Medical Inference:

Using Explanatory Coherence to Model Mental Health Assessment and Epidemiological Reasoning

Paul Thagard
paulthagard.com

Outline

1. Computer modeling
2. Mental health assessment
3. Epidemiology
4. Multimodal inference
5. Discovery
6. Errors
7. Social mechanisms

Cognitive Theory in Philosophy of Science

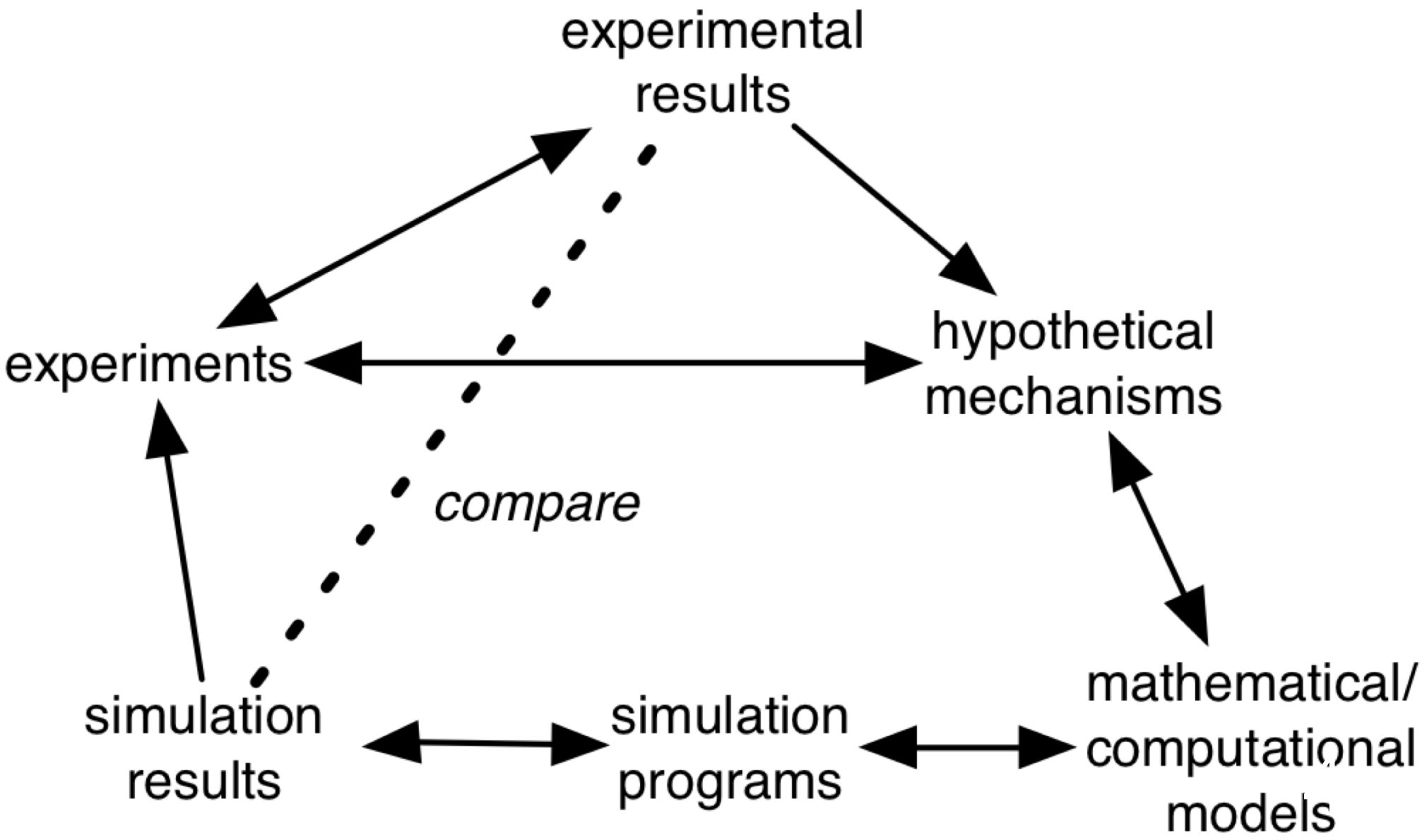
Like science, philosophy of science should explain, not just describe.

Cognitive science explains how scientists think (Kuhn, Darden, Giere, Nersessian, Thagard 2012).

Explanations are descriptions of mechanisms (Salmon, Bechtel, Machamer, Craver, Darden, Thagard 1999).

Mechanisms can be developed and evaluated by computer modeling.

Computer Models of Mechanisms (Thagard 2012, ch. 1)



Medical Inference

Physician diagnosis

Mental health assessment

Causal inference in epidemiology

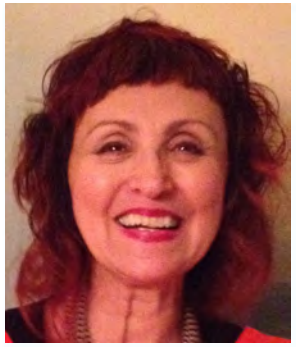
Multimodal inference

Treatment evaluation in evidence-based medicine

Model: Explanatory coherence

Mental Health Assessment

1. **Assessors:** psychiatrists, clinical psychologists, psychotherapists, family physicians
2. **Problems**: depression, anxiety, stress, social problems, psychosis, etc.
3. **Goals**: identify problem and plan treatment



Open Questions

1. How do psychotherapists and other professionals identify problems?
2. Is assessment the same as medical diagnosis?
3. What cognitive processes drive assessment?
4. How does assessment link with treatment?
5. What cognitive/affective errors arise?

Pattern Recognition

Mental disorders present with symptoms that can be listed.

Match symptoms to the list.

The patient has the disorder that best matches the lists.

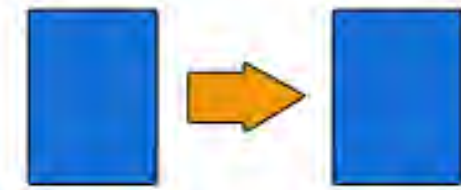
Example: Depression (5 of 9)

1. **Depressed mood most of the day**
2. **Markedly diminished interest or pleasure**
3. **Significant weight loss or gain**
4. **Insomnia or hypersomnia**
5. **Psychomotor agitation or retardation**
6. **Fatigue or loss of energy nearly every day**
7. **Feelings of worthlessness or guilt**
8. **Diminished ability to think or concentrate**
9. **Recurrent thoughts of death or suicide**

Problems with Matching

1. Patterns encourage mere counting rather than assessment of importance.
2. Disorders overlap and combine.
3. Disorders lack causal underpinnings (compare germ theory of disease, NIMH research domain criteria).
4. Identifying symptoms provides minimal clues to deep therapy, as opposed to quick (but sometimes effective) ones like cognitive-behavioral therapy.

Causal Patterns



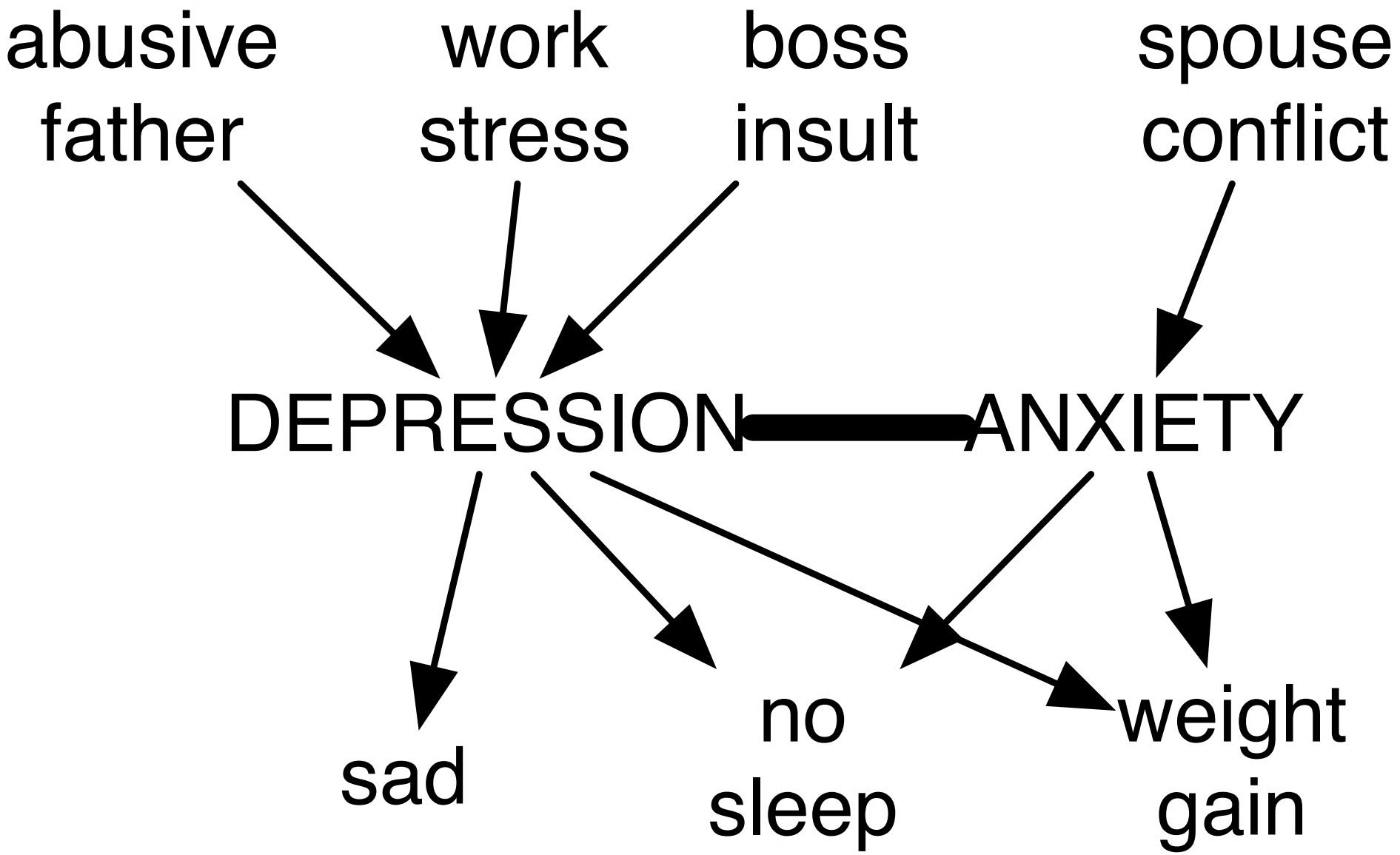
Stressors: economic, occupational, family, educational

Triggers: precipitating events

Symptoms: current manifestation

Stressors + triggers ⇒ symptoms

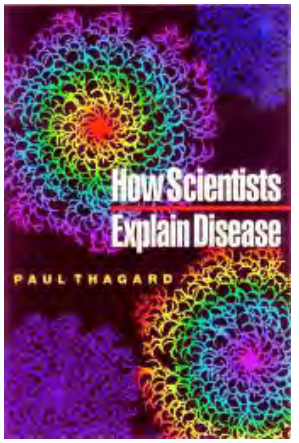
Treatment: intervene causally


abusive father
work stress
boss insult
spouse conflict
DEPRESSION
ANXIETY
sad
no sleep
weight gain

Explanatory Coherence

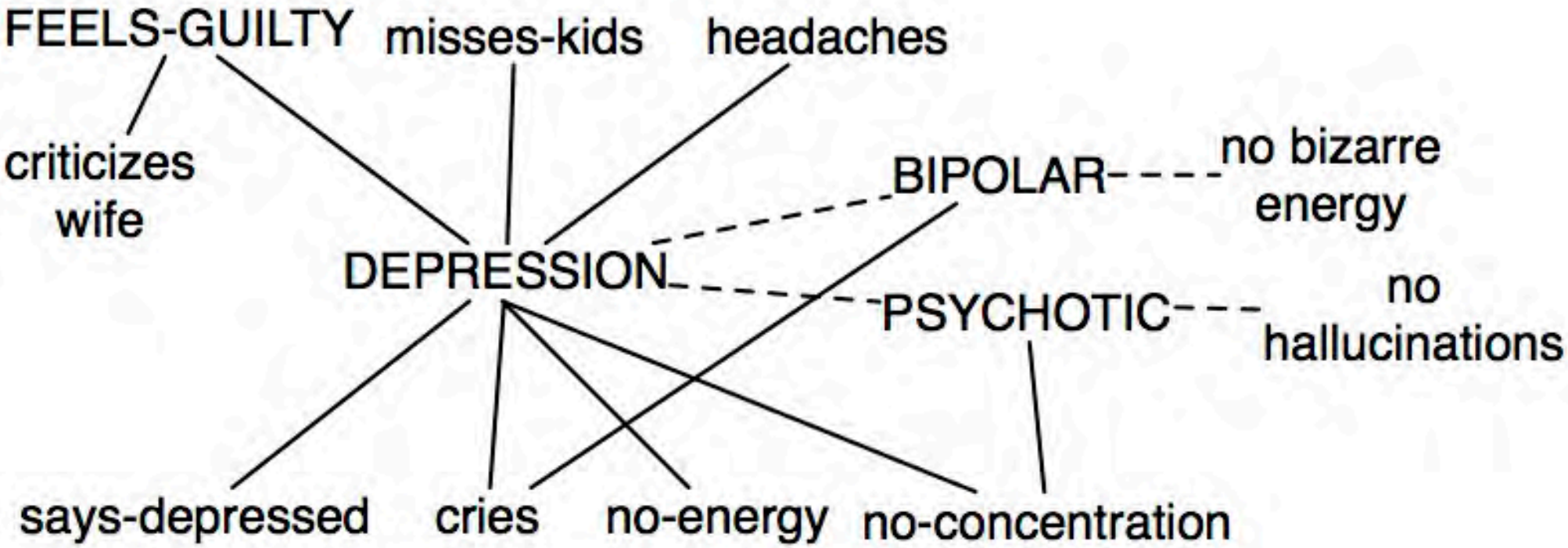
1. Morrison: the best diagnosis most satisfactorily explains the data, signs, and symptoms of illness.
2. Inference to the best explanation requires layers of causes, e.g. motives -> actions -> clues.
3. Layers of causes and alternative explanations are efficiently computed by maximizing explanatory coherence: Thagard 1989, 1992, 2000, 2009, 2012.

Constraint Satisfaction



1. Positive constraints: hypotheses explain evidence.
2. Data priority: evidence based on observation and experiment are better. (Not perfect: patients may lie – also a coherence problem).
3. Negative constraints: incompatible hypotheses.
4. Maximize coherence by neural and other algorithms. ECHO.

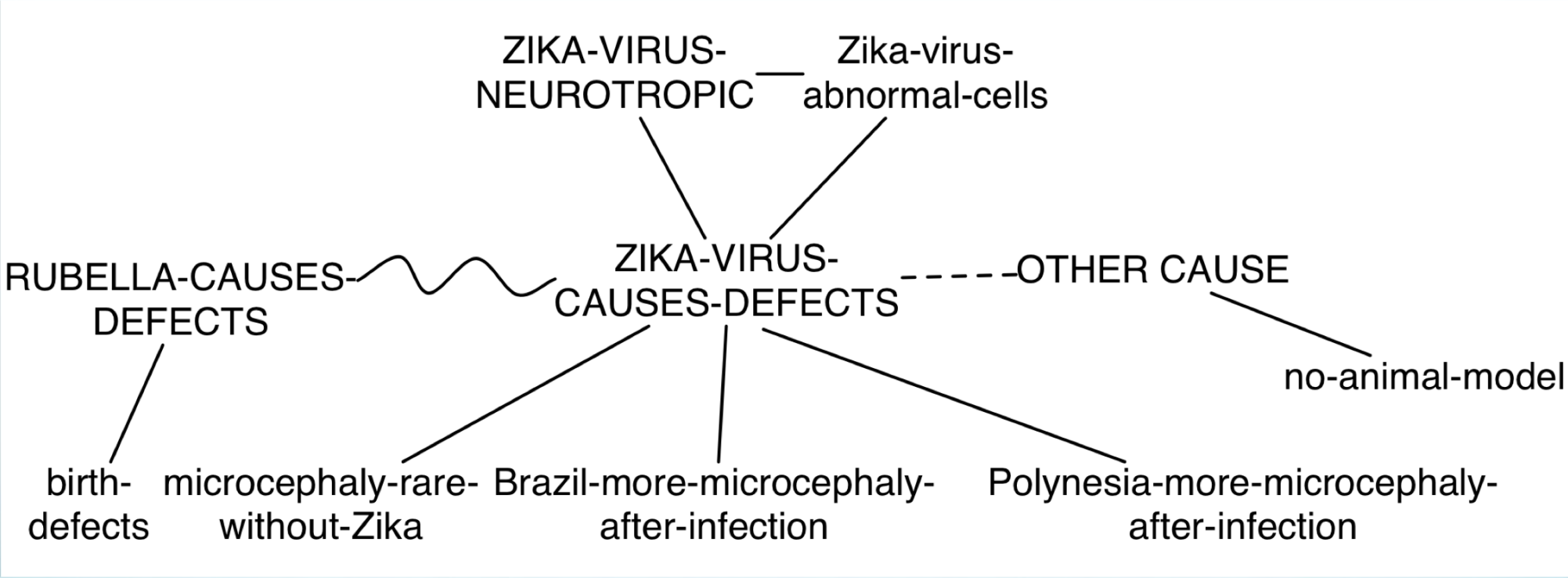
ECHO Simulation



Source: Thagard and Larocque 2018.

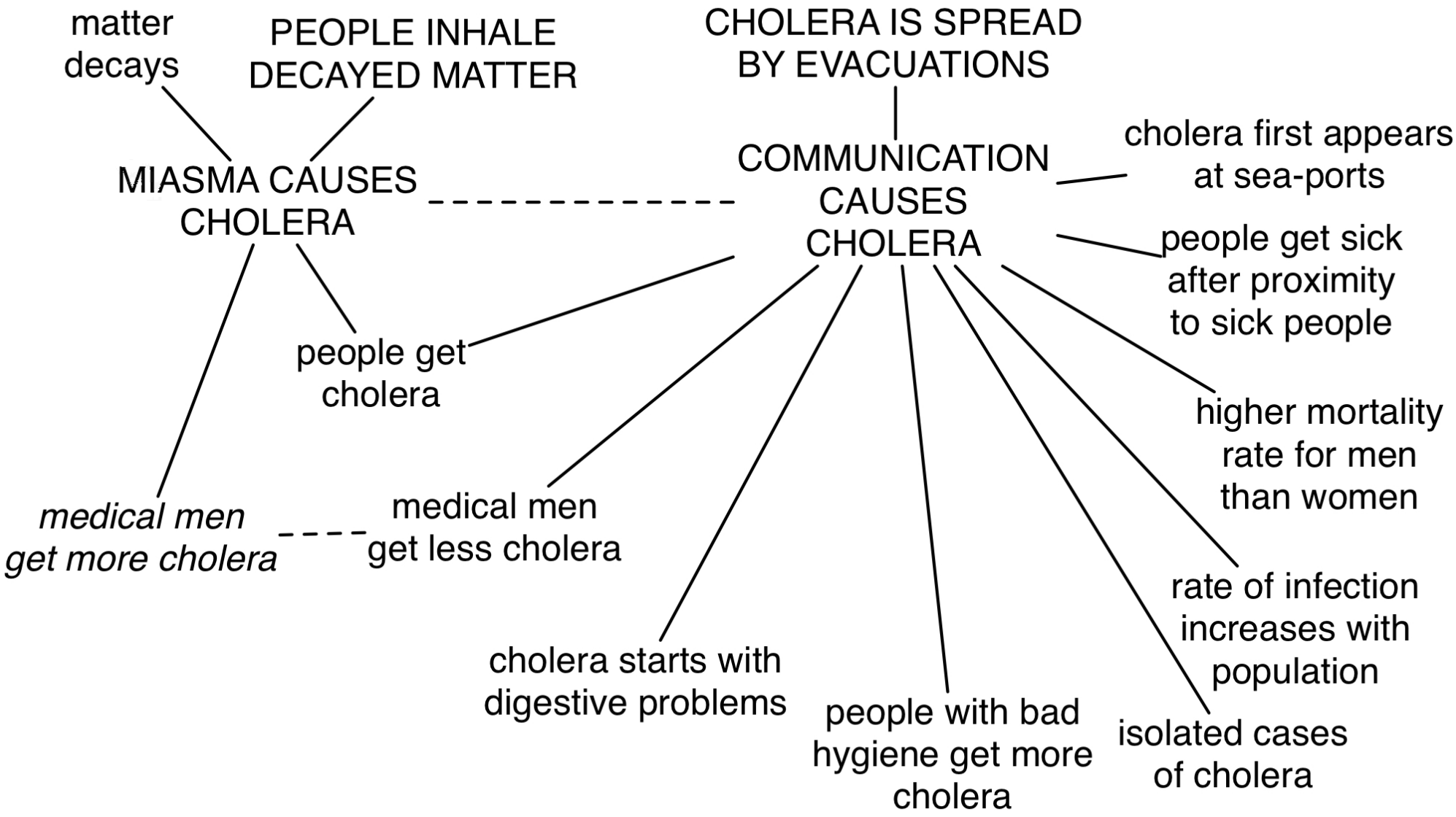
Epidemiology

Does the Zika virus cause birth defects?



Source: Daumann, Poston, & Thagard, in progress.

Snow: Cholera is contagious



Multimodal Inference

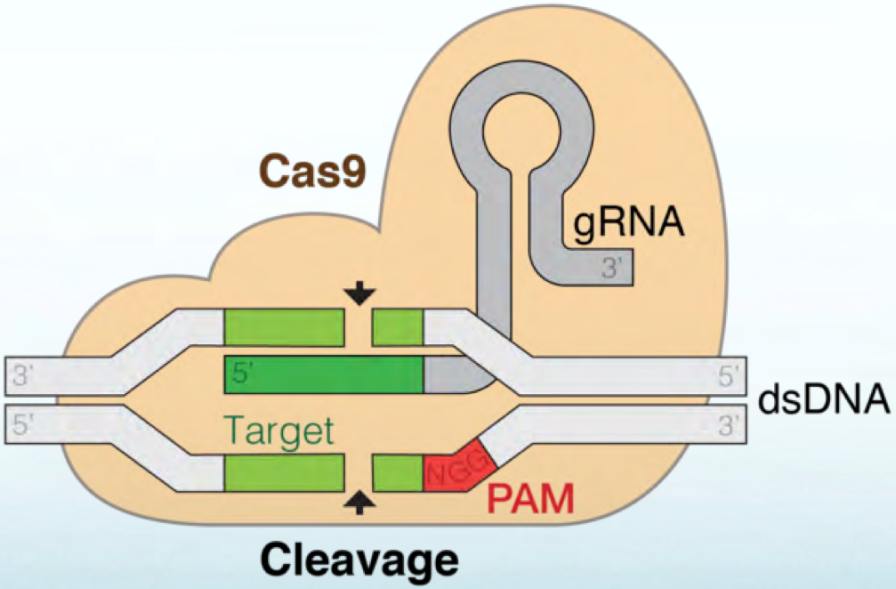
Medical inference is often nonverbal: visual, auditory, olfactory, tactile.

Embodied inference is compatible with ECHO, but not implemented.

Use Eliasmith's Semantic Pointer Architecture! Thagard, *Brain-Mind,* fall, 2018. + *Mind-Society, Natural Philosophy.*

Explain Discovery, e.g. CRISPR/Cas9

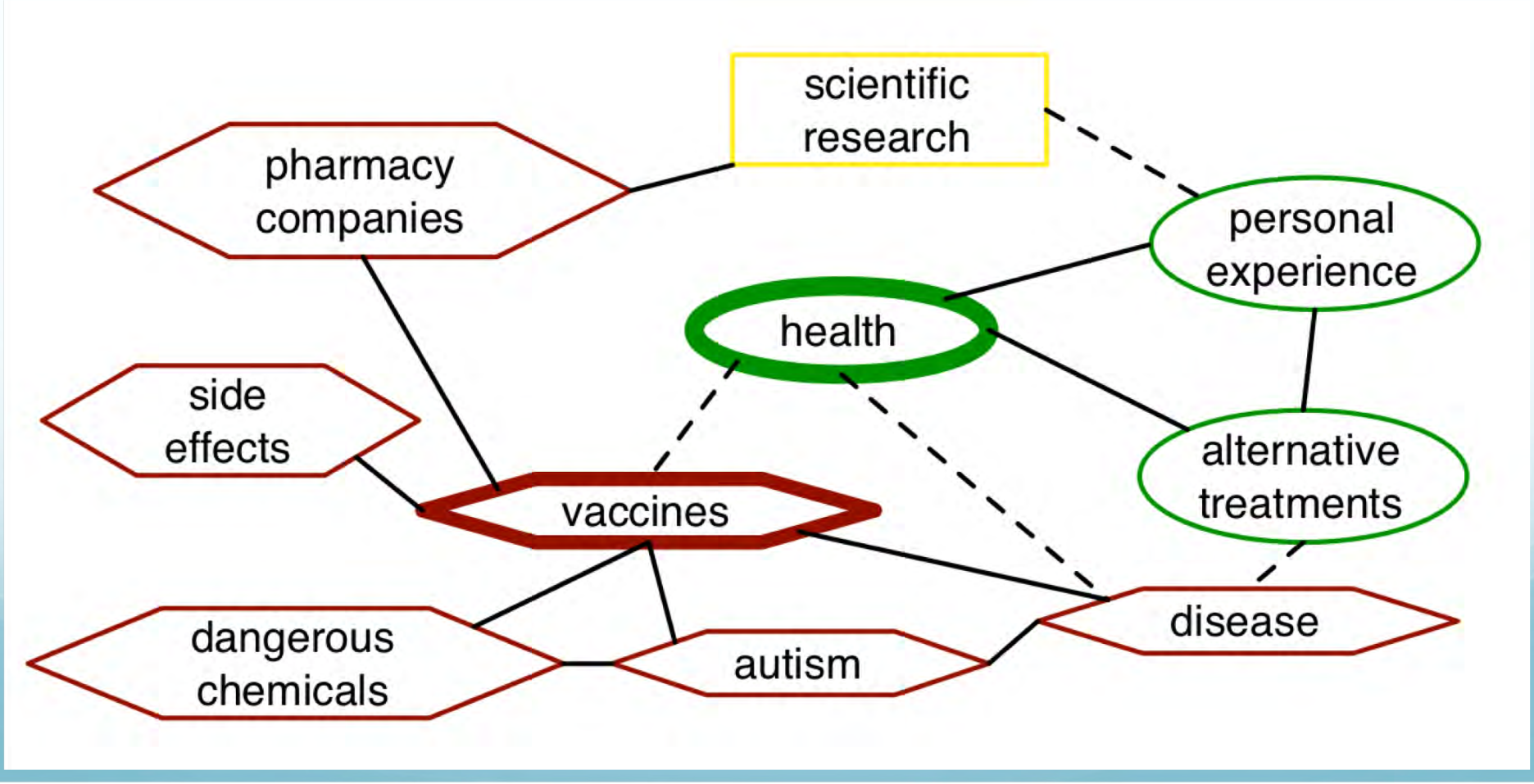
Scientific discovery produces concepts, hypotheses, instruments, and **methods** (procedural discovery).



Thagard, *Brain-Mind, ch. 11.*

Explain Bad Inferences, e.g. Vaccines are Harmful

Medical inference can result from emotional coherence, e.g. vaccines. Thagard, *Mind-Society, ch. 12.*



Social Mechanisms

Science is a social as well as a cognitive process. Agent-based modeling.

The main social mechanism is **communication** of concepts, hypotheses, methods, and values.

Communication is transfer of semantic pointers (Thagard, *Mind-Society*, ch. 3).

More simply, consensus based on explanation can be modeled as coherence + communication (Thagard 2000, ch. 7).

Conclusions

1. Philosophy of science can explain empirical findings by cognitive and social mechanisms.
2. Computer modelling aids in the development and evaluation of mechanisms.
3. Explanatory coherence applies to many kinds of medical and scientific inference, including mental health assessment and epidemiology.

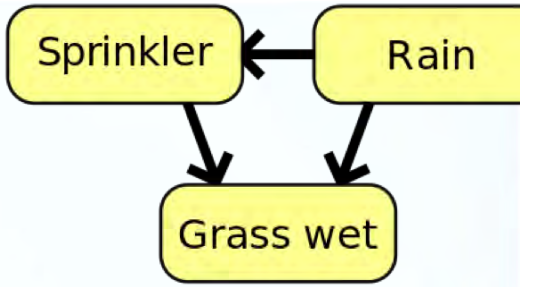
Treatise on Mind and Society

Oxford University Press, fall, 2018.

Brain-Mind: From Neurons to Consciousness and Creativity

Mind-Society: From Brains to Social Sciences and Professions

Natural Philosophy: From Social Brains to Knowledge, Reality, Morality, and Beauty.



Why not Bayesian?

1. Probabilities are largely unknown.
2. Interpretation of probability is problematic.
3. Probabilistic thinking is psychologically difficult. Need to explain errors.
4. Bayesian methods ignore other relevant psychological processes, e.g. analogy, empathy, treatment intentions.
5. Technical difficulties: large networks, feedback loops.