

# Presentism and Causal Processes

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## *Abstract*

Presentism is the view that only present temporal entities (tenselessly) exist. A widely-discussed problem for presentism concerns causation and, more specifically, the supposed cross-temporally relational character of it. I think that the best reply to this problem can already be found in the literature on temporal ontology: it consists, roughly, in showing that (at least) some of the main approaches to causation can be rephrased so as to avoid commitment to any cross-temporal relation, including the causal relation itself. The main purpose of this paper is to extend this reply to the process view, an approach to causation that has not been considered within this debate until now. I shall do this by taking into account Dowe's conserved quantity theory—a recent and prominent theory of this sort—and employing it as a proxy for the other major process theories of causation. In dealing with Dowe's process theory of causation, however, two additional problems must be faced: one concerns the four-dimensional spacetime framework on which its formulation relies; the other concerns the very notion of causal process (and the companion notion of causal interaction). While the presentistic account of Dowe's theory (and, virtually, of the process view of causation in general) put forth in this paper is intended primarily as a contribution to the mentioned paraphrase-based enterprise of reconciliation between presentism and causation, I shall also offer some reasons for presentists to prefer the process view of causation to the other views of causation that have already been reconciled with presentism.

*Keywords:* Causal processes, Causation, Cross-temporal relations, Presentism.

## 1. Introduction

Presentism is the metaphysical view that only present temporal entities (tenselessly) exist. (Presentism contrasts with a variety of views on time; for the purpose of this paper, however, it suffices to mention just the main opponent of presentism: *eternalism*, the view that past and future entities (tenselessly) exist as well.)<sup>1</sup> A widely-discussed problem for presentism regards causation—an aspect of reality playing a pivotal role in many branches of science and philosophy, and in ordinary thought as well. Part of this problem finds expression in the *argu-*

<sup>1</sup> As to the current “triviality debate”, in line with Sider (2001), Hestevold and Carter (2002), Torrengo (2012), and others, I think that the predicate ‘exists’ occurring in the definition of presentism (and of the other theories in temporal ontology) should be read as tenseless, i.e., as expressing an attribution of existence deprived of tense.

*ment from causation*, which runs as follows.<sup>2</sup> Causation is a relation taking events as relata. In many—if not all—cases, the causal relation is *cross-temporally exemplified* or, more briefly, *cross-temporal*, i.e., exemplified by its relata at different times. So, in many—if not all—cases, if one of the causal relata exemplifies the causal relation at the present time, the other one exemplifies it at a past time or at a future time.<sup>3</sup> But for a relation to hold between two (or more) entities, it is required that the entities it relates (tenselessly) exist (at the times they exemplify the relation). Hence, presentism must be false. As anticipated, however, the problem that presentism has with causation is captured by the argument from causation only partially. In fact, depending on the various ways of detailing its nature, causation may be thought to involve various further relations (e.g., precedence, temporal contiguity, spatial contiguity, momentum transfer) between the cause-event and the effect-event or between the constituents of them (e.g., objects and times). Of course, if any of these further relations prove to be cross-temporal—and some of them surely do so, e.g., the precedence relation, which is inherently cross-temporal—then they result to be problematic for presentism just like the causal relation.<sup>4</sup>

Various philosophers—Sider (1999), Crisp (2005), Bourne (2006: 109-15), Brogaard (2006) and (2013), and McDaniel (2010)—have addressed this problem by showing that at least some of the main views about causation—the regularity view, the counterfactual view, and the primitivistic view have been considered—can be reformulated so as to avoid commitment to any cross-temporal relation, not even to the causal one.<sup>5</sup> In this paper, the sort of reply put forward by these authors will be extended to a fourth major view of causation: the *process view of causation*.<sup>6</sup> This will be done by taking into consideration the version of it elaborated by Dowe (2000), namely the *conserved quantity theory* or *CQ theory*, and employing it as a proxy for any of the major process theories of causation. The idea is that the presentistic reformulation of Dowe's CQ theory expounded in this paper may be re-employed, with some appropriate modifications, to presentistically account for the other major process theories of causation as well. This way of proceeding seems licit for two complementary reasons: first, the CQ theory is one of the most recent and accurately worked-out process theories, and thus a good specimen of this kind of approach to causation; second, the CQ theory shares important structural similarities with the other major process theories: especially with recent proposals such as those of Salmon (1997 and 1998: 13-24)

<sup>2</sup> Other versions of this anti-presentistic argument are offered by Bigelow (1996), Crisp (2005), Bourne (2006: 109, 110), and McDaniel (2010).

<sup>3</sup> I write 'in many—if not all—cases' in order not to exclude in principle possible cases of simultaneous causation, i.e., cases in which the causal relation is exemplified by its relata at the same time.

<sup>4</sup> In this connection, it is worth mentioning that the argument from causation is part of the broader *argument from cross-temporal relations*, in which any cross-temporal relation is put forward as troublesome for presentism (hence, for example, besides causal relations, intentional, resemblance, semantic, and precedence relations).

<sup>5</sup> To be exact, the regularity view has been addressed by Sider (1999), Crisp (2005), and Bourne (2006: 110-13); the counterfactual view by Crisp (2005), Bourne (2006: 113-14), Brogaard (2006), and McDaniel (2010); the primitivistic view by Sider (1999), Crisp (2005), Bourne (2006: 114-15), Brogaard (2006) and (2013), and McDaniel (2010).

<sup>6</sup> I am not a presentist; in this paper, however, I put myself in the shoes of the presentist and defend presentism.

and Kistler (2006), but also—although to a lesser extent—with less recent proposals such as those of Aronson (1971), Fair (1979), and Castañeda (1980).

In recasting Dowe's process theory of causation according to a presentistic perspective, however, two problems must be addressed in addition to the one regarding cross-temporal relations. One concerns the fact that Dowe's CQ theory is originally formulated within the theoretical framework of Minkowski spacetime, which is a notoriously hostile environment for presentism. The other additional problem concerns the central notion of causal process and the companion notion of causal interaction, both of which designate sorts of entities that cannot fit in their entirety into the instantaneous present of the presentistic universe. As will be shown, this latter problem is an instance of a wider problem that presentism has with *durative events*, i.e., events taking a nonzero amount of time to occur.

This paper is organised as follows: §2 outlines the core content of Dowe's theory of causation (making a few little terminological changes and theoretical adjustments) and mentions some merits of the process view of causation both in general as a theory of causation and specifically for the presentist;<sup>7</sup> §3 addresses the problem of the Minkowskian spacetime framework; §4 addresses the problem of causal processes, causal interactions, and durative events *qua* temporally extended entities; §5 addresses the problem of cross-temporal relations; §6 concludes by offering a presentistic reformulation of Dowe's analysis of the grounds of causation and by laying bare the main controversial assumption underlying the solution adopted.

## 2. Essentials of Dowe's Conserved Quantity Theory of Causation

The key idea of the process view of causation is that a causal relation between two events must be accounted for by resorting to the causal processes and the causal interactions linking them. A *causal process* is the possession of a causally relevant physical property by an object through space and time (or spacetime) or the transfer of such a property by means of an object through space and time (or spacetime). A *causal interaction* is a spatial and temporal (or spatiotemporal) overlapping of two or more causal processes that involves the exchange of a causally relevant physical property between the constitutive objects of them or the transfer of such a property from the constitutive object of one causal process to the constitutive object of another. These notions may be taken to form the basic conceptual structure that, beyond differences in development and terminology, is common to the various process theories of causation.

In Dowe's CQ theory, the notions of causal process and causal interaction are defined as follows (2000: 90; for a reason that will be adduced in a moment, some amendments are made):

CQ1. A *causal process* is a world line [more exactly: a world tube] of an object possessing a conserved quantity.

CQ2. A *causal interaction* is an intersection of world lines [world tubes] that involves exchange of a conserved quantity.

<sup>7</sup> The exposition of Dowe's theory will be inevitably concise, focused on those elements having a relevance to the issue of its compatibility with presentism. The reader new to this theory is advised to refer directly to Dowe's works, especially to Dowe 2000 (chapters 5-8).

The notions of process and world line are defined as follows (2000: 90, 91; again, with some amendments):

A *process* is the world line [world tube] of an object, regardless of whether or not that object possesses conserved quantities. [...] A *world line* [just like a *world tube*] is the collection of points on a spacetime (Minkowski) diagram that represents the history of an object. This means that processes are represented by elongated regions, or 'worms', in spacetime.

The difference between a world line and a world tube is the following: a world line is the spatiotemporal path of an ideal point-like particle (not a real particle); a world tube is the spatiotemporal path of a real spatially extended object. And here is the announced reason to amend Dowe's exposition: the objects involved into the CQ theory belong to the latter kind, not to the former, as Dowe's very definition of object makes clear (2000: 91):

An *object* is anything found in the ontology of science (such as particles, waves and fields), or common sense (such as chairs, buildings and people).

For this reason, talk of world lines should be replaced by talk of world tubes throughout the exposition of the CQ theory. The notions of conserved quantity, intersection, and possession, which are also employed in CQ1 and CQ2, are defined as follows (2000: 91, 92):

A *conserved quantity* is any quantity that is governed by a conservation law, and current scientific theory is our best guide as to what these are. For example, we have good reason to believe that mass-energy, linear momentum, and charge are conserved quantities [...]

An *intersection* is simply the overlapping in spacetime of two or more processes. The intersection occurs at the location consisting of all the spacetime points that are common to both (or all) processes. An *exchange* occurs when at least one incoming, and at least one outgoing process undergoes a change in the value of the conserved quantity, where 'outgoing' and 'incoming' are delineated on the spacetime diagram by the forward and backward light cones, but are essentially interchangeable. The exchange is governed by the conservation law, which guarantees that it is a genuine causal interaction. It follows that an interaction can be of the form  $X, Y, \lambda$ , or of a more complicated form.

'*Possesses*' is to be understood in the sense of 'instantiates'. An object possessing a conserved quantity is an instance of a particular instantiating of a property. We suppose that an object possesses energy if science attributes that quantity to that body. It does not matter whether that process transmits the quantity or not, nor whether the object keeps a constant amount of the quantity.

According to Dowe, the relata of the causal relation are *states of affairs* conceived of along the lines of Armstrong (1997), i.e., as exemplifications of attributes (properties or relations) by particular objects (Dowe 2000: 168, 169). States of affairs may be either facts or events (2000: 169,170):

An *event* is a change in a property of an object at a time, for example, a quantitative change; or a related simultaneous change in more than one property of more than one object at a time, and so on. [...] A *fact* is an object having a property at

a time or over a time period. Because both events and facts concern objects, this fits well with the Conserved Quantity Theory.

I shall adopt, however, a partly different terminology, which I find more suitable and organic. Where Dowe talks of states of affairs, facts, and events, I prefer to talk, respectively, of *events*, *static events* and *dynamic events* (in line with Casati and Varzi 2006). This is a merely terminological departure from Dowe for the two typologies perfectly match with each other. In the rest of this section, Dowe's original terminology will be flanked to the one I favour; in the following sections of the paper, replaced by it.

For the purposes of this paper, it is important to establish a further distinction between kinds of events. As a time may be either an instant (i.e., a time of zero duration) or a period (i.e., a time of nonzero duration), we can distinguish between *instantaneous* events and *durative* events. Moreover, durative events can be plausibly considered as mereological sums of shorter and shorter events and, ultimately, of (infinite) instantaneous events ordered in temporal sequence (just like a period of time can be considered as composed of shorter and shorter periods and, by the end, by infinite instants in sequence).<sup>8</sup> As Dowe remarks, the attribute-exemplification view of events (states of affairs, in his terminology) "fits well with the Conserved Quantity Theory"; it may be added that causal processes and causal interactions may in fact be considered as durative events of particular sorts: causal processes as those consisting in the possession of a conserved quantity by a physical object; causal interactions as those consisting in the exchange of a conserved quantity by two or more physical objects.

Dowe's view also includes a form of physicalism, and it must be so if the CQ theory is to be considered as a conception of causation, not simply of physical causation. As Dowe writes (2000: 170):

[S]uch facts [static events] or events [dynamic events], if they enter into causation, must involve conserved quantities or supervene on facts and events involving conserved quantities. For example, the fact that the ball is green must supervene on the fact that various bits of the surface of the ball have certain physical properties by virtue of which the ball looks green. If these properties are not conserved quantities, then they in turn must supervene on conserved quantities. This seems to be a natural development of the Conserved Quantity theory.

Albeit natural, this physicalistic development is not compulsory for those interested in Dowe's CQ theory, which could be accepted as an analysis of physical causation, not of causation *tout court*.

To represent a static event (fact, in the original terminology) consisting in the possession of a specific amount of a quantity, Dowe introduces formulae like ' $q(a) = x$ ' or, more briefly, ' $q(a)$ ', reading 'object  $a$  has ( $x$  amount of) conserved quantity  $q$ '; if a second conserved quantity is involved, it is expressed by ' $q$ ' (2000: 170). To represent a dynamic event (event) consisting in the change in amount of a quantity, Dowe resorts to formulae such as ' $\Delta q(a)$ ', which presuma-

<sup>8</sup> The two distinctions intersect: since a change—in the simplest case—consists in the exemplification of two incompatible properties by the same object at two different instants, instantaneous events cannot be dynamic but only static, while durative events may be either dynamic or static.

bly reads ‘object  $a$  undergoes a variation in the amount of quantity  $q$ ’ (Dowe is not completely perspicuous on this point). To express a causal interaction, e.g., one involving objects  $a$  and  $b$ , and the quantity  $q$ , Dowe simply writes “the interaction  $\Delta q(a), \Delta q(b)$ ”.

In defining the grounds of the causal relation—i.e., in giving necessary and sufficient conditions for the causal relation to hold—Dowe, for simplicity, only takes into account the case where the causal relata are static events (facts, in his original terminology).<sup>9</sup> Where ‘ $a$ ’ and ‘ $b$ ’ represent two objects, and ‘ $q$ ’ and ‘ $q'$ ’ represent two conserved quantities, the causal relation is analysed as follows:

There is a causal connection (or thread) between a fact [a static event]  $q(a)$  and a fact [a static event]  $q'(b)$  if and only if there is a set of causal processes and interactions between  $q(a)$  and  $q'(b)$  such that:

- (1) any change of object from  $a$  to  $b$  and any change of conserved quantity from  $q$  to  $q'$  occur at a causal interaction involving the following changes:  $\Delta q(a), \Delta q(b), \Delta q'(a), \Delta q'(b)$ ; and
- (2) for any exchange in (1) involving more than one conserved quantity, the changes in quantities are governed by a single law of nature (Dowe 2000: 171, 172).

Although this analysis of the grounds of the causal relation involves exactly two objects and two quantities, it can be very easily adapted to cases involving any number of objects and quantities. On the one hand, it can be adapted to cases where only one object is involved by setting  $a = b$  (in which case there would be no causal interaction) or only one quantity by setting  $q = q'$ . On the other hand, it can be adapted to cases where more than two objects or quantities are involved by modifying condition (1), and precisely by adding, for any further quantity or object, the corresponding changes in that quantity possessed by that object. Condition (2) is introduced by Dowe in order to exclude cases where more independent causal interactions occur accidentally in the same place and time (e.g., the case where two billiard balls collide and at that very moment one of the two emits an alpha particle: in this case the emission of the alpha particle is not the effect of the collision because emission of alpha particles and collision between macroscopic objects are governed by different laws of nature).

It should be noticed that neither condition (1) nor condition (2) indicates, of  $q(a)$  and  $q'(b)$ , which one is the cause and which one is the effect. As Dowe

<sup>9</sup> Dowe does not worry to identify a single precise form that causal claims should take (in general or specifically in the CQ theory); in fact, he resorts to a variety of different formulations such as ‘there is a causal connection between a fact  $q(a)$  and a fact  $q'(b)$ ’, ‘ $q(a)$  and  $q'(b)$  are linked by a causal connection’, ‘the quantity of  $a$  is causally responsible for the quantity of  $b$ ’ (see 2000: 171-73). If, in looking for a single precise formulation, we stick to Dowe’s explanation of locutions like ‘ $q(a) = x$ ’ as *sentences*, we face a syntactical problem: the predicate ‘causes’ (just like ‘is causally connected to’ and the like) cannot take sentences as arguments (it would be a syntactical mismatch) but only singular terms. We may fix this problem very easily by introducing an “adapter” symbol that operates turning sentences into singular terms. For example, we may convene that, where  $P$  is a sentence expressing some event,  $\llbracket P \rrbracket$  is the event expressed by  $P$ ; in other terms, ‘ $\llbracket P \rrbracket$ ’ reads as ‘the event expressed by  $P$ ’. This is only a minor adjustment, which does not add anything substantial to Dowe’s account. It allows, however, to formulate causal claims in a more precise fashion. We may write, e.g., ‘ $\llbracket q(a) = x \rrbracket$  causes  $\llbracket q'(b) = y \rrbracket$ ’ and read it ‘the event expressed by ‘ $q(a) = x$ ’ causes the event expressed by ‘ $q'(b) = y$ ’.

(2000: 110) tells us, the CQ theory is symmetric with respect to time and thus noncommittal on the issue of causation's direction, being purposely designed to allow for backwards causation (the reality of which seems to be suggested by quantum mechanics). To account for the prevailing direction of causation in time (i.e., for the fact that, typically, causes are earlier than their effects), the CQ theory must be thus supplemented in some way, and the way chosen by Dowe's is to resort to a version of Reichenbach's fork asymmetry (2000: chapter 8).

Before proceeding with my presentistic re-elaboration of the CQ theory, I must spend a few words to explain why reconciling the process view of causation with presentism is something worth carrying out despite the fact that various views of causation have already been reconciled with it.<sup>10</sup> Since the process view of causation represents one of the standard approaches to causation (along with the other views that have already been reconciled with presentism),<sup>11</sup> a presentistically suitable interpretation of it would constitute an appreciable contribution to the global project of reconciling presentism and causation. This, in my opinion, is the major reason to engage in a presentistic account of the process view.

But the process view of causation has some merits that, perhaps, make it even preferable, both in general *qua* theory of causation and specifically *for a presentist*, to the three views of causation that have already been reconciled with presentism. Here are some of them. First, the idea that it is a causal process (a causal "thread" or "rope"), not simply a causal chain of discrete events, that leads from the cause to the effect is very intuitive, also from a common-sense perspective. Second, a physics-based interpretation of causation, while probably extraneous to common-sense, will be appealing to naturalistically inclined philosophers and might well be appealing to naturalistically inclined presentists, especially considering that presentists seem able to permit themselves only a naturalism with rather narrow limits. (But the narrowness of presentists' naturalism shows in dealing with Dowe's theory as well, as we shall see in the next section.) Third, the process view of causation appears better suited than discrete events-based views—such as the regularity, the counterfactual, and the primitivist views—to host *causal realism*, i.e., the conception that causation is ultimately grounded on causal properties understood as bestowing dispositions to behave in certain ways upon the objects exemplifying them (see Chakravartty 2005: §4). Naturally, in the case of the CQ theory, it would be conserved quantities to play the role of the causally relevant properties at issue.<sup>12</sup> By endorsing causal realism, presentists can perhaps compensate for their antirealism towards the various cross-temporal relations allegedly involved in causation and thus meet the problem of causation in a way that is more satisfying to those eternalists who find their position better because it allows for a realistic stance towards those relations.<sup>13</sup>

<sup>10</sup> I thank the anonymous referee who has recommended that this issue be addressed and has also given some valuable suggestions to address it.

<sup>11</sup> See, e.g., part two of *The Oxford Handbook of Causation*.

<sup>12</sup> Note, however, that the claim that the process view is in accordance with causal realism is not defended by Dowe (who, in fact, seems to take no stance at all on the issue of causal realism).

<sup>13</sup> Naturalism and suitedness to host causal realism as merits of the CQ theory have been suggested by the anonymous referee mentioned in footnote 10.

### 3. The Spacetime Framework

Naturalism is an attractive feature of the CQ theory globally considered, and presentists may well agree on that. However, not every naturalistic element of the CQ theory is of benefit to presentism; in fact, two of them seem rather a threat to it.

As previously mentioned, the CQ theory is devised to allow for backwards causation (it is therefore time-symmetric and needs to be integrated by an explanation of the prevailing direction of causation). But it is very plausible that backwards causation is incompatible with presentism (see Faye 2015: §2); hence, it is very plausible that if backwards causation is real, then presentism is false. The reality of backwards causation, however, is rather controversial; hence, the inability to account for it does not appear to be a very disturbing inadequacy of presentism. Moreover, while this inability may represent a limit to presentists' naturalism (in the case that quantum mechanics really offers reasons to admit of backwards causation), at least it relieves them of the need to account for the idea that causation has a *prevalent* direction: presentists may take causation to have just one direction and causes to be definitionally prior to their effects (how to account for temporal precedence without invoking the precedence relation will be shown in §5).

A more serious problem for presentism, however, emerges from another, very noticeable naturalistic element of Dowe's theory: its being formulated drawing upon Minkowski's four-dimensional spacetime conception, i.e., the geometrical formulation of the special theory of relativity (STR) (see, in particular, Dowe 2000: 90-92). No doubt, this is a theoretical framework *prima facie* hostile to presentism. And that for at least two reasons: first, it is typical of eternalists to treat time as analogous to a fourth spatial dimension and to conceive of the universe as a *four-dimensional* block universe; second, as is well known, one of the most troubling arguments against presentism (and in favour of eternalism) is grounded on the relativisation of simultaneity at a distance involved by STR—or, more precisely, by its standard interpretation, i.e., the Minkowskian or Einsteinian one.

I think, however, that the *four-dimensionality* of Minkowski spacetime *per se* does not represent a problem for presentism: Galilean spacetime is also four-dimensional, but it raises no problem for presentism. By 'spacetime', one may mean a spatiotemporal entity, i.e., the concrete reality itself as it is conceived of by eternalists (the block universe); however, by 'spacetime' physicists primarily mean a *four-dimensional manifold*, i.e., a mathematical—hence, *abstract*—entity. Understood in this latter way, a spacetime can be considered neutral with regard to the various theories conflicting in temporal ontology: such a manifold can be used to *represent* an eternalist block universe or a presentist slice universe, depending on the section of the manifold we consider corresponding to what (tenselessly) exists (see Wüthrich 2013).

The real problem for presentism stems from the peculiar geometrical features of Minkowski spacetime as compared to the Galilean one. Minkowski spacetime, unlike the Galilean one, does not allow to define an invariant notion of simultaneity at a distance, which is a necessary prerequisite for an objective cosmically extended present. Since, I think, the notion of an objective cosmically extended present is essential to presentism, I consider as simply incoherent any attempt to reconcile presentism with STR by giving up this notion. Presentism needs a spacetime structure supporting absolute simultaneity. It is far beyond the scope of this paper to discuss whether such a "reactionary need" may be satis-



fied and, if so, how (by boldly rejecting STR as false, by endorsing a non-standard, Neo-Lorentzian interpretation of STR, or otherwise?); I shall therefore sidestep this problem and turn to the next one.

#### 4. Causal Processes and Durative Events

As mentioned in §2, causal interactions are formed by the spatiotemporal overlapping of causal processes; causal processes are plausibly regarded as entities of a broader category, namely durative events; and durative events, in turn, are plausibly regarded as mereological sums of shorter and shorter durative events and, ultimately, of (infinite) instantaneous events ordered in temporal sequence. Two intertwined problems for presentism appear here: one concerns durative events' being *mereological sums* of shorter events, i.e., their being entities having *temporal parts*; the other concerns durative events' being *temporal sequences* of shorter events. In this section, I address the former problem (postponing the treatment of the latter one to the next section).

A durative event does not fit into the instantaneous present of the presentistic universe: if an event is a durative one, then it can be *only partly* present, i.e., only in some instantaneous part of itself. But the following principle, which might be called *Principle of Mereological Sums*, seems very plausible:

(MS) Necessarily, a mereological sum of parts  $x_1 \dots x_n$  (tenselessly) exists only if  $x_1 \dots x_n$  (tenselessly) exist.

(MS) can be justified by the following reason: the existence of a mereological sum of certain parts *conceptually* requires that *all* of its parts (tenselessly) exist; without any of its parts, something could not even qualify as a mereological sum *of them*. (Notice that I am not saying that by removing some part from a mereological sum, it would cease to be a mereological sum; I am saying that it would cease to be *that specific* mereological sum that is formed, among other parts, by *that specific* part.) So, if (MS) is true and there are durative events, then presentism is false.

I believe that, confronted with this problem, presentists must bite the bullet and give up the idea that there exist (tenselessly and thus present-tensedly) durative events. Admitting that is not too bad for presentists, though. Presentism can still allow for instantaneous events individually considered and can also allow for *temporal sequences* of them (temporal sequences that, of course, must be conceived of in some presentistically appropriate way: for example, in the way that will be expounded in the next section). And, most importantly, a (presentistically conceived of) sequence of instantaneous events would still be able to do, within the CQ theory, the basic theoretical work that is done by a causal process, namely “conveying” a conserved quantity from the cause to the effect.

While assuming this anti-realistic stance on durative events, and thus on causal processes and causal interactions too, presentists may decide to retain, for communicative ease only, *talk* of durative events, causal processes, and causal interaction. This may be done by setting some conditions for the usage of those locutions. We may convene (i) that if one or more objects exemplify through a period of time one or more attributes, then we *say* that a “durative event” occurs at that period of time; (ii) that if a physical object possesses a conserved quantity through a period of time, then we *say* that a “causal process” occurs at that period of time; (iii) that if two objects are spatially adjacent or overlapping through a

period of time during which they exchange a certain quantity, then we *say* that a “causal interaction” occurs at that period of time.<sup>14</sup> This metaphysically non-serious use of these locutions may be signalled by enclosing them between double quotation marks, as I have done just now. (How the talk of *periods of time* might be understood within a presentistic framework will be expounded in the next section.)

## 5. Cross-Temporal Relations

First, let us explain in a little more detail what cross-temporal relations are and why they are troublesome for presentism. As said in §1, a cross-temporal relation is, approximately, a relation that is exemplified by its relata at different times. More precisely, as Torrenco (2008: 15) writes:

A relation  $R$  is cross-temporally exemplified by  $x_1 \dots x_n$  if and only if each  $x_i$  enters [i.e., exemplifies]  $R$  at a different time than some  $x_j$ .

So, if a cross-temporal relation is exemplified by one of its relata at the present time, then it is exemplified by at least one other relatum at a past time or at a future time. But, according to the so-called *Principle of Relations*,

(PR) necessarily, if  $x_1 \dots x_n$  exemplify a relation  $R$ , then  $x_1 \dots x_n$  (tenselessly) exist (each one at the time it exemplifies  $R$ ).

Hence, any relatum that is cross-temporally related to a present entity (*tenselessly exists at some non-present time*), and this is incompatible with presentism.

Dowe’s CQ theory of causation, as can be seen from the concise exposition of it given in §2, appears to involve a variety of relations. In what follows, I shall review the ones that are cross-temporal or might be suspected to be so, and show how to dispose of those that really are. In line with the authors mentioned in §1, this disposal will be carried out by implementing a rephrasing strategy consisting in the replacement of any portion of causal discourse including predicates expressing the exemplification of a cross-temporal relation (e.g., ‘causes’ or ‘is earlier than’) by locutions able to play similar theoretical roles but having ontic commitments compatible with presentism, such as *primitive tensed properties*, i.e., properties incorporating tense (e.g. *having been true* and the like), and *simultaneously exemplified relations*, or *simultaneous relations* for short, i.e., roughly, relations exemplified by all of their relata at the same time.<sup>15</sup> Thus, an alternative way of expressing the CQ theory will be shown, one that does not force us admitting of cross-temporal relations.

### 5.1 Precedence Relation and Handling of Tense

The *precedence* (or *earlier than*) relation does not play a showy role in the CQ theory. It is involved, nevertheless: the CQ theory presupposes that, typically (alt-

<sup>14</sup> As regards the counterintuitive idea that an object may not simply be spatially adjacent with another but may also spatially overlap with it, we must be reminded that, in Dowe’s CQ theory, by ‘objects’ are meant not only the material objects of common sense, such as chairs and animals, but also the impalpable objects of physics, such as fields and waves, for which it makes sense talking about spatial co-location and, thus, of spatial overlapping.

<sup>15</sup> More precisely, a relation  $R$  is simultaneously exemplified by  $x_1 \dots x_n$  if and only if each  $x_i$  exemplifies  $R$  at the same time as any other.

though not necessarily), causes are earlier than their effects; moreover, as pointed out in §4, presentists' "causal processes", while not being (real) causal processes, still consist in *temporal sequences* of instantaneous events. So, presentists must account both for the temporal precedence of causes over their effects and for "causal processes" in some way that does without the precedence relation. This can be achieved by resorting to metric tense operators metaphysically interpreted in a certain way.

Let us first introduce *non-metric tense operators*: the past tense operator 'P', reading 'it was true that', and the future tense operator 'F', reading 'it will be true that'.<sup>16</sup> These operators are the basic expressive devices to which, typically, presentists resort in order to attain a presentistically suitable interpretation of sentences containing past-tensed or future-tensed predication. Such an interpretation is carried out in two steps: first, the past- or future-tensed sentence at issue is reformulated in the present tense; then, the apt tense operator is placed in front of the thus obtained sentence. Consider, for example, a past-tensed sentence and a future-tensed sentence expressing some generic instantaneous event of the sort involved in Dowe's theory of causation:

(1) Something had a certain amount of quantity  $q$ ,

and

(2) Something will have a certain amount of quantity  $q$ .

Assuming a tense operator-based semantics, (1) and (2) will be rendered, respectively, as:

(1.1) **P**(something has a certain amount of quantity  $q$ ),

and

(2.1) **F**(something has a certain amount of quantity  $q$ ),

whose structures may be further made explicit, respectively, as:

(1.2) **P**( $\exists y \exists z (q(y) = z)$ ),

and

(2.2) **F**( $\exists y \exists z (q(y) = z)$ ).

Here, Dowe's symbolical rendering for the having (or possession) of a quantity is adopted (the only difference being that the variable ranging over possible amounts of the quantity at issue—here, the variable  $z$ , ranging over possible amounts of  $q$ —is bound by the quantifier, whereas in Dowe's original formulation it is left free). For a better readability, I shall use different individual variables, possibly with subscripts, for different kinds of entities:  $y, y_i$ , etc. for objects;  $z, z_i$ , etc. for amounts of quantities; later on, I shall also use  $x, x_i$ , etc. for another sort of entity: intervals of time or, better, degrees of tensedness.

The idea that, from a metaphysical point of view, underlies the presentistic appeal to a tense operator-based semantics for past-tensed and future-tensed predication is, it seems to me, that it allows to qualify as past or future an event (e.g., the possession of an amount of quantity  $q$  by some physical object) in an

<sup>16</sup> More precisely, 'P' and 'F' are called *weak* (non-metric) tense operators, in contrast with *strong* (non-metric) tense operators, namely 'H' and 'G', which read, respectively, 'it has always been true that' and 'it will always be true that'. On the semantics of tense, see Ludlow (2006); on tense logic, see Galton and Goranko (2015).

“indirect” way, namely by saying (in the metalanguage) that the present-tensed proposition representing it (in our example, the one expressed by the present-tensed claim ‘something has a certain amount of quantity  $q$ ’) was or will be true. This supposedly enables presentists to claim that something *was* or *will be* in certain way, *existed* or *will exist*, without entailing that that thing *is tenselessly* in that way *at some past or future time* or *tenselessly exists at some past or future time*—which is something presentists deny (and, vice-versa, eternalists affirm).<sup>17</sup> So, presentists are supposedly able to claim that (1) and (2), interpreted as (1.1)/(1.2) and (2.1)/(2.2), may be true without entailing the truth of ‘something (tenselessly) has a certain amount of quantity  $q$  at some past or future time’ and the truth of ‘something (tenselessly) exists at some past or future time’. Of course, tense operators must be primitive to do the semantic work that they are supposed to do within a presentistic framework.<sup>18</sup>

But, I think, the nature of tense operators needs to be specified a little further. The problem of a presentistically suitable interpretation of past-tensed and future-tensed predication re-emerges for the metalinguistic renditions of ‘**P**’ and ‘**F**’ (‘it was true that’ and ‘it will be true that’), which do in turn contain past-tensed and future-tensed predications: surely, by claiming (in the metalanguage) that a certain present-tensed proposition was or will be true, presentists do *not* want to entail that that proposition *is (tenselessly) true at some past or future time*: this would in turn entail that that proposition *(tenselessly) exist at that time*, which, again, is something that presentists deny. I think that a viable way for presentists to fix this problem may be to further reduce past-tensed and future-tensed predications of the property *being true* to present-tensed predications of *primitive tensed properties*, i.e., respectively, of the past-tensed property *having been true* and of the future-tensed property *going to be true* (as is known, properties of this kind, somehow “incorporating” tense in themselves, are often invoked by presentists in dealing with the grounding problem: see, e.g. Bigelow 1996).<sup>19</sup> If this suggestion is accepted, then, (1.2) and (2.2) will be (metalinguistically) understood as follows:

(1.3) The proposition  $[\exists y \exists z (q(y) = z)]$  has *having been true*,

and

(2.3) The proposition  $[\exists y \exists z (q(y) = z)]$  has *going to be true*.

It is now possible to introduce metric tense operators. A *metric tense operator* is a tense operator that not only tells that a proposition was or will be true but also

<sup>17</sup> E.g., a sentence like (1) may be rendered in eternalistic terms as ‘There (tenselessly) exists something that (tenselessly) has a certain amount of quantity at a past time’, where the adjective ‘past’ may be understood in turn as ‘that is (tenselessly) earlier than the present time’.

<sup>18</sup> An anonymous referee has complained that the employment of a tenseless predication of existence in defining presentism is in tension with the ideological commitment to primitive tense operators. I must disagree with her/him on this point. Tenseless predication and recourse to primitive tense operators are compatible and are both of use to presentists: tenseless predication is required to capture the sense in which the present, unlike the past and the future, *exists*; primitive tense operators are required to capture the sense in which the past and the future, respectively, *existed* and *will exist*.

<sup>19</sup> The idea that tense operators may be understood, ultimately, as present-tensed predications of primitive past- or future-tensed properties has emerged in conversation with Francesco Orilia.

specifies *when* it was or will be true by indicating the amount of time intercurrent between the present instant and the instant at which the proposition was or will be true. The metric past tense operator is ' $\mathbf{P}_x$ ', which reads 'it was true the interval  $x$  ago that...'; the metric future tense operator is ' $\mathbf{F}_x$ ', reading 'it will be true the interval  $x$  hence that...'. The variable  $x$  ranges over positive real numbers, which, chosen a suitable unit of measure (e.g., seconds, hours, days), are taken to specify the sizes of time periods between past or future instants and the present instant.

As they stand, however, metric tense operators are not immediately acceptable to presentists: tense operators resort to *periods of time*, which are something that presentists cannot accept in their ontic inventory, and that for exactly the same reasons for which they cannot accept durative events: presumably, periods of time are composed of shorter and shorter periods of time, and ultimately of infinite durationless instants, ordered by the precedence relation. So, what can we do? We could conceive of the metric indices as specifying not time periods but *degrees of past-tensedness* (of the property *having been true*) and *degrees future-tensedness* (of the property *going to be true*), taken, again, as primitive. We could think that the past-tensedness (of *having been true*) expressed by ' $\mathbf{P}$ ' and the future-tensedness (of *going to be true*) expressed by ' $\mathbf{F}$ ' have degrees, and that these degrees are picked out by the corresponding metric tense operators. We can interpret this in the terms of the distinction between determinable properties and determinate properties: while ' $\mathbf{P}$ ' expresses simply the exemplification of the determinable property of *having been true*, ' $\mathbf{P}_x$ ' expresses the exemplification of a determinate *having been true*, i.e., one having a determinate amount of past-tensedness, namely  $x$ ; and similar considerations hold, *mutatis mutandis*, for the future tense operators. Again, presentists may retain *talk* of "periods of time" for its usefulness, with the understanding, however, that what metaphysically underlies this talk, from their perspective, are determinate past-tensed and future-tensed properties of propositions, and not real, temporally extended periods of time.

In order to simplify our symbolic rendering, we may introduce a single tense operator ' $\mathbf{T}_x$ ' (for 'Tensedness') and, assuming that  $P$  stands for any present-tensed sentence and  $x$  ranges over real numbers, convene that: for  $x < 0$ , ' $\mathbf{T}_x P$ ' is equivalent to ' $\mathbf{P}_{|x|} P$ '; for  $x = 0$ , ' $\mathbf{T}_x P$ ' is equivalent to  $P$ ; and for  $x > 0$ , ' $\mathbf{T}_x P$ ' is equivalent to ' $\mathbf{F}_x P$ ' (see Galton and Goranko 2015: §7.2). So, by setting a negative value for  $x$ , we (present-tensedly) predicate, of the proposition  $[P]$ , the property *having been true* with a degree  $x$  of past-tensedness; by setting a positive value for  $x$ , we predicate, of  $[P]$ , the property *going to be true* with a degree  $x$  of future-tensedness; and by setting value 0 for  $x$ , we do not predicate, of  $[P]$ , any tensed property.

Equipped with metric tense operators understood in this way, we can express the temporal precedence of an event over another without employ the predicate 'is earlier than' (or its synonyms). E.g., instead of writing 'the event  $\exists y_1 \exists z_1 (q(y_1) = z_1)$  is earlier than the event  $\exists y_2 \exists z_2 (q(y_2) = z_2)$ ',<sup>20</sup> we can write as follows:

$$(3) \exists x_1 \exists x_2 (x_1 < x_2) \wedge (\mathbf{T}_{x_1} (\exists y_1 \exists z_1 (q(y_1) = z_1)) \wedge \mathbf{T}_{x_2} (\exists y_2 \exists z_2 (q(y_2) = z_2))).$$

The idea behind this paraphrase (and the others that will follow) is that any part of discourse expressing the exemplification of the precedence relation can

<sup>20</sup> Or, mindful of what has been said in footnote 9, ' $\llbracket \exists y_1 \exists z_1 (q(y_1) = z_1) \rrbracket$  is earlier than  $\llbracket \exists y_2 \exists z_2 (q(y_2) = z_2) \rrbracket$ '.

be replaced by a *conjunction of tense-logical propositions*: propositions are taken to exist *at the present time*; consequently, the relation expressed by ‘ $\wedge$ ’, and by any other dyadic propositional connective, may be taken to relate two present entities and, then, to be simultaneously exemplified;<sup>21</sup> each proposition, however, including a metric tense operator, is in turn able to “indirectly” qualify a certain event as past or future (in a certain degree) or as present.

By means of metric tense operators, we can also describe a temporal sequence of instantaneous events constituting a “causal process” in a way that is fully compatible with presentism. E.g., a “causal process” consisting in the possession of the quantity  $q$  by a generic object  $y$ , beginning  $m$  units of time ago or hence and ending  $n$  units of time ago or hence, may be expressed as follows:

$$(4) \quad \forall x ((m \leq x \leq n) \rightarrow \mathbf{T}_x(\exists y \exists z (q(y) = z))),$$

which is equivalent to a very long—in fact, infinite—disjunction of all sentences of the form ‘ $\mathbf{T}_i(\exists y \exists z (q(y) = z))$ ’ with  $m \leq i \leq n$ , i.e., something like the following:

$$(4.1) \quad \mathbf{T}_m(\exists y \exists z ((q(y) = z) \wedge \dots \wedge \mathbf{T}_n(q(y) = z))).$$

It should be noticed that (4) as well as (4.1) allow  $z$  to take different values through time. In fact, according to Dowe, for a process to be causal, it is only necessary that the constitutive object of the process possesses a conserved quantity at every stage of it, no matter whether the amount of the quantity remains constant throughout the process or not. And the same, of course, must hold for “causal processes” as well. To designate concisely such “causal processes” in which the amount of the quantity is not stable through time, we may use Dowe’s original symbology: e.g., in the case of the “causal process” represented by (4) and (4.1), we may write ‘ $\Delta q(y)$ ’.

Obviously, the tense operator-based account of temporal sequences adopted in (4) and (4.1) can be extended, with the apt changes, to “durative events” that are not “causal processes” (e.g., a leaf’s being green for two hours).<sup>22</sup> And it can be extended, again with the apt changes, to “causal interactions” as well, as will be shown in a moment.

## 5.2 Exchange Relation

A quantity exchange may be taken to consist in the exemplification of a triadic *exchange* relation having a quantity and two objects as relata; correspondingly, a sentence like ‘two objects (presently) exchange the quantity  $q$ ’ may be symbolised by a formula such as ‘ $\exists y_1 \exists y_2 (E_q y_1 y_2)$ ’.<sup>23</sup> Of course, other metaphysical accounts and symbolisations of the structure of quantity exchanges are feasible. The important issue, here, is whether the exchange relation is cross-temporal or simultaneous. In this connection, I think, two relevant cases should be distinguished: the case where two objects exchange some quantity *in a direct way*, i.e., without exchanging it with

<sup>21</sup> I think that, from a presentistic perspective, propositions must be understood as temporal (perhaps omnitemporal) entities, not as atemporal ones; and that because they must be able to change truth-value across time (as time flows), whereas atemporal entities are subtracted to the possibility of any sort of change.

<sup>22</sup> For a different way to account for “durative events” within presentism see Orilia (2012).

<sup>23</sup> Thus, an exchange involving more than two objects or more than one quantity must be understood as involving *different exemplifications* of the exchange relation (not a single exemplification with more than two objects or more than one quantity).

some intermediary object (e.g., the exchange of linear momentum between two billiard balls colliding with each other), and the case where they exchange the quantity *in an indirect way*, i.e., by exchanging it with some intermediary object (e.g., the exchange of energy between the Sun and the Earth by means of photons traveling from the former to the latter). If two objects exchange a quantity without intermediary objects, the exchange occurs in both objects at the same time: the giving up of a quantity by one object temporally coincides with the gaining of it by the other object; there is no temporal delay between the giving up and the gaining of the quantity.<sup>24</sup> And this suggests that, where the exchange is direct, the exchange relation is exemplified simultaneously. It is important to point out a necessary condition for an exchange to be direct: an exchange is direct only if it is *local*, i.e., if, throughout the exchange, the objects involved in it are spatially adjacent or overlapping. On the other hand, if the exchange is indirect, it is possible that the periods during which each of the two objects exchanges the quantity with the other do not coincide: surely, this happens in the case in which the exchange is *non-local*, i.e., it is between two spatially non-adjacent or non-overlapping objects: while locality is a necessary condition for an exchange to be direct, non-locality is a sufficient condition for an exchange to be indirect. In such a case, the intermediary objects behave like “vehicles” of the quantity: they move, thereby conveying the quantity (like in the previously mentioned example of the Sun exchanging energy with the Earth). But moving takes time; hence, an indirect non-local exchange between two objects involves some temporal delay between the giving up of the quantity by one object and the gaining of it by the other object. It would seem, thus, that an indirect and non-local exchange of a quantity involves a cross-temporal exemplification of the exchange relation.

Quite clearly, the exchanges *primarily* involved in causal interactions (as they are understood within the CQ theory) are those of *direct* (and, thus, local) kind. A causal interaction between two causal processes, therefore, may be viewed as a *simultaneous exemplification of the exchange relation* (by the quantity and the objects constituting the interacting causal processes) *lasting for a certain time*, which may in turn be understood as a *temporal sequence* of instantaneous simultaneous exemplification of the exchange relation (by the quantity and the objects constituting the interacting causal processes).<sup>25</sup> Presentists may understand a “causal interaction” between two “causal processes” in an analogous manner, provided that the notion of temporal sequence is understood, again, in a suitable way—for example, by means of metric tense operators. The simplest case of a “causal interaction”, say, the case where two generic objects,  $y_1$  and  $y_2$ , exchange the quantity  $q$ —something that Dowe would represent by a formula like ‘ $\Delta q(y_1), \Delta q(y_2)$ ’—could be rendered in a manner that fits presentism as follows:

$$(5) \quad \forall x ((m \leq x \leq n) \rightarrow \mathbf{T}_x (\exists y_1 \exists y_2 (E_q y_1 y_2))),$$

where  $m$  and  $n$  are the intervals of time intercurrent between the present instant and, respectively, the beginning and the end of the “causal interaction” or, better, the corresponding degrees of tensedness.

<sup>24</sup> This is what I have been able to glean from physics textbooks with the help of friends who have an understanding of physics much deeper than mine.

<sup>25</sup> Of course, this neither amounts to say nor entails that an exchange relation might be exemplified for just one instant: it is exemplified so long as the two objects undergo a change in amount of the relevant quantity.

However, it should be noted that it may well be—and, in fact, it is commonly—the case that direct exchanges between two objects, in turn, involve indirect non-local exchanges between *parts of those objects*. During a direct exchange of a quantity between two objects, their parts also exchange that quantity; but any two spatially non-adjacent or non-overlapping parts can exchange it only in an indirect way. E.g., if two billiard balls collide, each ball, considered in its entirety, exchanges with the other, considered in its entirety, a certain amount of momentum in a direct way (through the adjacent parts); however, during the collision, the various parts of each ball are also involved in exchanges of momentum and, of course, any two spatially non-adjacent or non-overlapping parts can exchange it only in an indirect way. As previously mentioned, indirect exchanges involve a temporal delay and seem thus to involve a cross-temporal exemplification of the exchange relation. To avoid this, where the predicate ‘exchanges’ is intended to express an indirect exchange, we may replace it with a presentistically apt description the *chain of direct exchanges* between the intermediary spatially adjacent or overlapping objects conveying the quantity, i.e., by a conjunction of formulae like (5). (Given the impractical verbosity of such conjunctions, presentists may nevertheless keep using the predicate ‘exchanges’ also to express indirect exchanges, provided that it is considered simply as a useful, but metaphysically inappropriate, way of talking.)

### 5.3 Causal Relation

Lastly, we have the cross-temporal relation that has given rise to the discussion about presentism and causation in the first place: the causal relation itself. The causal relation may be dispensed with by replacing any causal claim containing the troublesome predicate ‘causes’ (or its equally troublesome companions, such as ‘is causally connected to’ etc.), e.g., ‘the event  $\exists y_1 \exists z_1 (q(y_1) = z_1)$  causes the event  $\exists y_2 \exists z_2 (q(y_2) = z_2)$ ’,<sup>26</sup> by a causal claim of the following form:

$$(6) \exists y_2 \exists z_2 (q(y_2) = z_2) \text{ because } \exists y_1 \exists z_1 (q(y_1) = z_1),$$

where an instance of causation is rendered by means of the dyadic connective ‘because’, which expresses a simultaneous relation holding between propositions representing the effect-event and the cause-event.<sup>27</sup> Of course, formulae like (6) must be integrated by tense operators to express the temporal priority of the cause-event over the effect-event, for example, as follows:

$$(6.1) \exists x_1 \exists x_2 ((x_1 < x_2) \wedge (\mathbf{T}_{x_2}(\exists y_2 \exists z_2 (q(y_2) = z_2)) \text{ because } \mathbf{T}_{x_1}(\exists y_1 \exists z_1 (q(y_1) = z_1))))).$$

### 6. Conclusion

In the light of what has been said in the previous sections, Dowe’s analysis of the grounds of causation may be reformulated as follows. A generic instance of causation, e.g.:

$$(7) \exists x_1 \exists x_2 (\mathbf{T}_{x_2}(\exists y_2 \exists z_2 (q(y_2) = z_2)) \text{ because } \mathbf{T}_{x_1}(\exists y_1 \exists z_1 (q(y_1) = z_1)))$$

<sup>26</sup> Or, perhaps better, ‘ $\llbracket \exists y_1 \exists z_1 (q(y_1) = z_1) \rrbracket$  causes  $\llbracket \exists y_2 \exists z_2 (q(y_2) = z_2) \rrbracket$ ’.

<sup>27</sup> An operator-based account of this sort has been originally suggested as a presentistically suitable account of the primitivistic view of causation. However, it can be assumed as a general replacement for the problematic causal claims of the typical form ‘*c* causes *e*’ (where *c* and *e* stand for events).



holds if and only if the following four conditions are satisfied:

- (i)  $x_1 < x_2$ ;
- (ii)  $\forall x((x_1 \leq x \leq x_2) (\mathbf{T}_x(q(y_1) = z_1) \vee \mathbf{T}_x(q'(y_2) = z_2) \vee \mathbf{T}_x(\mathbf{E}_q y_1 y_2) \vee \mathbf{T}_x(\mathbf{E}_{q'} y_1 y_2)))$ ;
- (iii) any change of object from  $y_1$  to  $y_2$  and any change of conserved quantity from  $q$  to  $q'$  in the temporal succession described by (ii) occur at a “causal interaction” involving the following changes:  $\Delta q(y_1)$ ,  $\Delta q(y_2)$ ,  $\Delta q'(y_1)$ ,  $\Delta q'(y_2)$ ; and
- (iv) for any exchange in (iii) involving more than one conserved quantity, the changes in quantities are governed by a single law of nature.

Condition (i) expresses the temporal precedence of the cause-event over the effect-event in the form of a relation between degrees of tensedness (as previously mentioned, given up the possibility of backwards causation, presentists may assume temporal precedence as the basis for the distinction between cause and effect); condition (ii) expresses the temporal sequence of instantaneous possession-events and instantaneous exchange-events, i.e., the “causal processes” and the “causal interactions” going from the cause-event to the effect-event; conditions (iii) and (iv) are simply reformulations with minimal adjustments of the conditions (1) and (2) given in Dowe’s analysis.

In this paper, I have been engaged in the attempt of reformulating the CQ theory in a way that is compatible with presentism. This has been done by replacing a series of interconnected, presentistically unwelcome ontic commitments—in first place, to cross-temporal relations and to non-present events, objects, and times, but also to (real) causal processes and (real) causal interactions—with presentistically acceptable ontic commitments, namely to propositions, simultaneous relations, and primitive tensed properties. The most controversial of these ontic commitments is doubtlessly the third one, which is at the same time an ideological commitment. In fact, the plausibility of primitive tensed properties has been challenged by Sider (2001: 36-41) and Cameron (2011); so, the plausibility of the presentistic account of the CQ theory put forward in this paper ultimately depends on whether their objections can be properly answered. Carrying out a defence of primitive tensed properties, however, is a task that must be left for another time.<sup>28</sup>

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