# THE LOCALISM OF THE CONSERVED QUANTITY THEORY †

Agustín VICENTE*

Received: 2002.4.22.
Final Version: 2002.7.25.

* Departamento de Filosofía, Lógica y Filosofía de la Ciencia, Facultad de Filosofía y Letras, Universidad de Valladolid, Pl. del Campus s/n, 47011 Valladolid. E-mail: agusvic@fyl.uva.es

BIBLID [0495-4548 (2002) 17: 45; p. 563-571]

ABSTRACT: Phil Dowe has argued persuasively for a reductivist theory of causality. Drawing on Wesley Salmon's mark transmission theory and David Fair's transference theory, Dowe proposes to reduce causality to the exchange of conserved quantities. Dowe's account has the virtue of being simple and offering a definite "visible" idea of causation. According to Dowe and Salmon, it is also virtuous in being localist. That a theory of causation is localist means that it does not need the aid of counterfactuals and/or laws to work. Moreover, it can become the means by which we explain counterfactuals and laws. In this paper, I will argue that the theory is not localist (and hence, that it is less simple than it seems). As far as I can see, the theory needs the aid of laws.

Keywords: Conserved quantity theory (CQ theory), Localism of theories of causation, Counterfactuals, Laws of Nature.

CONTENTS

## *Introduction*

In a series of writings presented during the last decade, Phil Dowe has argued persuasively for a reductivist theory of causality. Drawing on Wesley Salmon's mark transmission theory and with the precedent of David Fair's (1979) transference theory, Dowe proposed to reduce causality to the exchange of conserved quantities. Dowe's account has the virtue of being simple (being "beautiful in its simplicity", in the words of Salmon (1994))

*THEORIA - Segunda Época*
*Vol. 17/3, 2002, 563-571*

and offering a definite "visible" idea of what causation is. According to Dowe and Salmon, it is also virtuous in being localist. That a theory of causation is localist means that it does not need the aid of counterfactuals and/or laws to work. Moreover, it can become the means by which we explain counterfactuals and laws.

In this paper, I will argue that the theory is not localist (and hence, that it is less simple than it seems). As far as I can see, the theory needs the aid of laws.

I will first present the theory and show what its merits are. Then I will go on to explain my criticisms to its presumed localism.

## *The Theory*

Dowe usually presents his conserved quantity theory ('CQ theory' hereafter) in the following way:

> CQ1: A *causal interaction* is an intersection of world lines which involves exchange of a conserved quantity.
>
> CQ2: A *causal process* is a world line of an object which possesses a conserved quantity.

(The conserved quantities are: mass-energy, linear and angular *momentum* and charge).

As it has been said, this reductive theory has two basic influences. The first is David Fair's transference theory, according to which causality is reduced to the transference of energy or *momentum*. This notion of transference is understood as a flow of a particular amount of energy or *momentum* from one object to another, and defined in terms of the time derivative of the energy or *momentum*. The second is Wesley Salmon's mark transmission theory. I will introduce Dowe's theory and its merits beginning with this second influence.

Salmon was convinced by Dowe in most of the aspects of his theory (cf. Salmon (1994, 1997)). However, before opting for the conserved quantity theory, Salmon (cf. 1984) held for a long time a theory in which causality was analysed in terms of mark transmission. Both then and now, Salmon's main target was to distinguish between causal processes and pseudoprocesses. His former theory was articulated by means of the following definitions: (i) a process is something that shows a consistency of characteristics; (ii) a mark is the alteration of a characteristic that occurs in a single local intersection; (iii) a causal process is a process capable of transmitting marks; (iv) a causal interaction is an intersection of two processes whereby both are permanently marked. With this apparatus, Salmon tried to draw a demarcation line between causal processes and processes such as the movement of a shadow. His widest discussed example is that of the beacon rotating in the centre of a circular building. A brief pulse of light going from the beacon to the wall is a causal process. If a red filter is placed in its path, the pulse turns red, and remains red from the point of intersection to the wall without further intervention. In contrast, the spot of light that travels around the wall is a pseudoprocess. It can turn red for a moment if, for instance, you place a filter on a point of impact on the wall, but from that point onwards, the spot will not be red without further intervention. As I say, another example of a pseudoprocess is that of a moving shadow: any intervention at the shadow at t —a change of colour, say, from grey to blue- does not carry over to the shadow at t' without further intervention of your part. (Whereas an alteration in the source of the shadow — the light or the body- results in a persistent change).

The CQ theory coincides in this general diagnosis. Processes such as the movement of a shadow or of the spot of light in Salmon's example are pseudoprocesses. The spot of light, in its movement around the wall, has velocity and luminosity, but does not have energy, *momentum* or charge. These belong to the light pulse and to the wall over which it impacts (see Dowe (1992)). The vague concept of mark transmission acquires thus a definite meaning: instances of mark transmission are changes in conserved quantities. In this sense, the conserved quantity theory improves over the initial mark theory: it coincides with the mark theory's diagnoses (that in turn coincide with those of intuitions), but is deeper and more precise. As a matter of fact, the conserved quantity theory can explain why the movement of a shadow or of the rotating spotlight in the circular building are not causal processes. Properties such as velocity cannot be transmitted[1], or exchanged, because they are not conserved. In the classical mechanical interactions the incident *momentum* equals the salient, and it can be thus said that one of the objects transmits its *momentum* to the other, or that they both exchange their *momenta*. Nothing of this sort can be said about velocity: the incoming velocity may vanish in great part. It is thus explained that a process consisting in an object's having velocity but not mass, cannot be a causal process. In order to be a causal process it is necessary that the object has some property that can be transmitted or exchanged, and this means a conserved property.

I take it that the "cleanness" with which this theory accommodates the intuitive distinction between processes and pseudoprocesses is the best argument in its favour. Another very important supportive consideration for the theory, in my view, is that it "makes us see" what causation is, that is, it provides a definite idea as to what causal interactions are, and removes a lot of the mystery that surrounds that elusive relation.

A third significant advantage that Salmon finds in the CQ theory is that it enables him to dispose of a remnant of counterfactual analysis present in his former mark transmission theory (cf. Salmon (1994, pp. 302, 303)). I am not completely sure about whether Dowe's theory is really localist as far as counterfactuals are concerned. There may be interactions taking place between objects that instantiate the same value of a given conserved quantity so that there is no difference in their incoming value and their salient value. Now Dowe rejects the thing-like or substance-like view on conserved quantities, defended, for instance, by Fair (1979), according to which conserved quantities are things or substances that physical objects posses and pass from one to another according to the physical laws. Dowe's position is that the exchange he talks about cannot be seen as, say, a monetary exchange, or an exchange of one thing (a book) for another (a piece of bread). The use of 'exchange' in his theory, he says, is "metaphorical", and stands for a change in the value of a quantity. That is, a causal interaction is, in the end, an intersection of world lines which involves variations in the values of conserved quantities. Thus, in a case like the one commented Dowe's theory should say that the interaction was not causal, unless the criterion was reformulated so that virtual exchanges are contemplated (i.e. an interaction is causal if and only if there is either an actual or a merely virtual exchange of conserved quantities). But that an interaction involves a virtual exchange means that if the value of the conserved quantity instantiated by any one of the processes had been different, then there would have been an actual exchange of conserved quantities.

The simplest example that comes to mind in this respect is an elastic interaction of two causal processes carrying equal quantities of linear *momentum* with the same direction. In such a case, there is no difference in the value of the *momentum* instantiated by any of the objects/processes before and after the interaction. However, there is a difference in the direction of the vector, which in the case of the *momentum*, is also conserved. I suppose that Dowe's CQ theory is not restricted to magnitudes, but applies also to vectors when these are universally conserved, so this simple case would not be a counterexample to his non-counterfactualist theory. But I wonder whether one could contrive a similar case involving energy (and only energy).

## *An Odd Reduction*

My criticism to the presumed localism of the theory, however, comes from its need to invoke laws. In order to put my point, I will make some comments on the "odd" character of the reduction we are concerned with.

The proponents of the CQ theory, or variants of this theory, as well as those who propose to reduce causality to the action of forces (see Bigelow and Pargetter (1990)), take it that they are not doing conceptual analysis. Rather, they are offering necessary a posteriori identifications. However, one can see that the reduction of causality to the exchange of conserved quantities is highly peculiar in that it does not adjust to the pattern of the typical examples of reductions of natural kinds. If that pattern is imported to the present case (as, I think, Kistler (1997) does), we obtain the result that in the worlds where energy, linear and angular *momentum* and charge are instantiated, but not conserved, still there is causality and is identical to the exchange of these (there) not conserved quantities. I think this cannot be. The main — and essential — reason to identify causation with the exchange of these quantities is that these quantities are conserved, so the identity cannot hold in those worlds in which our conserved quantities are not conserved. That is, the identity of causality to the exchange of conserved quantities is not metaphysically necessary.

But if the usual model of necessary identities does not hold, how can we understand the CQ theory? One possible way to do it is restrict the modal scope of the reduction, so that causality is only of physical necessity the exchange of our conserved quantities. However, this goes against what seems to be a principle of the identity relation, namely, that if two entities are identical, they are identical in all (metaphysically) possible worlds.

Another question is that there seems to be no principled reason why a world where energy, *momentum* and charge are not conserved, but other quantities are conserved and exchanged in interactions, should lack causality. (Or worse, that causality would be the exchange of those quantities that are not conserved there). It seems more intuitive, and coherent with the reasons we may have for believing in the CQ theory, that in such a world there is causality, and that causality in that world is the exchange of the quantities that are there conserved.

Given these two initial questions about the reduction, I think the most plausible candidate as a reducing basis of causality is not the exchange of our conserved quantities, but something much more complicated, namely, the exchange of the quantities governed by the conservation laws of a certain world when that world is taken as actual. As it can be seen, this reducing basis is not a physical property or relation, but a function that takes physical law-structured worlds as inputs and gives physical relations as outputs. Still, the identification between causality and this function is a posteriori; i.e. it is not the case that what is offered is the "primary intension" of the term 'causality'[2].

The problem with this view, however, is that if the defender of the CQ theory were happy with it, then she would have become committed to a nonlocalist theory of causation, since the *explanans* of the theory makes essential mention to conservation laws.

Implicit in what has been said, however, is the idea that 'causality' may be a natural kind term that rigidly designates a certain relation (or function). I do not know whether this makes sense, for, in general, it seems to be difficult to develop the notion of rigid designation so that it applies to predicates. Now let me assume that the idea can acquire a definite meaning. Still it may be possible to deny that 'causality' is a rigid designator. This seems to be Dowe's (2000) position[3]. However, he does not claim that 'causality' is a descriptive term either. Rather, his claim is that what his theory attempts to do is give an *empirical analysis* of the everyday notion of causality.

An empirical analysis, according to Dowe, is a restrictive analysis provided by science of a folk concept that yields contingent identities. What physics has done with the notion of causality, he says, is analogous to what it did with the concept of energy, which was a common sense vague notion that was refined and received precise boundaries in the hands of physics. He says "there are many ways that science does inform philosophy, and where philosophy takes these results into account, *that* is empirical analysis" (2000; p. 18). So empirical analysis is an enterprise different from conceptual analysis. But why does empirical analysis give only contingent identities? As I have said, Dowe claims that his theory cannot tell us what causality is in a world that has different conservation laws. Take such a world: Is an object that possesses a quantity that is there conserved a causal process there? Is an object that possesses a quantity that is here conserved (but not there) a causal process there? "The answer in both cases is that the theory does not say" (2000, p. 22).

> In calling this an empirical analysis we emphasise the priority of the claim that the identity holds in actuality. In calling the analysis a contingent identity, we mean that it is contingent on the laws of nature and perhaps even on boundary conditions (*op.cit.*).

I must confess I have some difficulties in understanding Dowe's position. Let's go back to his analogy. Science, as he says, has provided an empirical analysis of the notion of energy. Does this not mean that what 'energy' refers to is fixed for all possible worlds? But his idea, if the analogy works, is that we do not know what energy is in worlds with a different physics from ours. Or consider weight. Classical mechanics tells us that weight is the product of mass and gravitational acceleration. According to Dowe's idea of empirical analysis, this identity holds only in the actual world, and is silent as to what weight may be in a world without gravitational forces (if there can be one). But we know for sure that in such a world there is no weight.

Even if it were defended that 'causality' is a descriptive term — which is not Dowe's position —, there would be no reason to claim to be as ignorant about modal matters as Dowe claims to be. For Dowe says that the theory remains silent even about the worlds where it seems clear that the term, with whatever descriptive material it brings with it, would pick out something, for instance, those worlds where conservation laws govern properties different from the ones conserved in the actual. (The same reasons that make the term pick out the exchange of conserved quantities here would make it pick out the exchange of conserved quantities there).

So I think that this modal agnosticism is unmotivated. Hence, I take it that the most plausible view on the theory is that 'causality' is a rigid designator (if it is possible (i) that 'causality' is a natural kind term, and (ii) that natural kind terms are rigid designators) that stands for a function that picks out exchange relations with different *relata* in the different physical worlds. If this is admitted as a reducing basis (and there is no better candidate on offer) then the CQ theory cannot do without laws.

## *Notes*

† I have to thank Kepa Ruiz and Francisco Cano for their help in physical matters and an anonymous referee for his/her comments. Research for this paper was funded by a posdoctoral fellowship of the Basque Government and by the UPV/EHU 109.109-HB078/99 project from the University of the Basque Country.

[1] I will use these terms, 'transmission' and 'exchange' as if they were synonymous. They express clearly different notions, but I think these differences are not relevant for the present purposes. In contrast, the concept of transference, which belongs to Fair's theory, has very significant differences with the notions of exchange and transmission, as used by Dowe and Salmon respectively (see below).

[2] I am here using a talk that has become very influent lately, that of two-dimensionalism (see Chalmers (1996)). According to two-dimensionalism, terms have two kinds of meaning or intension. Secondary intensions pick out the referents of the terms when other worlds are taken as counterfactual, and thus stay with the referent of the term in our world, so to speak, whereas primary intensions consider other worlds as actual. So the primary intension of a term is also a function from possible worlds to referents (or 'secondary intensions'). However, this function is linked *a priori* to the term. For instance, the primary intension of 'water' is the function that picks out the odourless, colourless, tasteless liquid that fills oceans and lakes in each world.

[3] It is Fair's: "if the statistical mechanical analysis of temperature cannot be faulted for not telling us what temperature is in all possible worlds, the physicalist analysis of causation ought to share the analysis's immunity from such criticism" (1979, p.232). In the heyday of necessary a posteriori physicalist reductions of these days, this position does not seem to be easy to defend. The analogy, of course, is condemning.

## *BIBLIOGRAPHY*

Bigelow, J. and Pargetter, R.: 1990, 'Metaphysics of Causation', *Erkenntnis,* 33: 89-119.
Chalmers, D.: 1996, *The Conscious Mind,* Oxford, Oxford University Press.
Dowe, P.: 1992, 'Wesley Salmon's Process Theory of Causality and the Conserved Quantity Theory', *Philosophy of Science,* 59: 195-216.
Dowe, P.: 1995, 'Causality and Conserved Quantities: A Reply to Salmon', *Philosophy of Science* 62, 321-333.
Dowe, P.: 2000, 'The Conserved Quantity Theory Defended', *Theoria* 15, 11-31.
Fair, D.: 1979, 'Causation and the Flow of Energy', *Erkenntnis* 14, 219-250.
Kistler, M.: 1997, 'Reducing Causality to Transmission', *Erkenntnis* 48, 1-24.
Salmon, W.: 1984, *Scientific Explanation and the Causal Structure of the World,* Princeton, Princeton University Press.
Salmon, W.: 1994, 'Causality Without Counterfactuals', *Philosophy of Science* 61, 297-312.
Salmon, W.: 1997, 'Causality and Explanation: A Reply to Two Critiques', *Philosophy of Science* 64, 461-477.

*Agustin Vicente* is associate professor at the University of Valladolid. He presented his dissertation, focused on the exclusion problem for mental causation, in December 1998, at the University of the Basque Country. He has enjoyed a postdoctoral fellowship at the University of Barcelona, and has been associate professor at the University of Santiago de Compostela. He has published several papers in *Theoria*, *Crítica* and *Erkenntnis*. His work is now focused on two main topics: mental causation and the relationships between language and thought.