3. MECHANISM AND EMERGENCE

Paul Thagard
University of Waterloo

1

3a. MECHANISTIC EXPLNATION

Paul Thagard
University of Waterloo

2

Outline

1. Mechanism
2. Science examples
3. Psychology
4. 3-analysis of mechanistic explanation
5. Strengths
6. Weaknesses

3

Mechanistic Explanation

How does a bicycle move?
Parts: frame, wheels, gears, chain, pedals,
Structure: e.g. pedal connected to gear.
Interactions: e.g. pedal moves chain.
Changes: e.g. wheels turn.

4

Mechanism

Mechanism = system of interconnected parts whose interactions produce regular changes.

Results may be emergent, i.e. belonging to wholes but not parts because they result from interactions of parts.

Note that "produce" means more than just what happens next: cause!

5

Mechanisms in Science

Simple machines: lever, pulley, screw

Atoms (ancient Greeks, e.g. Epicurus)

Newtonian mechanics

Dalton's atomic theory

Darwin's evolution by natural selection

Genetics

Germ theory of disease

6

3-analysis of mechanistic explanation

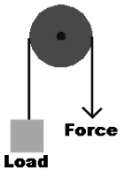
1. Exemplars: Newton, molecules, Darwin, infections, etc.
2. Typical features: parts, connections, interactions, changes
3. Explains: changes, probability
   Explained by: underlying mechanisms

7

Terminology

1. Craver, Darden: mechanisms are entities and activities.
2. Bechtel: mechanisms are parts and operations.
3. Social science: mechanisms are sets of equations.

Note role of images and diagrams.



8

Controversies

1. Are explanations mechanisms (Craver) or representations of mechanisms (Bechtel)?
2. Are mechanisms in the world or in the mind?
3. Do mechanisms have start and finish conditions? Examples: digestion, neural firing.

9

Mechanistic Theories in Cognitive Science

1. Processes are explained by identifying mechanisms, i.e. systems of parts whose interactions produce regular changes.
2. Computational mechanisms: representations and procedures applied to them generate thinking.
3. Neural mechanisms: neurons and their interactions (excitation, inhibition) across multiple brain areas produce inferences.

10

Computational Explanation

How does a computer work?

Parts: data structures, e.g. strings, numbers, lists

Structure: data have parts, relations

Interactions: algorithms operate on data

Changes: calculations, inferences

11

Psychological Explanation

How does a mind work?

Parts: representations, e.g. concepts, image, rules, analogies, emotions

Structure: representations have parts, relations

Interactions: procedures operate on representations

Changes: inferences

12

Neural Explanation

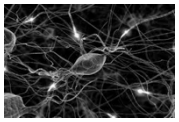
How does a brain work?

Parts: neurons, neural groups, brain areas

Structure: neurons are connected by synapses between axons and dendrites

Interactions: neurons excite and inhibit each other

Changes: inferences are changes in patterns of firing



13

Social Explanation

How does a society work?

Parts: people

Structure: relationships, hierarchies

Interactions: verbal and non-verbal communication

Changes: behaviors, institutions

14

Discussion

1. What mechanistic explanations are most plausible, and which ones are less plausible?

15

Strengths of Mechanistic Explanation

1. Numerous examples in physics, chemistry, biology, medicine, psychology
2. Satisfying: provide causal answers
3. Competing mechanisms can be evaluated with respect to evidence for parts, connections, interactions, and resulting changes.

16

Weaknesses of Mechanistic Explanation

1. Mechanisms in narrative explanations are rarely known. Need psychohistory.
2. Some sophisticated deductive explanations ignore parts: quantum entanglement, economic models, Bayesian psychology, etc.
3. Are mechanisms objective in the world?

17

Application to Consciousness

1. Consciousness results from brain mechanisms.
2. Consciousness results from computational mechanisms.
3. Consciousness results from bodily mechanisms.

18

3a. Conclusions

1. Mechanisms provide explanations in many sciences.
2. Mechanistic explanations are causal.
3. Mechanistic explanations are not universal.

19

3b. Causality and Emergence

Paul Thagard
University of Waterloo

20

Outline

1. Causality
2. Emergence
3. Multilevel emergence
4. The self
5. Mental illness

21

What is Causality?

1. Causality is an illusion (positivism)
2. Causal power – mysterious
3. Constant conjunction – Hume
4. Probability (effect given cause) > probability (effect)
5. Causality is a mind-detectable temporal pattern in the world resulting from mechanisms.

22

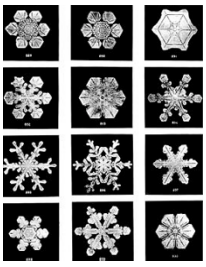
3-analysis of Causality

1. Exemplars: pushes, pulls, motions
2. Typical features:
   a) Sensory-motor-sensory patterns – infants
   b) Regularities: children
   c) Manipulations: children
   d) Statistical dependencies + causal networks: scientists
3. Explains: why things happen, why interventions work. Explained by ???

23

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. (Wimsatt, Bunge)



24

Emergence differs from:

1. Reduction: everything at level 2 is explained by changes at level 1
2. Autonomy: level 2 is independent of level 1
3. Supervenience: necessarily, for every difference at level 2 there is a difference at level 1
   a) Too strong: necessity
   b) Too weak: does not say why level 2 depends on level 1

25

3-analysis of emergence

1. Exemplars: water is liquid, organs function, economic crashes, riots
2. Typical features: parts, wholes with properties resulting from interactions
3. Explains: complexity, unpredictability
   Explained by: Non-linear causal interactions

26

Discussion

What examples of emergence can you think of?

How useful is emergence for understanding explanation?

27

The Multilevel Self

Social self: Parts are people.

Psychological self: Parts are mental representations.

Neural self: Parts are neurons.

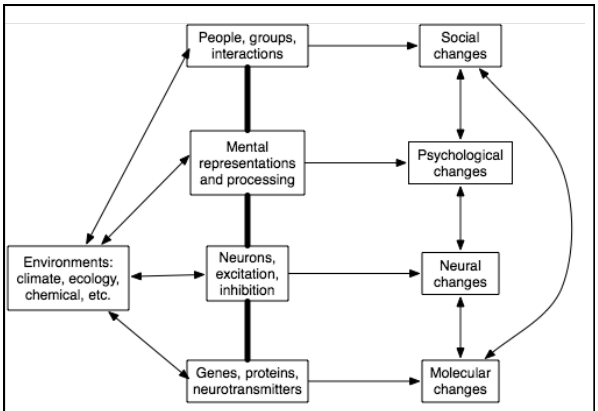
Molecular self: Parts are chemicals.

These are not four selves, but components of one complex system.

Multilevel emergence: the self emerges from multiple levels.

See Thagard 2014 (*Philosophical Psychology*) & Thagard and Wood, 2015 (*Frontiers in Psychology*)

28



29

Recursive Emergence

Changes in wholes result from changes in parts that themselves have emergent properties.

E.g. body ← organs ← tissues ← cells ← proteins and other molecules

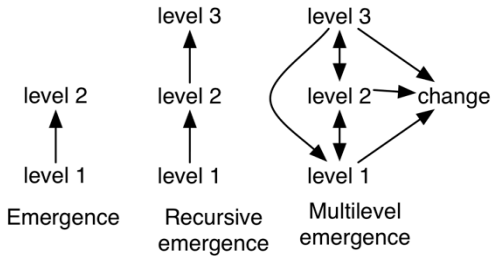
30

Multilevel Emergence

Social events (e.g. riots) and changes (e.g. government) result from multilevel emergence: social, psychological, neural, and molecular mechanisms.

31

Kinds of Emergence



32

Application to Consciousness

1. Thagard and Stewart (2014): Consciousness results from brain mechanisms: neural representation, binding into semantic pointers, semantic pointer competition.
2. Consciousness results from recursive emergence, i. e. emergence from emergence.
3. Multilevel emergence? Social?

33

3b. Conclusions

1. Emergence is common in sciences.
2. Emergence is possession of properties by wholes resulting from interactions of parts.
3. Multilevel emergence produces selves.

34