Evidence and causality
in the social and medical sciences

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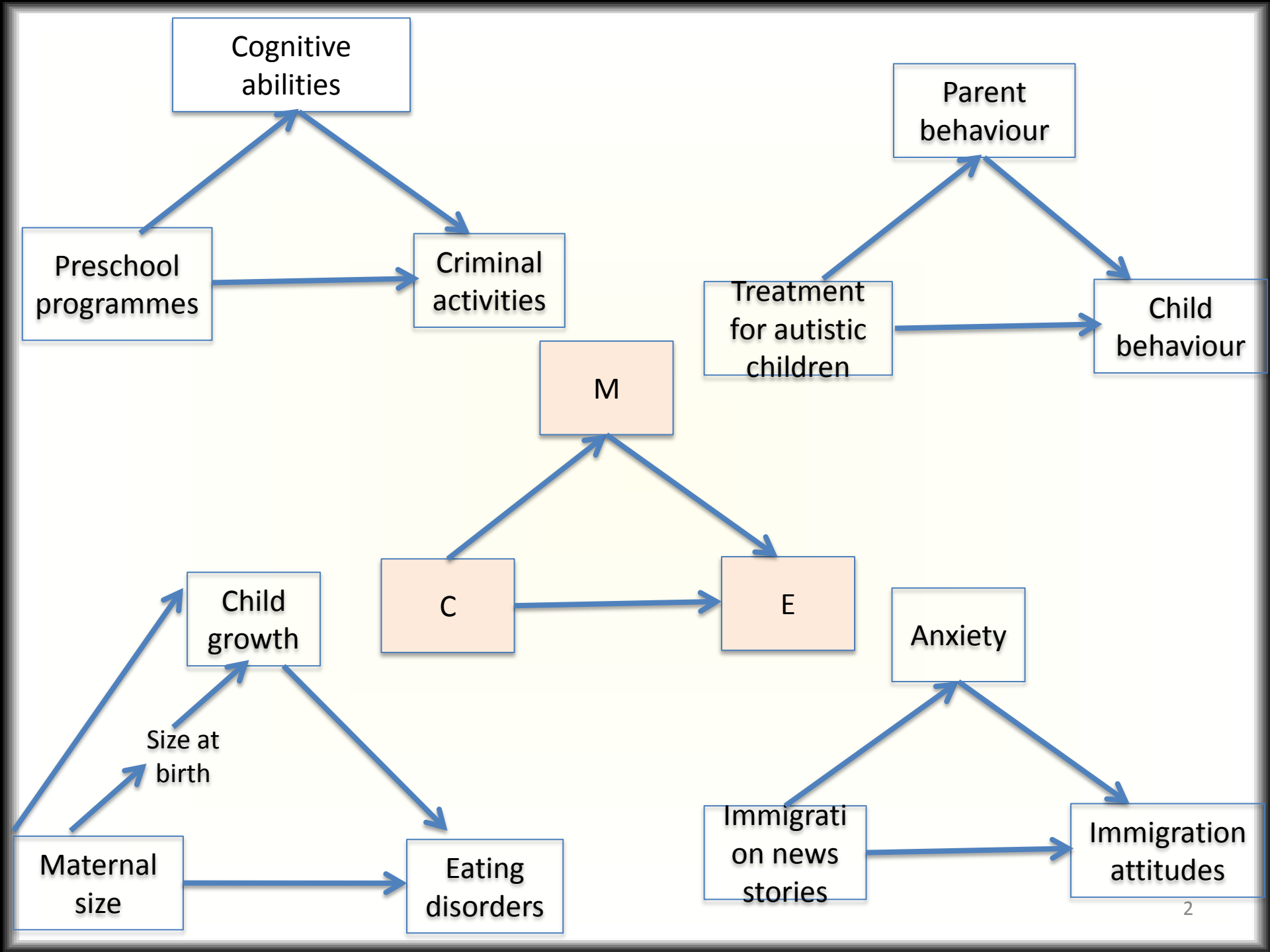
from September 2014: Universiteit van Amsterdam


Cognitive abilities
Preschool programmes
Criminal activities
Parent behaviour
Treatment for autistic children
Child behaviour
M
C
E
Child growth
Size at birth
Maternal size
Eating disorders
Anxiety
Immigrati on news stories
Immigration attitudes

Overview

Causality – Philosophical Theory and Scientific Practice

- Causal assessment
- 5 philosophical questions; 5 scientific problems

Evidence – of difference-making and of production

- What it is
- Where we get it from

Causality

- Causal pluralism
- Interaction between
- Philosophical Theory and Scientific Practice

PHILOSOPHICAL THEORY AND SCIENTIFIC PRACTICE

Causal assessment

‘What Causes What’

Different things we may want to establish:

- what’s the cause of a patient’s illness
- who is (legally / morally) responsible for some state of affairs
- what are the causes of unemployment
- what causes dysfunction in an organisation
- which pathways explain some cellular behaviour
- …

Goals of causal analysis

Knowledge-oriented

Understand and explain a phenomenon of interest

Action-oriented

Predict, intervene on, control a phenomenon of interest

Design / model / debug a system

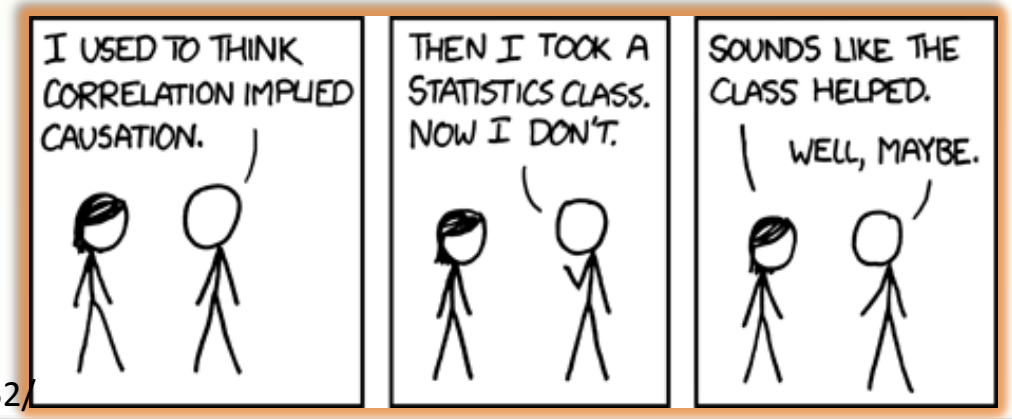
Do causes need to be causes?

Consider:

Smoking and cancer are associated. Should I quit smoking?

Smoking causes cancer. Should I quit smoking?

Causes trigger actions. Mere beliefs can't, nor mere associations.



Source: http://xkcd.com/552/

5 philosophical questions

Metaphysics
What is causality? What kind of things are causes and effects?

Semantics
What does it mean that C causes E?

Epistemology
What notions guide causal reasoning? How can we use C to explain E?

Methodology
How to establish whether C causes E? Or how much of C causes E?

Use
What to do once we know that C causes E?

5 scientific problems

Inference
Does C cause E? To what extent?

Prediction
What to expect if C does (not) cause E?

Explanation
How does C cause or prevent E?

Control
What factors to hold fixed to study the relation between C and E?

Reasoning
What considerations enter in establishing whether / how / to what extent C causes E?

EVIDENCE

What is evidence?

Information, cues, data, results, … indicating that

C *makes a difference* to E

C *produces* E

Evidential pluralism:
To establish causal relations,
we need multiple sources of evidence

Evidence of difference-making in statistical modelling

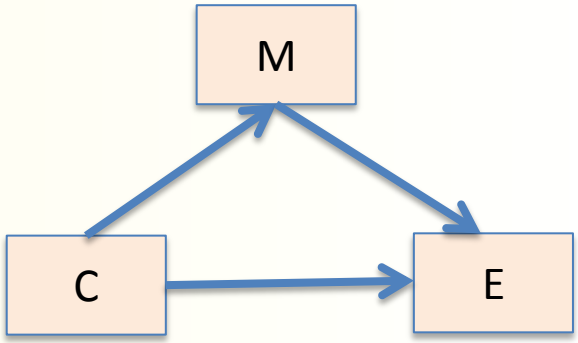
C changes the probability of E

$P(E|C) > P(E)$; $P(E|C) < P(E)$

Variations in C are steadily associated with variations in E

$E = \beta C + \varepsilon$; $Y = \beta X + \varepsilon$

Difference-making in mediation analysis



A mediator is …

“ a variable that occurs in a causal pathway from an independent variable to a dependent variable. It causes variation in the dependent variable and itself is caused to vary by the independent variable ”

Last (1988), from David’s slides, with thanks!

Evidence of production

C is connected to E via…

- A biological mechanism
- A physical process
- A social mechanism / structure
- Information transfer
- …

Where do we get evidence from?

In our background knowledge

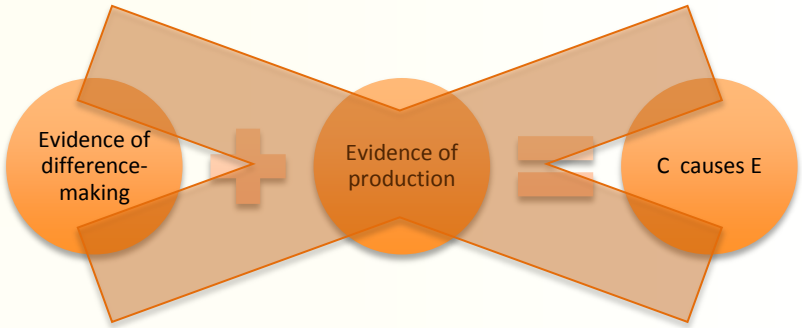
From preliminary analyses of data

As interpreted results of a study

Evidence is something
you seek, use, evaluate
during the whole process of
model building and model testing

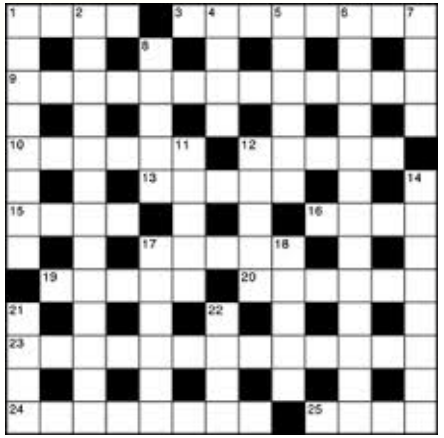
Ask again: What is evidence?

Not a checklist



Related to interpretation, explanation, justification

How to fit pieces of evidence together



The analogy of reinforced concrete

When competing mechanisms act and we have to decide which one will 'win'

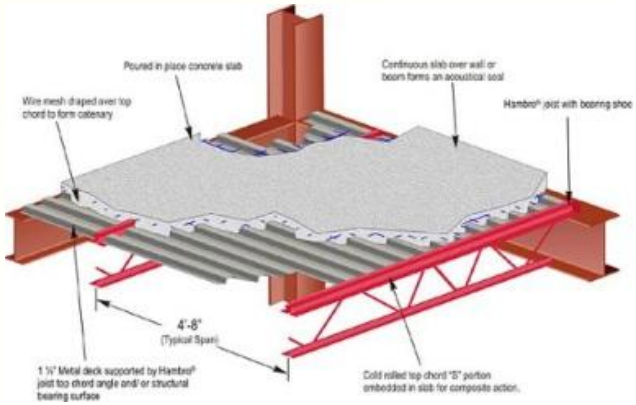
Evidence:

integration, not check list, not substitution

- Difference making helps with masking
- Production (mechanisms) helps with confounding

Difference making and production help each other with their respective weaknesses

- Integration helps solve more problems, and better



Integration – not a new idea: Bradford Hill's guidelines

1. Strength of association
2. Temporality
3. Consistency
4. Theoretical plausibility
5. Coherence
6. Specificity in the causes
7. Dose response relationship
8. Experimental evidence
9. Analogy

CAUSALITY

How many concepts? Many!

Causality

- Polysemic, thick concept

Causal verbs

- Pulling, pushing, binding, …

Causal methods

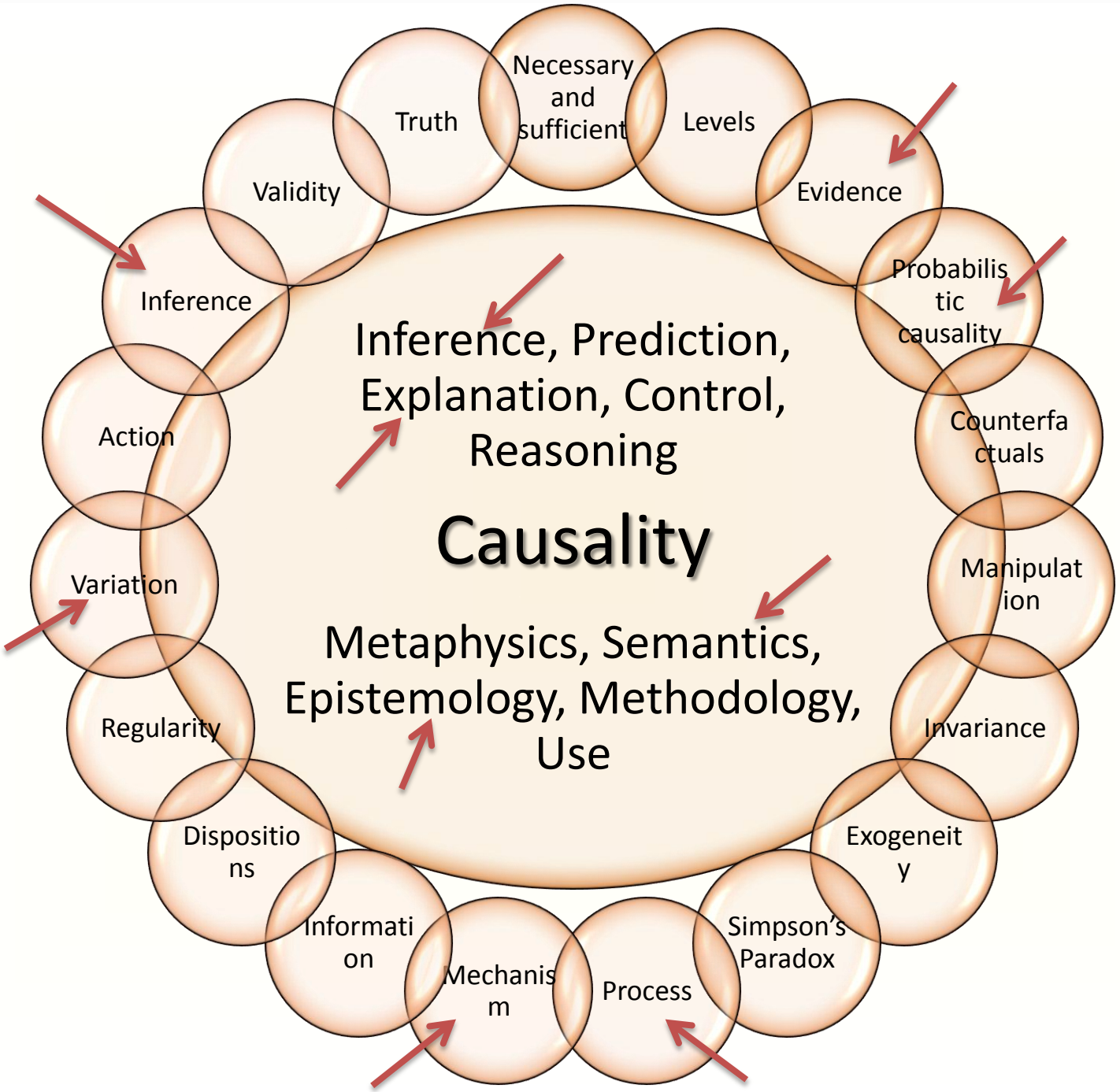
- Tracking what varies with what
- Understanding what produces what, and how, and when

Different sources of evidence

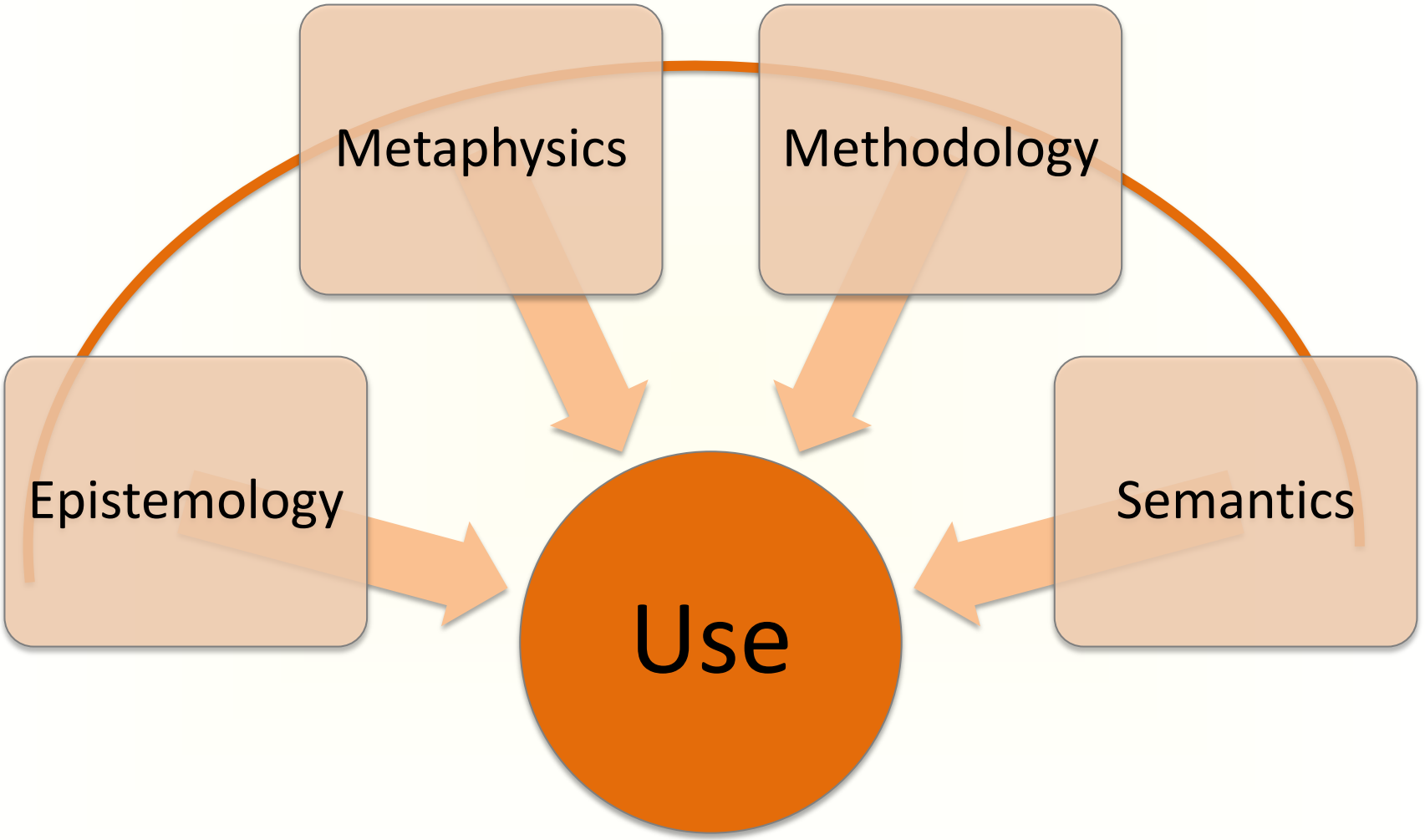
- Evidence of difference making, of production

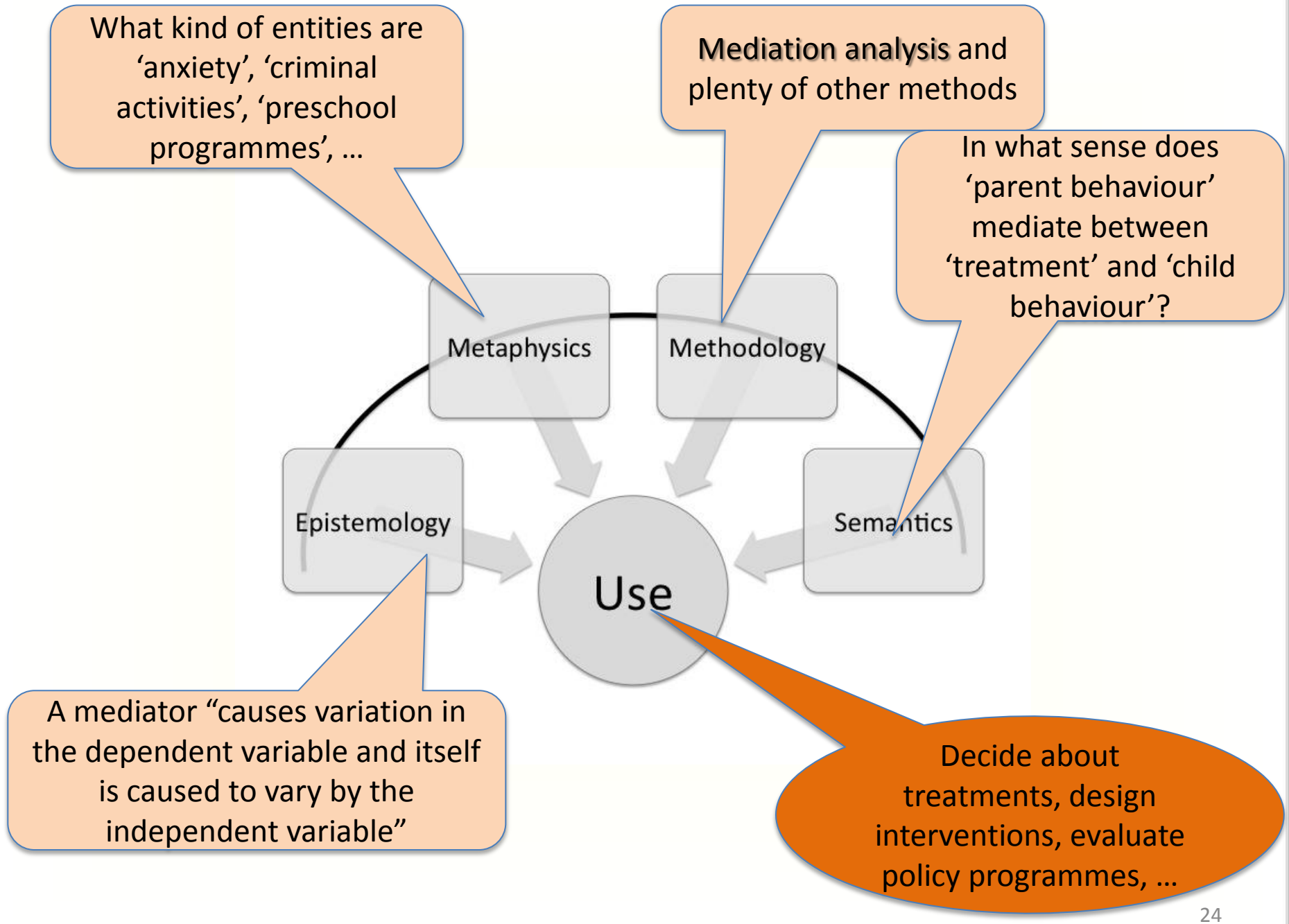
…

Causal pluralism:
Causality cannot be reduced to one single concept
but has to be analysed using several concepts


Necessary and sufficient
Truth
Levels
Validity
Evidence
Inference
Probabilistic causality
Inference, Prediction, Explanation, Control, Reasoning
Action
Counterfactuals
Causality
Variation
Manipulation
Metaphysics, Semantics, Epistemology, Methodology, Use
Regularity
Invariance
Dispositions
Exogeneity
Information
Simpson's Paradox
Mechanism
Process

WHAT DOES PHILOSOPHICAL THEORY HAVE TO DO WITH SCIENTIFIC PRACTICE?


Metaphysics
Methodology
Epistemology
Semantics
Use


What kind of entities are ‘anxiety’, ‘criminal activities’, ‘preschool programmes’, …
Mediation analysis and plenty of other methods
In what sense does ‘parent behaviour’ mediate between ‘treatment’ and ‘child behaviour’?
Metaphysics
Methodology
Epistemology
Semantics
Use
A mediator “causes variation in the dependent variable and itself is caused to vary by the independent variable”
Decide about treatments, design interventions, evaluate policy programmes, …

TO SUM UP AND CONCLUDE

Causality prompts several philosophical questions and is concerned with several scientific problems

- Epistemology, Metaphysics, Methodology, Semantic, Use
- Inference, Explanation, Prediction, Control, Reasoning

Evidence of difference-making and of production

- Concerns (mainly) epistemology and methodology
- Is needed for inference and explanation

Causality is a polysemic, thick concept

Many notions are at work in the sciences – don't have to stick to one single idea of causality

Philosophical theory and scientific practice are at their best when they work together

Further readings

B. Clarke, D. Gillies, P. Illari, F. Russo, J. Williamson, “Mechanisms and the evidence hierarchy”, *Topoi*, 2014.

S. Haack, *Defending Science. Within Reason*, Prometheus Books, 2003.

P. Illari & F. Russo, *Causality: Philosophical Theory Meets Scientific Practice*, OUP, in press.

F. Russo, *Causality and Causal Modelling in the Social Sciences. Measuring Variations*, Springer, 2009.