University of Kent All blogs

Mechanisms and Causality

A research project funded by the Leverhulme Trust (September 2007 – September 2010)

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This Leverhulme-funded project aims to investigate how mechanisms are used across the sciences in causal explanation and causal inference, finding both the similarities and the interesting differences between different sciences. The mechanisms studied will be protein synthesis in biology, the theory of mind mechanism in psychology, natural selection in evolutionary biology, the price mechanism in economics, and gravitational attraction in physics. The ultimate intention is to use insight from the practice of using and discovering causal relationships in the sciences to inform philosophical work on the metaphysics and epistemology of causation.

Reading Groups

18 December 2008: discussion group, Lille (12 noon)
Wimsatt 94 – The ontology of complex systems,
Bechtel Abrahamsen 08 – From reduction back to higher levels,
Leuridan – Can Mechanisms Really Replace Laws of Nature

19 November 2008 – Reading group: Wimsatt – The ontology of complex systems (CGU2, 3.30-5pm, Centre for Reasoning)

Autumn 2007, Fortnightly Wednesdays 2-4pm, Grimond Seminar room 7

October 3: Peter Machamer, Lindley Darden and Carl Craver (2000). **Thinking about mechanisms**. Philosophy of Science, 67:1-25.

October 17: William Bechtel and Adele Abrahamsen (2005). **Explanation: a mechanist alternative**. Studies in History and Philosophy of Biological and Biomedical Sciences, 36:421-441.

October 31: Stuart Glennan (2002). **Rethinking mechanistic explanation**. Philosophy of Science, 69:S342-S353.

November 14: Stathis Psillos (2004): **A Glimpse of the Secret Connexion: Harmonizing Mechanisms with Counterfactuals**. Perspectives on Science 12(3):288-319.

November 28: Peter Machamer (2004): **Activities and Causation: The Metaphysics and Epistemology of Mechanisms**. International Studies in the Philosophy of Science 18(1):27-39.

December 12: Lindley Darden and Carl Craver (2002): **Strategies in the Interfield Discovery of the Mechanism of Protein Synthesis**. Studies in History and Philosophy of Biological and Biomedical Sciences 33:1-28.

Spring 2008, Tuesdays 10.30-12, ElecSem 1

January 22: Phyllis McKay & Jon Williamson (working paper): **In defence of activities**

February 19: Ned Hall (2004): Two concepts of causation, in Collins, Hall & Paul (eds), **Causation and counterfactuals**, MIT Press

March 4: Mary Morgan (1991): **The Stamping out of Process Analysis in Econometrics, in Appraising Economic Theories**, ed N. de Marchi & M. Blaug (Edward Elgar, pp 237-263 and 270-272). Photocopies will be available with Miriam Waters in the Philosophy office, SECL, Cornwallis Building.

March 18: Julian Reiss (2007): **Do We Need Mechanisms in Social Science?**, Philosophy of the Social Sciences 37(2), 163-184.

April 1: K.D. Kokkotas & N. Stergioulas: **Gravitational waves from compact sources**, in Proceedings of the 5th International Workshop "New Worlds in Astroparticle Physics" see also here and here and intro of

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Publications

Phyllis McKay Illari, Federica Russo & Jon Williamson (eds): **Causality in the sciences**, Oxford University Press, [Amazon UK US], 2011. Introduction:

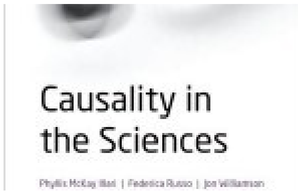
There is a need for integrated thinking about causality,

Events

28-29 June 2010 – **Work in progress in causal and probabilistic reasoning** (Kent Reid Hall Campus, Paris, Centre for Reasoning)

27 January 2010 – **Second UCL-Kent workshop on causality** (KS25, 11-5.20pm, Centre for Reasoning)

9-11 September 2009 – **Mechanisms and causality in**



> *probability and mechanisms in scientific methodology. Causality and probability are long-established central concepts in the sciences, with a corresponding philosophical literature examining their problems. On the other hand, the philosophical literature examining mechanisms is not long-established, and there is no clear idea of how mechanisms relate to causality and probability. But we need some idea if we are to understand causal inference in the sciences: a panoply of disciplines, ranging from epidemiology to biology, from econometrics to physics, routinely make use of probability, statistics, theory and mechanisms to infer causal relationships.*
>
> *These disciplines have developed very different methods, where causality and probability often seem to have different understandings, and where the mechanisms involved often look very different. This variegated situation raises the question of whether the different sciences are really using different concepts, or whether progress in understanding the tools of causal inference in some sciences can lead to progress in other sciences. The book tackles these questions as well as others concerning the use of causality in the sciences.*

Edited Collection: **Causality in the sciences**, OUP, 2010

Phyllis McKay Illari and Jon Williamson:**What is a mechanism: thinking about mechanisms *across* the sciences**, *European Journal for Philosophy of Science* – in press;

> *After a decade of intense debate about mechanisms, there is still no consensus characterization. In this paper we argue for a characterization that applies widely to mechanisms across the sciences. We examine and defend our disagreements with the major current contenders for characterizations of mechanisms. Ultimately, we indicate that the major con-*

the sciences (CGU4)

8-19 September 2008 – **Causality Study Fortnight** (CGU4)

23 July 2008 – **Kent-UCL workshop on causality and linking mechanisms** (CGU2, 1-6pm)

tenders can all sign up to our characterization.

Jon Williamson:**Mechanistic theories of causality**, *Philosophy Compass* 6(6): 421-432, 433-444, 445-447, 2011. Part 1: ; Part II: ; Teaching and learning guide: ; Local combined copy:

Part I of this paper introduces a range of mechanistic theories of causality, including process theories and the complex-systems theories, and some of the problems they face. Part II argues that while there is a decisive case against a purely mechanistic analysis, a viable theory of causality must incorporate mechanisms as an ingredient, and describes one way of providing an analysis of causality which reaps the rewards of the mechanistic approach without succumbing to its pitfalls.

Phyllis McKay Illari: **Why theories of causality need production: an information-transmission account**, *Philosophy and Technology* 24(2): 95-114, 2011;

In this paper, I examine the comparatively neglected intuition of production regarding causality. I begin by examining the weaknesses of current production accounts of causality. I then distinguish between giving a good production account of causality and a good account of production. I argue that an account of production is needed to make sense of vital practices in causal inference. Finally, I offer an information transmission account of production based on John Collier's work that solves the primary weaknesses of current production accounts: applicability and absences.

Phyllis McKay Illari:**Agency theories are not dead yet**, under submission;

Phyllis McKay Illari and Jon Williamson:**In defence of ac-**

tivities, under submission;

Phyllis McKay Illari:**Mechanistic evidence: Disambiguating the Russo-Williamson Thesis**, *International Studies in the Philosophy of Science*, 25(2): 1-19, 2011;

Phyllis McKay Illari and Jon Williamson: **Function and organization: comparing the mechanisms of protein synthesis and natural selection**, Studies in History and Philosophy of Biological and Biomedical Sciences 41, pp. 279-291, 2010, doi 10.1016/j.shpsc.2010.07.001; ;

> *In this paper, we compare the mechanisms of protein synthesis and natural selection. We identify three core elements of mechanistic explanation: functional individuation, hierarchical nestedness or decomposition, and organization. These are now well understood elements of mechanistic explanation in fields such as protein synthesis, and widely accepted in the mechanisms literature. But Skipper and Millstein have argued (2005) that natural selection is neither decomposable nor organized. This would mean that much of the current mechanisms literature does not apply to the mechanism of natural selection.*
> *We take each element of mechanistic explanation in turn. Having appreciated the importance of functional individuation, we show how decomposition and organization should be better understood in these terms. We thereby show that mechanistic explanation by protein synthesis and natural selection are more closely analogous than they appear – both possess all three of these core elements of a mechanism widely recognized in the mechanisms literature.*

Phyllis McKay Illari and Jon Williamson: **Mechanisms are real and local**, in Phyllis McKay Illari, Federica Russo and Jon Williamson (eds): *Causality in the Sciences,* Oxford University Press, 2011;

> *Mechanisms have become much-discussed, yet there is still no consensus on how to characterise them. In this paper, we start with something everyone is agreed on – that mechanisms explain – and investigate what constraints this imposes on our metaphysics of mechanisms. We examine two widely shared premises about how to understand mechanistic explanation: (1) that mechanistic explanation offers a welcome alternative to traditional laws-based explanation and (2) that there are two senses of mechanistic explanation that we call 'epistemic explanation' and 'physical explanation'. We argue that mechanistic explanation requires that mechanisms are both real and local. We then go on to argue that real, local mechanisms require a broadly active metaphysics for mechanisms, such as a capacities metaphysics.*

Lorenzo Casini, Phyllis McKay Illari, Federica Russo and Jon Williamson: **Models for prediction, explanation and control: recursive Bayesian networks**, *Theoria* 26(1):5-33, 2011.

> *The Recursive Bayesian Net (RBN) formalism was originally developed for modelling nested causal relationships. In this paper we argue that the formalism can also be applied to modelling the hierarchical structure of mechanisms. The resulting network contains quantitative information about probabilities, as well as qualitative information about mechanistic structure and causal relations. Since information about probabilities, mechanisms and causal relations is vital for prediction, explanation and control respectively, an RBN can be applied to all these tasks. We show in particular how a simple two-level RBN can be used to model a mechanism in cancer science. The higher level of our model contains variables at the clinical level, while the lower level maps the structure of the cell's mechanism for apoptosis.*

Lorenzo Casini, Phyllis McKay Illari, Federica Russo and Jon

Williamson: **Recursive Bayesian networks for prediction, explanation and control in cancer science: a position paper**, Proceedings of the International Conference on Bioinformatics, Valencia, 20-23 January 2010;

The Recursive Bayesian Net formalism was originally developed for modelling nested causal relationships. In this paper we argue that the formalism can also be applied to modelling the hierarchical structure of physical mechanisms. The resulting network contains quantitative information about probabilities, as well as qualitative information about mechanistic structure and causal relations. Since information about probabilities, mechanisms and causal relations are vital for prediction, explanation and control respectively, a recursive Bayesian net can be applied to all these tasks.
We show how a Recursive Bayesian Net can be used to model mechanisms in cancer science. The highest level of the proposed model will contain variables at the clinical level, while a middle level will map the structure of the DNA damage response mechanism and the lowest level will contain information about gene expression.

George Darby and Jon Williamson: **Imaging Technology and the Philosophy of Causality**, *Philosophy and Technology* 24(2): 115-136, 2011.

Russo and Williamson (2007) put forward the thesis that, at least in the health sciences, to establish the claim that C is a cause of E one normally needs evidence of an underlying mechanism linking C and E as well as evidence that C makes a difference to E. This epistemological thesis poses a problem for most current analyses of causality which, in virtue of analysing causality in terms of just one of mechanisms or difference making, cannot account for the need for the other kind of evidence. Weber (2009) has suggested to the contrary that Giere's probabilistic analysis of causality survives this criticism. In this paper we respond to Weber's suggestion, argu-

ing that Giere's account does not survive the criticism, and we look in detail at the case of medical imaging technology, which, we argue, supports the thesis of Russo and Williamson (2007).

Jon Williamson: **Probabilistic theories of causality**, Helen Beebee, Chris Hitchcock & Peter Menzies (eds): *The Oxford Handbook of Causation,* Oxford University Press, pp. 185-212, 2009;

This chapter provides an overview of a range of probabilistic theories of probability, including those of Reichenbach, Good and Suppes, and the contemporary causal net approach. It discusses two key problems for probabilistic accounts: counterexamples to these theories and their failure to account for the relationship between causality and mechanisms. It is argued that to overcome the problems, an epistemic theory of causality is required.

Jon Williamson: **Causal pluralism versus epistemic causality**, Philosophica 77, pp. 69-96, 2008;

*It is tempting to analyse causality in terms of just one of the indicators of causal relationships, e.g., mechanisms, probabilistic dependencies or independencies, counterfactual conditionals or agency considerations. While such an analysis will surely shed light on some aspect of our concept of cause, it will fail to capture the whole, rather multifarious, notion. So one might instead plump for pluralism: a different analysis for a different occasion. But we do not seem to have lots of different concepts of cause – just one eclectic notion. The resolution of this conundrum, I think, requires us to accept that our causal beliefs are generated by a wide variety of indicators, but to deny that this variety of indicators yields a variety of concepts of cause. This focus on the relation between evidence and causal beliefs leads to what I call *epistemic* causality. Under this view, certain causal beliefs are appropriate or ratio-*

nal on the basis of observed evidence; our notion of cause can be understood purely in terms of these rational beliefs. Causality, then, is a feature of our epistemic representation of the world, rather than of the world itself. This yields one, multifaceted notion of cause.

Links

University of Kent **Centre for Reasoning**
The Leverhulme Trust