



## Troubles With Power Structuralism's Account of Causation

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### Abstract

*The Power Structuralist View (PSV) is an account of causation in which causal relations are reduced to the powers that are activated in the subject by another subject's powers, instantly and simultaneously. PSV is based on two main assumptions: (a) holism; (b) reductionism. After justifying the choice to place PSV within the so-called 'process accounts' of causation (PA), I will show how, generally, every PA must solve the so-called "transference paradox" (TP) and why PSV is an innovative account. However, PSV creates two main problems: (1) how to explain the instantaneous activation between correlatives; (2) how to explain which kind of "nexus" takes place between powers. I will argue that, in order to solve (1), PSV needs to adopt an intervalist position, but this leads to a form of monism that contradicts (a). Regarding (2), the reductionist approach implies the assumption that "all relations between powers are internal" and, therefore, a form of monism, again against premise (a). PSV reduces causation to a 'primitive concept' (the ontological dependence) but, in this way, point (2) remains unexplained. The problem of physical transference (or reciprocal influence) remains unanswered, and PSV seems to be a covert form of occasionalism.*

### Preliminary assumptions

In very general terms, "causation is what somehow keeps together the events in the history of the universe, which otherwise would happen one after the other without any connection between them".<sup>1</sup> It is a definition that describes well our fundamental insights about the notion of cause. However, anyone who has closely studied the contemporary debate on this notion, acknowledges that, at present, the concept of cause cannot be univocally defined: there is not scholarly consensus about it.<sup>2</sup> For example, at the antipodes of that intuitive definition, in today's discussion we can find a position called *eliminativism* – that dates back to Hume, Mach, Russell, and Heisenberg<sup>3</sup> – according to which the notion of cause is obsolete. This is not an unproblematic conclusion, but in this article it is not possible to examine the arguments against eliminativism.

Suffice it to say that in the current debate one can, in fact, find many accounts that still use the concept of cause and try to explain how causality between entities and objects can occur. This article aims to examine one of them, the *Power Structuralist View (PSV)*,<sup>4</sup> in which causal relations are reduced to the powers that are activated in the subject by another

subject's powers, instantly and simultaneously. We will see in detail this position and its weaknesses.

From the brief description of PSV given above, however, it is clear what basic question every theory of causality must face: the definition of the *cause relation*, the metaphysical basis of the connection between *relata*. As Schaffer points out,<sup>5</sup> regarding the *cause relation*, the numerous possible options can be reduced to two: a *nomological account* (NA), in which this connection is an abstract law; and a *process account* (PA), in which the connection is due to the *transference of "something"* (energy or information) between one object and another. Both accounts can be formulated according to a probabilistic or a deterministic view of the causal sequence.

Assuming these are the only two alternatives, since PSV generally reduces abstract laws to the powers of the objects, we can ascribe PSV to be of the *process accounts*. However, as we will see, PSV is a very special PA: perhaps it is not even possible to place it completely in a PA or in an NA. By distancing oneself from both, could PSV offer a plausible description of causation? In trying to answer this question in the next section, I will analyse the intrinsic difficulties of each PA, and then discuss whether we also find these difficulties in PSV.

A final clarification is necessary before proceeding. The theories about causation are distinguished also based on the nature and number of their *causal relata*.<sup>6</sup> In PSV, it is assumed that *causal relata* are the objects that science recognizes as ontologically fundamental (e.g. quantum field). The nature of these objects is currently difficult to define. Contemporary physics does not often consider physical realities as "things", but as *numerical relations* (elementary particles are not "things": we do not even know if they are "physical"). However, the case I will analyze, both as regards PA and PSV, is limited to the causal (efficient) relations that occur between microscopic physical objects. I will assume, as PSV supporters do, that: *causal relata* are the fundamental units that physics recognizes as distinct from one another, and capable of causal action;<sup>7</sup> a distinction between cause and effect is possible. Other forms of causation can be admitted, such as that of the mind, but for the purpose of this article I shall analyse only the afore-mentioned kind.<sup>8</sup>

## The "transference paradox"

The *process account*, which implies the *transference of "something"*, has been traced back to Aristotle's *influx model*, which describes causation as the transference of an entity (usually a property) from a cause to an effect.<sup>9</sup> This account hides a paradox – usually forgotten in recent literature – that concerns every physical model based on the *contagion model of causation*,<sup>10</sup> including the *process account* (or *causal process theories*: a term used to indicate the positions that involve the transference of energy. What I call the *transference paradox* (TP) has to do with at least three interrelated issues:

1. *Contact* between entities: if there are separate entities that interact causally, they must be able to accidentally come into contact. However, that of contact is an ancient problem on which there is still no agreed solution. It can be divided into the following sub-problems:
  - (1.a) The contact should take place between two entities on their border, that is, on an *infinitely small region* (the limit of an object); it should "start" in an infinitely small region, and then continue on another infinitely small one. However, if an infinitely small region is a portion of indeterminate (vague) reality, contact remains an impossibility. Without contact, however, there can be no transfer if not an instantaneous one (more on

this later). If it is true that mathematics provides us with tools to overcome this aporia, it is not clear how abstract mathematical tools can correspond to an actual physical reality. This means that the mathematical explanation describes the process as it can ideally occur and also the final physical result of the process (as we can measure it in its individual phases and in its result), but does not adequately explain how an infinitesimal transfer of “something” can occur.

(1.b) Being infinitely small and shared by entity A and entity B (i.e. overlapping), the point of contact would have a vague identity and location.

2. *Transfer unit*: if a quantity of 1 passes from A to B, a quantity of 0.5 has passed before, in the instant immediately preceding. We should therefore imagine the transfer of an infinitely small quantity, which is paradoxical because an infinitely small quantity, an infinitely small space, and an infinitely small time are vague and abstract concepts that have no corresponding physical reality; this is the challenge to Leibniz’s infinitesimals: they are abstract and ambiguous entities, without a possible correspondence in physical reality. This applies to every transferred *unit*, be it a piece of simple information, a trope or a fragment of spacetime.
3. *Fusion and composition*: these problems are not limited to the TP, but extend to pluralism itself (i.e. an ontology that considers that concrete individual entities exist). In fact, there is no agreement on the possibility that these phenomena may occur: fusion and composition are aporetic concepts in many respects,<sup>11</sup> and the process of transfer involves both. If the transfer takes place with the inclusion of *small parts* from A to B, what held the parts together in A and what holds them together in B? This is the philosophical *Composition Question*, which is much discussed and on which no agreement has yet been reached.

All these points bring us back to *infinity*, a notion at the heart of numerous controversies in the fields of physics, mathematics and metaphysics<sup>12</sup> and often underestimated when discussing mechanical causality. Of course, it is a subject of debate whether or not TP has been solved.<sup>13</sup> For the sake of the analysis of PSV, let us assume that it is still an open problem; what are some ways of solving the problems listed in the previous three points?

About point 1, in order to avoid the paradox that one quantity is partially in an object and partially in another, the transference should be instantaneous.<sup>14</sup> If a variable switches values discontinuously at a boundary, “there would be no instant identifiable by its intrinsic properties alone as the one at which the change occurred”.<sup>15</sup> Therefore, either the transference is instantaneous, or there are infinitely small parts that are added to one another in the object, somehow *merging with it* (with all the problems, well known in contemporary analytic philosophy, entailed by the composition between parts). In the latter case, however, the concept of infinitesimal is applied, which is probably aporetic. Introducing infinite intermediaries in order to make the transference possible may produce a regressive series.

In order to solve the other points of the paradox, various metaphysics have been proposed throughout history. I refer to only some of the significant ones:

- (i) The *occasionalist view*, quite widespread in the history of philosophy. According to his interpreters, for example, Descartes adopted, at least initially, a *transference conception* of causation.<sup>16</sup> However, he seems to argue that properties cannot move from one body to another,<sup>17</sup> and fails to explain how momentum or force can be transferred from one object to another.<sup>18</sup> Descartes then opts for an *occasionalist view*,<sup>19</sup> very similar to Hume’s eliminativism, paving the way to a radical interpretation, where God continually recreates the world in every moment and in different forms

(the sequence that emerges appears to humans as a “nexus of cause”).<sup>20</sup> Another author who came to occasionalism is Leibniz: God does not intervene in every causal action,<sup>21</sup> but the modification of monads is the result of an instantaneous modification of the perceptions of all the spiritual monads in the universe, due to pre-established harmony (note also that monadism came along with the awareness that nothing in the physical realm could correspond to mathematical *infinitesimals*). In the occasionalist account, there is an instantaneous and contactless transfer: the quantity disappears from A and instantly appears in B. This vision is highly counterintuitive and refers to a sort of “magical re-creation”. But it could be well suited to an *entia successiva* ontology (although unusual, it is an economic option from an ontological point of view).<sup>22</sup> Variants of occasionalism, on the other hand, cannot eliminate a form of connection between events or processes, i.e. their regularity, predictability and irreversibility.<sup>23</sup>

- (II) *Idealism*: if quantities are not material objects, they have no boundaries, therefore they need not touch one another and can overlap without problems. However, there is the risk of transforming physical reality into an illusory projection of spiritual entities, as in the immaterialist interpretation of Leibniz’ monadism.<sup>24</sup> Or we face the problem of trope theory, undecided between *modular tropes* and *modifier tropes*.<sup>25</sup> The first tropes are material (they have the characteristic which they bring, for example “being spherical”), but this category does not help us solve the problems listed above; the second ones are immaterial, but in this case we fall into pure idealism. Furthermore, in the “causation by tropes” of the modular model,<sup>26</sup> it is necessary to explain how the tropes influence one another, how they appear, how they combine, and how they are fused (the problems related to TP).
- (III) *Pythagoreanism*: this is the option put forward by Cassirer.<sup>27</sup> We can describe mathematical relations, but not how causality occurs: the latter must simply be assumed to be something that happens; we can describe relations, but not what they are in their essence, as such descriptions are approximate idealizations of reality (science, therefore, does not describe the substratum, limiting itself to the formalization of relations). In this case, however, we no longer attempt to explain how causality occurs (only the mathematical variation is described, without delving into the ontology of fundamental realities). This is a form of “mathematical ontology” dating back to Newton.<sup>28</sup>
- (IV) *Process account*. Processism, in all its versions (from Whitehead to more recent formulations), solves the TP by postulating the existence of continuous processes, thus eliminating the existence of discrete entities; time and space are also understood as intervals rather than as atoms. Although it is not possible, here, to retrace all the criticisms addressed against this approach. The processes are part of a single process (the universe), otherwise they would be discrete separate entities (the same applies to intervals). If the whole universe is a single continuous process-substance, however, monist outcomes are inevitable. This is not a problem in itself: monism is an acceptable option, and does not necessarily eliminate the existence of causality. However, in this case we must also embrace the corollary of monism: there no longer are truly separate entities, and therefore the transference is accomplished in a space-time continuum.<sup>29</sup> Unsurprisingly, this option is accepted by those who draw monistic conclusions from quantum mechanics.
- (V) *Gunk ontology*, which allows for the penetration of infinitesimal (undetermined) particles into an object.<sup>30</sup> Although we cannot retrace the discussion on gunk here, we can mention that this ontology is favoured by several authors: it is conceivable, logically consistent, and scientifically serious.<sup>31</sup>

(VI) *Conserved Quantity Theory*. It could be argued that TP does not occur in a *causal process* such as the one described in Dowe's works.<sup>32</sup> However, if Dowe eliminates objects by introducing only quantities, he does not explain what they are or how they can be transmitted. The transfer of quantities is taken for granted, not explained. Schaffer notes that Dowe's position "looks to invoke the very notion of 'flow' that the process account is supposed to analyze".<sup>33</sup> It seems that Dowe's position implicitly refers to the "contagion model". Aronson,<sup>34</sup> Fair<sup>35</sup> and Castañeda<sup>36</sup> also use the notions of contact and transfer. In the case of Collier,<sup>37</sup> the transfer is between *information* but, as mentioned above, the TP is generated also in this kind of model (supposing that the ontological status of "information" can be clarified).<sup>38</sup>

The TP concerns all the philosophical systems that affirm the transfer of something between any entities that enter into a causal relation. It seems that the solutions proposed to solve TP contain counterintuitive aspects, or they do not completely solve TP. So, let us try to imagine that TP is still an open problem. PSV is a different solution than those listed: what explanatory advantages does it allow with respect to them? What new problems does it generate?

## A look at Quantum Mechanics

Before proceeding to examine PSV, we can ask another radical question: does *Quantum Mechanics* (QM) description of the fundamental reality makes it possible to avoid TP? The question is legitimate because QM seems to question two of TP fundamental premises:

1. QM seems, with its *indeterminism*, to jeopardize the concept of cause: electrons go from A to B by all possible paths, as if forming a cloud of possibilities; QM therefore entails a radically chaotic world, where many events have no cause.<sup>39</sup> However, the idea that QM may imply the elimination of causation is highly controversial and will not be addressed here.<sup>40</sup>
2. Understanding the so called fundamental particles as interpenetrating fields *weakens the separability between the entities* from which the above-mentioned problems arise.

Without pretending to be exhaustive, let us consider this second aspect. The world of QM presents three novelties with respect to that of classical physics: *nonseparability*, *nonlocality* and *superposition* (e.g., entanglement). Entanglement implies that the identity and individual nature of the particles depend on the system as a whole. This means that no particle has its own properties. The properties pertain to the system and occur episodically in the particles:

The existence of pure entangled states means that, if we consider a composite system consisting of spatially separated parts, then, even when the state of the system is a pure state, the state is not determined by the reduced states of its component parts. Thus, quantum states exhibit a form of *nonseparability*.<sup>41</sup>

As is known, there are many interpretations of quantum theory. According to Rovelli<sup>42</sup> – his position is highly contentious and by no means one of the leading interpretations of quantum mechanics, but we take it into consideration because it is the most radical with respect to the non-existence of physical entities, and therefore the one that could most plausibly eliminate a premise of the TP – elementary particles do not always exist, but do so only when interacting.<sup>43</sup> They materialize at a given location when they hit something, and when nothing disturbs them, they are nowhere. Quantum theory describes how things *happen*, not how things *are*: the possible interactions and characteristics of a particle exist only in relation

to another particle. This means that none of the particle's variables are defined during the period between an interaction and the next.<sup>44</sup>

According to QM, however, when an interaction occurs, the physical variable of the particle takes on only certain discrete values. According to Rovelli, this leads to a form of *relationism*: *there are no actual particles*, but fields or probability clouds in which particles "appear" on the basis of their interactions. Particles are diffused in space-time like fields, and fields interact as particles.<sup>45</sup> This position, by eliminating the *relata*, seems to avoid TP. Yet, there must be among fields (albeit always distinct from each other) a form of influence, unless we want to give up defining how it happens or accepting it emerges spontaneously and instantaneously. According to some interpretations, for example, the particles, understood as interpenetrating fields, exchange among themselves a third particle called "field quantum", which is virtual and therefore undetectable.<sup>46</sup> But again, we have a re-emerging of TP. Rovelli believes<sup>47</sup> that the relational interpretation of quantum mechanics (RQM) is the most reasonable one,<sup>48</sup> but this idea is strongly debated in philosophy of science, because of the *ontological questions* it generates. The first: is reality reduced to relations, or is it our knowledge that is relational, and therefore stops just before fundamental reality? Among the realist interpretations of QM, we find *epistemic structural realism* (ESR) and *ontic structural realism* (OSR).<sup>49</sup> The first – very close to Rovelli's position<sup>50</sup> – argues that we cannot know the entities that instantiate the structures of the world, but we can describe their properties and relations. That is, we can know the relational structures between things, while we cannot have access to the intrinsic properties of such entities. From an ontological point of view, a realist approach to entities can be maintained, since it is only our access to them that is relational. The Kantian echoes of this approach are obvious and often explicit:<sup>51</sup> science cannot penetrate the noumenal level, but only the phenomenological level (i.e. the causal relations between entities).<sup>52</sup>

The main feature of OSR, on the contrary, according to Ladyman,<sup>53</sup> is eliminativism: there are no individual entities, but only relational structures. This position excludes that of Hume, since there are neither particles nor isolated elementary facts. It also introduces a form of *downward causation*,<sup>54</sup> where the structure determines the physical values and properties of the individual entities that compose it (these entities are no longer completely separated, being dissolved in the structure). This position is problematic and controversial: according to its premises, each structure is inserted in a network of structures and, therefore, if the top-down action of the structures were pervasive, then the "universal structure" would be single, unchanging, and capable of determining all the properties of the micro-structures and of the individual entities that belong to it. According to Ladyman,<sup>55</sup> OSR challenges the view that there are individual entities, because it claims that the structure of the whole has an ontological priority over the parts (relations have priority over intrinsic properties). This outcome may strike us as strongly and uncomfortably monistic.

In order to avoid monism, Esfeld claims<sup>56</sup> (as opposed to Ladyman and in line with Aristotelian metaphysics) that the existence of individual entities can be maintained even if they do not have irreducible intrinsic properties. This can be done by attributing *holistic properties*, i.e. extrinsic, relational dispositions, to all the particles taken as a whole: the *structure*, corresponding to the wave function, is instantiated by the distribution of matter in space. This wave function is the field (and also, in a way, the order or relation of ontological dependence). Esfeld's position is based on the metaphysical claim that there can be no relations without *relata*. The latter must be accepted as existent entities. His is a form of *moderate structural realism* (not eliminativism) called *quantum holism*.<sup>57</sup> With Esfeld's position, we have entered a *second ontological question* raised by the QM: what

degree of reality that we should confer to fundamental entities (particles or structures)? The question is far from simple.<sup>58</sup> In QM, we observe correlated events and changes in pairs of entities that escape normal causal explanations: the wholes (and the Whole) determine the parts, but the parts also determine the whole.

Moreover, we observe simultaneous changes in locally distant systems that behave as if they were a single system. The system resulting from distant events turns out to be a whole that is superior to the parts and capable of determining their previously undetermined physical value. The parts (or systems) are therefore entangled. However, depending on the quantum interpretation that we adopt, entanglement can be understood as epistemic (there is something hidden that we do not yet know), or ontological. About the latter, we can have two main positions: *holism* or *monism*. Wegter-McNelly, for example, defends a *holistic interpretation*<sup>59</sup> similar to Esfeld's, and believes that entanglement is an isolated phenomenon: not all systems are entangled and the adjective "relational", in order to be used, needs the existence of distinct objects – or processes – that are put in relation with one another.<sup>60</sup> *Ontological holism*, in this case, implies that there is an "addition of being" to the whole (it is something "more" than the sum of its parts): this addition determines a profound unity between the parts, which therefore are no longer separate (although they may be separate by space). This can be valid both for the entities (or systems: there are no longer two separate electrons, but a sort of unique entity that "electronises" itself into two electrons) and for their individual properties. Holism indicates that there are no intrinsic properties of spatially separated objects, but only properties of the system. These properties, after the measurement-observation, attribute values to the *individual elements* (also Rovelli's relationism could be a case of physical relational holism, which holds that there are physical relations between some physical objects that do not emerge from their intrinsic properties). However, Lewis claims that a supporter of *hidden variables theory* could say that such behaviours are due to unknown states. From these forms of holism that refer to "wholes", we can move on to a *radical monism*, according to which there is a single quantum whole instead of separate entities. In this perspective, the universe is a single state that always influences all its sub-states, which can never be isolated from one another.

*Radical quantum monism* (supported by Bohm, for example) is simply an updated Spinozism: we have a single whole (given by the equation of the universe) whose objects are apparent modes (the collapse of the equation). The equation is the only substance, whose *logos* is described in a discrete way by mathematical language (one of the possible human languages). In Bohm's hyper-relational view, the universe is an infinite potential field where objects emerge as holograms without modifying it:<sup>61</sup> in other words, it is a continuous substance (a field), organized into fields that "appear" as particles with certain values (granularity). In order not to evolve toward monism, holism must affirm that there is a connection between the parts of the whole, but that the parts remain "parts", that is, that objects (wholes) continue to exist in the Whole (and causally influence the Whole in a down-top direction). In order for this to be the case, however, it is necessary that the wholes be *in* relation but not (only) relations. This seems to be clear in Esfeld's position. The systems, despite entangled – and although we may not know their intrinsic properties – are still identifiable systems. Fields, systems, entities, however, are *relata* within a system of relations, but cannot be just relations. They can be superimposed, coexistent, diffuse, vague, but still distinct wholes (entities) from the Whole. Therefore, it is true that the QM questions the existence of separate and distinct entities (a premise of TP), and yet, it is still difficult to provide an ontological model of quantum data (both holism and monism are problematic). All things considered, it still seems early to choose between the various interpretations.

According to Lewis<sup>62</sup> QM could – at least in some cases, as in the *many-worlds interpretation* and in the *theory of hidden variables* – be an example of *underdetermination*. More radically, Dawid claims<sup>63</sup> that the radical structuralism assumed by the most advanced QM theories entail a dissolution of ontology. Russell adopted a more moderate view,<sup>64</sup> still valid in my opinion, by suggesting that a new, specifically quantum-based, coherent and systematic ontology does not yet exist.

About QM, therefore, we can say that:

- at present we do not have a shared ontological interpretation of the data of quantum physics and it is therefore premature to affirm that it may have eliminated the concept of cause or the existence of physical entities (both of these premises are indispensable for TP): so QM at present does not help us to solve TP;
- even if we support minority interpretations (such as RQM, OSR or various forms of quantum holism), we will find ourselves in a series of difficulties in explaining reality. If we accept a holistic interpretation, TP arises again. In the monistic interpretation of QM, maybe the TP does not arise (see next paragraph), but relationalism without *relata* is difficult to support.

Now, as we shall see, PSV is a holistic position and a case of process account: it must therefore explain how to solve the TP, i.e. the “transfer of something”. We must also define whether a monist system – where all relations are internal – can be considered consistent (and whether it contains causal relations or not).

## Open questions of the “flux of energy account” and monist systems

There is another possibility of understanding the PA starting from a “one substance” view, linked to the concept of spacetime. We have seen that, in the *process account*, every cause-effect relation is linked to the passage of a quantity of energy from one object to another, at an infinitesimal level.<sup>65</sup> This model, however, requires us to think of energy as something that can be transferred, by contact or through a third entity (a *field*, a *virtual particle*), from one object to another, and it is not clear how this energy can be defined in ontological terms. What are the identity and boundaries of “energy particles”? What identity they have if they were – as accepted by scientific community – waves or parts of a field (a mode of a continuum)? Since there are no real shared answers to these questions, the term “energy” seems to be a *theoretical device* (considering that *virtual particles* do not solve the aporia).<sup>66</sup> However, let us consider the hypothesis that energy is a deformation of spacetime.

In this system, the “passage” of energy would imply the modification of “parts of spacetime”, just like the curve of a rope is propagated through the rope. In this case, all the curves are connected through internal relations: according to Heil,<sup>67</sup> all external relations can indeed be reduced to internal relations i.e. as modes of a non-relational substance. Individual entities and relations are “concrescences”, nodules, of a single extended substance: the field or spacetime. The objects’ identity depends on this modification of substance. But, again: what can it mean to say that transference corresponds the undulatory concrescences of spacetime? These concrescences of spacetime are all modes of a uniform substance, but modes have – in every *monist system* – a very ambiguous ontological status. If the substance is one and *there is no transference of something between its parts*, we have the spontaneous birth of the substance’s modes, with a strongly occasionalist outcome. What leads a concrescence *A* to move and become a concrescence *B*, if not the transfer of



something from one region of the substance to another? On the contrary, if we admit that something is transferred from one mode to another, we must adequately characterize these modes. If this is true, in the monist account, the TP could potentially hide under the notion of modes. What about *process ontologies*? On the one hand, they avoid the TP because they abandon atomism, and therefore are well suited to QM,<sup>68</sup> as long as it is interpreted radically (i.e. eliminating the *relata*).

On the other hand, they must determine how there can be a continuous process with real separated parts (sub-processes). The process must have continuity between its parts, in order to be a process, and continuity implies that the process has no longer parts: only the whole process exists (and therefore a single process, a Whole; as we have seen above, process ontologies cannot escape monism). If we do not have continuity, on the contrary, we have objects, but we no longer have a concept for causal relations (what is needed, perhaps, is something that stands between continuity and particularity, but this does not seem possible, unless we accept the gunk hypothesis along with its apophasis).

TP is also eliminated in a *four-dimensional theory of spacetime*, since in this case each object neither acquires nor loses anything: the changes are only successive stages of a single object which is always present as a whole. In this view, there are no real interactions between objects, since objects are eternally present. The perceived changes amount to the coordinated coexistence of the “parts” of objects extended in the four-dimensional spacetime. Obviously, there is still considerable debate on the question of whether the four-dimensional theory is the best account of reality. Even after the analysis of these models, therefore, it seems that the conclusions of the previous sections can be confirmed: where a *holistic* view is maintained, TP is generated; where it is abandoned, in favor of a kind of *monism*, one falls into other aporias intrinsic to monism itself. Given this, let's finally see what solutions PSV offers to all these impasses.

## Dispositionalism and the Power Structuralist View (PSV): activation between powers

PSV is a dispositionalist interpretation of the PA. Dispositionalism assumes a spontaneous connection between different types of entities, expressed by the term power, which performs the ontological function of both substance and relations. Powers are *irreducible “relational” properties* that dispose the bearer in a certain way.<sup>69</sup> They are monadic properties – are *relative* – mutually interdependent not for their existence, but for their exercise: each “agent power” requires a “patient power” on which to act.<sup>70</sup> In this interpretation of Aristotle, the category of relation coincides with the *ontological dependence* between relatives. Causal relations are reduced to the powers that are activated in the subject by another subject's powers, instantly and simultaneously:<sup>71</sup> according to this new interpretation, Aristotle cannot be considered a supporter of the *influx model*. However, as we will see, dispositionalism needs PA as background for its account of causation. Dispositionalism is also called *powerism* (or Power Ontology) and is commonly opposed to *nomism* and *neo-humeanism*.<sup>72</sup> According to Koons and Pickavance,<sup>73</sup> the difference between the three approaches lies in how they consider natural laws. Power ontology eliminates causal relations by reducing them to dispositions: an object has a set of inherent possibilities that are activated due to an interaction with other realities, or that determine the object's development from the inside (internal finality).<sup>74</sup> So, in a first approximation, powerism solves TP by reducing the transference to the mutual activation of powers.<sup>75</sup>

In this view, according to Heil,<sup>76</sup> all relations are internal, because each power is connected with the other by an intrinsic correlation. In the PSV proposed by Marmodoro,<sup>77</sup> powers have a kind of intrinsic transition. This view invalidates the classic objection (the *Always-packing Argument*) according to which powerism would transform the world into a set of pure possibilities.<sup>78</sup> In the PSV, power passes from potentiality to actuality while remaining the same power:<sup>79</sup> for example, human sight is a power (*first actuality, ability*) that remains such even when it is in *realization*<sup>80</sup> (when it sees; *second actuality*). Nothing prevents some powers from being *always activated*.<sup>81</sup>

The issue of the power's activation is widely misunderstood, perhaps because it requires a kind of intellectual conversion. Let us consider this aspect of PSV. We usually imagine power as an inactive reality that is present in substances and becomes activated when another power "approaches"; but a power (ability) is always active, as the substance is always the activity of being what it is,<sup>82</sup> that is, the sum of its abilities. What is usually called "power", therefore, is always active (it is a *first actuality*) but is somehow *inhibited*<sup>83</sup> in its manifestation to us: in certain conditions, although the power is active, we do not see it. An effective example is the magnet: a magnet is always magnetic, but we see its magnetism only when we bring it close to a piece of metal. The metal did not activate the power, but only made manifest a power that was always there and active. In PSV, we find a structure of powers (*reciprocating correlatives*), each in different *activation states*. Aristotle, according to Marmodoro,<sup>84</sup> identifies a *generic possibility* (e.g., I could learn French), a *first realization* (e.g., I can speak French) and a *second realization* (e.g., I am speaking French).

The potential concerns only the "generic possibility", while *powerfulness* concerns the second. In both states, power is capable of producing change. Powers, therefore, are dependent on one another for their activation and realization. Aristotle's world, however, is not a world of pure possibility. A power is an activity (effectivity, *energheia*) of the substance, whose ability (potentiality, *dynamis*) can take two forms of realization (*entelechia*): a dispositional capacity (ability) and its actual exercise (actuality). The passage from the first to the second is the activation, which however does not give life to two different entities, since the ability and its realization refer to the same thing (as do sight and the act of seeing). In the PSV, the matter of substances is their ability (*dynamis*) and the form is the principle of activity (*energheia*). After the activation, we find two kinds of activities: the *perfect activity*, where the realization of the activity corresponds to the activity itself (the end is internal; e.g.: the seeing); the *imperfect activity* (the end is external; e.g.: motion). A power always exists both as *dynamis* and *energheia*, but it is realized by manifesting itself in exercise only after a certain activation. Furthermore, depending on the kind of power, it can give rise to a perfect or imperfect activity. In other words, powers are always in actuality but not always realized, because they are not always activated. Once activated, a power is both potential (an ability) and in activity (as it is being implemented). There are not two powers, one corresponding to the manifestation and one to the ability: the power is always one.<sup>85</sup>

In the PSV, causation consists in modifying (through contact) a power from its ability (potentiality; that is always in activity) to its realization. The ability in actuality – but not in realization – is called potentiality because it implies incompleteness. Even when it is being realized (in a perfect or imperfect way), it maintains a certain potentiality, since the realization is the ability at work. The model is *reductionist*, in the sense that the causal relation is established by the observer. It is real, because it exists in reality, but it is not a third entity between the two *causal relata*: there is nothing that moves or acts as a "bridge" between the correlative powers of two substances. Causal relations "emerge" from the interaction (ontological dependence) and from the modification of the two *causal relata*.

In an ontology of pure powers,<sup>86</sup> there are no transitions of powers in a substance, but only *transitions of status*: a potential power (ability) and its manifestation are the same. Powerism is not a *relational ontology*,<sup>87</sup> if this expression means that a power is physically related to another power. Powers are related only by ontological dependence. This dependence is in no way a “bridge” or a third entity.

## First problem: the instantaneous activation

In PSV causal relations are reduced to the powers that are activated in the subject by another subject’s powers, instantly and simultaneously. As we have seen in the section “The transference paradox”, the instantaneousness of the transfer is a decisive issue for any account of causation, and therefore it is crucial also for powerism. On the one hand, it seems intuitive that, if we have two powers in two objects, the reciprocal influence must be *instantaneous* and *simultaneous*. Otherwise, as in TP, there would be a continuous transmission between an infinitely dense sequence of states. According to Koons and Pickavance:

In a Neo-Humeist mosaic of instantaneous points, it seems that all cause-effect transactions must be instantaneous. [...] This transmission is continuous and dense rather than discrete, since between any later stage of the process and any earlier stage there are an infinite number of instantaneous stages, each causally prior to the one and causally posterior to the other. How are we to think about continuous causation? How can there be an infinite number of intermediaries between a cause and its effect? Wouldn’t such an infinity of intermediaries involve the existence of infinite causal regresses?<sup>88</sup>

If we substitute powers in the mosaic points, we have the same dilemmas about powers reciprocal influence. The authors are saying that, if we accept instant activation, we inevitably fall into regresses, and therefore into what we have called the TP. In order to avoid this problem, the authors propose to assume that continuous causation involves an *undivided continuum* of events, so that two events are connected by continuous causation, if they are both part of a process. In this case, Koons and Pickavance claim, the process is a temporally extended whole, more fundamental than any of its unextended, instantaneous parts. The process could be also divided into shorter intervals, but never into instants. These states can be called “stages” of the process, according to the authors. If the undivided process is as fundamental as its parts, the instants are no more fundamental than the intervals. The latter are indispensable to account for our reality, and therefore their postulation respect the qualitative economy of metaphysical inquiry.

Although we can plausibly provide a model both in an instants-only (*instantism*) and an intervals-only (*intervalism*) perspective, the second option avoids the oddities of gunky time and TP by stopping short of claiming that an interval is divided into sub-processes. What is granted to the process is only potential divisibility, but not actual division: since there are no infinite processes in place, the existence of a *unitary process* (as a continuous whole) must be accepted. Powerists tend to embrace the intervalist view: at least in some of their versions,<sup>89</sup> they overcome the Neo-Humean view because they consider existing causal processes extended over time that combine causes and effects into a whole – a whole which consists of the entire evolution that leads the agent-power to transform the patient-power. These processes have a precise direction, both in terms of correlatives and in terms of time-line. The problem of powerism is that agent and patient *are the process*, acting like one

entity (monism). Thus, it appears that both an instants-only (*instantism*) and an intervals-only (*intervalism*) perspective creates problems for the PSV. Intervals-only can solve the problem of how powers are influenced by avoiding TP, but it leads to a form of monism that contradicts the fundamental thesis of powerism, i.e., that there are distinct entities with distinct powers.

## Second problem: which kind of “nexus” and “contact” takes place between powers?

We have already seen that PSV has a reductionist approach to relations: correlative powers are linked only by ontological dependence, a capacity for mutual activation without any exchange of “something”. However, the basic question of *which kind of “nexus” takes place between powers* remains unanswered. Mumford puts forward<sup>90</sup> an illuminating intuition: if one does not abandon the perspective of the *separation of objects*, the causation will remain inexplicable. Unfortunately, Mumford also concludes that, in this reconceptualization of causation, there is reciprocity and causation between *distinct existences* and the causal relation *would not even be an external one*. The italics underline that powerism does not abandon the acceptance of separate existences, nor can it. In this way, however, TP emerges again: how is the nexus between two distinct existences (powers) possible? As we have already seen in the sections “Dispositionalism and the Power Structuralist View” and “First Problem”, the alternative is to understand the relations as internal (also Mumford’s reconceptualization of powerism seems to imply this). However, if the relations are only internal we have a form of *monism* where distinct existences are not allowed. It is not obvious that the paradigm “all relations are internal” leads to monism. As is known, there is extensive debate around this topic that cannot be summarised here. We can only mention that, according to some metaphysicians, if internal relations exist, there are no separated entities.<sup>91</sup> If we want to preserve *holism* – as in PSV – we must explain an additional form of relation, maybe an *external* one. However, the notion of external relation seems to encounter a number of difficulties<sup>92</sup> that lead to the reduction of all external relations to internal ones. Without forgetting that the existence of *internal relations* also seems uncertain.<sup>93</sup> This may raise a larger problem: the notion of relation itself could probably be antinomical (we must affirm that relations are both external *and* internal).<sup>94</sup>

In this perspective, PSV eliminates the need of the concept of relation. However, the nexus between powers – when powers are distinct entities – cannot be an unclear reciprocal instantaneous influence: even if we can call the nexus “ontological dependence”,<sup>95</sup> its status remains rather obscure.<sup>96</sup> It is a *formal relation* (or a *thin* relation, according to Mulligan),<sup>97</sup> but how can it work in the real world? Of course, every metaphysical system needs some *primitive notions*, but in this case the result is that PSV separates the entities but it is unable to explain how they are connected. PSV wants to avoid monism and the TP, but at the cost of introducing an arbitrary primitive notion. This leads us to a secondary problem: if we wanted to abandon substantialism, we could understand powers as immaterial (not local, without borders or physical materiality), that is, as simple *floating* properties. After all, Aristotle believed that we have no knowledge of the substance except as an indispensable metaphysical – not physical – principle that allows us to identify one entity over another. What remains to be explained is how these properties interact. Without the mechanical passage of something from one power to another, we have a world of immaterial entities that manifest properties spontaneously (and from nothing) just because another property is in their proximity: this implies a form of occasionalist

immaterialism, which Bertrand Russell would criticise as a kind of “magic” (not unlike the magical aspect of Plato’s doctrine of participation).

Unsurprisingly, due to its reluctance to abandon the existence of separate objects, powerism can be hybridized with a few Humean intuitions, generating what is called *Humean dispositionalism*.<sup>98</sup> However, it has been pointed out<sup>99</sup> that the application of the notions of powers to the Humean system substantially coincides with Spinozism or, alternatively, with OSR (which is a form of cosmic holism, or quantum monism, according to opposite interpretations): in the last two cases, it is difficult to defend the real existence of separate objects and the existence of contingency (hence, the basic Humean intuition is lost).

Another problem related to the “nexus” is that of “contact”. Contact has always been considered a serious ontological problem, and, according to some authors, in order to overcome it we must completely redesign our ontology.<sup>100</sup> Causation “by powers” requires a (contingent, external) contact between them, even if there is no passage of “something” (e.g., transmission of a form).<sup>101</sup> Is this “contact” only a *proximity* between independent powers that triggers activation? According to Aristotle, apparently, the contact and appropriate background conditions enable a power to be instantaneously activated. Therefore, in this interpretation of Aristotle, *proximity* is the triggering condition. In the future, PSV should therefore clarify the following questions: (a) if the contact is ontologically possible; (b) if it is ontologically necessary (i.e. in QM do we still need a “contact”, if there are no localized particles?); (c) if the ontological problem of contact can be solved through *gunk*, an ontological view that could also be useful to explain quantum phenomena. At this point, as suggested by Marmodoro<sup>102</sup> and Migliorini,<sup>103</sup> we should try to formulate a gunky power ontology. But these are still other paths to explore.

### Third problem: actualism

The article aims to analyse the hidden problems of the PSV. Although the most important one is the nexus problem of the TP, PSV also raises a secondary dilemma regarding the possibility of having powers that pass from one state (deactivation - *inactive causal powers*) to another (activation). Is the inactive-active transition instantaneous? Are the ability and the realization always the same power? If the difference is not ontological, is there real change? If a manifest and a latent power are different, what makes them achieve the ontological change? These questions cannot all be answered here. However, if the power becomes another kind of entity, we must explain how this is possible. This is why the difference between latent power and its manifestation has been denied.<sup>104</sup> However, a motor engine that is running and one that is turned off are not physically the same, despite being the same motor; nor is a living body and a dead body the same thing. However, if a latent power is different from its manifestation, either we justify how the passage happens, or we admit that the power has always the same status. In the latter case, we would have a form of *actualism*.<sup>105</sup>

Here the problem is not whether powers can exist in the subject without being manifested (or if the connection between powers is necessary or contingent), but how to justify the passage between states. In order to avoid actualism (a world of *actualities* and of powers always in realization), the position that affirms the existence of passages between states must explain what the passages consist of and how they occur. If there is no real difference between the ability and its realization, we run the risk of transforming all the substances into pure acts; if, on the contrary, if there is an actual change of state, then the power that is not

activated and the power that is activated cannot be the same thing. The above-mentioned example of “human sight” is misleading: the realization of the power is possible because something else (the light, the electrical signals of the neurons) has been added to the power. In *mechanism* or in a *categorical properties account* (the contrary of dispositionalism) we have, for example, only actualities (entities in realization: fragments of extension, energy, or properties) combined and/or in motion/transfer.

This issue is adumbrated in a few recent contributions,<sup>106</sup> although it is formulated differently and left substantially pending. Hüttemann, for example, explains causation by making explicit reference to the *antidote* (a disturbing factor), which could coincide with *inhibition* (something that intervenes in a natural chain of causes or manifestation of powers): the basic idea is that phenomena have a tendency, but this tendency can be blocked. McKittrick suggests that the notion of activation should be eliminated in order to avoid the “classic” causal regression (potential entities require actual entities to be carried out, but this means that there cannot be only potential entities, as in pandispositionalism). As a result, McKittrick concludes that powers are inherently active and all one needs to do is to combine them in order to have a manifestation. Activation and realization do not correspond to a change of status, but to the removal of an inhibition.

## A possible model of “actualism”? A few suggestions

If powers are always active and always in realization, we can imagine a “hide-and-seek model” in which a power (e.g., the light-power present in the Sun) is inhibited by another power (e.g., the rock-power present in the Moon) with the effect that we see the first power “disappear” (e.g., an eclipse), although neither of the two powers is really “activated” at a given time. We simply observe one power (which is always in realization) being “weakened”. The advantage of this model is that it avoids the problematic change of status of the power and the TP. However, the model presents a few weaknesses: (a) it does not explain how one power can “obscure” the other; (b) an “always-active” power seems to coincide with a categorical property, thereby thwarting powerism itself;<sup>107</sup> (c) it forces us to revise our intuitions: for example, we should consider ourselves to be “always on fire” (since our substance has the characteristic of being flammable), although we do not see this power manifest itself because other powers are balancing it.

Is this model applicable to all cause-effect relations? With a little imagination, it is. In the case of motion, for example, we should imagine that bodies are “always in motion”, although they appear relatively motionless. Although counterintuitive, the model has a certain affinity with the theory of relativity, in which objects do not move in space and time, but in spacetime. It would be interesting to understand how to apply this model to the interaction between quantum fields. The idea as such is not unthinkable. However, it has a metaphysical price: active substances change, move and influence one another only apparently; from an absolute (divine?) point of view, all substances are always totally in realization. If it is true that the fundamental particles are essentially single powers that are always active and always realizing, and if it is true that they are unextended, we are dealing with something that is strikingly similar to the abstract object that is commonly called “categorical property”. This, however, brings us back to Neo-humeanism.

## Conclusions

These preliminary considerations on the PSV's account of causation show the problems that it entails in terms of the formulation of a coherent ontology. Heil even considers<sup>108</sup> that explaining causation with the notion of powers – which he considers the most reasonable solution – is *hopelessly metaphorical*; however, according to him, other theories about causal chains are no less metaphorical. Heil concludes that this is due to the fact that our thoughts on the universe are driven by metaphors. To a large extent, it is possible to agree with this somewhat pessimistic (from an analytical point of view) conclusion. We observe and measure different kinds of causation, but we are still far from having a clear idea of what causation really is. After all, if it is really reductionist, the PSV is likely to be an updated version of occasionalism (without God). Of course, from the analysis we have done, a doubt may now arise regarding the initial choice to place PSV among the NA, since PSV eliminates the “transfer of something”. Nevertheless, in PSV there is also no place for abstract law, and therefore PSV certainly does not belong to the NAs. Can PSV therefore remain in this ambiguity?

In my view, if PSV wants to present itself as an effective description of physical causality, it must make a choice: either accept the transfer of something between the powers (falling in TP); or it accepts that the instantaneous modification of the powers happens in a mysterious way; or it accepts consideration as a kind of monism; or it accepts that there is some kind of abstract law that interacts with powers. It seems to me, however, that PSV cannot accept any of these positions. How it can turn into an adequate account of causation, therefore, remains an open question. Historically, *mechanism* – a view that claims to explain every phenomenon by reducing it to the exchange between fragments of extension (Descartes), forces (Leibniz)<sup>109</sup> or energy (today)<sup>110</sup> – has supplanted the internal finalism of Aristotle.<sup>111</sup> Today, in turn, we witness mechanism being replaced by PSV, a view inspired by Aristotle (according to whom powers are a kind of internal cause). In both views, however, the problem of transference (or reciprocal influence) remains unanswered, and both seem to be a covert form of occasionalism. Can we therefore survive, philosophically, in an occasionalist framework? Marmodoro concludes:

Assuming Aristotle is looking for an answer as to how one power affects another, adding a further item to the causal series would not offer an explanation. It would only continue the regress generated in the search for the mechanism of causal efficacy. [...] Aristotle avoids the regressive series of introducing further intermediaries by assuming the efficacy of an active power on a passive one [...]. There is no further *underlying mechanism* to uncover. [...] Aristotle has identified a ground-level activity that cannot be explained by more primitive ontological tools.<sup>112</sup>

Causation cannot be further explained, and the transference of particles or energies cannot be considered the only kind of causation: because it is subject to the paradox of transference and “the regressive series of intermediaries” (a kind of Bradley's regress of causation). This is certainly true, but so is the fact that the explanation of the transference of energy is the most fundamental. This efficient causality needs an exhaustive explanation that PSV does not yet provide. The “underlying mechanism” must still be adequately investigated from a philosophical point of view.

In conclusion, if we accept that the use of primitive concepts is not sufficient (as PSV) and we exclude idealism; if we accept that the description of our world must be a form of holism (excluding monism or process ontologies); then, PSV still has much to do in order to explain how causality can occur on a physical level. It is not possible to replace the aporias of the concept of cause (due to the TP) with a primitive notion: this is a simple but unacceptable

way of hiding a paradox. PSV is a promising path in many respects, but at present, it seems unable to explain causality in a satisfactory manner.

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  44. One of the phenomena of QM is the *complementarity* of variables. ↵
  45. C. Rovelli, *La realtà non è come ci appare*, pp. 105-119. ↵
  46. C. Rubbia, *L'infinito: riflessioni di un fisico*, in G. Toraldo di Francia (ed.), *L'infinito nella scienza*, Enciclopedia Italiana, Firenze 1987, pp. 29-46, here p. 31. However, not all particles behave in the same way: in QM there are particles that can overlap and others that cannot

- occupy the same quantum state (R.J. Russell, *Quantum Physics in Philosophical and Theological Perspective*, cit.). ↵
47. J. Schaffer, «Spacetime the One Substance», *Philosophical Studies*, 2009, n. 145, pp. 131-148). ↵
  48. This minimalist realism, based on the *no-miracles argument* can be traced back to: J. Worrall, «Structural Realism: The Best of Both Worlds?», *Dialectica*, 1989, n. 43, pp. 99–124; see L. Candiotti, «The Reality of Relations», *Giornale di Metafisica*, 2017, n. 2, pp. 537–551. ↵
  49. C. Rovelli, F. Laudisa, «Relational Quantum Mechanics», *Stanford Encyclopedia of Philosophy*, 2013, 08 october 2019, ed. E.N. Zalta, <https://plato.stanford.edu/archives/sum2013/entries/qm-relational/>. ↵
  50. J. Ladyman, «Structural Realism», *Stanford Encyclopedia of Philosophy*, 2014, 08 october 2019, ed. E.N. Zalta, <https://plato.stanford.edu/entries/structural-realism/>, par. 3.1. ↵
  51. Even if all the properties of an entity were extrinsic, however, we would still have the reference object, as postulated by Esfeld. M. Esfeld, «Quantum Entanglement and a Metaphysics of Relations», *Studies in History and Philosophy of Modern Physics*, 2004, n. 35, pp. 601-617; Id., *The Reality of Relations*, in A. Marmodoro, D. Yates (eds.), *The Metaphysics of Relations*, Oxford University Press, Oxford 2016, pp. 219-234. ↵
  52. J. Ladyman, *Structural Realism*. ↵
  53. M. Paolini Paoletti, F. Orilia, *Philosophical and Scientific Perspectives on Downward Causation*, Routledge, New York 2017. ↵
  54. J. Ladyman, *The Foundations of Structuralism and the Metaphysics of Relations*, in A. Marmodoro, D. Yates (eds.), *The Metaphysics of Relations*, pp. 177-197. ↵
  55. M. Esfeld, «Do Relations Require Underlying Intrinsic Properties? A Physical Argument for a Metaphysics of Relations», *Metaphysica*, 2003, n. 4, pp. 5-25. ↵
  56. L.J. Cordovil, «Contemporary Quantum Physics Metaphysical Challenge». ↵
  57. See: K. Wegter-McNelly, *The Entangled God: Divine Relationality and Quantum Physics*, Routledge, New York 2011. ↵
  58. *Ibi*, p. 118. ↵
  59. J.P. Lewis, «Interpretations of Quantum Mechanics», *Internet Encyclopedia of Philosophy*, 2017, 08 october 2019, <http://www.iep.utm.edu/int-qm/>. ↵
  60. A.P. Ligomenides, *Scientific Knowledge as a Bridge to the Mind of God*, in J. Polkinghorne (ed.), *The Trinity and an Entangled World: Relationality in Physical Science and Theology*, Eerdmans, Grand Rapids 2010, pp. 74–92. ↵
  61. J.P. Lewis, *Interpretations of Quantum Mechanics*, par. 7. ↵
  62. R. Dawid, «Scientific Realism in the Age of String Theory», *PhilSci Archive*, 2007, 08 october 2019, <http://philsci-archive.pitt.edu/3584/>. ↵
  63. R.J. Russell, *Quantum Physics in Philosophical and Theological Perspective*, p. 350. ↵
  64. D. Fair, «Causation and the Flow of Energy», *Erkenntnis*, 1979, n. 14, pp. 219-250; H.-N. Castañeda, *Causes, Causity, and Energy*, in P. French, T. Uehling Jr., H. Wettstein (eds.), *Midwest Studies in Philosophy*, vol. IX, University of Minnesota Press, Minneapolis 1984, pp. 17-27. ↵
  65. A. Marmodoro, *Power Mereology*. ↵
  66. J. Heil, *Relations*, in R. Le Poidevin (ed.), *The Routledge Companion to Metaphysics*, Routledge, New York 2009, pp. 310-321. ↵
  67. J. Seibt, «Process Philosophy», *Stanford Encyclopedia of Philosophy*, 2018, 08 october 2019, ed. E.N. Zalta, <https://plato.stanford.edu/entries/process-philosophy/>; H. Brown, «A Process Ontology», *Axiomathes*, 2014, n. 24, pp. 291-312; H.M. Bickhard, «Some Consequences (and Enablings) of Process Metaphysics», *Axiomathes*, 2011, n. 21, pp. 3-32; J. Klose, *Process Ontology from Whitehead to Quantum Physics*, in H. Atmanspacher, H. Primas (eds.), *Recasting Reality*, Springer, New York 2009, pp. 151-170. ↵
  68. A. Marmodoro, *The Metaphysics of Powers*, Routledge, New York 2010. ↵
  69. A. Marmodoro, E. Mayr, *Breve storia della Metafisica*, Carocci, Roma 2017. ↵
  70. A. Marmodoro, *Aristotle on Perceiving Objects*, p. 34. ↵
  71. Neo-humeanism defends the existence of facts consisting of categorical properties (opposed to dispositional ones) arranged in instantaneous points in space and time (the neo-humean

- lewisian mosaic). An intermediate view is Tugby's *Platonic dispositionalism*, in which the dispositions between entities are the instantiation of dispositions between universals. However, by the author's admission, *Platonic Dispositionalism* coincides with second-order *Priority monism*. See: M. Tugby, *The Metaphysics of Pan-Dispositionalism*, in A. Bird et al. (eds.), *Properties, Powers, and Structures: Issues in the Metaphysics of Realism*, Routledge, New York 2012, pp. 165–179; Id., «Categoricalism, Dispositionalism, and the Epistemology of Properties», *Synthese*, 2014, n. 191, pp. 1147-1162; Id., «Universals, Laws, and Governance», *Philosophical Studies*, 2016, n. 173, pp. 1147-1163. [↵](#)
72. C.R. Koons, H.T. Pickavance, *Metaphysics*. [↵](#)
73. S. Mumford, *Causal Powers and Capacities*, in H. Beebe, Ch. Hitchcock (eds.), *The Oxford Handbook of Causation*, pp. 265-278. [↵](#)
74. A. Marmodoro, *Power Mereology*, pp. 114-115. [↵](#)
75. J. Heil, *Causal Relations*. [↵](#)
76. A. Marmodoro, *Power Mereology*. [↵](#)
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82. On other actions that could be analysed in addition to the *triggering*, see: N. Cartwright, *Causal powers: Why Humeans Can't Even Be Instrumentalists*, in J.D. Jacobs (ed.), *Causal Powers*, Oxford University Press, Oxford 2017, pp. 9–23. [↵](#)
83. A. Kosman, *The Activity of Being*, cit.; C. Witt, *Ways of Being. Potentiality and Actuality in Aristotle's Metaphysics*, Cornell University Press, Ithaca 2003. [↵](#)
84. A. Marmodoro, *Do Powers Need Powers to Make Them Powerful?*, in A. Marmodoro (ed.), *The Metaphysics of Powers*, Routledge, New York 2010, pp. 27-40; Id., *Power Mereology*. [↵](#)
85. A. Marmodoro, *Potentiality in Aristotle's Metaphysics*, in K. Engelhard, M. Quante (eds.), *The Handbook of Potentiality*, Springer, New York 2018, pp. 15-43. [↵](#)
86. «Aristotle does not introduce relations in his ontology, but [...] monadic relatives». A. Marmodoro, *Aristotle on Perceiving Objects*, pp. 63-64. [↵](#)
87. C.R. Koons, H.T. Pickavance, *Metaphysics*, chap. 9. [↵](#)
88. S. Mumford, *Filled In Space*, in B. Gnassounou, M. Kistler (eds.), *Dispositions and Causal Powers*, cit., pp. 67-80; S. Mumford, L.R. Anjum, *Getting Causes from Powers*, Oxford University Press, Oxford 2011, p. 116; Id., *Mutual Manifestation and Martin's Two Triangles*, in J.D. Jacobs (ed.), *Causal Powers*, Oxford University Press, Oxford 2017. [↵](#)
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110. The idea of *causal powers* has been rehabilitated with respect to Descartes, Bacon, Locks and Newton’s critiques of the Aristotelian-scholastic position. M. Kistler, B. Gnassounou, *Dispositions and Causal Powers*, pp. 1-42. ↵
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