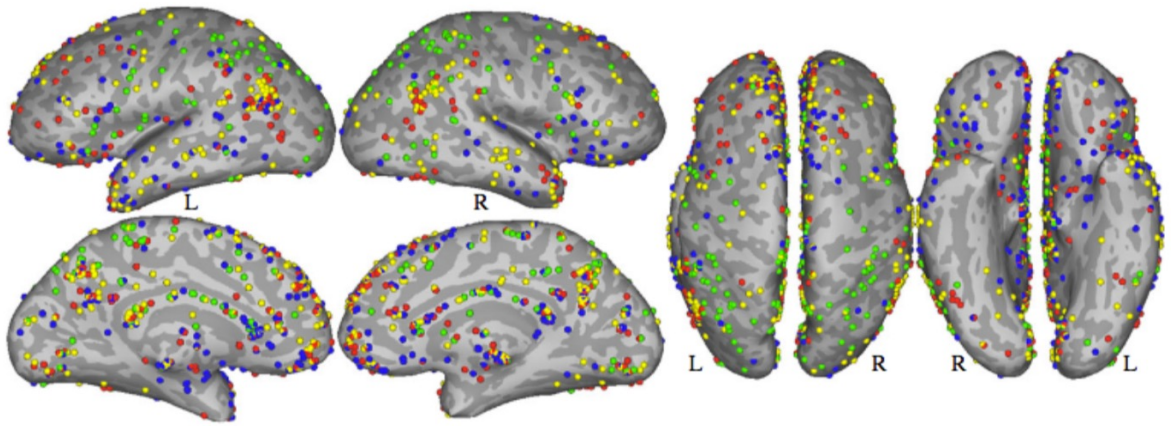
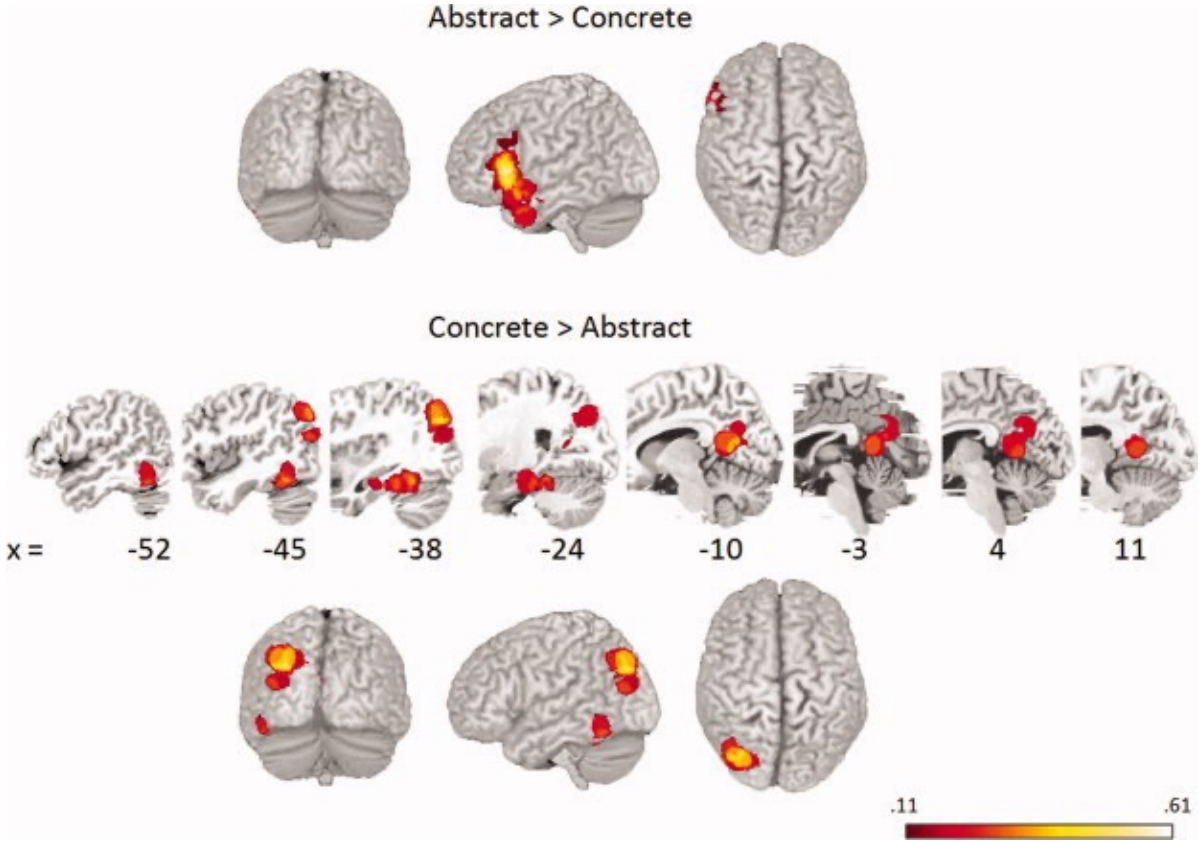


Figure 1. Peaks from all contrasts used in the meta-analyses. Green—numbers, blue—emotion, red—morality, yellow—theory of mind.

Desai, Reilly & van Dam (2018)

Neural representation of abstract and concrete concepts: A meta-analysis of neuroimaging studies

- Meta-analysis of 19 studies contrasting abstract and concrete words
  - Two contrasts were examined: *abstract > concrete* and *concrete > abstract*
- Results suggest:
  - greater engagement of the verbal system for processing of abstract concepts
  - greater engagement of the perceptual system for processing of concrete concepts



Wang, Conder, Blitzer & Shinkareva, 2010

Dual Coding Theories

Best of both worlds?

- Idea behind dual coding: **Abstract/linguistic representations & embodied representations are involved in language comprehension**

- Research on the role of context
  - When are people more likely to rely on amodal or modal processes?
  - Are there certain situations where it might be more or less important to simulate a perceptual, motor, or affective experience in order to comprehend the language?

Barsalou et al., 2008

The “CODES” model

- **Context Dependent Simulation**
- Maybe our conceptual representations are not *only* somatic and motor reactions
- In this model, conceptual representations are context-dependent
  - Individual differences (e.g., handedness, expertise...)
  - Language context (e.g., single words, sentences, etc.)
  - And what about comprehension goals / motivation for the processing?
    - Sometimes it could be enough to have a shallow understanding, vs deeper processing

Winkielman et al, 2020; Davis et al, 2021

Potential interpretations of the data

concepts + sensorimotor systems:

1. **Strong embodiment** – the conceptual and motor systems are one and the same (Binder & Desai, 2011)
2. **Weak embodiment** – conceptual representations are embodied at different levels of abstraction. The extent of embodiment depends on conceptual familiarity, contextual support, and the current demand for sensorimotor info
3. Embodied processes are **functionally relevant** for conceptual processing (e.g., elaboration) but distinct from the representation of meaning (Mahon & Caramazza, 2008)
4. Embodied processes are entirely **epiphenomenal** (Mahon & Caramazza, 2008)
5. A **combination** of epiphenomenal and functional **depending on situation**

Davis et al, 2021

Some takeaway points

- Understanding language is embodied/ involves "mental simulation" (rather than just amodal symbols)
- Evidence for mental simulation comes from behavioral research (response time), neuroimaging studies (fMRI), and transcranial magnetic stimulation studies
  - these studies show that: "mental simulation" happens, and is not just epiphenomenal
- Metaphors use a source idea (usually familiar, concrete) to refer to a target idea (usually unfamiliar, abstract)
  - Metaphors we use to talk about abstract ideas often correspond with how we think about those ideas
- There is evidence that abstract concepts (e.g., time) can be understood by simulating source domain experiences