What is Mind?

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Outline

1. Theories of Mind
2. Neural representation
3. Recursive binding
4. Interactive competition
5. Representations
6. Creativity

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Theories of Mind

1. Mind=soul (dualism, e.g . Descartes)
2. Mind=nothing (behaviorism, e.g. B. F. Skinner)
3. Mind=computer (functionalism, e.g. Turing)
4. Mind=brain (identity theory, e.g. JJC Smart)

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Mind-Brain Identity

"Mind=brain" is short for: **All mental processes are brain processes**.

Includes:

perception (e.g. vision, pain)
memory
inference, reasoning, learning
language
emotion
consciousness

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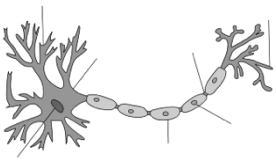
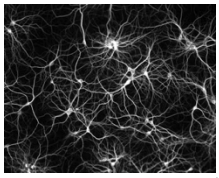
Mind=Brain: Neurons

Brains consist of neurons: cells connected to other cells that build up electrical charges and then fire.

Neurons are connected to other neurons by synapses and fire by chemicals called neurotransmitters.





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Mind=Brain: Representation

Groups of neurons (populations, assemblies) can represent the world by their firing patterns.

Concepts (and other mental representations) are patterns of firing in neural groups.

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Neural Representation

(Chris Eliasmith, Terry Stewart)

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Binding in the Brain

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.

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Convolution in Action

(Thagard & Stewart, AHA!, *Cognitive Science*, 2011)

Recursive Binding

Binding is recursive: binding of bindings of bindings ....

Binding using vectors can produce syntactic complexity (Eliasmith and Thagard, *Cognitive Science*, 2001).

Binding (via convolution) can produce *semantic pointers* that function syntactically, semantically, and pragmatically, with properties akin to both symbols and distributed neural representations.

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Semantic Pointers (Eliasmith 2013)

Semantic pointers are patterns of neural firing that:

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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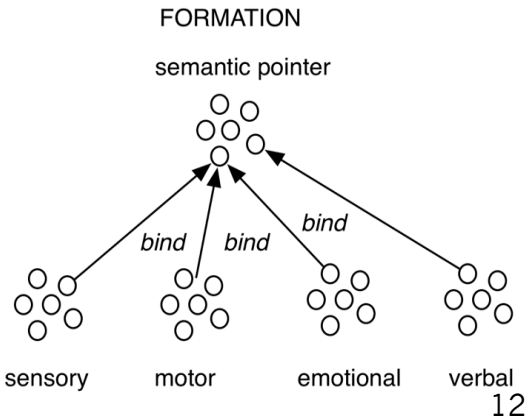

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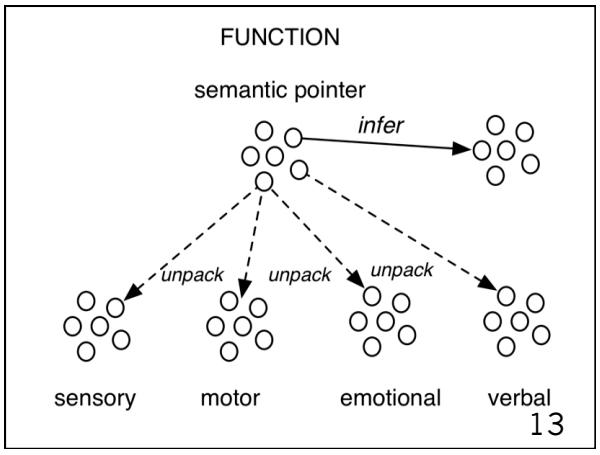

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Binding Processess

Self-consciousness of creativity requires:

BIND (self, discovery, emotional reaction)

Discovery results from binding representations (Thagard & Stewart, *Cognitive Science, 2011;* Thagard, *The Cognitive Science of Science,* 2012).

Emotion results from binding cognitive appraisal and physiological perception (Thagard & Aubie, 2008; Thagard, *The Brain and the Meaning of Life*, 2010, Thagard & Schröder, in press).

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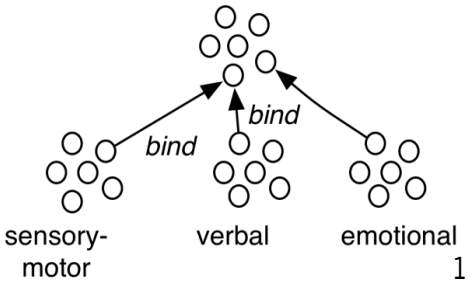
Concepts



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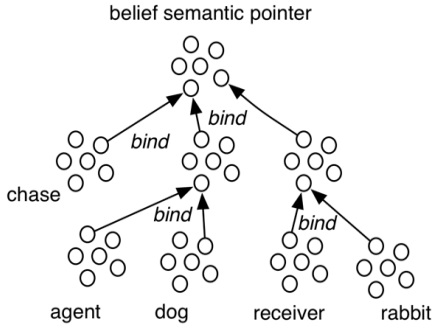
Beliefs



Interactive Competition

Rumelhart & McLelland: Many processes, e.g. language result from interactive activation and competition in neural networks.

Smith & Kosslyn (2007): interactive competition model of attention.

Hypothesis: consciousness of all sorts results from interactive competition among semantic pointers!

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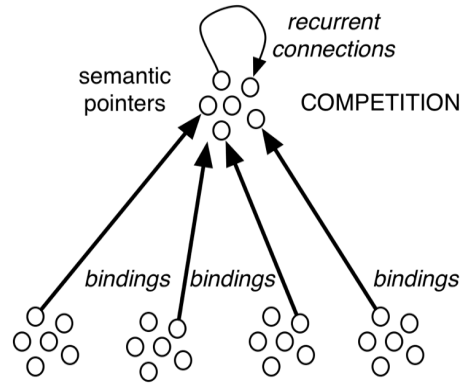

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What is Creativity?

A creative product is:

1. new (novel, original),
2. valuable (important, useful, appropriate, correct, accurate), and
3. surprising (unexpected, non-obvious).

Exemplars: relativity theory, television, public education, Starry Night

Typical features: new, valuable, surprising

Explanatory roles: Creativity explains success, etc.

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Creative Intuition

Where does it come from?

1. Divine inspiration: Muses
2. Platonic apprehension
3. Computational generation
4. Neural mechanisms

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Three Mechanisms

Parts	Interactions	Emergent result
Neurons	Excitation, inhibition, synaptic connections	Representation by firing patterns
Neural groups	Recursive binding	Semantic pointers
Semantic pointers	Interactive competition	Conscious experience

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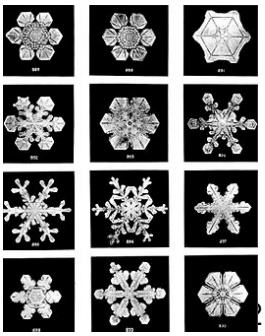
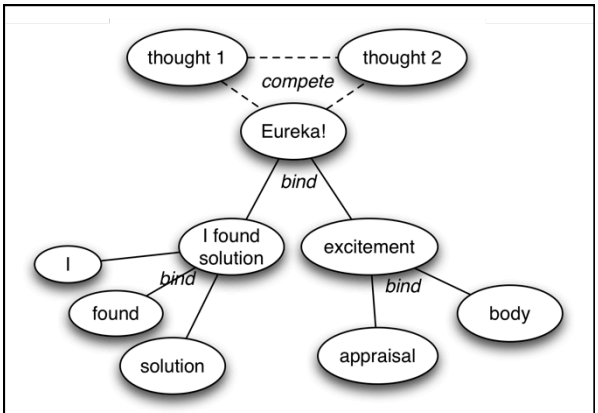
Emergence

Emergent properties are possessed by the whole, not by the parts, and are not simple aggregates of the properties of the parts because they result from interactions of parts.





Products of Creativity

Domains: scientific discovery, technological invention, social innovation, artistic imagination

1. **Concepts**: atom, atomic bomb, hospital, impressionism
2. **Hypotheses**: evolution, fission, public education, atonal music
3. **Things**: moons of Jupiter, wheel, University of Bologna, Mona Lisa
4. **Methods:** experimentation, computer programming, universal health care, impressionism

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Conclusions

1. Semantic pointers show how mental processes can be brain processes.
2. This hypothesis explains concepts, creativity, etc.
3. The best explanation of mind is mind=brain.

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