

Goals / Motivations



To *inform better language use in the classroom* when teaching abstract concepts/words



Raising awareness of how abundant the use of metaphor is in how we *communicate science* (and how we communicate in general)



The *type of metaphor* employed can impact how learner/receiver frames the concept in their mind

Related to cultural background; expectations of interpretation; *equity in the classroom*

Are your students interpreting your language in the same way that you do?

Theoretical Framework

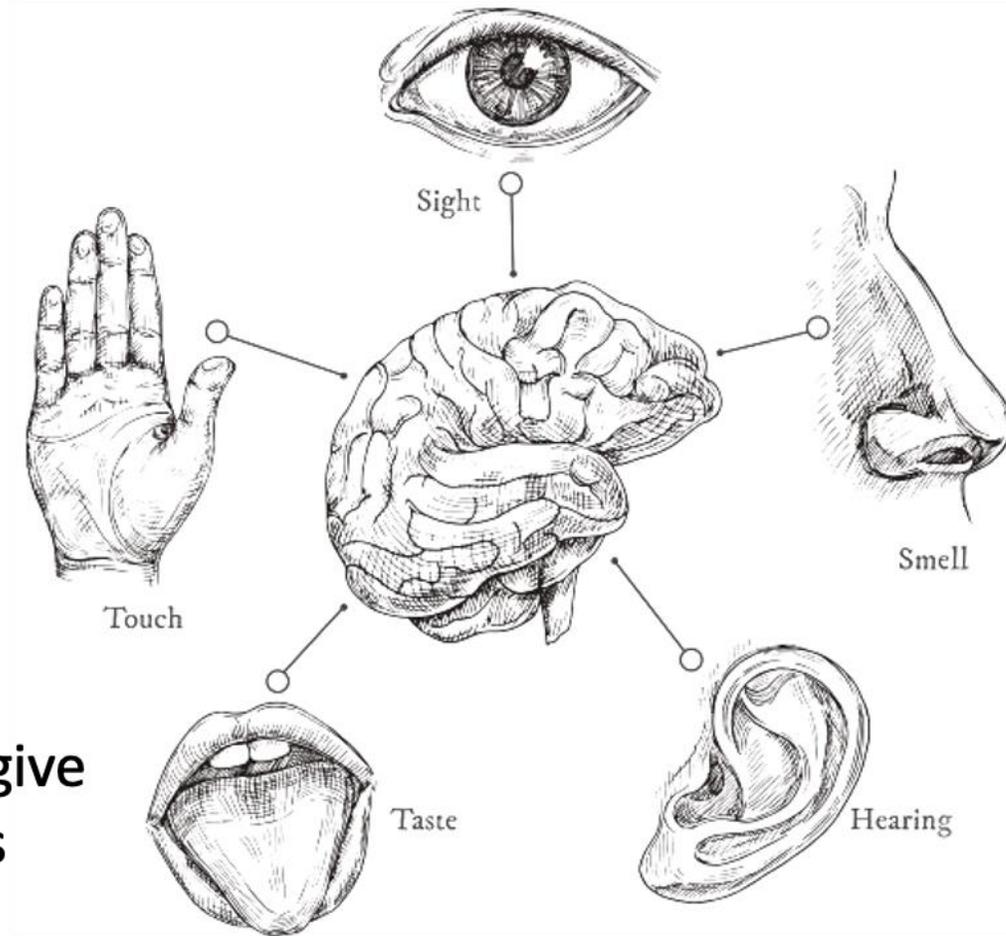
- Embodied cognition/experientialism/conceptual metaphor theory
 - We develop meaning of the world by interacting with it (concrete, embodied experiences) (Kahneman, 2011; Lakoff & Johnson, 1980, 1999; Shapiro, 2011)
 - We project knowledge from these concrete experiences (source) onto abstract concepts (target) through metaphor. (see also Bereiter, 2002; Carey, 2008; Grady, 1998; Indurkha, 1992; Kahneman, 2011; Nersessian, 2008, Reddy, 1979)
 - We share biology, environment, and culture therefore develop with a family resemblance of meaning. (Lakoff & Johnson, 1998)



I understand...

- It is clear to me now.
- You have really opened my eyes.

- I feel your pain.
- I finally got a grasp of the situation.



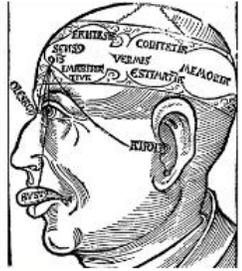
- This was enough to give me a taste of what is going on.
- Let me chew on that a while.

- Her thoughts were fragrant with potential.
- That idea stinks.

- Your message came through loud and clear.
- It was music to my ears.

Embodied experiences help us reason about abstract concepts: The case of the mind

Hippocrates (460 – 370 BC) and the **hydraulic brain** (blood, phlegm, black bile, yellow bile) after the origin of water clocks (still use sayings like ‘flow of emotions’)



370 BC

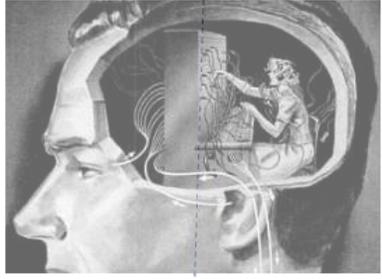
322 BC

Galen (130-210 AD) hydraulic **automaton** (programmable, predictable outcomes)

210 AD

1600s

electric telegraphy and **switchboard** metaphors



Mid 19th century

1950s

The brain doesn't work like a computer and a new, integrative metaphor is needed to go forward with AI research (Zarkadakis 2015).

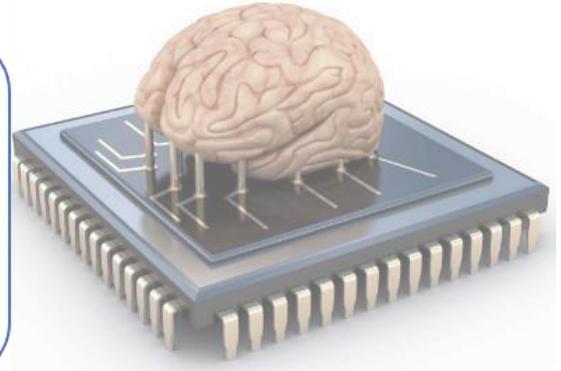
2015



Aristotle (384-322 BC) The mind is a **blank tablet** to be written on (tabula rasa)

René Descartes (1600s) **Machine** metaphor

The **computer** metaphor: Brain (hardware) and mind (software) duality. It is impossible to talk about human intelligence without using the computer metaphor (Epstein, 2016).



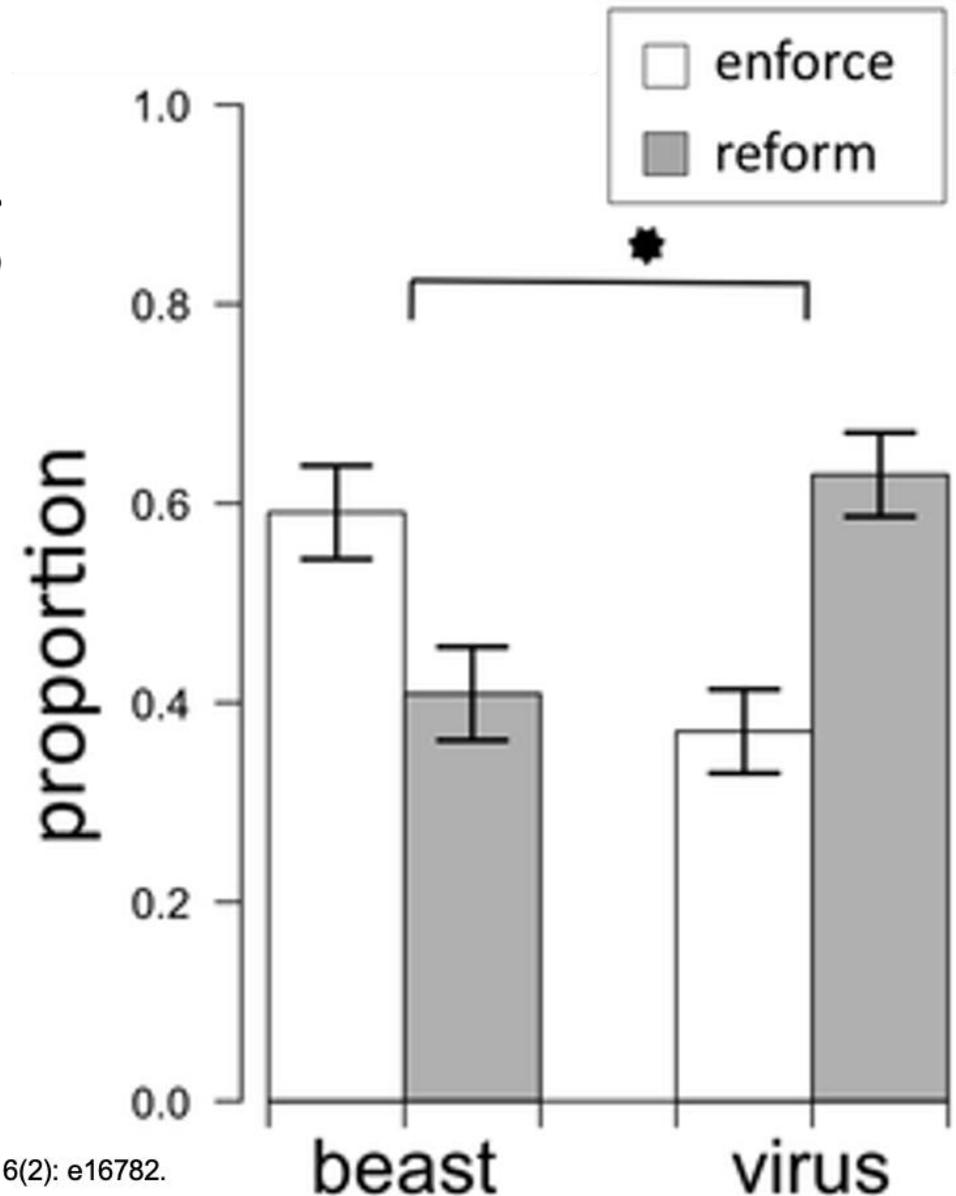
Metaphors also influence how we think about abstract concepts

- Metaphor use
- Experiential gestalt (Lakoff & Johnson, 1999)
- Cascade of associations (Kahneman, 2011)



Crime is a virus infecting/beast attacking

- a **virus** metaphor for crime was associated with more **systemic, reform-oriented** approaches to crime reduction whereas a **beast** metaphor for crime was associated with more **direct, enforcement-oriented** approaches.
- ...the influence of the metaphorical framing is covert: people do not recognize metaphors as an influential aspect in their decisions.
- ...the influence of metaphor we find is strong...



Battle metaphor for cancer

- Overall, the data are consistent with the hypothesis that **battle metaphors increase the perceived difficulty of cancer treatment**. Because battles are difficult, framing treatment as a battle increases perceptions of its difficulty, potentially making people less receptive to health information about cancer.
- Reading about a person's "battle" with cancer **increased participants fatalistic beliefs about cancer and its controllability**. This is especially concerning because high cancer fatalism is associated with numerous negative health behaviors.
- Thus, this final study finds **no evidence that people are more vigilant when thinking of cancer as an enemy to battle**. This is especially noteworthy because (i.) motivating people to take action is often the intention of these metaphors and (ii.) monitoring is often a very effective prevention strategy



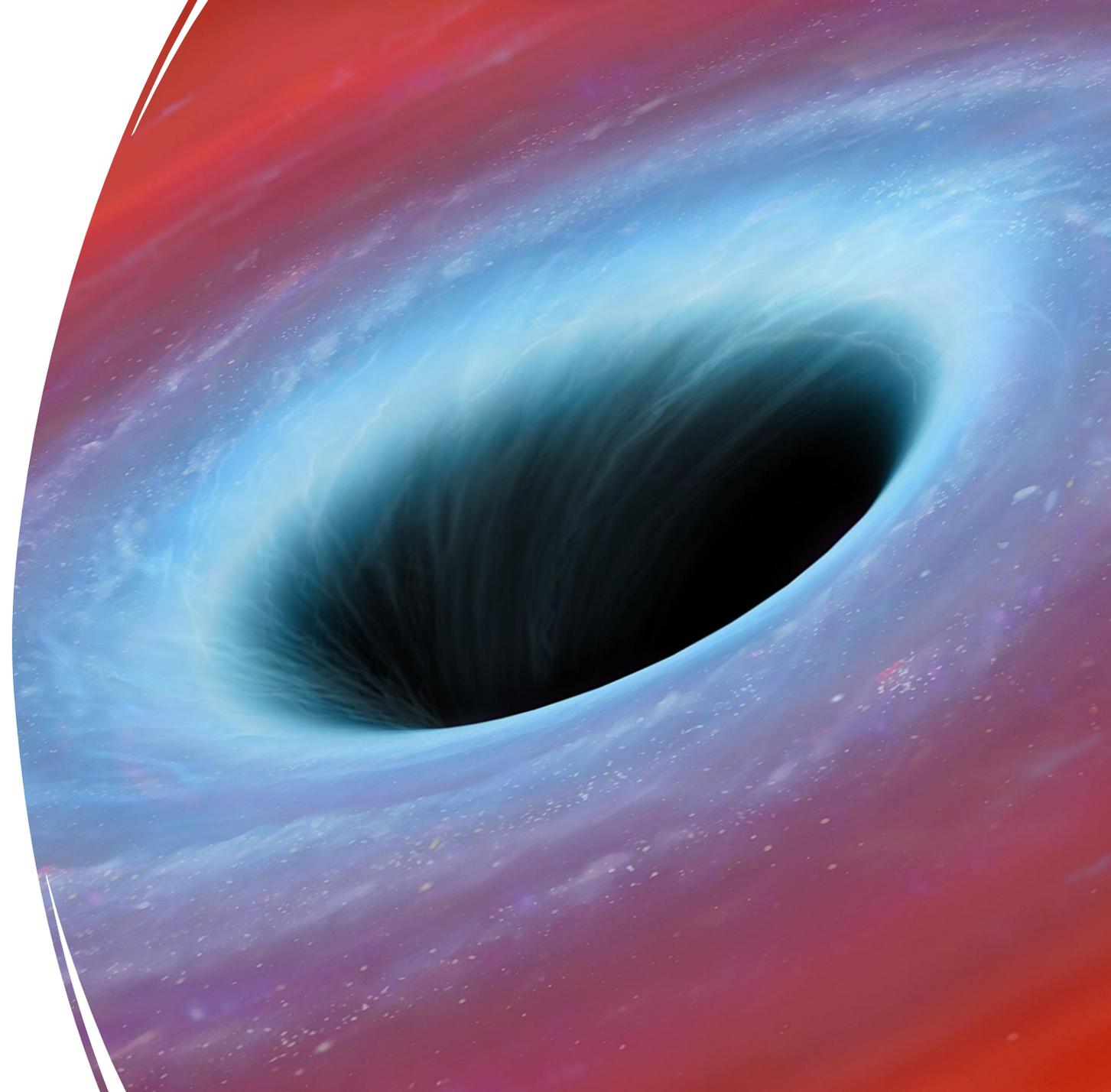
Metaphors highlight and hide features of reality

- ***Highlight***

- The general behavior of material disappearing into the black hole
- Consumes matter and energy

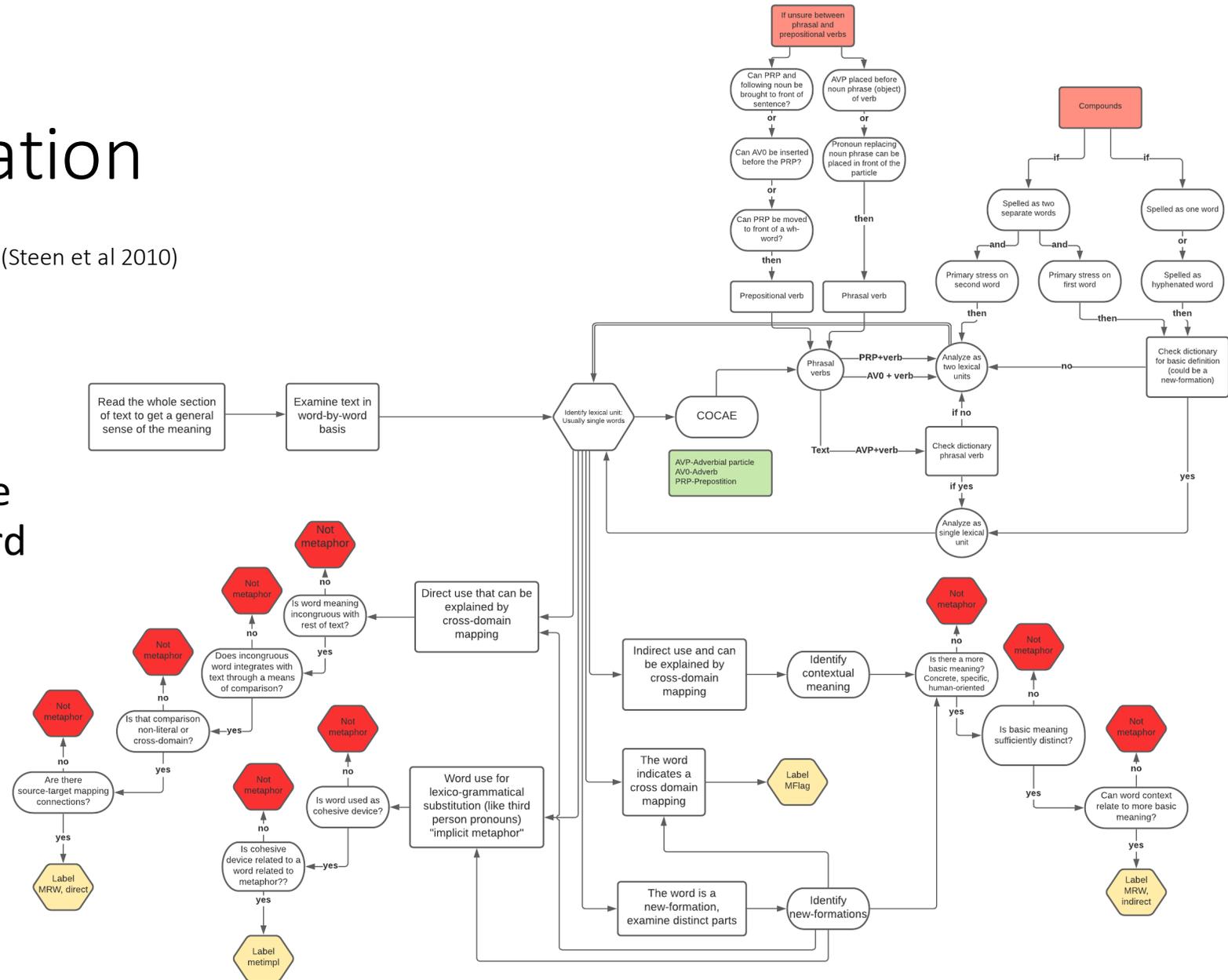
- ***Hide***

- There is a very dense mass in the center
- There is no hole



Metaphor Identification Procedure (MIPVU) (Steen et al 2010)

- Analyze word by word
- Using consistent corpus, determine the contextual meaning of the word and the most basic meaning
 - Basic meaning: Typically the most “concrete” or “human-oriented” definition
- If there is a difference, the word is classified as metaphorical



Note: This will typically relate back to a metaphor that was already identified as MRW (indirect or direct)

For example

- Plates move as rigid **bodies**, so it may seem surprising that the North American Plate can be moving at different rates in different places.
 - Contextual meaning: (4) The main or central part of crustal area
 - Most basic meaning: (1) The whole physical structure of a person or animal, including the head, arms and legs.
 - Indirect metaphor (language of science): ROCKS ARE A PERSON



Different categories of metaphors (plate tectonics related)

- Direct (deliberately used to teaching)
 - “Mountain ranges had formed like wrinkles on a dried-up apple” (THE CRUST IS THE SKIN OF AN APPLE)



Different categories of metaphors (plate tectonics related)

- Indirect metaphors (part of the language of science)
 - Continental drift (CONTINENTS ARE ICEBERGS)
 - Tectonic plates (THE LITHOSPHERE IS A CERAMIC DINNER PLATE)
 - Earth's crust (EARTH IS A LOAF OF BREAD)



Different categories of metaphors (plate tectonics related)

- Implicit metaphor (incidental via the author), e.g. EARTH IS/ROCKS ARE A PERSON
 - “Plates move in a rational manner...”
 - “The mantle pushing up...”
 - “Mantle plumes were responsible for...”
 - “A mature island...”
 - “Understood their relative age...”



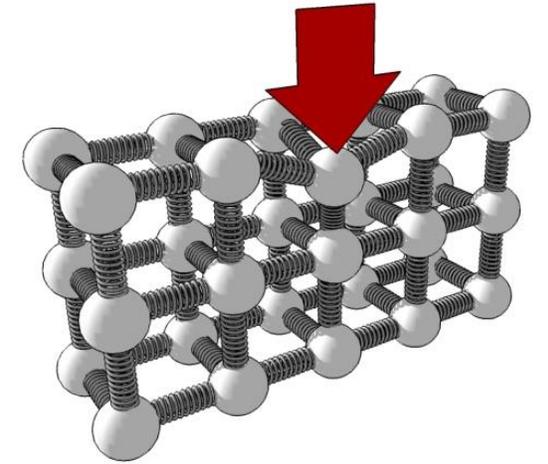
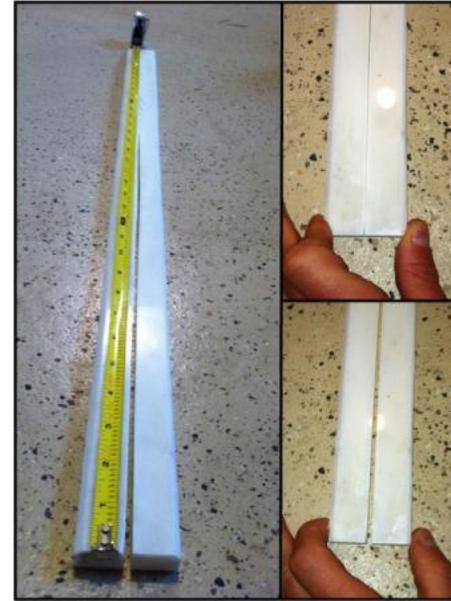
The tectonic plate metaphor

- Tectonic has no meaning for a novice
- Plate is what they ate off for dinner
 - Plates are separate
 - Plates are brittle
- This conceptual understanding impeded student understanding about how earthquakes happen
 - “plates colliding”
 - “plates breaking”



Taking a CMT/embodied cognition approach

- Enable experiences in the target domain
- Refer to an embodied source domain (LITHOSPHERE IS THE SKIN OF THE EARTH)
 - “Wholeness” vs. separateness
 - Elasticity vs. brittle breakage
- Reflect an embodied source domain
- Discuss what metaphor hides and highlights (Niebert et al. 2012)



Nature is an Agent¹

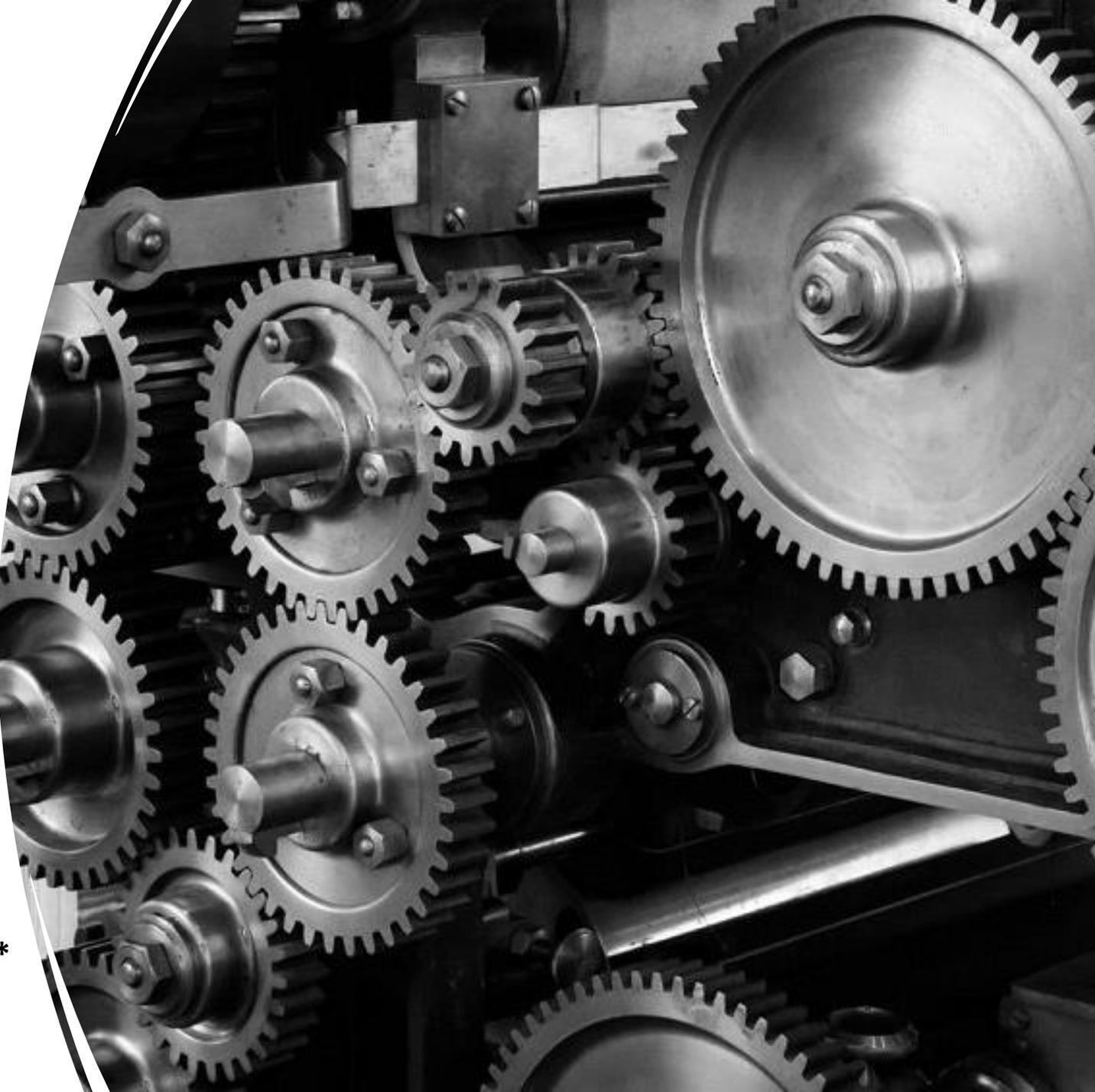
- “climate **forcing** [...] is when conditions change to **give the climate a little nudge** in one direction or the other”
- “frozen soil contains **trapped organic matter**”
- “role of greenhouse gases (GHGs) in **controlling** the climate”
- “the **dominant** gases of the atmosphere are nitrogen (as N₂) and oxygen (as O₂)”
- “glaciation **is favoured** at low seasonal differences”
- **“CO₂ **traps** heat in the atmosphere and **leads** to climate warming”**

¹Examples from: Earle, S. (2019). Physical Geology, 2nd Edition. CC-BY. Available: <https://opentextbc.ca/physicalgeology2ed/>



Earth/Nature is a Machine¹

- “...but also in alpine glaciers and permafrost — melting is one of the key **feedback mechanisms**...”
- “Another **mechanism** is related to continental collisions...”
- “...this is a **feedback mechanism** that has the potential to equal or surpass the forcing that has unleashed it...”
- “The **mechanism** for that relative climate stability has been the evolution of our atmosphere...”
- “...Both these gases **accumulate** in the atmosphere and **add to** the warming effect...”
- ****“...a climate-forcing mechanism** is the increase in the amount of carbon dioxide (CO₂) in the atmosphere...”**



¹Examples from: Earle, S. (2019). Physical Geology, 2nd Edition. CC-BY. Available: <https://opentextbc.ca/physicalgeology2ed/>

Agent vs. Machine

- **Agent:** An entity with goals, motivations, desires, etc. Someone or something that acts to “cause” changes.
 - **Highlights:** Aspects of nature tend to move in a certain direction, e.g. toward minimum energy, equilibrium; similar inputs lead to similar outcomes, just like a person with certain preferences
 - **Hides:** Nature, as far as we know, does not have a conscious awareness; indirect, but consistent, outcomes do not occur because of preferences, but because of complexity
- **Machine:** An unthinking/automatic mechanism or process; a piece of equipment that does a particular job.
 - **Highlights:** CO₂ can, like a piece of a machinery, cause an effect when interacting with energy in the atmosphere
 - **Hides:** The carbon cycle does not perform an essential intentional function; it was not designed or built for a purpose



Agent vs. Machine

- These two ideas with conflicting emphasis occur often in discussions of concepts in geoscience, sometimes within the same phrase or paragraph
 - ****“CO₂ traps heat in the atmosphere and leads to climate warming”****
 - ****“...a climate-forcing mechanism is the increase in the amount of carbon dioxide (CO₂) in the atmosphere...”****
- Both are useful, but it is important that novices understand what is **highlighted** and **hidden** by each metaphor
 - Do students being introduced to these concepts/metaphors understand their limitations?





Challenges

- ***Which one is the basic meaning?***
 - Concrete, specific, human-oriented
 - Example: record (geological **record**) (MacMillan)
 - 1. information kept about something that has happened (contextual and basic meaning)
 - 4. a large round black piece of plastic containing music or other sounds
- ***Is there enough distinction between contextual and basic meanings?/grammatical role (adjective) versus grammatical category (verb)***
 - Example: **stretching** and **bending** vibrations
- ***What counts as a single lexical unit?***
 - Compound words (“**full-blown** climate changes”)
 - Phrasal verbs
 - Collocations



Challenges

- ***Use of MIPVU procedure***
 - Was developed by linguists conducting broad survey of many types of literature
 - Our purpose is an in-depth survey of a specific technical discipline

- ***Use of certain metaphors changes*** with scientific understanding, but can cause retention (metaphorically speaking, of course) of misconceptions

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