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## Extended cognition and the causal-constitutive fallacy: in search for a diachronic and dynamical conception of constitution

### Abstract

Philosophical accounts of the constitution relation have been explicated in terms of synchronic relations between higher- and lower-level entities. Such accounts, I argue, are temporally austere or impoverished, and are consequently unable to make sense of the diachronic and dynamic character of constitution in dynamical systems generally and dynamically extended cognitive processes in particular. In this paper, my target domain is extended cognition based on insights from nonlinear dynamics. Contrariwise to the mainstream literature in both analytical metaphysics and extended cognition, I develop a nonstandard, alternative conception of constitution, which I call "diachronic process constitution". It will be argued that only a diachronic and dynamical conception of constitution is consistent with the nature of constitution in distributed cognitive processes.

### Keywords

fallacy, causal, search, cognition, diachronic, extended, dynamical, conception, constitutive, constitution

### Disciplines

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## 1. Introduction

In analytical metaphysics, the standard and representative view of constitution is known as “material constitution”. Material constitution can be summarized as a *synchronic* one-one relation between spatially and materially coincident objects of different kinds, or as a many-one relation, where one object or entity is constituted by an aggregate of objects or entities. In the context of material constitution, “synchronic” implies *atemporal* such that it is not part of the very essence of materially constituted entities that they unfold in time. In this sense, the “time” in question is “technical” in the sense that things exist in time just as things have a spatial dimension or weight. Essentially, then, material constitution involves a mode of constitution between entities in which time plays a role only in so far that it becomes possible to specify a constitutive relation at a time instant  $t$  – viz., moment by moment, snapshot by snapshot. For example, as articulated by Gibbard (1975), in the classical case of *David* (a token statue) and *Piece* (a token piece of marble), both *David* and *Piece* are created at the exact same time and destroyed at the exact same time, viz., *David* did not evolve over time; rather *David* is constituted at a time instant  $t$ . Here time is reduced to a set of punctuated specifications, with the fact that *David* is in time – just as *David* has a certain weight – is not essential to the constitutive nature of *David*. Furthermore, together with the idea that constitution is atemporal, this example also highlights that material constitution holds between two objects that spatially and materially coincide with one another – that is, if  $x$  (or the  $x$ s) constitutes  $y$ ,  $x$  (or the  $x$ s) and  $y$  exist at the same place at the same time and they share the same material parts (cf. Bennett 2004, 2011; Wasserman 2004).

This paper offers an alternative to this view of constitution by focusing on the dispute between defenders of “extended cognition” (EC) and their internalist critics. In particular, advocates of EC state that in orchestration with neural elements, extra-neural bodily and worldly elements partially *constitute* putative cases of distributed cognitive processes or modes of cognitive processing (cf. Clark & Chalmers 1998; Clark 2008; Menary 2007; Sutton 2010; Wheeler 2010; Wilson & Clark 2009; Wilson 2010). But, there are philosophers who claim that the defenders of EC commit the so-called “causal-constitutive fallacy” (C-C fallacy) (Adams & Aizawa 2001, 2008; Aizawa 2010). Because issues such as causal coupling are part of the argument for EC, those who think that EC commits the C-C fallacy are arguing that defenders of EC make an unjustifiable inference from causal dependence to constitutive dependence. The reason for this is that it is commonly thought that causation and constitution are independent relations such that facts about causal relations do not tell us anything about facts of constitutive relations (cf. Bennett 2011). Hence, so the critics argue, nothing follows about constitution from facts about causation on its own. As a first approximation, and if material constitution is indeed the representative view of constitution, it may seem that the critics of EC are correct in charging the defenders of EC with the C-C fallacy. If we consult the case of *David* and *Piece*, it makes little sense to start with claims about causation and then infer to claims about constitution – *Piece* constitutes *David*, *Piece* does not cause *David* to exist. But first approximations are not always accurate. Indeed, it only seems that those who argue that the fans of EC are guilty of committing the C-C fallacy are correct, because those critics have misunderstood the nature of the constitution relation involved in *most* cases of extended cognitive processes or modes of cognitive processing<sup>1</sup>.

If I am correct to insist on the need for an alternative conception of constitution, this would have ramifications for the metaphysics of constitution, in that, it demonstrates the need to broaden how we conceive of the constitution relation itself, on the one hand, and what kinds of relations the constitution relation may hold between, on the other. Furthermore, the need for an alternative conception of constitution also points to the failure of some philosophers to pay attention to the metaphysical baggage their statements carry with them, and consequently, involve them in. Hence, although the issue that I shall argue in this paper starts within naturalistic philosophy of mind (the extended cognition hypothesis), it ultimately speaks to wider issues about constitution in analytical metaphysics.

### 1.1. Argument and scope

Occasionally conflict with existing intuitions is unavoidable. This is one of those instances. Note that I said that the critics of EC have misunderstood the constitution relation in most versions of EC<sup>2</sup>. This

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<sup>1</sup> Another critic of the extended cognition framework is Rupert (2009). Note that I omit discussion of Rupert in this paper, because Rupert’s work, even though it takes the metaphysics of mind seriously, is focused more on integration in terms of mechanisms rather than on the constitution relation, the latter being the topic of discussion in this paper.

<sup>2</sup> I use the concepts “extended” and “distributed” interchangeably throughout this paper.

has ramifications for the argument that I shall develop here. That is, the issue that I shall discuss in this paper is that there is an assumption shared on both sides of the EC vs. anti-EC debate that is misleading and that requires the development of an alternative, nonstandard account of the nature of the constitution relation for it to be resolved. I shall identify, first, what the misleading assumption is in the literature concerning EC. What is misleading is the assumption that the constitution relation, in distributed cognitive processes or modes of cognitive processing, is (a) *synchronic* and (b) *fundamentally distinct* from causation. This assumption generates two interesting implications. First, as a universally quantified argument against all cases of EC, the C-C fallacy turns on an argument that is wrong, namely that the conception of constitution used by the defenders of EC must be compatible with how it is characterized in analytical metaphysics. However, most cases of putative cognitive extension do not dovetail with the notion of constitution developed in metaphysics, and *vice versa*. So, critics of EC such as Adams & Aizawa are simply wrong to insist that the C-C fallacy points to something flawed in all cases of EC. Second, even if most cases of EC do not mesh (i.e., are incompatible) with the standard and representative notion of constitution in analytical metaphysics, some defenders of EC (e.g., Clark 2008; Rowlands 2010) misleadingly adopt central metaphysical concepts such as constitution without additional explanation as well as scrutiny (to my knowledge, Hurley (2010) was the first to point to this problem), thus misconstruing the relation of constitution in cases of alleged higher-level distributed forms of cognitive processes and their lower-level sub-processes and components.

Note that the diachronic and dynamic conception of constitution to be developed here is (in fact) implicit in some articulations of EC – especially in second-wave versions of EC (Menary 2007; Sutton 2010) – even if this diachronic/dynamic notion of constitution has not been explicitly articulated. On the one hand, then, part of my project in this paper is to make explicit what is already in the existing literature on EC. On the other hand, however, the diachronic/dynamic account of constitution on offer here undermines other views of constitution that are equally held in the debate over EC – this is why I state that Adams & Aizawa are wrong in charging all cases of EC with the C-C fallacy, since the claim they advance presupposes the applicability of synchronic material constitution to EC; moreover, this is why I state that certain defenders of EC (e.g., Clark 2008; Rowlands 2010) are wrong to (blindly) adopt metaphysical building-relations from analytical metaphysics without additional scrutiny. To extend on these remarks, this paper offers a challenge to those who have either argued from material constitution to the claim that EC commits the C-C fallacy (which I will show that Adams & Aizawa have) or thought it plausible to base an argument for EC by appeal to constitution as a synchronic relation of dependence between different entities (which I will show that Clark (2008) and Rowlands (2010) have), while attempting to articulate a diachronic and dynamic conception of constitution that I think is present in certain formulations of EC.

For instance, in section three, I shall refer to Wilson's recent review of the metaphysical literature on constitution (2007, 2009) in order to make the claim that the notion of constitution that Adams & Aizawa (2001, 2008) are working with is what Wilson identifies as *compositional* constitution – a species of material constitution used in analytical metaphysics. This specification is important, since (as I shall argue) this notion of material constitution is incompatible with the constitutive nature of most cases of distributed cognitive processes – as a result, I shall argue that Adams & Aizawa are wrong to charge all advocates of EC with the C-C fallacy. Note that Wilson also identifies a second species of material constitution, which he refers to as *ampliative* constitution. As with compositional constitution, I shall spend some time substantiating the claim that this second form of material constitution is equally inconsistent with most cases of EC.

Now the alternative to what I shall refer to as *synchronic material constitution*, which covers both compositional constitution and ampliative constitution, I call *diachronic process constitution*. To get an initial fix on what this nonstandard mode of constitution is, and how it is compatible with most of the constitutive cases of EC, I shall start by identifying that cases of EC are *hybrid*. Firstly, cases of EC are made up of both causal and constitutive relations. That is, mainstream versions of EC (cf. Clark 2008; Menary 2007; Sutton 2010; Wheeler 2005; Wilson 2011) run the argument that cognition is constituted by the simultaneous, mutually influencing unfolding of heterogeneous as well as complex processes and their component parts. Constitution is an exclusively *interlevel* dependence relation: a relation between the putative higher-level distributed cognitive process and its lower-level sub-processes and their components. Causation, in contrast, is a strictly *intralevel* dependence relation between processes and their components at a lower level from the constituted process<sup>3</sup>. Consider, e.g., the following claim

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<sup>3</sup> A note of clarification: The term 'level' plays different roles across different sciences (cf. Craver & Bechtel 2007, p. 548). Scientists discover lower levels by decomposing systems or processes into their component parts. In cases of EC – just like in cases of biological mechanisms – levels talk is not equivalent to cutting nature by its joints,

made by Menary: “X is the manipulation of the notebook *reciprocally* coupled to Y – the brain processes – which together constitute Z, the process of remembering.” (2006, p. 334; italics in original) On this formulation lower-level processes X and Y constitute Z. Causal interaction is between X and Y, whereas the constitutive relation is between Z at a higher level and X and Y at a lower level. Secondly, processes – at both the level of the constituted and the constituents – unfold in continuous time (*cf.* van Gelder 1998). The temporal element in cases of EC is multifaceted, in that, such cases are dynamically embedded at multiple time-scales: e.g., at the time-scales of lower-level processes and their components – the temporal dynamics of neural processes, the temporal dynamics of bodily manipulation, and the temporal dynamics of cultural practices within which the overall distributed process unfolds. Higher-level processes – like the process of distributed remembering commonly run over longer time-periods than some of its lower-level components – e.g., various neural top-down modulations (*cf.* Craver & Bechtel 2007, p. 550). So, Z is constituted by processes unfolding over different temporal frequencies, while Z itself is dynamically unfolding in real time.

But what does this tell us about the issue of constitution in EC? Relations of constitution in putatively distributed processes (like Z) does not “sit” statically, atemporally wedged in between higher and lower-level entities as in cases of material constitution. Unlike the notion of time expressed in synchronic material constitution, where “time” is reduced to a series of snapshot instances and where “time” is not essential to the very essence of the constituted, distributed cognitive processes are constituted in a *time continuous* dynamical system, and dynamical systems are *quantitative in time* (*cf.* van Gelder 1998, p. 618; see also Chemero 2009). By “quantitative in time,” I here mean that both the constituents and the constituted in cases of distributed cognition are richly embedded in time such that if we change this embedding – e.g., by slowing down some of the processes – we change either the behavior of the lower level processes and their components or the higher level phenomenon, or both, depending on which of the processes we change (*cf.* Smithers 1998, p. 652). As Wheeler points out, in the psychological arena, richly temporal phenomena include “(i) the rates of change within, the actual temporal duration of, and any rhythmic properties exhibited by, individual cognitive processes, and (ii) the ways in which those rates of change, temporal durations, and rhythms are synchronized both with the corresponding temporal phenomena exhibited by other cognitive processes, and the temporal processes taking place in the cognizer’s body and environment.” (2005, p. 106) If the notion of “time” in synchronic accounts of material constitution entails that temporality itself is not essential to the constitutive nature of entities constituted, then the explanatory language of material constitution will be inappropriate for describing and explaining dynamical systems, and the way in which such systems give rise to distributed cognitive processes, that are temporal in their very essence.

Note that this difference tracks a distinction between what I shall call *epistemological synchronicity* and *ontological synchronicity*. Furthermore, once I have this distinction in play, it is possible to distinguish further between epistemological synchronicity and ontological synchronicity, on the one hand, and *ontological diachronicity*, on the other. To make sense of this, consider, first, that dynamical systems theory conceptualizes systems *geometrically* so as to specify regions in a dynamical state space, distances, and trajectories in a space of all possible states within the phase boundaries of a dynamical system. For example, a cognitive scientist may employ the tools of dynamical systems theory to describe the token phenomenon as existing in a particular location in a dynamical model at time *T*<sub>2</sub>, say. This is what I mean by epistemological synchronicity. However, epistemological synchronicity is importantly different from ontological synchronicity by which I mean that the ontological nature of some phenomenon is independent for its existence on being dynamically embedded *in time*; that is, it is not dependent for the way in which it instantiates on the manner of how it temporally unfolds. The classical case of *David* and *Piece* is an example of ontological synchronicity – see above. Note that ontological diachronicity contrasts with both epistemological synchronicity and with ontological synchronicity. First, unlike the conception of synchronic material constitution, which turns on ontological synchronicity, the conception of constitution in dynamically distributed processes of cognition depend for their specific manner of existence on being embedded in time. This is why the conception of material constitution in analytical metaphysics is temporally impoverished. Second, if one applies the perspective of epistemological synchronicity to an ontologically diachronic, higher-level phenomenon, such an application can at best yield snapshots of a linear development. This kind of synchronic modeling or measuring strategy is often a practical necessity in empirical sciences, e.g., cognitive science, but should not be mistaken (or conflated) as genuine evidence for the higher-level processes and its sub-processes and components as being ontologically synchronic.

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since what is a lower at one level, after all, can be higher at another level. By using the term ‘level’ here, I simply mean that the observed pattern constituted by certain elements is above (i.e., higher) than the below (i.e., lower) constituents.

To see that there is room for a conception like diachronic process constitution is to see the importance of the fact that we need to have a way of articulating what the relation of constitution in distributed cognitive processes really *is*. So what I want to identify by developing the notion of diachronic process constitution is the constitution relation involved in distributed cognitive processes, and how that constitution relation itself is diachronic and dynamic – just as the *relata* may be.

With this initial sketch of the argument to be developed in much more detail, and with the brief motivation and characterization of diachronic process constitution, the argumental structure of the rest of this paper is as follows. In section 2, the task will be to consider a few examples to serve as a backdrop for the discussion that follows in later sections. In section 3, I shall review Wilson's two senses of material constitution, while (a) showing that Adams & Aizawa are working with the notion of material constitution known as compositional constitution, and (b) develop the argument that whether adopting either compositional or ampliative constitution is irrelevant, since neither is compatible with cases of distributed cognitive processes. Having done this, I shall begin to contrast the concept of synchronic material constitution with diachronic process constitution in relation to the C-C fallacy in section 4. Finally in section 5, I focus on developing further the idea of diachronic process constitution.

## 2. Some examples

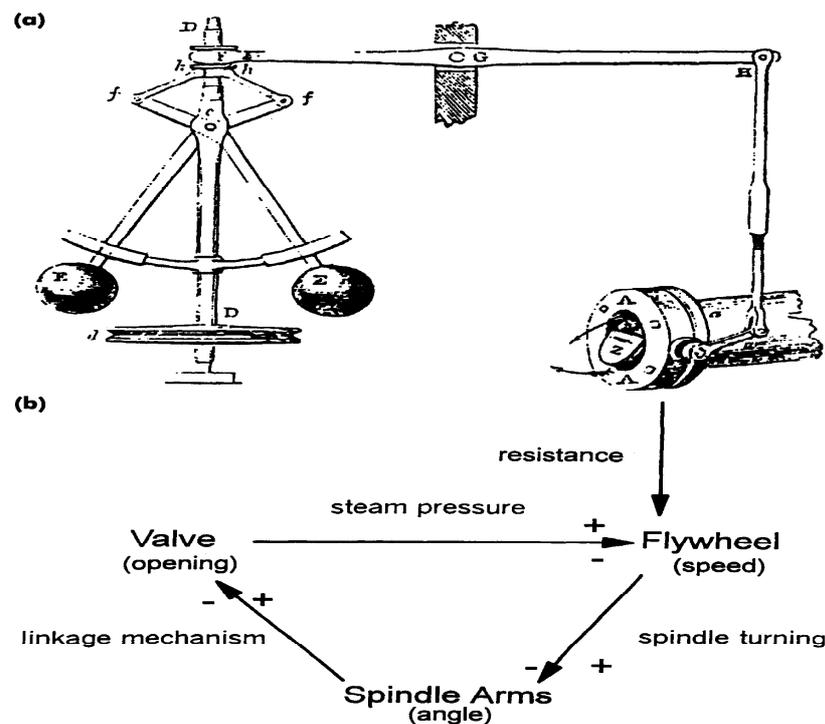
A first task is to sketch and discuss a few examples to serve as a backdrop for the discussion that will follow in later sections. I shall begin with the critics of EC. In his "The coupling-constitution fallacy revisited" (2010), Aizawa says: "Once one sees that a causal connection between a process of type X and a process of type Y is not enough to convert the Y process, or even the conjoined X-Y process, into a process of just type X, then one can also see that essentially the same point applies even when there is a reliable causal connection between X and Y." (2010, p. 333) According to Aizawa, there are persistent intuitions to the effect that those who infer constitution from causation are committing an instance of the C-C fallacy. As one of Adams & Aizawa's leading cases to illustrate this argument, they provide this non-cognitive example:

"The liquid Freon<sup>TM</sup> in an older model air conditioning system evaporates in the system's evaporator coil. The evaporator coil, however, is causally linked to such things as a compressor, expansion valve, and air conditioning ductwork. Yet, the evaporation does not extend beyond the bounds of the Freon<sup>TM</sup>. So a process may actively interact with its environment, but this does not mean that it extends into its environment." (2008, p. 91)

Regardless of whether one finds the description "evaporation does not extend beyond the bounds of the Freon<sup>TM</sup>" a bit pseudo-scientific (*cf.* Ross & Ladyman 2010, p. 161), Adams & Aizawa are, of course, correct to claim the following: "a compressor and an expansion coil have complementary roles to play in air conditioning, although this provides no reason to think that a compressor is an expansion coil or vice versa." (2008, p. x) Indeed, most central air conditioners have two separate components: the first is a condenser coil; the second is an evaporator coil. The evaporator is typically mounted inside the house. It is an inner coil in a heat pump that, during cooling mode, absorbs heat from inside the house and boils the liquid refrigerant (e.g., Freon<sup>TM</sup>) to a vapor, which then cools the house. In contrast, the condenser is typically placed outside the house. It is a network of tubes filled with refrigerant that removes heat from the hot evaporated liquid so that the refrigerant becomes a liquid again. But, there is a serious problem with employing such an example as evidence for the unjustifiability of putative cases of EC. As I have mentioned, EC cases are hybrid, consisting of both causal relations and relations of constitution. Constitution holds exclusively between levels, and is therefore an interlevel relation of dependence, whereas causation occurs only within the same level, and is thus an intralevel relation. In this example, Adams & Aizawa conflates intralevel causal relations with interlevel constitutive *relata*, in the sense that they start by assuming that the evaporator coil and the condenser coil are in constant causal interaction and, then, conclude from this that neither the evaporator coil nor the condenser coil is constitutive of one another. If Adams & Aizawa insist that their example works against EC, they would be deliberately twisting the interpretation of cases of EC. For simplicity only, consider again the relationship between Z (the distributed process of remembering) and its constituents X and Y (the process of manipulating a notebook causally coupled to brain processes). By analogy, if the example of evaporation in an air conditioning system were to map onto the example of distributed remembering, it would follow that defenders of EC were arguing such implausible things as: that the manipulation of a notebook extends into the brain processes and, therefore, that X (the manipulation of the notebook) is Y (various brain processes). Unsurprisingly, no one on the side of EC has ever made such a remarkably strange claim. It would be consistent with most cases of distributed cognitive processes, if Adams & Aizawa were to reformulate their example accordingly: X is the process of absorbing heat and thus

transforming a liquid refrigerant into vapor (the function of the evaporation coil) reciprocally coupled to *Y* – the process of transforming the vapor into liquid refrigerant (the function of the condenser coil) – which together constitutes *Z*, the process of maintaining constant room temperature. This reformulation would respect the distinction between causation and constitution, with causation occurring at the lower constituent level, and constitution holding between the constituted higher level and the constituents at lower levels.

For an example of a different kind, albeit still non-cognitive, consider these points concerning the now familiar case from dynamical systems theoretical approaches to cognition: the Watt (centrifugal) governor<sup>4</sup>. First, the Watt governor is a mechanism for controlling the speed of a steam engine (see Fig. 1):



**Fig. 1:** Watt's centrifugal governor for a steam engine. Adapted from Bechtel (1998, p. 302). (a) Is a drawing of the centrifugal governor, and (b) is a schematic representation showing that the angle of the Spindle Arms carries information about the speed of the Flywheel for the Valve, which uses the angle to determine the opening, thereby regulating the speed of the Flywheel.

Second, Watt solved the problem of maintaining constant speed for the flywheel by attaching a vertical spindle to the flywheel, which would rotate at a speed proportionate to that of the flywheel itself. Watt then attached two arms with metal balls on their ends to the spindle; both were free to rise and fall and, as a consequence of centrifugal force, would do so in accordance with the speed of the governor. Due to a mechanical arrangement, the angle of the arms would change the opening of the valve, thus having an effect on the amount of steam driving the flywheel. This provided a system, the result of which was “that as the speed of the main wheel increased, the arms raised, closing the valve and restricting the flow of steam: as the speed decreased, the arms fell, opening the valve and allowing more steam to flow. The engine adopted a constant speed, maintained with extraordinary swiftness and smoothness in the presence of large fluctuations in pressure and load.” (van Gelder 1995, p. 349)

Standardly the example of the Watt governor (WG) has been used as a prototype of a dynamical system with the grand ambition of establishing an anti-computational and anti-representational (often accompanied by a drive towards anti-nativism) approach to cognition and cognitive science. Note that

<sup>4</sup> In the article “What might cognition be, if not computational” (1995) van Gelder recommends that the operations of the Watt Governor, along with a dynamical mathematical description of its operations, be understood as a prototypical model for cognitive science and for the ontology of cognition.

for the present purpose, I bracket these agendas<sup>5</sup>. Instead I shall use this case so as to further motivate the idea of diachronic process constitution between dynamically evolving processes. Similarly to putative cases of EC, the centrifugal governor is hybrid in that it is composed of both constitutive and causal relations. Even if talk of causation might seem problematic in cases where there is a constitutive relation between higher- and lower-level phenomena (*cf.* Craver & Bechtel 2007), in this example this is entirely unproblematic. That is, by attending to the constitutive relationship between *Y* (the process of maintaining a constant speed level) and the sub-processes such as closing of the valve, the rotation as well as height of the spindle arms, etc., we can trace both intralevel processes of reciprocal, mutually influencing causation between lower-level processes and their components, while explicating what is the constitutive relation between *Y* and its constituents. Because of this, the correct way to *causally* explain how the centrifugal governor works is to explain the mutually modulatory and interconnected character of the components, whereas the engine speed is *constituted* by the overall dynamics of this lower-level dynamic.

Before furthering my analysis of how to understand the distinction between synchronic material constitution and diachronic process constitution, there is an issue that needs attention. To begin, then, note that in discussions of constitution, what we are presupposing is that we are discussing the *nature* of some phenomenon, *viz.*, that phenomenon's ontology. This, however, poses an important question, namely whether insights from nonlinear dynamics (as in the case of dynamical systems theory) provide us with an account of *epistemological* constitution, where the constituted phenomenon is merely some artifact of a particular model or formalism generated through macroscopic analysis, whether we get an account of *ontological* constitution, which informs us about the *nature* of the system in question, or do we get an account of constitution that straddles both categories? In section 5.5, I show that dynamical systems are ontologically constituted in the sense that the relation between higher- and lower-level processes is such that it exhibits both bottom-up and top-down *constitutively mediated effects* (*cf.* Craver & Bechtel). Hence, even if all dynamical systems are instances of what I have termed "epistemological constitution," because modeling is necessary in order to understand the behavior of the system – as its interdependent variables evolve over time – dynamical systems are also ontologically constituted. This justifies my use of nonlinear dynamics in the debate about constitution in cases of distributed cognition.

To continue distinguishing between cases of synchronic material constitution and the test case of diachronic process constitution (Watt's governor), note that unlike the example of *David* and *Piece*, the constitutive relation in the centrifugal governor does not consist in a relation between objects that are different in kind synchronically. Rather, in the example of the centrifugal governor, the relation of constitution holds between *processes* both at the constituted level and at the level of the constituents, and processes depend on "*spatiotemporal or causal continuity*" (Hofweber & Velleman 2010, p. 20; italics added) for their persistence. To persist, in the sense of processes, is in fact to exist as a dynamical unfolding over time. Although this may be a conceptual truth (*cf.* Hofweber & Velleman 2010, p. 7), it gives rise to an interesting dilemma: how can the relation of constitution that holds between relata of processes be atemporal (i.e., synchronic) if the relata themselves (at both the higher-level and the lower-level) are *essentially* temporal (i.e., diachronic)? In other words, if the very nature of a process is to unfold over time for a process to *be* what it is, then how can its existence be determined at an atemporal instant? In the case of *David* and *Piece* this dilemma does not arise, simply because the relation of constitution holds between objects and is articulated at a very high degree of abstraction. Objects such as *Piece* and *David*, however, have their identity determined at every moment at which they exist. Hence, unlike processes, objects such as *David* and *Piece* do not depend for their existence on dynamical evolution over time. Note that the philosophical terms commonly used to specify the kind of persistence relevant to *David* and *Piece* is *endurance*, whereas the concept generally attached to processes, whose existence is not determined at every moment of their existence, is *perdurance* (*cf.* Goldie 2011, p. 124; Hofweber & Velleman 2010, pp. 1-2). Once we take seriously the distinction between perdurance and endurance, the dilemma of invoking an atemporal notion of constitution where both of the relata are inherently temporal, evaporates; however, only because it is possible to identify an alternative notion of constitution – diachronic process constitution. Of course, even in dynamical cases like the Watt governor, the constitutive relation between the higher-level process of maintaining a constant speed and the relevant sub-processes and their components at a lower-level might appear to hold synchronically; however, this is so only because of our need to represent it spatially by drawing, for example, a representation of the dynamical mechanism on a

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<sup>5</sup> Readers interested in the debates about anti-computationalism, anti-representationalism, and anti-nativism, see in particular Beer (1995), Clark (1997), Kelso (1995), Port & van Gelder (1995), Smith (2001), Thelen & Smith (1994), and van Gelder (1995, 1998).

blackboard or modeling the operations of the Watt governor as illustrated in Fig. 1. But this spatial representation is misleading, because the spatial representation does not map onto the dynamical nature of the constitution relation when considering the dynamics of the centrifugal governor. To quote the dynamical cognitive scientist Scott Kelso, like “a river whose eddies, vortices, and turbulent structures do not exist independently of the flow itself,” (1995, p. 1) so it is with Watt’s centrifugal governor – its higher-/ and lower-level processes do not persist unless they dynamically unfold over time. Now was the constitution relation between  $Y$  (the process of maintaining a constant speed) and the  $x$ s (the constituents) to be wholly determinate of  $Y$ ’s identity that constitution relation would have to be intrinsic to a time instant (*cf.* Hofweber & Velleman 2010, p. 16). If, however, the nature of something – e.g., a process like  $Y$  – from one moment of its existence to the next moment of its existence depends on temporal continuity, which is indeed the case for  $Y$ , then its constitutive character must allow for  $Y$  to be persisting *as* a perduring process. At this stage, perhaps an additional analogy might help to drive home my point. A process (or dynamic pattern) like the Mexican wave is built up from or constituted by individual fans that communicate and cluster together in smaller groups around or throughout a soccer stadium, say. The process of orchestrating and maintaining a Mexican wave is a temporally extended process, since each temporal event in the overall process depends on the presence of causal continuity between them. What there is of this process at a particular moment is insufficient to determine that a Mexican wave is unfolding. Hence, in articulating the nature of the existence of a Mexican wave, it is not enough to single out an atemporal constitution relation between a part (or parts) and the whole. Moreover, the process is not present in its entirety at any single moment in time – or, as Hofweber & Velleman point to “the process [is] not present in its temporal entirety within the confines of the moment” (2010, p. 20) – but requires spatiotemporal continuity for it to exist. Hence, just as processes evolve at both higher-level processes and lower-level processes in the centrifugal governor, the constitution relation continuously evolves with them, since – and analogous to the example of the Mexican wave – the higher-level processes is not wholly constituted by the processes or events at a singular, instantaneous moment.

Thus, specifying the diachronic nature of higher-level processes, along with the diachronic nature of lower-level processes, and explaining the constitutive relation between these, is what I aim to do by pushing for the concept of diachronic process constitution. This proposal obviously conflicts with metaphysical intuitions about constitution. But this conflict is unavoidable and absolute necessary if we are to explain the constitutive nature of perduring distributed cognitive processes.

### 3. Two concepts of synchronic material constitution

A critical step in articulating one fork of my overall argument – that the C-C fallacy is wrong and thus obviously misleading – is to establish what notion of constitution Adams & Aizawa are working with<sup>6</sup>. As I have already claimed, Adams & Aizawa are working with the specific notion of compositional constitution, a species of what I have called synchronic material constitution. This specification I now need to spell out in more detail. To so I shall piggyback on Wilson’s recent review of the metaphysical literature on material constitution (2007, 2009), where Wilson distinguishes between compositional and ampliative constitution, both of which are modes of synchronic material constitution. The benefit of surveying this review of material constitution is that it allows me to argue that regardless of Adams & Aizawa taking either compositional constitution or ampliative constitution aboard – from which to justify their claim that friends of EC are committing the C-C fallacy – neither of these can justify such a critical argument.

Consider that both compositional and ampliative constitution share two necessary conditions that any adequate analysis of synchronic material constitution must satisfy:  $y$  is materially constituted by  $x$  (or the  $x$ s) during  $p$  only if:

“**Coincidence:**  $x$  is completely material in itself, or the  $x$ s are completely material in themselves, and  $y$  is spatially and materially coincident with  $x$  (or the  $x$ s) during  $p$ .” (Wilson 2009, p. 370)

“**Distinctness:** it is possible for  $x$  (or the  $x$ s) to exist without there being anything of  $y$ ’s type that is (even partially) spatially and materially coincident with  $x$  (the  $x$ s). (Wilson 2009, p. 370)

One may suspect that it is these two standard and representative conditions of material constitution that motivates (or generates) most of Adams & Aizawa’s intuitions about the C-C fallacy. With the case of

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<sup>6</sup> Recall that the other fork is that some defenders of EC blindly adopt the concept of constitution from analytical constitution, thereby misconstruing the relation of constitution in their defense of EC. I will consider this issue later on.

the air conditioning system as our backdrop, consider that the coincidence condition requires a specific form of *overlap*, namely the *complete* overlap of space and material between  $y$  and  $x$  (or the  $x$ s) for the duration of the constitution relation (cf. Wilson 2007, p. 5). For instance, it is coherent to say that two or more roads *partially* overlap, since at their spatial intersection, they share the same material. Simile with the case of the air conditioning system, where it seems equally coherent to say that the condenser coil and the evaporator coil share parts of the same material. However, just as two or more overlapping roads do not share the same spatial and material parts completely, the evaporator coil and the condenser coil do not share the same spatial and material parts completely. Indeed, if this is a necessary condition that all adequate analyses of material constitution must fulfill, it is easy to see why Adams & Aizawa make the claim that the evaporator coil does not constitute the condenser coil, or *vice versa*. With this condition explained (although it can be done so in more detail), we can already see why Adams & Aizawa are mistaken in arguing that all cases of EC commit the C-C fallacy. Recall the schematically defined case of EC in Menary (2006): “ $X$  is the manipulation of the notebook *reciprocally* coupled to  $Y$  – the brain processes – which together constitute  $Z$ , the process of remembering.” (2006, p. 334; italics in original) Once we have this picture, it is clear why the coincidence condition of synchronic material constitution cannot be employed to justify the argument that all defenders of EC commit the fallacy of conflating causation with constitution. On the one hand, nowhere does Menary claim that  $X$  and  $Y$  must spatially and materially coincide completely. Indeed, this would be a rather bizarre thing to claim. On the other hand, even if it is possible for  $X$  and  $Y$  to exist without there being anything of  $Z$ 's type (this is the requirement of non-identity stated in the distinctness condition),  $Z$  does not spatially and materially overlap completely with  $X$  and  $Y$ . I find it fully coherent to claim that the relationship between  $X$  &  $Y$  and  $Z$  is such that the space-time path of  $Z$  includes the space-time path of  $X$  &  $Y$ . This is because, if  $X$  &  $Y$  constitute  $Z$ , higher-level processes such as  $Z$  is built up from  $X$  &  $Y$ . However, it does not follow from this that a higher-level process (like  $Z$ ) and its lower-level constituent sub-processes (like  $X$  &  $Y$ ) completely overlap materially with one another. That  $X$  &  $Y$ , on the one hand, and  $Z$ , on the other, do not completely overlap materially with one another can be illustrated by highlighting that  $Z$  and  $X$  &  $Y$  are embedded dynamically at multiple and different time-scales. For instance, neural assemblies run over time-scales of milliseconds, whereas the practice of manipulating a notebook runs over longer time-scales. Thus, it makes little sense to insist on material coincidence given the dynamic nature of distributed processes like  $Z$  and their sub-processes and components.

### 3.1. Compositional constitution

To continue this analysis of material constitution, what Wilson dubs *compositional* constitution, has, in addition to the conditions of coincidence and distinctness, two further necessary conditions that it is commonly expressed to imply:

“**Intrinsic Necessitation:**  $x$  is in some intrinsic state(s), or the  $x$ s that compose  $y$  are arranged, during  $p$  such that  $x$  itself, or the  $x$ s themselves, necessitate the existence of  $y$ .” (2009, p. 371)

“**Constituent Necessitation:** whenever  $y$  exists, there must be something of  $x$ 's type that is [...] spatially and materially coincident with  $y$ .” (Wilson 2009, p. 371)

In the intrinsic necessitation condition the idea that constitution is a compositional, part-whole, relation finds its most clear expression. It is now possible to address a second fork in my argument, namely that some defenders of EC take for granted the applicability of theory-laden metaphysical notions such as constitution without taking the additional step of providing a proper analysis of such terms. Consider, for example, these two quotes by Clark (2008) and Rowlands (2010) respectively: (a) “We thus come to what is arguably the most radical contemporary take on the potential cognitive role of nonbiological props, aids, and structures: the idea that, under certain conditions, such props and structures might count as *proper parts of extended cognitive processes*.” (Clark 2008, p. 68; italics in original); and (b) “*EM* is a claim about the *composition* or *constitution* of (some) mental processes.” (Rowlands 2009, p. 54; italics added) Both Clark and Rowlands explicitly express a commitment to constitution as compositional – Rowlands does so explicitly, whereas Clark does so by using the notion of “proper part,” which refers to the formal theory of extensional mereology.

It is misleading for defenders of EC to make use of compositional constitution for several reasons. First, compositional constitution is a strict partial ordering, like the notion of a proper part in the formal theory of extensional mereology. A partial ordering is a reflexive, transitive, and antisymmetric relation (cf. Varzi 2009, p. 4). In the context of extensional mereology, we can understand transitivity as stating that “any part of any part of a thing is itself part of that thing.” (Varzi 2009, p. 4), and formally  $(P_{xy} \wedge$

$P_{yz} \rightarrow P_{xz}$ . That a partial ordering is antisymmetric can be expressed as follows: “Two distinct things cannot be part of each other.” (Varzi 2009, p. 4), and formally  $(P_{xy} \wedge P_{yx}) \rightarrow x = y$ . Finally, reflexivity implies that “[e]verything is part of itself.” (Varzi 2009, p. 4), which formally is expressed as  $P_{xx}$ . There are individual problems with all these conditions. The idea that constitution is transitive is controversial because one can observe legitimate senses of “part” that are not transitive. For instance, consider these two arguments:

- 1.A This chain is constituted by metal links.
- 1.B Those metal links are constituted by physical particles.
- 
- 1.C This chain is constituted by physical particles.

In this case, the premises (1.A) and (1.B), together with the criterion of transitivity, entail (1.C). But what about the following argument:

- 2.A This queue is constituted by a sequential order of people.
- 2.B That sequential order of people is constituted by physical particles.
- 
- 2.C. This queue is constituted by physical particles.

This argument appears to have the same form as (1A-1C). However, even if both arguments rely on the principle of transitivity, unlike (1A-1C), (2A-2C) is controversial, in that it is not clear that (2A-2C) can accommodate transitivity. Specifically, unlike a metal chain, which one might think of as nothing more than various entities appropriately organized, queues are more than simply their physical parts – regardless of how these might be arranged. According to Wilson, if this is correct, then there is a non-trivial metaphysical difference between entities such a chain and a queue and their constituents. That is, as Wilson nicely puts it: “Consider any chunk of physical matter. If you merely add physical matter to this chunk, there will be a way to do so that itself creates a chain. But there is *no* such way of proceeding here that creates a statue.” (2009, p. 369; italics in original) The same is true of a queue. Mere addition, or, for that matter, arrangement, will not suffice to constitute a statue or a queue, since their identity are partly made up of physical, intentional, and socio-cultural relations “that pertain in the broader locale of that constituent physical matter.” (Wilson 2009, p. 369) We can simply note that not all sequential line configurations of people constitute a queue (Hutchins 2005, p. 1559). Soldiers standing at attention are in a sequential line configuration, yet they do not constitute a queue. Part of what makes a sequential line configuration a queue is that that sequential line configuration is embedded within socio-cultural practices with the appropriate norms (*cf.* Hutchins 2011a). The second problematic element concerning compositional constitution being a strict partial ordering – insofar as some defenders of EC use this notion of constitution – is that the principle of reflexivity states that everything is a part of itself. But it is (*prima facie*, at least) counter-intuitive to view entities like people in our argument (2A-2C) as parts of themselves (*cf.* Wilson 2007, p. 7). If it is counter-intuitive to view people – or, for that matter, objects such as *David* and *Piece* – as parts of themselves, then it is also counter-intuitive to count a process (distributed remembering, say) as a part of itself. Finally, both Clark and Rowlands emphasize that they focus on *processes* in the above quotes. This, however, since compositional constitution is a synchronic relation of dependence, and processes are diachronic in their very essence, provides Clark and Rowlands with the dilemma I outlined earlier: how can the relation of constitution that holds between relata of processes be atemporal (i.e., synchronic) if the relata themselves (at both the higher-level and the lower-level) are *essentially* temporal (i.e., diachronic)? In other words, if the very nature of a process is to unfold over time for a process to *be* what it is, then how can its existence be determined at an atemporal instant? The answer is that it cannot; hence, Clark and Rowlands ought to avoid the employment of compositional constitution to argue for EC.

### 3.2. Ampliative constitution

The second concept of synchronic material constitution identified by Wilson (2007, 2009) is *ampliative* constitution. This notion is interesting to consider simply because it is not characterized by intrinsic necessitation conditions but rather by two conditions that go beyond relations of extensional, part-whole, mereology to consider *contextual* and *relational* aspects of both constituents as well as the constituted phenomenon. One might think that because of its relational and contextual aspects that this relation of constitution is precisely the kind of constitution relation defenders of EC should be working with. This can be motivated further, since the mode of ampliative constitution explains the underlying

intuition that the constituted phenomenon is *more than simply* its internal physical constituents – that is, there is more to the constitution of a phenomenon than is physically “within” that phenomenon. Unfortunately we have to do much better than appealing to ampliative constitution in order to explain the mode of constitution in distributed cognitive processes. To get a fix on this, I first need to highlight and explain what ampliative constitution is.

Let us begin by noticing, as Wilson does, that the concept of ampliative constitution has been particularly important in the work of Lynne Rudder Baker (1999, 2000) – with the aim of establishing a constitutive view of persons. For my purposes, here, the discussion of persons is irrelevant. Instead I shall keep my focus on the example introduced at the beginning of this paper, the relation between *David* and *Piece*. For Baker, “*x* constitutes *y* at *t* =<sub>df</sub>

- a) *x* and *y* are spatially coincident at *t* and share all the same material parts at *t*; and
- b) *x* is in *D* at *t*; and
- c) It is necessary that  $\forall z [F^* zt \text{ and } z \text{ is in } D \text{ at } t) \rightarrow \exists u(G^* ut \text{ and } u \text{ is spatially coincident with } z \text{ at } t)]$ ; and
- d) It is possible that (*x* exists at *t* and  $\sim \exists w[G^* wt \text{ and } w \text{ is spatially coincident with } x \text{ at } t]$ ); and
- e) If *y* has any nonspatial parts at *t*, then *x* has the same nonspatial parts at *t*.” (1999, p. 149; see also Baker 2000)

As Wilson (2009) has shown, the case of *David* and *Piece* satisfies conditions (a)-(e). *David* and *Piece* are both materially as well as spatially coincident during *t*. *Piece* is in art-rich cultural circumstances, given a title, and put on display at *t*. Necessarily for anything that has “being a piece of marble” as its modal property (the mode in which a property is had necessarily or possibly by an object) and is presented as a figure in art-rich cultural circumstances, given a title, and put on display at *t*, then something exists that has “being a statue” as its modal property that materially and spatially coincides with “being a piece of marble” at *t*. In (d) the modal claim made is simply that it is possible that *Piece* exists at *t* and that *Piece* does not spatially and materially coincide with anything that has “being a statue” as its modal property at *t*. The final condition says that neither *Piece* nor *David* has nonspatial parts. I will not discuss this latter point further, since the debate concerning EC is consistent with some form of philosophical naturalism. This fits snugly with Wilson’s view of ampliative constitution, with the notion of material constitution being further based on the following two conditions:

“**Extrinsic necessitation:** *x* (the *x*s) is (are) in extrinsic conditions during *p* that themselves necessitate the existence of *y*.” (Wilson 2009, p. 371)

“**Relational/Intrinsic Constraint:** *y* is relationally individuated and *x* (the *x*s) intrinsically individuated.” (Wilson 2009, p. 371)

With these two conditions defined, we can now assess whether Adams & Aizawa presuppose the notion of compositional constitution (which I have argued that they do) or whether they assume the soundness of the notion of ampliative constitution, both notions of material constitution are incompatible with most cases of EC. Since I have already argued for the first horn of this, *viz.*, that compositional constitution is inconsistent with distributed cognitive processes, I focus only on the second horn here – that ampliative constitution is equally problematic.

First, if we attend only to the relational/intrinsic constraint of ampliative constitution, this specific constraint is insufficient twofold. On the one hand, it is insufficient for the defender of EC to attempt to ground the constitution claim of EC. The fact that a process *Z* (e.g., the process of remembering) in the case introduced in Menary (2006) is relationally individuated will not suffice to establish the claim that environmental elements play a constitutive role in certain tokens of cognitive processes. Put differently it is not enough to show that certain socio-cultural circumstances are causally necessary for a process to be extended or not. In fact, in contrast to EC, where some of the physical constituents of a cognitive process may be located “outside” the brain and body of an individual, the relational/intrinsic constraint specifies that all the physical constituents (*x* or the *x*s) are located *internally* to the individual in question. On the other hand, if Adams & Aizawa take this particular form of synchronic material constitution onboard, it will not be possible for them to justifiably underpin the charge that defenders of EC commit the C-C fallacy – rather, such an argument would beg the question against the relation of constitution in EC. That is, if the constitutive nature of distributed cognitive processes does not reflect the kind of constitutive character implied by relations of ampliative constitution, then how could critics of EC, like Adams & Aizawa, base the argument for the C-C fallacy on ampliative constitution? Indeed, they could not.

Second, in his recent review of material constitution, Wasserman (2009) discusses four different problems confronting synchronic material constitution. These problems are interesting in this context,

since if either Adams & Aizawa or (some) defenders of EC adopt the relation of ampliative constitution this carries with it its own set of metaphysical problems. Of the four problems that Wasserman focuses on, one problem in particular interests me. This is the so-called *grounding objection* raised against the plausibility of synchronic material constitution (for various ways of stating this objection, see Bennett 2004; Burke 1992; Simons 1987; and Zimmerman 1995). Let us focus again on the case of *David* and *Piece*. As we know, both *David* and *Piece* share the same matter. Hence, the two objects share many of the same properties (e.g., weight, size, color, etc.). Commonly this aspect is taken to imply that *David* and *Piece* share many of the same categorical properties. Similarly *David* and *Piece* also differ in many non-categorical properties such as conditions of existence (their both in non-identity relations with one another). But what could account for these differences? Moreover, how can two things that are exactly alike in so many respects still differ in other respects? Wasserman calls this the grounding objection to synchronic material constitution, “since it appeals to the common idea that non-categorical properties and grounded in categorical properties.” (2009, p. 6) For instance Baker (1999) attempts to explain this grounding in terms of *David* being a statue, and *Piece* being a lump of matter, because *David* is admired as a piece of art, there are reviews written about *David*, and *David* exists as a statue relative to an art community. But, as Wasserman says, the “problem with this explanation is that it seems to get things exactly backwards, for it is natural to say that *David* is admired, reviewed, and discussed by those in the art community *because it is a statue* (rather than a mere lump of clay).” (2009, p. 7) Another possible response would be to attempt to ground the non-categorical features of *David* and *Piece* in historical facts (Wasserman 2009, p. 7). But such a response – even if it might work in metaphysics – it will not work concerning distributed/extended cognition. That is, references to causal-historical facts will not appeal to the EC theorist for the simple reason that such an appeal could too easily be utilized and altered to work as a critique of EC. In particular, Adams & Aizawa could say that it is metaphysically innocent to argue that relational properties can be accounted for by appeal to causal-historical facts. This they can infer from the externalist lessons on the individuation of mental content from Putnam (1975) and Burge (1979).

Hopefully it will now be clear why synchronic material constitution, regardless of the constitution relation being compositional or ampliative, is inconsistent with EC. In the next section, I will attempt to contrast synchronic material constitution with diachronic process constitution, while relating this to the C-C fallacy.

#### **4. Synchronic material constitution, diachronic process constitution and the C-C fallacy**

Lest the reader think that I am straying too far from matters of cognition, let me remind you that what is in dispute is the grain of fit between concepts in analytical metaphysics such as constitution and the nature of dynamical cognitive processes in EC. I have deliberately selected the most widely discussed examples in metaphysics – for instance, the relation between *David* and *Piece* – to establish what such examples tell us about the constitutive nature of objects, when that constitutive relation is supposed to hold synchronically. I have used these cases contrastfully with cases of dynamical EC – e.g., the process of distributed remembering (Menary 2006) and van Gelder’s (1995) case of the centrifugal governor that is intended to show that the underlying dynamics in certain systems involve certain kinds of causation (complex, continuous reciprocal and mutually modulatory) that are involved in the make up of higher-level processes.

One might wonder, of course, if the move from synchronic material constitution to what I term diachronic process constitution is simply a bloodless coup? First, if my claim turns out to be correct, then this establishes that defenders of EC must avoid any blind adoption of the notion of constitution from metaphysics, because of the latter’s incompatibility with EC cases. Second, the need to pursue an alternative account of constitution points to something problematic with the concept of constitution as this concept is understood in analytical metaphysics. In other words, if the relata we are investigating are inherently temporal – which all relata are in dynamical systems – the tool-kit of metaphysics, especially concerning the issue of constitution, cannot be applied to explain inherently temporal, dynamical phenomena. Dynamical systems, however, are ubiquitous in nature (*cf.* Beer 2000; Friston & Stephan 2007; Kelso 1995; van Gelder 1998). Hence, the synchronic formulation of constitution as material constitution is applicable to only a small number of phenomena. Much more care and additional development of the notion of constitution is required to get at the nature of processes and other phenomena, where change in time and temporal unfolding is essential. In particular, since all cognitive processes unfold in time continuous dynamical systems (*cf.* Spivey 2007; Varela et al. 2001), we need to address these fine temporal details in order to identify the constitutive nature of just that which evolves over time.

In case the reader wonders whether the argument I am pursuing in this paper implies (a) restricting constitution to diachronic processes, and (b) to the relations between processes, this is not my intention. For example, I find it coherent to argue that constitution holds both (c) synchronically, and (d) between two or more distinct objects or entities. The claim I find incoherent is the attempt to explain cases of (a) and (b) by applying the metaphysical tool-kit best suited to explain (c) and (d), because the relation of constitution that holds in dynamical systems such as cognitive systems are incompatible with how the relation of constitution is conceived of in the analytical metaphysics literature. Pushing the idea of diachronic process constitution is meant to put in bold that we need to avoid exactly such a conflation and misapplication of phenomena and explanatory schema.

Before embarking on the task of explaining the idea of diachronic process constitution in detail, I wish here to map out a few interesting differences. The first of these differences is between constitution and causation. In her discussion of metaphysical building-relations, Bennett (2011) notes that causation as well as constitution is irreflexive, asymmetric, and transitive. If so, what differentiates causation, on the one hand, from constitution on the other, then? Even if both causation and constitution are 'directed' in some relevant sense, these two dependence relations are typically understood to be wholly distinct, full stop. Here Bennett points to the most commonly accepted additional feature of constitution that is not shared by causation, namely that a further necessary feature of a relation's counting as a relation of constitution is that it be *synchronic*, thereby holding atemporally. In contrast to constitution, causation – so Bennett informs us – is “paradigmatically *diachronic*, and that idea is frequently invoked to distinguish causation from relations like composition, constitution [...]” (2011, pp. 93-94; italics in original)

Although this is a tempting way to discriminate between causation and constitution, especially when considering dynamical cases such as distributed cognitive processes or modes of processing, on occasions temptation is best restricted. I think this is one of those occasions. On the one hand, although she does not further develop this idea, Bennett herself stresses that we “should not require that building relations be *synchronic*.” (2011, p. 94; italics added) As I mentioned, although she does not go on to develop this line of thought, it is important for my present purposes, in the sense that if some philosophers find my idea that metaphysical building relations can be diachronic obviously flawed (in some way), here we have a reputable philosopher of metaphysics stating that such an idea might not be so obviously mistaken. In fact, when conceivable as diachronically evolving, relations like constitution share far more features with certain modes of causation, especially what Clark (1997) and Wheeler (2005) call “continuous reciprocal causation” (CRC), than one might suspect. We already have the idea that both causation and constitution can be diachronic, so I will leave this aside for now. What about the property of *asymmetry*? Even if it is standardly accepted that constitution and causation are asymmetric, in cases of EC, we should resist this assumption. Consider again Menary's process of remembering: “X is the manipulation of the notebook *reciprocally* coupled to Y – the brain processes – which together constitute Z, the process of remembering.” (2006, p. 334; italics in original) This is the specific form of causation involved in CRC and nonlinear dynamics, in that, CRC “involves multiple simultaneous interactions and complex dynamic feedback loops, such that (i) each [process] partially determines, and is partially determined by, the causal contributions of larger numbers of other [processes], and, moreover, (ii) those contributions may change radically over time.” (Wheeler 2005, p. 260)

What, then, about constitution? Craver & Bechtel note that all interesting cases of interlevel constitutive relations are *symmetrical* (2007, p. 553). Focusing on mechanisms, they state that: “The relation is symmetrical precisely because the mechanism as a whole is fully constituted by the organized activities of its parts; a change in the parts is manifest as a change in the mechanism as a whole, and a change in the [whole] is also a change in at least some of its component parts.” (Bechtel & Craver 2007, p. 554) I will have much more to say about the issues of temporality and symmetry concerning constitution in the section that follows.

The second difference that I wish to highlight is between how most EC theorists understand relations like constitution on the one hand and my account of diachronic process constitution on the other. For instance, Sutton (personal communication) assumes that constitution is synchronic, thus endorsing the standard view of constitution in analytical metaphysics. Equally, Sutton assumes that constitution and causation are different. *Prima facie*, there is nothing problematic with the latter assumption, since what Sutton wants to claim is that if the disparate components are, in fact, part of a single cognitive system or process, then those components constitute that system or process. The causal interactions are not in themselves the ground for the constitution claim, though they are indeed a useful sign for the existence of such a distributed system or process. But this assumption is open to interpretation such that it is consistent with the one used in analytical metaphysics: that there is a fundamental difference between causation and constitution, and that difference is that whereas the

latter is synchronic, the former is diachronic. The problem, as I see it, is that this concedes too much to the critics. If there is a significant difference between causation and constitution, with that difference being that causation is diachronic (temporal) whereas constitution is synchronic (atemporal), then how does something that is inherently temporal (the complex causal relations between processes and their component parts at a lower level) atemporally constitute something that is inherently temporal at a higher level (e.g., the distributed process of remembering)? What Sutton needs – to avoid the charge of the C-C fallacy – is an independent argument that grounds the relation of constitution, *viz.*, we need to show how components are integrated such that they make up a larger system. In the next section, I take on this project by highlighting the issue of constitutively mediated effects.

This brings me to the final difference I want to focus on in this section, namely that between the C-C fallacy and diachronic process constitution. Specifically, if a defender of EC were to work with diachronic process constitution, this defender would not commit the C-C fallacy. On the one hand, as I have highlighted, the C-C fallacy turns on an argument that conflates intralevel causal relations with interlevel constitutive relations, in the sense that the C-C fallacy works only if an inference is made from causation to constitution, where these relations are said to persist on the same level, e.g., that of the constituents. On the other hand, the C-C fallacy assumes that constitution is itself synchronic – this should be evident since the C-C fallacy turns on compositional constitution. But since cases of distributed cognitive *processes* are temporal, and synchronic notions of constitution fail to pick out the fine temporal details essential to what it is to be a process, the C-C fallacy is just question begging.

## 5. Diachronic process constitution

To further unravel the notion of diachronic process constitution, I will discuss several core features of diachronic process constitution in turn in this section.

### 5.1. “Small-m” mereology, not “big-M” mereology

It is quite intuitive to associate part-whole relations with relations of constitution, and because appeals to the formal ideas of the theory of extensional mereology has been quite influential in metaphysics in general, perhaps, then, we should also think of diachronic process constitution as consistent with the formal part-whole theory of extensional mereology? Burrowing a distinction from Wilson (who modifies this distinction from Simons (1987)), I shall now argue why diachronic process constitution can (and should) be expressed without any appeal to extensional mereology. The relevant distinction is that between *small-m* mereology and *big-M* mereology, with the latter referring to the specific formal theories of Mereology that grew out of Lesniewski’s *Foundations of a General Theory of Manifolds* (1916) and Leonard & Goodman’s *The Calculus of Individuals* (1940). The primary concern with the notion of big-M Mereology is that it construes the part-whole relation as a partial ordering, *viz.*, as an antisymmetric, reflexive, and transitive relation. Recall that in sub-section 3.1, I argued that regardless of considering the relation between *David* and *Piece*, on the one hand, or the relation between *Z* (process of remembering) and *X* (manipulation of notebook) and *Y* (brain process), on the other, neither *David* nor *Piece* and neither *Z* nor *X* & *Y* can plausibly be thought of as part(s) of itself (themselves). Perhaps even more problematically, the extensionality principle of big-M Mereology violates the representative and commonly accepted idea that constitution is a relation of non-identity – it states that if *x* (or the *x*s) and *y* share the same proper parts, then *x* (or the *x*s) is *y*. Given the attention from constitution theorists on distinguishing the relation of constitution from a relation of identity, I shall follow Wilson’s advice in thinking that “it would seem prudent to avoid building this into one’s view of constitution from the outset.” (2007, p. 7) This is, of course, still fully consistent with conceiving of small-m mereology as in line with diachronic process constitution.

### 5.2. Process ontology ‘yes’, but non-eliminative

While this paper – and my account of diachronic process constitution – is not intended as a defense of process ontology and does not offer a comparison of such views with alternative ontological models, such as traditional substance ontology, and various competitor views, e.g., Whitehead’s event ontology, trope ontology, stage ontology, and so on – tasks for another occasion – diachronic process constitution shares a *kinship* with some form of non-eliminative process ontology. First, unlike certain eliminative variations of process ontology (*cf.* Psillos 2001) such as French & Ladyman’s (2001) account of ontic structural realism, who argue that our best physics is incompatible with ontological categories such as “individuals,” on my account of diachronic process constitution, the very idea of processes presupposes that processes have *individual parts*. A process might involve any number of component parts, but it

always involves *some* parts. Even though processes themselves may occupy the relata in relations of constitution (as in the relation between *Y*, the process of remembering, and *X & Y*, the process of manipulating a notebook reciprocally coupled to brain processes respectively), we need to be aware that our analysis, and subsequently explanation, must stop somewhere. That is, even if our best physics tell us that individual entities do not exist – e.g., only quantum fields exist – this will not make much sense in the context of cognitive science. In cognitive science we want to be able to locate and preferably identify entities as well as their activities (*cf.* Bechtel & Richardson 1993; Bechtel 2008; Craver 2007; Machamer et al. 2000). Note, though, that there is an important and non-trivial difference between how process ontologists (see e.g., Seibt 2009) conceive of individual parts and how the notion of “part” is preserved and propagated in approaches to synchronic material constitution.

To appropriately characterize “part” in processual terms, we must replace what Seibt has recently called the “particularist conception of individuals” – i.e., entities that are intrinsically individuated and which have a determinate unique location – with a view of individual parts that focuses not so much on “location but on ‘*specificity-in-functioning*’ in the widest sense of ‘functioning,’ i.e., focuses on the dynamic role of an entity (e.g., an activity) *within a certain dynamic context.*” (2009, p. 484; italics added). This is a crucial difference between accounts of synchronic material constitution and the idea of diachronic process constitution for a couple of reasons. First, both compositional constitution and ampliative constitution presuppose that the physical constituents are intrinsically individuated – this we can see in the intrinsic necessitation constraint and in the relational/intrinsic constraint respectively. If processes, according to process ontologists, are individuation-dependent upon the larger context within which they are embedded for their dynamical function, processes cannot be intrinsically individuated. Second, moving from a particularist notion of individuals to a view of component parts as individuated qua their specificity-in-functioning is indicative of a shift away from focusing on the material as well as spatial *co-location* of relata in constitutive relations to a practice of individuating aspects of nature in terms of *dynamic function* – *viz.*, in terms of what is happening or is going-on in situated context.

Framing the constitutive thesis of EC in terms of ontological frameworks akin to certain modes of process ontology is consistent with particular strands of EC theorizing. For instance, Menary (2012) distinguishes between “artifact extension” (AE) and “enculturated cognition” (EnC). AE is the version of EC advocated by Clark & Chalmers (1998), Clark (2008), and Wheeler (2010). EnC, on the other hand, appeals to the idea that cognitive processes are driven and partly constituted within a species of cultural practices (*cf.* Hutchins 2008, 2011a, 2011b; Menary 2007), and motivates a shift away from a focus on “things” to an enactivist approach to cognition as the unfolding of dynamical processes and/or patterns (*cf.* Chemero 2009; Di Paolo 2009; Kelso 1995; Thompson 2007; Varela et al. 1991). At least as far I can tell, EnC is process-based; an idea nicely captured in Di Paolo (2009). It is in virtue of this that cognitive processes involve multiple feedback loops and organizing activity across the boundary of the organism itself, which reveals incoherence in the notion of “intrinsically individuated constituents”.

To proceed further with my analysis of why diachronic process constitution shares a kinship with specific strands of noneliminative process ontology, what we need, to get a firmer grip on these issues, is an example to analyze. Before doing this, however, I briefly want to digress in order to consider one possible counter-argument that Adams & Aizawa could attempt to mount. Adams & Aizawa could try the argument that even if processes are relationally individuated, it is still the case that the constitutive base must be *bounded*. That is, Adams & Aizawa could argue that the constituents must somehow be contained within the whole. On the one hand there is something quite right about this kind of claim, in the sense of the following: I have argued that diachronic process constitution is consistent with small-m, part-whole, mereology; hence, it is coherent to think that this requires the space-time path of the whole to include the space-time path of the parts. On the other hand, however, despite the requirement that the whole “contains” the parts, it is still not transparent what privileges some *instance* (token) boundaries over others. Consider, for example, Campbell & Bickhard’s case of a candle flame. The question they ask is, what is the relevant constitutive boundary of a candle flame? They ask, might it be the “hottest colour in the center of the flame? The cooler but still visibly radiating boundary outside of that hottest domain? The collective boundary of the candle and one of those colour phase change boundaries? The cubic meter of the candle?” (2011, p. 36) A candle flame is an open, non-equilibrium system. It is open in the sense that it interacts with its environment – exchanging energy and matter. It is non-equilibrium in the sense that without these interactions, it cannot maintain proper (low) levels of entropy (*cf.* Kelso 1995, p. 4). Like the candle flame, the mammalian brain is an open system (*cf.* Churchland 2005), and thus cannot be understood or explained through some “encapsulated reductionism” (*cf.* Spivey 2007, p. 122), since some of the parameters that dynamically drive open systems are not “internal” or bounded within the system itself. Because open systems depend for their existence upon their interactions with their environments so as to lower systemic entropy, their

existence cannot be solely determined by properties or powers within certain contained boundaries. So, appeal to the idea that the constitutive base must be bounded is flawed.

Continuing my discussion that diachronic process constitution shares a kinship with certain forms of noneliminative process ontology, let us consider the dynamical system I foregrounded in section 2, the Watt (centrifugal) governor. It is not too surprising, I think, that dynamical systems (and distributed dynamical processes such as the distributed process of remembering) do not dovetail with explanations in terms of synchronic material constitution, because analytical metaphysics is not well equipped so as to deal with dynamic phenomena in general. The insights from dynamics (see e.g., Kelso 1995; van Gelder 1995, 1998) throws into question how we should understand the notion of “part,” if indeed we keep (as I have argued) the requirement that processes involve component parts as an element of our ontology of processes. Unlike synchronic views of material constitution, where constituent parts are *particulars* (i.e., “entities that (i) each have a determinate *unique* spacetime location and (ii) have this location necessarily since they are individuated in terms of [their] location.” (Seibt 2009, p. 484)), processes are best explained and understood as having *non-particular* component parts. Recall that to appropriately describe parts in processes, we must move away from what Seibt calls the “particularist conception of individuals,” and replace it with a perspective that puts emphasis “not on location but on ‘specificity-in-functioning’ in the widest sense of ‘functioning,’ i.e., focuses on the dynamic role of an entity (e.g., an activity) *within a certain dynamic context.*” (2009, p. 484; italics added) Now, applying Seibt’s (2009) model of processes to the context of dynamical systems (*viz.*, to the Watt governor), we can say the following. First, processes are *temporally extended*, i.e., there is no such thing as an instantaneous process. In the case of the Watt governor, the process of maintaining a constant speed of the flywheel does not take place at a time instant  $t$ ; rather, it is the unfolding of a complex pattern or process over time. Second, processes do not necessarily occur in a unique spatiotemporal location – ontologically speaking, a process is *not a particular*. Albeit mechanically organized, which of course limits the freedom of movement in the Watt governor, the throttle valve, the arm angle, the spindles, the pulley belted to the flywheel, and the collar slides are all in continuous and mutually influencing interaction. Third process must be *individuated in terms of their roles in a dynamic context* – that is, because they are non-particulars, they must be individuated so. In dynamic systems theoretic terms, we can explain the relationship between the steam engine and the governor system such that the arm angle of the governor, call this  $\theta$ , is a parameter of the engine system, whereas the engine speed, call this  $w$ , is a parameter of the governor system (van Gelder 1995, p. 357). This relationship between  $\theta$  and  $w$  is known as *coupling*, which enables us to explain the dynamical behavior of  $\theta$  and  $w$  as comprising what van Gelder refers to as a “single dynamical system in which both arm angle and engine speed are state variables.” (1995, p. 357)

Similarly to  $\theta$  and  $w$ , we can think of the relationship between an agent (a brain, perhaps) and its environment as two dynamical systems  $A$  and  $E$  dynamically coupled to one another, and where both  $A$  and  $E$  are time-continuous dynamical systems. The dynamical systems theorist Beer represents this coupling as follows:  $S$  is a sensory function from environmental states to agent parameters, and  $M$  is a motor function from agent state variables to environmental parameters, with  $S(X_E)$  standing in for an agent’s sensory inputs, and  $M(X_A)$  corresponding to its motor outputs. As Beer shows, this gives us the following equations:  $X_A = A(X_A; S(X_E); U'_A)$ , and  $X_E = E(X_E; M(X_A); U'_E)$  (1995, p. 181). Given the continuous reciprocal coupling between  $A$  and  $E$ , Beer emphasizes that we can see – just like the case with  $\theta$  and  $w$  – “the two coupled nonautonomous systems  $A$  and  $E$  as a single autonomous dynamical system  $U$  whose state variables are the union of the state variables of  $A$  and  $E$  [...]” (1995, pp. 182-183).

How does this relate to the C-C fallacy? First, if a process  $x$  occurs in  $y$  and  $y$  is causally interacting with  $z$ , it does not follow (so Adams & Aizawa argue) that  $x$  “extends into”  $z$ . This is the form of Adams & Aizawa’s example of the air conditioning system: if evaporation occurs in an evaporation coil and the latter is causally linked to a compressor coil, it does not follow that evaporation “extends into” the compressor coil. Nobody, I believe, would dispute this. But, as I argued, this template is deeply problematic for the simple reason that most defenders of EC do not argue in a way corresponding to that template. Indeed, having made the distinction between a “particularist conception of individuals” and a “non-particularist conception of individuals,” it is easy to show that Adams & Aizawa are indeed committed to the former conception of individual entities as *particulars*. This is a serious point, since it is an incoherent assumption when applied to processes as related in relations of constitution. Consider that “something is a particular if by necessity it occurs in one entity only.” (Seibt 2010, p. 29) In other words,  $x$  occurs in  $y$  if by necessity it only occurs in  $y$  – evaporation occurs in  $y$  if by necessity it only occurs in  $y$ . But as we have seen, processes cannot be explained by such necessitation and location-exclusive requirements. Hence, working with particularist assumptions presents a problem for Adams & Aizawa.

### 5.3. Counterfactual dependency

To further highlight some of the similarities between causation and a diachronic notion of the relation of constitution, together with providing an answer to a possible objection from Adams & Aizawa, I will now consider the issue of counterfactual dependency.

There are many ways by which to attempt to discriminate between causal dependency and constitutive dependency. One way, presented in this paper, is to assume that only causation is temporal, whereas constitution is atemporal. Of course, this may hold only in cases where we contrast synchronic material constitution with causation – it does not hold, I have argued, once we contrast a diachronic and process based notion of constitution with causation, since both of these are temporal. Another possibility seems to be to explain causal dependency in terms of counterfactual dependency, and from this try to show that only causal dependency can be explained counterfactually, whereas counterfactual dependency is insufficient to justify constitutive dependency. This, I suspect, is yet another assumption that is driving Adams & Aizawa's insistence that defenders of EC commit the C-C fallacy.

In this sub-section, then, my aim is to establish that diachronic process constitution is immune to such an accusation. Indeed, I shall show that one cannot appeal to counterfactual dependency in order to discriminate between causation and constitution.

The basic idea of analyzing causation in terms of counterfactuals is that causal claims can be made understandable as well as explained in terms of counterfactual conditionals of the form: if *C* had not occurred, *E* would not have occurred. But why think that causation (or causal claims) is conceptually linked with counterfactuals? For instance, according to Menzies, one "reason is that the idea of a cause is conceptually linked with the idea of something that makes a difference and this idea in turn is best understood in terms of counterfactuals." (2008, p. 4). Or, in the words of Lewis: "We think of a cause as something that makes a difference, and the difference it makes must be a difference from what would have happened without it. Had it been absent, its effects – some of them, at least, and usually all – would have been absent as well." (1973, p. 161) Consider, firstly, the following schematic claim: a cognitive process *Z* causally depends on two other processes, *P* and *S*, just in case if *P* and *S* had not occurred *Z* would not have occurred. Consider, secondly, our familiar example: this process of remembering is constituted by processes of manipulating a notebook jointly and reciprocally coupled to brain processes. This statement can be causally explained in terms of counterfactual conditionals of the following form: *Z* causally depends on *X* and *Y* just in case if *X* and *Y* had not occurred *Z* would not have occurred. Insofar as the counterfactual conditional – "if *X* and *Y* had not occurred, *Z* would not have occurred" – entails the causal statement "*X* and *Y* causes *Z*," it seems that Adams & Aizawa could argue: given such an entailment of the counterfactual conditional, the defender of EC is still committing an instance of the C-C fallacy, since it is not enough to show that *Z* is causally dependent on *X* and *Y* if the target is to establish that *Z* is constitutively dependent on *X* and *Y*.

Note, however, that for Adams & Aizawa to justifiably make this claim stick, they need to establish the additional claim that the sort of dependency expressed by counterfactuals is limited to relations of causal relations. But such a claim they will be unlikely to construct successfully. In his (1973), "Causes and counterfactuals," Kim points out that the "sort of dependency expressed by counterfactuals is considerably broader than strictly causal dependency and that causal dependency is only one among the heterogeneous group of dependency relationships that can be expressed by counterfactuals." (1973, p. 570)<sup>7</sup> There are cases involving processes, whose persistence is dependent on spatiotemporal or causal continuity, and in which one event is a constituent part of another. Consider, for example, Hofweber & Velleman's example of the process of writing a cheque:

"A process of writing a cheque is a temporally extended process, with temporal parts consisting in the laying down of each successive drop of ink. What there is of this process at a particular moment – the laying down of a particular drop – is not sufficient to determine that a cheque is being written, and so it is not sufficient to determine which particular process is taking place. [...] Not only, then, is the process not present in its temporal entirety within the confines of the moment: it is not fully determined by the events of the moment to be the process that it is." (2010, p. 14)

In this case, my laying down of each successive ink drop,  $I_1, \dots, I_n$ , is a constituent event in the overall process of writing a cheque; and, following Kim, it is probably true to say: 'If I had not laid down each successive ink drop,  $I_1, \dots, I_n$ , I would not have written a cheque'. But, it is unlikely that my putting an ink drop down followed by another drop of ink causally determines me writing a cheque. Hence, the first key point of this is: "counterfactual dependency is too broad to pin down causal dependency." (Kim 1973, p. 571) Indeed, if this is the case, then Adams & Aizawa cannot straightforwardly identify

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<sup>7</sup> I am grateful to Neil McDonnell for suggesting the relevance of Kim's (1973) article to this discussion.

the case of distributed processes of remembering with the C-C fallacy. Recall: “X is the manipulation of the notebook *reciprocally* coupled to Y – the brain process – which together constitute Z.” (Menary 2006, p. 334; italics in original) This statement can be given both causal and constitutive explanation, and both of these can be analyzed in terms of counterfactuals. In contrast to ‘Z causally depends on X and Y just in case if X and Y had not occurred Z would not have occurred,’ this statement can also be understood as saying ‘Z constitutively depends on X and Y just in case if X and Y had not occurred Z would not have occurred.. Thus, Adams & Aizawa cannot use counterfactual analysis to pin down a distinction between causal dependence and constitutive dependence.

#### 5.4. Hybridity

Suppose Adams & Aizawa accept the claim that counterfactual dependency cannot motivate (underpin) the C-C fallacy. Nevertheless, in the context of my claim that most cases of EC are *hybrid*, involving both causal and constitutive relations, they could still argue that if diachronic process constitution does not rely on inferring constitution from causation (or coupling), then *that* is not a defense of what other extended cognition theorists have said.” (Adams & Aizawa 2008, p. 104; italics in original) Rather, it “seems to be an abandonment of the coupling [causation] to constitution arguments, [...]” (Adams & Aizawa 2008, p. 104) On the one hand, they would be absolutely correct to specify that insofar the defenders of EC adopts the account of diachronic process constitution, they are not making an inference from causation to constitution. This is because causal relations are exclusively *intralevel*, where the constitutive relation is *interlevel*. On the other hand, Adams & Aizawa might also be correct to point out that such an account might not qualify as a proper defense of what other (previous) EC theorists have said. But why is that a problem? Indeed, the C-C fallacy itself turns on there being a fallacious inference from causation to constitution. If there is no such fallacious inference on my account, this is *not* a problem for me; rather, it is a problem for the critics. In particular, it seems that Adams & Aizawa have a problem with any account that abandons any such inference, since such an account would overcome (and therefore be immune to) the accusation of unjustifiably inferring from facts about causation to facts about constitution.

#### 5.5. Symmetrical relation: top-down and bottom-up constitutively mediated effects

Many assumptions about causation and constitution preclude that such relations are symmetric in the sense that both causation and constitution are typically thought to be asymmetric. Consider, first, that in most cases of causation, cause and effect are thought to be distinct in terms of both nonoverlap and in terms of nonimplication (*cf.* Lewis 2000, p. 78). On the specific mode of causation that both Clark (2008) and Wheeler (2005) refer to as CRC, two things are important to highlight: (a) cause and effect are indeed distinct such that a cause precedes its effect; but (b) cause and effect is not in a relation of nonimplication, since CRC involves multiple simultaneous interactions and complex feedback loops between causes and their effects. Secondly, even if it is a common feature of material constitution that it is asymmetric, we should not think that all instances of constitution are asymmetric. Indeed, Craver & Bechtel (2007) remind us that interesting modes of constitution are symmetric. As they state: “The relation [of constitution] is symmetrical precisely because the mechanism as a whole is fully constituted by the organized activities of its parts; a change in the parts is manifest as a change in the mechanism as a whole, and a change in the [whole] is also a change in at least some of its component parts.” (Bechtel & Craver 2007, p. 554)

In this final sub-section my goal is to discuss how we should understand this in relation to my claim that most cases of EC are hybrid. To do so, I will refer to three quite different examples, one of which is cognitive. I begin with two non-cognitive cases.

What I hope to have shown so far is that if Adams & Aizawa argue that defenders of EC confuse constitution with causation, it is in fact Adams & Aizawa that violate the central idea that causation is an intralevel phenomenon, whereas constitution is an interlevel phenomenon. In their discussion of why it is erroneous to suppose that causation works across different levels, Craver & Bechtel (2007) use an example from Patricia Churchland (1993), who expresses a similar worry concerning causation as an interlevel phenomenon. The example of choice is from the *Betty Crocker Cookbook*. As Craver & Bechtel re-iterate Churchland’s claim:

“Betty correctly explains that microwaves work by accelerating the component molecules in the food. However, she takes a decidedly wrong turn when she explains further that the excited molecules rub against one another and *generate* heat through friction. Betty’s error, of course, is in supposing that heat is causally produced by the increase in mean kinetic energy when in fact heat is *constituted* by their mean kinetic energy. The causal reading in this case is simply erroneous.” (2007, p. 555)

Similarly with our case of *Z*, the process of distributed remembering. The flaw that Adams & Aizawa commit is similar to Betty's error, in that they charge the defenders of EC with the claim that *X* (the process of manipulating the notebook) reciprocally coupled to *Y* (brain process) is what *generates* (i.e., causes) *Z*, when in fact *Z* is constituted by *X* and *Y*. Similarly to *Z*, heat is comes about through CRC at a lower level. We should know have a grip on the idea that causation is in fact symmetric. But how can we express the idea that constitution, as an interlevel relation, is symmetric?

Enter the second non-cognitive example, the classical example from dynamical systems theory of a fluid heated from below and cooled from above. The phenomenon in question is *convection rolls*. Of course, I do not want to claim that distributed/extended cognition simply is like a fluid composed of homogenous elements. Far from it, since most cases of EC consists of a multiplicity of heterogeneous elements. But this dynamical, albeit non-cognitive, example highlights in a easy to understand way what the dynamicists refer to as a *collective variable*, which is the kind of mechanism that will allow me to show just how constitution can be symmetric. Here is how the example goes. Take some oil, put it in a pan, and apply a heat source from below. As the heat is applied it increases the difference in the temperature between the top and the bottom of the oil layer. At a critical threshold, an event called an instability occurs such that the liquid begins to self-organize a coherently rolling motion. This motion is a convection roll. What happens is that the cooler liquid at the top is denser (and heavier), thereby falling, whereas the liquid at the bottom is warmer (therefore less dense and lighter), thus tending to rise to the top. The resulting convection roll is called a collective or cooperative effect in the language of dynamical systems theory. The temperature gradient itself is referred to as a control parameter, yet it is not a parameter that encodes or pre-specifies the pattern of convection rolls. What is fascinating here is that a pan of oil may contain something on the order of  $10^{20}$  molecules (Kelso 1995, p. 8) all subject to random disordered motion. However, once the rolling motion begins, the convection rolls ensure that "all parts of the liquid no longer behave independently but are sucked into an ordered, coordinated pattern that can be described precisely using the parameter concept [*viz.*, by using the order parameter or collective variable concept]." (Kelso 1995, p. 8) Notice now that the collective variable (*viz.*, the rolling motion of convection rolls) is *constituted* by the collective cooperation of the individual parts of this dynamical system, here the fluid molecules. Yet the collective variable "governs or constrains the behavior of the individual parts." (Kelso 1995, p. 8) On the one hand, the component parts constitute the whole, yet the whole can affect the behavior of its parts, on the other. On my view, then, the interlevel relationship is constitutive, and because the constitutive effects run from both bottom-up and from the top and down, this is why diachronic process constitution is symmetric. Because of this, by applying the distinction between constitution as an interlevel relation and causation as an intralevel relation, we can identify the interlevel constitutive relation as between the convection roll (or rolls) and its component parts without having to fallaciously appeal to this relationship as a form of causation.

Such constitutively mediated top-down and bottom-up effects between diachronically unfolding processes can be usefully applied to cases of distributed cognitive processes. Hence, I now turn to the third, and this time cognitive, example.

Here I consider the example of transactive memory, that is, how processes of collectively shared autobiographical remembering brings with it the understanding that the distributed processes of remembering are (a) inherently diachronic, (b) integrative in the sense that members of a successful transactive memory systems may in time turn what is initially differentiated knowledge into shared new emergent knowledge, and (c) constitutive such that transactive remembering can have top-down mediated effects on the individuals forming the larger transactive system.

Seeking to integrate studies of collaborative recall with richer qualitative empirical analysis on shared memory, along with the idea that social and environmental elements may play constitutive roles in the process and product of shared memory, Harris et al's (2010) and Sutton et al's (2010) use of Wegner's (1986) notion of a "transactive memory system" (TMS) to cases collaborative remembering in elderly couples (see also Barnier et al. 2008). First, according to Wegner, a TMS is a socially integrated cognitive system with higher-level features. Second, a TMS highlights a shared division of cognitive labor concerning encoding, storing, and retrieving of knowledge from different domains across different individuals. Third, a TMS generally consists of two interrelated components. One component, the TMS structure, is a representation of the member's shared understanding of the division of cognitive labor. Knowledge of what each member possesses, and is responsible for. The second component, the TMS processes, is the set of transactive processes that take place when a group encodes, stores, and retrieves information relevant to the task undertaken by the group. According to Wegner:

"Transactive memory is therefore not traceable to any of the individuals alone, nor can it be found somewhere "between" individuals. Rather, it is a property of a group. This unique quality of transactive memory brings with it the realization that we are speaking of a constructed system, a mode of group

operation that is built over time by its individual constituents. Once in place, then, the transactive memory system can have an impact on what the group as a whole can remember, and as a result, on what individuals in the group remember and regard as correct even outside the group. In short, transactive memory derives from individuals to form a group information-processing system that eventually may return have a profound influence upon its individual participants.” (1987, p. 191)

To explore the effects of transactive remembering in long-term couples, Harris et al (2010) conducted interviews with twelve couples. This procedure was done at their homes over two occasions, one week apart from one another. On each occasion, participants were asked to learn and recall a list of words, had to recall various personally relevant semantic information such as the date of their engagement, the names of some of the wedding guests, and had to engage in extensive autobiographical remembering of significant events in their past. Comparing the individual recall data with the data gathered from the collaborative recall tasks, the results of these comparative studies show a mismatch between situations where collaborative remembering emerges as a consequence of couples adopting an interactive style of dynamically reconstructing an episode together, whereas attempts of cross-cueing in other cases were unsuccessful (Sutton et al. 2010, p. 552).

Here is one of the dialogues, where a couple is successful in collaborating in an interactive and dynamic manner, where the speaker role shift rapidly between the two individuals, with the narrative being jointly constructed (Sutton et al. 2010, p. 551):

*Husband:* No, I asked her out that night, but she said she couldn't go.

*Wife:* No, that's right.

*H:* So then I started to pester her the next week.

*W:* You did, you turned up after my [classes].

*H:* [Cooking classes].

*W:* On Monday night.

*H:* That'd be it.

*W:* And took me for coffee.

*H:* Yes, the next Monday night.

*W:* And impressed me.

*H:* Yes.

Where there is a mnemonic division of labor, as in this case of elderly couples, the differentiation and socially distributed processes of retrieval, encoding, and sharing of autobiographical memory, result in an integrative process of socially distributed remembering at the dyadic level. Furthermore, collective remembering – just like convection rolls, the Mexican wave, the workings of the centrifugal governor, and so on – depends for its existence on spatiotemporal continuity. For transactive remembering to persist it must persist as a dynamical unfolding in real time. Of course, even in dynamical cases such as transactive remembering one might insist that despite the process of transactive remembering are time continuous, *viz.*, quantitative in time, this does not prevent one from describing or explaining such a phenomenon synchronically. I raise this point here, because it allows me to rehearse the subtle but very important distinction between *epistemological synchronicity*, on the one hand, and *ontological synchronicity*, on the other. For instance, dynamical systems theory conceptualizes systems geometrically, that is, in terms of regions in state space, distances and trajectories in a space of possible states. A cognitive scientist, for example, may use the mathematical paradigm of dynamical systems theory to point to the position of a system in a dynamical state space, locating the system at  $T_2$  over an interval  $T_1, \dots, T_n$ . This is an example of epistemological synchronicity, where synchronic explanation is a product of a particular model enabling a scientist or philosophers to describe or explain that token phenomenon as existing somewhere on a dynamical trajectory at a particular clock time  $T_2$ , say. But epistemological synchronicity is different from *ontological synchronicity*. By this I mean the nature of a phenomenon is independent of being dynamically embedded in time; not dependent for its existence on the way in which it unfolds over time. *David*, as we saw, in thus a case of ontological synchronicity, where the higher-level phenomenon of transactive remembering is a case of *ontological diachronicity*. Recall that by this I mean that the higher-level process, together with its lower-level processes and their components, is dependent for their existence on being dynamically embedded in time. Furthermore, if one applies the perspective of epistemological synchronicity to an ontologically diachronic process – like the Mexican wave or transactive remembering – such an application can at best present snapshots of a linear development. Put another way, it cannot specify the time continuous nature of the dynamical phenomenon in question.

According to Barnier et al. (2008, p. 38), transactive memory theory predicts that recalled memories by individuals in diachronically unfolding retrieval processes would be more than the sum of

individual memory. That is, the constituted process of successful transactive remembering should have emergent properties that are not only greater than, but also *different* than the sum of individual memory – either in terms of the amount of autobiographical memory recalled or in terms of the quality of those memories. With regards to the dialogue above, consider how the results of the same event is described during their (the husband and the wife’s) separate individual interviews:

“H: Ah, I used to turn up down her, she used to give, umm, what do you call it, teaching, she used to teach, umm, women in Manly how to cook. So she ran teaching classes. So I used to turn up there after, and take her out for coffee or something.”

W: And then the next week he appeared at my work after the evening class had finished, taking me out for coffee – that was the beginning of the courtship.” (Sutton et al. 2010, p. 551)

Once the process of transactive remembering is initiated, the husband and wife begin to collaborate in a coherent fashion. The TMS is no longer merely two separate individuals with their individual memory of their shared past; rather, they cooperate to create a coherent and dynamic shared pattern of autobiographical memory that unfolds over time. This *new* version will affect, in a top-down fashion, their individual memories of the event, and it is “quantitatively and qualitatively different from what each remembered alone.” (Barnier et al. 2008, p. 38) In the language of dynamical systems theory, we can say that the parts (the husband and wife) no longer behave independently but “are sucked into an ordered, coordinated pattern [...]” (Kelso 1995, p. 8), and this patterns have top-down constitutively mediated effects on the component parts.

## 6. Conclusion

The empirical and theoretical approach I have developed in this paper departs from much of the core and mainstream literature in both analytical metaphysics and extended cognition. I have argued that if we wish to understand and explain the constitutive relation in cases of distributed cognitive processes, we cannot rely on the traditional (i.e., standard and representative) framework to material constitution in analytical metaphysics. Instead, what is needed is a notion of constitution that shares a kinship with noneliminative process ontology and that is inherently diachronic. I have argued that this notion of diachronic process constitution breaks away from how constitution is typically considered in the debate about anti-EC and EC. In relation to this debate, I have attempted to show that the critics – such as Adams & Aizawa – are wrong to criticize most cases of EC with committing the C-C fallacy, because Adams & Aizawa are working with a notion of synchronic compositional constitution that is inconsistent with most cases of EC. Finally, and I think most importantly, I have introduced to the debate about extended cognition a framework within which to appropriately explain the difficult but important issue of the metaphysics of extended cognition.

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