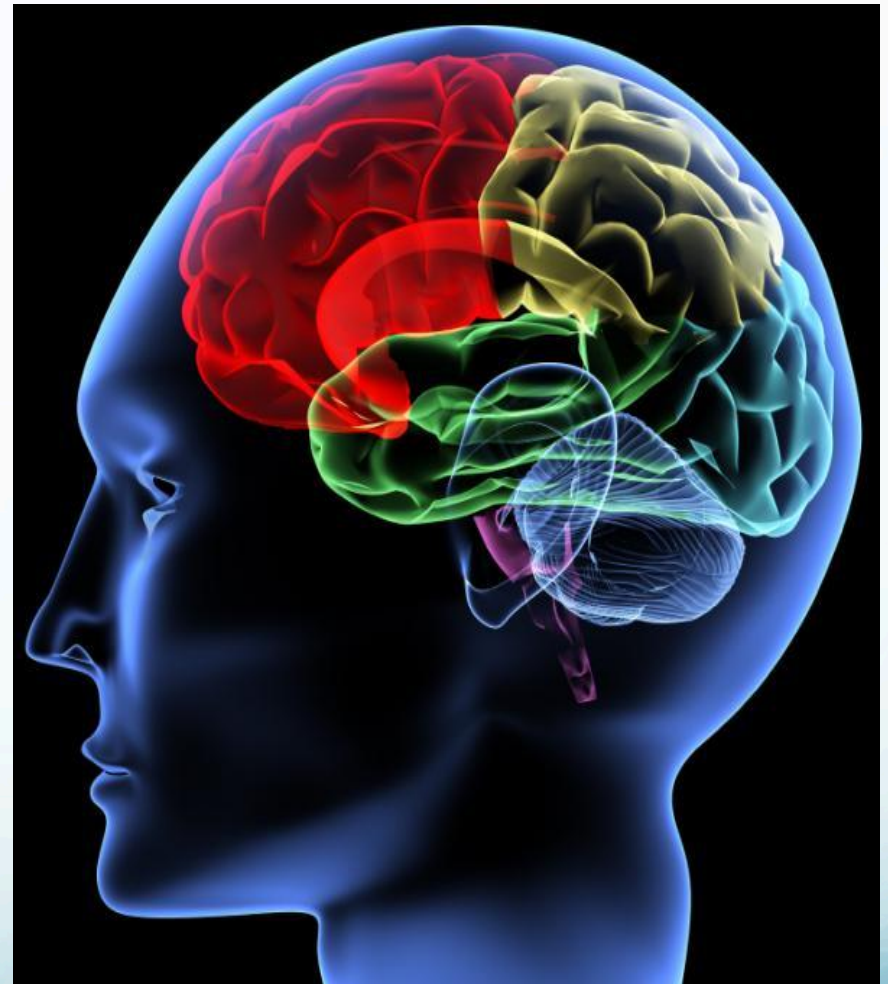# Why Reason? Inference, Reasoning, and Education

Paul Thagard

University of Waterloo
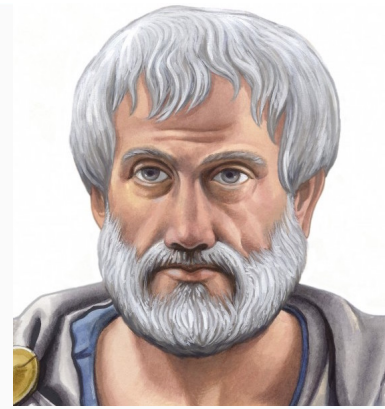
Outline

1. Reasoning vs. inference
2. Semantic pointers
3. Against reasoning
4. Reasoning reclaimed
5. Communication

Standard View

1. Reasoning and inference are the same.

2. The function of reasoning is to make correct inferences: deductive, inductive, and practical.

3. Rationality is using good reasons.

REASONING *VS* INFERENCE

REASONING	INFERENCE
Language	Multimodal: language, sensory imagery, motor, emotion
Serial, step-by-step, like deduction	Parallel, based on coherence
Slow, deliberate, social Conscious	Fast, automatic, individual Unconscious

Dual Process Theories

Reasoning is system 2: explicit, controlled, effortful, domain general, etc.

Inference is system 1: implicit, automatic, low effort, nonverbal, etc.

Kahneman, *Thinking Fast and Slow*

Problem: What are these systems or processes? Mechanisms?

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The New Synthesis

Thesis (1950s): Intelligence results from the processing of physical symbols. (Herbert Simon, traditional AI)

Antithesis (1980s): Intelligence results from sub-symbolic processes in neural networks, operating with distributed representations.

Synthesis: Neural networks are capable of symbolic processes, using semantic pointers.

Chris Eliasmith: *How to Build a Brain*, Oxford U. Press, 2013. Eliasmith et al. (2012), *Science*.

Representation and Binding

Representation: pattern of firing in population of neurons

Synchrony: neurons fire in temporal coordination
 Syntax: e.g. Shastri, Hummel
 Consciousness: e.g. Crick, Engel, Scherer

Convolution: activity of neural populations becomes "twisted together": convolve.

Representations are braided together.

Eliasmith has shown how neural populations can perform convolution.
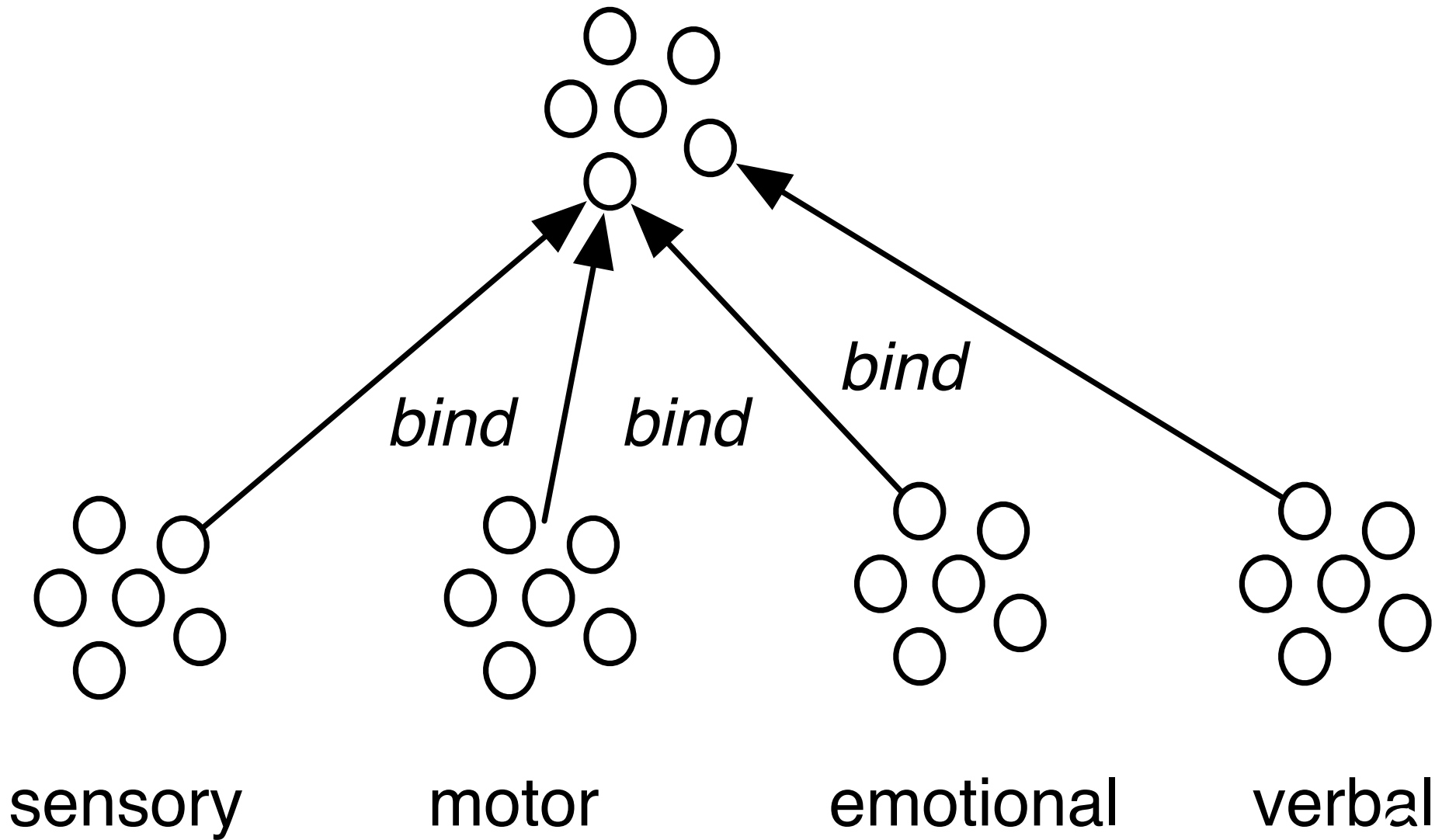
Semantic Pointers
(Eliasmith 2013)

Semantic pointers are patterns of neural firing:

1. provide *shallow meaning* through symbol-like relations to the world and other representations;

2. expand to provide *deeper meaning* with relations to perceptual, motor, and emotional information;

3. support complex syntactic operations;

4. help to control the flow of information through a cognitive system to accomplish its goals.
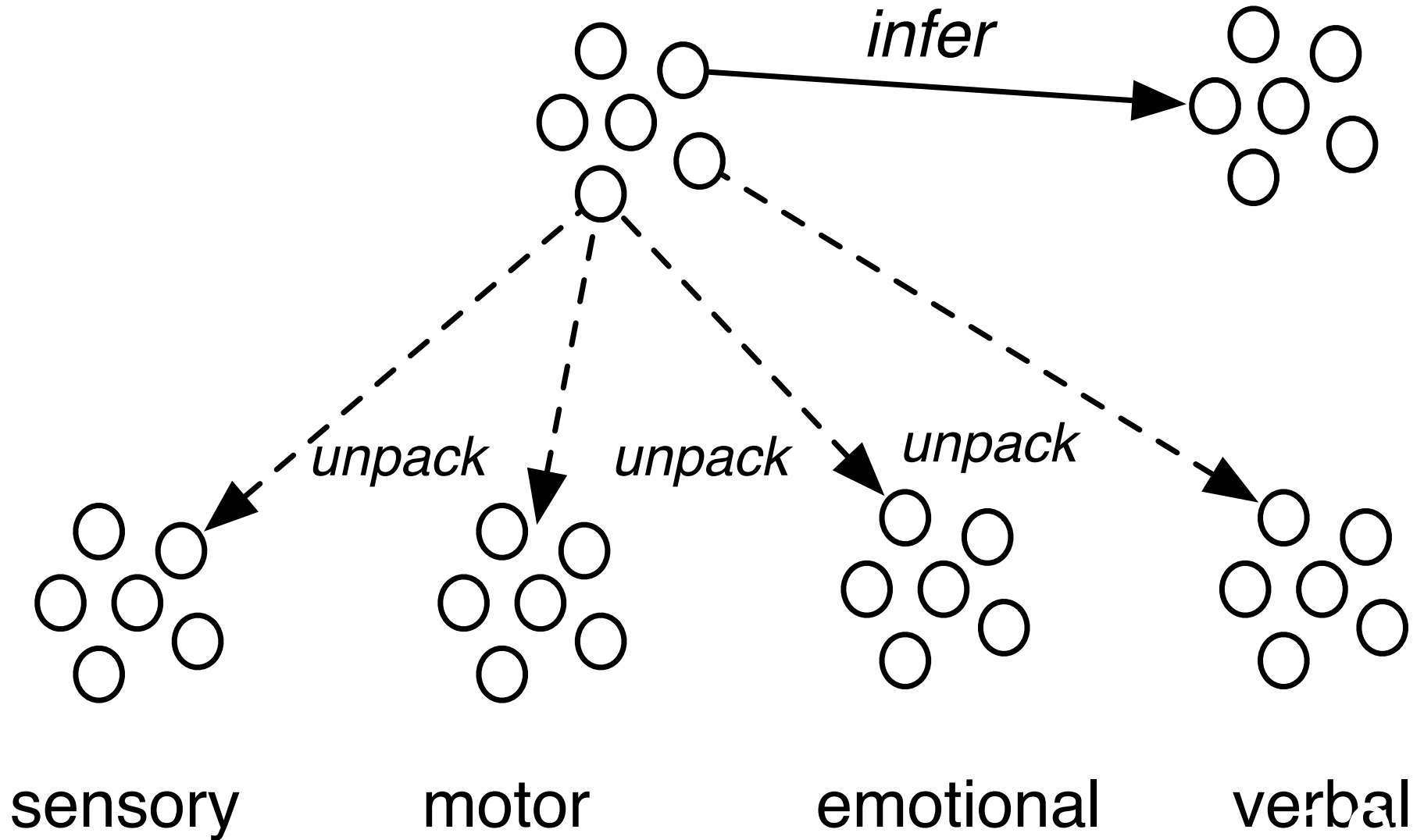
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FORMATION

semantic pointer

bind   *bind*   *bind*

sensory   motor   emotional   verbal

FUNCTION

semantic pointer

infer

unpack   _unpack_   _unpack_

sensory   motor   emotional   verbal

Semantic Pointers Explain:

Emotions (Thagard and Schröder, 2014)

Intention and action (Schröder, Stewart, and Thagard, 2014)

Consciousness (Thagard and Stewart, 2014)

Creativity (Thagard and Stewart, 2011)

Concepts (Blouw, Solodkin, Thagard, Eliasmith, 2016)

Imagery, language, etc. (Thagard, *Brain-Mind*, in progress).

Social sciences and professions (Thagard, *Mind-Society*, in progress).

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Reasoning Rejected

Reasoning does not have the assumed purpose of getting people to believe correctly by virtue of good arguments.

Inference is parallel constraint satisfaction, e.g. by explanatory and emotional coherence. Thagard, *The Cognitive Science of Science,* 2012.

At best, reasoning just serves to convince other people (Mercier & Sperber BBS 2011).

Reasoning Reclaimed

But argument has value: It can provide high-quality, structured information that can help people flip to new cognitive-affective structures.

Reasoning provides information about the elements and constraints that go into coherence judgments.
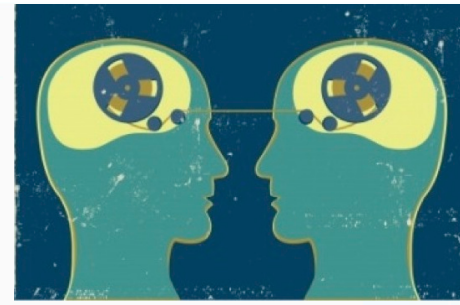
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Reasoning Reclaimed: Examples

1. Personal decisions, e.g. retirement.

2. Legal decisions, e.g. guilty verdicts.

3. Scientific conflicts, e.g. theory choice.

Advantages:

1. Use writing to overcome attention limitations.

2. Share information with others.

Semantic pointer communication

Mechanisms are systems of connected parts whose interactions produce regular changes (Bechtel, Craver, Darden).

Minds operate by neural mechanisms that construct and transform semantic pointers (Eliasmith).

People interact by social mechanisms, where the parts are people and the interactions are communication.

Communication

Communicating is not just transferring verbal messages.

Nonverbal messages: pictures, sounds, touches, smells, tastes, movements, emotions (values, attitudes)

Nonverbal communications: gesturing, pictures, sounds, pointing, tone of voice, body language, facial expressions, etc.

Emotional Communication

Mirror neurons

Emotional contagion via mimicry

Nonverbal spread

Verbal spread

Attachment-based learning

Empathy and emotional analogy

Altruism and sympathy

Emotional cuing, e.g. anger -> guilt

Power: provide something desired, or threaten something feared

Propaganda, advertising

Teaching

Interaction rituals

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Reasoning Reclaimed

Argument is only a part of semantic pointer communication, but can nevertheless be useful by providing elements and constraints for coherence-based inferences.
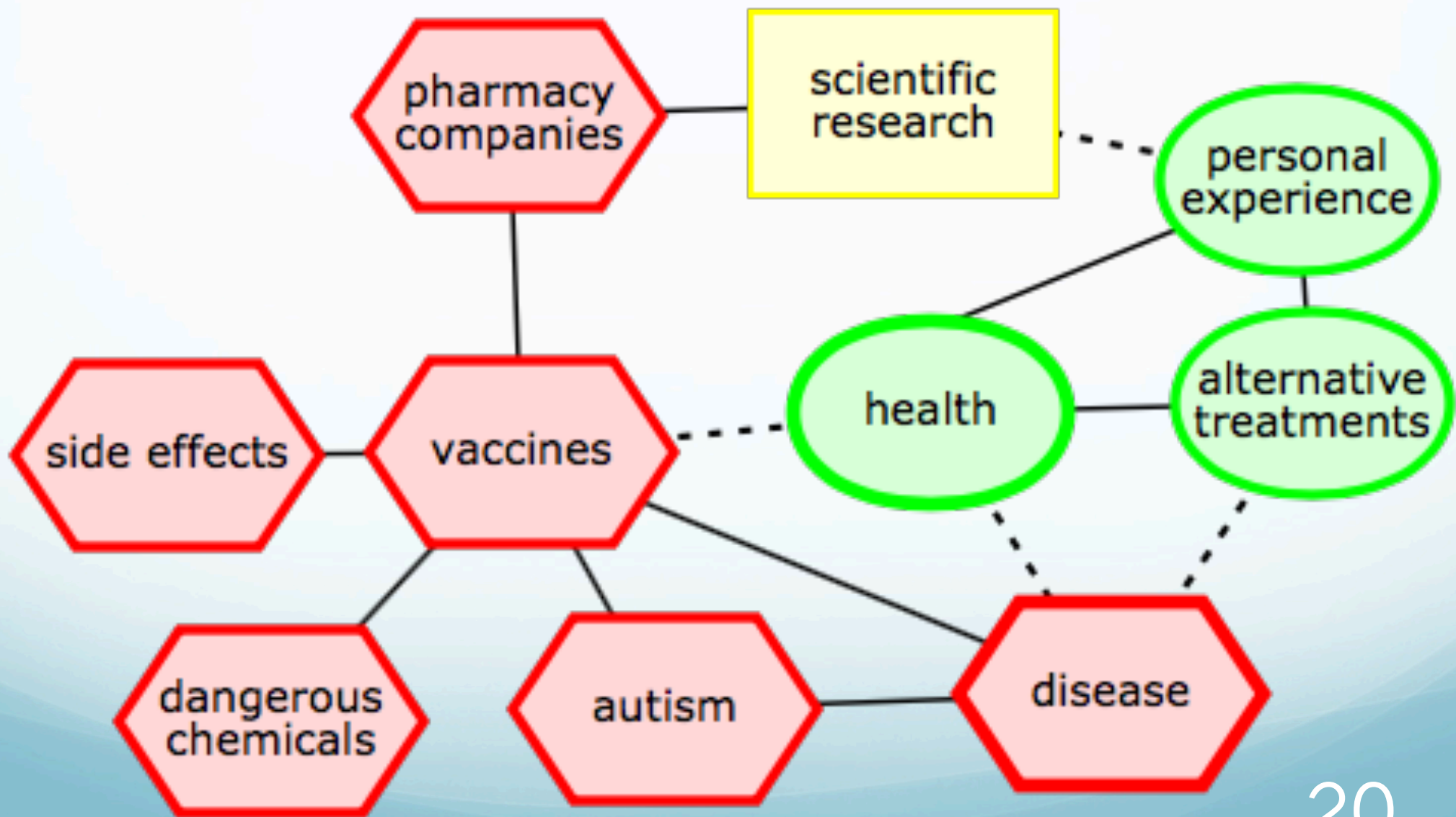
Reasoning can help to transfer, instill, install, and elicit semantic pointers.
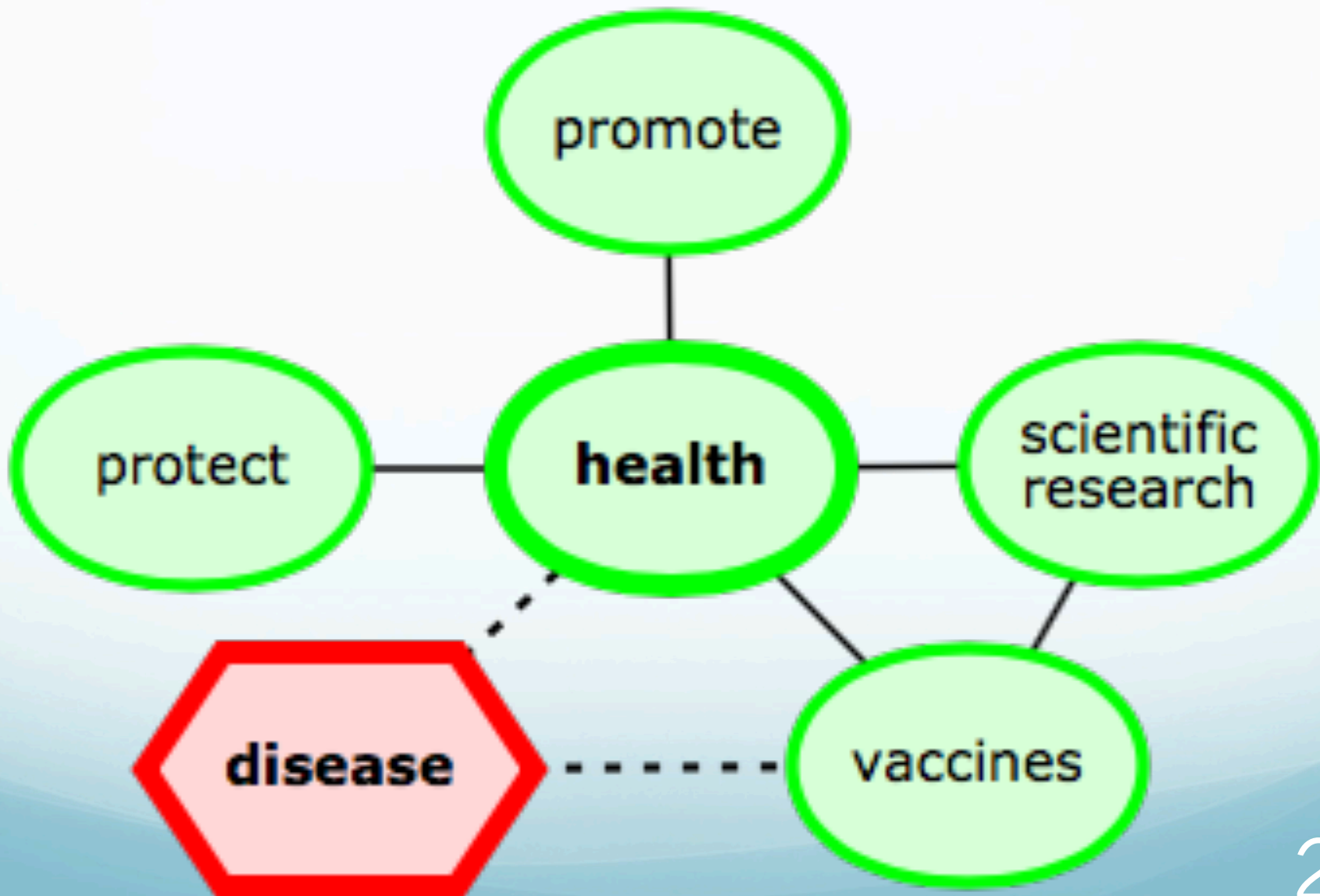
Vaccination Debates

1. Should children be vaccinated?

2. Should parents be required to vaccinate their children?

3. How can parents be educated concerning the values of vaccines?

Vaccination Skeptics

Vaccination Defenders

Social Cognitive-Emotional Workup of Vaccination: A

Concepts and values: vaccination, virus, medicine

Images: pictures

Beliefs: vaccines are untested and cause illnesses

Rules: vaccinate -> sick child

Multimodal rules, e.g. <shot> -> <hurt>

Social Cognitive-Emotional Workup of Vaccination: B

Analogies: Vaccines are time bombs.

Emotions: fear, hope, pride

Inferences: coherence, motivated, fear-driven

Communication: transfer and instillation of semantic pointers

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Vaccination Education

Communication transfers emotional values, not just facts.

Communication is nonverbal (facial expressions, body language, tone of voice, images), not just words.

Teaching Better

1. Reasoning is different from inference.
2. Teaching is semantic pointer communication.
3. Teaching is sensory-motor.
4. Teaching is embodied and transbodied.
5. Teaching is emotional, motivational.
6. Learning requires conceptual change.

Domain General

The Cognitive Science of Science
Explanation, Discovery, and Conceptual Change
Paul Thagard

1. Hypothesis formation
2. Explanatory coherence
3. Analogy
4. Emotion
5. Probability and statistical inference

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Conclusions

1. Reason and inference are different.

2. Thought and communication involve semantic pointers.

3. Reasoning is limited but still useful in education.