

Mental Causation In a Physical Brain?

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Abstract Mental causation is a philosophical concept attempting to describe the causal effect of the immaterial mind on subjects behavior. Various types of causality have different interpretations in the literature. I propose and explain this concept within the framework of the reciprocal causality operating in the brain bidirectionally between local and global brain levels. While committing myself to the physical closure assumption, I leave room for the suggested role of mental properties. Mental level is viewed as an irreducible perspective of description supervening on the global brain level. Hence, mental causation is argued to be interpreted as a convenient metaphor because mental properties are asserted to be causally redundant. Nevertheless, they will eventually help us identify and understand the neural and computational correlates of consciousness. Within cognitive science, the proposed view is consistent with the connectionist and dynamic systems paradigms, and within the philosophy of mind, I see it as a form of non-reductive physicalism.

1 Introduction

The concept of mental causation forms a core ingredient of an old philosophical debate about the mind-body relationship, and the explanation of its functioning remains resistant to widely accepted answers. Cartesian dualist view of different substances has fallen out of favor among most philosophers and cognitive scientists, and at the opposite end of the spectrum, eliminative materialists argue that the mind is really the brain and that we will be able to provide a complete account of man in purely neural terms, rendering the psychological accounts eventually redundant. Between the two extremes, there exists a spectrum of intermediate positions, trying to establish a relationship between the immaterial mind and the physical brain, mostly in terms of properties (Robb & Heil, 2003).

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The difficulty obviously stems from qualitative differences between mental states (such as beliefs or intentions) that are private, accessible to introspection, and brain states (neural activations) that are objective but remain subjectively inaccessible. In addition, the mind-body relationship calls for explanations of the mutual interactions, as suggested by our own experience. For example, we know that certain chemical substances, when digested, affect mental states, and, reversely, realizing that one would have to pass an important exam will evoke responses in his/her body. The latter type of effect is by some referred to as mental causation. From the view of folk psychology it seems obvious, but philosophically and scientifically, I think, there still remains some ambiguity as for what exactly does the causal work.

In the recent decades, physicalism has been one of the dominant philosophical positions, coming in various versions, that depend on the acknowledged role of the mental in the mind-brain relationship. Most philosophers understand physicalism in its wider sense (trying to avoid *reductio ad absurdum*) by including not only the physical level but also the chemical and biological levels of organization – that are all dealt with natural sciences, up to, but not including, the psychic (mental) level. Following Emmeche et al. (2000), I will assume four primary levels that span the “major scales” of organization – physical, biological, psychic and social. I agree with the critics that treating mentality as epiphenomenon totally neglects the phenomenal dimensions of subjective experience and cannot provide a complete ontological account of the human mind (Kim, 1998). The appealing alternative, non-reductive physicalism, tries to provide room for the mental aspects, while preserving the assumption of causal closure of the physical world, claiming that for each physical event there exists a sufficient physical cause. One attractive idea is that of supervenience (Davidson, 1970): the mental properties “supervene” on the physical properties but are not reducible to them. The central idea of supervenience is that no mental change can occur without accompanying physical changes. According to Kim (1998), supervenience lapses into epiphenomenalism, because mental properties are not assumed to have causal power in affecting physical states (due to the physical closure assumption).

Nevertheless, I will argue that the physical closure assumption is compatible with non-reductive view of the mind-brain relationship, and propose to view mental causation as a convenient metaphor. Specifically, I will defend and discuss the following claims (introduced in Farkaš, 2007): (1) Although traditionally only two levels (physical and mental) have been considered in the philosophical debates, we must consider (at least) three levels of description, in order to come up with a plausible account of mind-brain relationship, (2) within the brain, the causal links exist within levels, as well as between levels, providing an account to both bottom-up and top-down (mental) causation, (3) this view is consistent and supported by the connectionist and the dynamical systems approaches to cognition, (4) the physical world (brain and body) is causally closed, rendering the mental causation epiphenomenal, (5) mental properties are a convenient metaphor and crucial for investigation of neural and computational correlates of conscious mental states.

2 Levels and modes of description

As correctly noted by Bakker and Den Dulk (1999), one has to be careful in order not to mix causation with the levels of description (or explanation), because only causal explanation requires temporal order, levels of description (of the same phenomenon) do not. The more careful description of a complex phenomenon at multiple levels (modes) provides a more accurate picture and may help thinking about how different descriptions of the same phenomenon relate to each other. In the context of mind-brain relationship, I will refer to levels when talking about the physical object – the brain, or its parts (i.e. different spatial scales). The modes of description will be reserved for different perspectives (third-person versus first-person) when emphasizing the difference between physical description and mental description (on the same spatial “scale”).¹ In philosophical papers, the debate is typically restricted to two modes of description, mostly in terms of properties.

In most cases, the brain events are not further fine-grained by philosophers, that is, where (at which level) they occur. For understanding causality in the view to be proposed, it is crucial to shift the emphasis to the brain (biological level) and distinguish in it *at least two* (sub)levels of organization. The brain is known to possess structures at various levels of organization, relevant from the viewpoint of neuroanatomy and neurophysiology (from neurons, micro circuits, via neural assemblies to the whole brain) with their mutual interactions (Churchland & Sejnowski, 1992). Each level can be viewed as a graph where the activation of a node represents one element in the graph but at the same time this activation is a global state at the lower of spatial organization (the whole-part relationships). Without loss of explanatory power, I will only assume two physical² levels of description, the local (L) “microlevel” and the global (G) “macrolevel” (Figure 1). These two levels will be sufficient for capturing the essence of our interpretation of causality in the physical domain. It is further assumed that some phenomena observed at G level (having physical properties) can also be described as having mental properties (M level), resulting in two different modes of description. Associating (relating) G and M levels is supported by recent neuroscience evidence trying to uncover the neural correlates of conscious experience (Section 5). The G and M modes represent different ontologies (and hence are subject to different epistemologies). Actually, the highest level of organization in the brain (G) is both a level (within the physical domain) and a perspective (accessible to third-person methods) having a mental “counterpart” (M). The lower, physical level L does not have such a feature. Effects at G level are claimed to *emerge* from interactions at L level, and in return, G level *enslaves* subsequent activations at the lower level (the terms coined in synergetics by Haken, 1983). On the contrary, properties at M level supervene on (are determined by) physical properties at G level.

¹ It is problematic to talk about scale for immaterial entities; here I just mean that mental mode of description corresponds to the global brain level of description in the physical domain.

² Henceforth, following the mainstream, I will conveniently use this term to refer to material biological level, as opposed to psychic level, which is referred to as mental level.

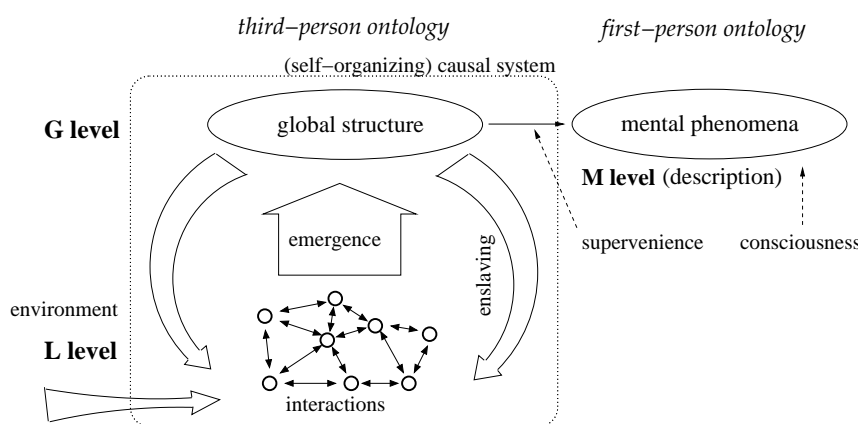


Fig. 1 Sketch of the discussed mind-brain relationship. The brain is causally closed, hence embodying both bottom-up and top-down causation. Only some global brain states have supervening mental properties.

As an important feature of the scheme, the mind-brain operates in an open loop by constantly interacting with the environment (via the body). The inputs and outputs from/to the environment operate at L level, entering/leaving the brain in a physical form, via primary sensory/motor areas. It is also interesting to stress the importance of the environment despite the fact that the vast majority of neurons receives inputs from other neurons.³ The role of environment is even stronger in the enactment approaches (Varela et al., 1991) expanding the mind to go beyond the brain (and body) but with respect to our topic I do not find this emphasis important, so we can restrict ourselves to the brain as the physical “counterpart” to the mind.

3 Causation

Understanding the nature of causation is the core feature of science in general. Ellis (2005) suggests that the key question is whether in addition to physical laws (assumed to be truly causal laws), other forms of causation such as those investigated in biology, psychology, and sociology are also genuinely effective, or rather they are epiphenomena grounded in purely physical causation. I agree with the view that the strictly reductionist approach (i.e. assuming the existence of fundamental constituents among which interactions occur) cannot work, simply because such an elementary physical level does not exist (Davies, 1984). It is hence justified to use causal explanations appropriate for the particular level of the system organization, as long as, I argue, these refer to the physical matter. When assuming a particular level, one has in mind elements at that level (e.g. neurons, neural maps, etc.) whose

³ Environmental inputs are very precious, because the long-term sensory deprivation in awake state normally leads to malfunctioning of the mind.

activity is quantified by specific variables (spiking rates, local field potentials), interacting with one another as in a directed graph. A mental level of description has a special status, because it is subjective and does not represent a new level, only a perspective of description, supervening on G level. That is, an event at G level cannot cause an event at level M, simply because they are two different descriptions of the same entity (event). For example, the global patterns of neurons firing in the cortex do not cause perception of an object, nor vice versa. How do causal mechanisms work within the brain? Keeping in mind persisting controversies in the literature, I will argue that causation operates in two ways: (a) in parallel, simultaneously at different levels where the cause and effect are intra-level, and (b) in the bottom-up and top-down manners, where the cause and effect are from different levels (they are inter-level).

3.1 Intra-level causation

The same phenomenon can be explained at various levels (or perspectives). The psychological mode provides explanations, in terms of beliefs, intentions and plans, using concepts that are very close to our thinking and subjective experience, and hence have shaped commonsense (folk) psychology. For example, the representational theory of mind (Fodor, 1987) postulates that mental processes are causal processes that involve transitions between internal representations. Standing in empirical opposition, eliminative materialists see commonsense psychology as pseudoscientific theory of unseen causes of our behavior (Churchland, 1989). They draw on the connectionist explanation referring to distributed neural activations that underlie the higher-level mental processes and actually, embody the causal chains. The two empirically opposed positions can be reconciled by holding the goodness of folk psychology (mental phenomena) to be established independently of particular facts concerning the underlying neural substrate (Dennett, 1987). In other words, the psychological account of human cognition can operate exclusively on the mental level, ignoring the question of how the underlying mechanisms might be instantiated in the brain. However, the importance of the neural level in case of mind-brain may be highly relevant, contrasting with a computer metaphor of the mind where the levels of software and hardware are safely separable and where the level of computation is well defined (Dennett, 1996). Despite that, the explanation endeavor within the symbolicists' camp is justified, because reductionist, mechanistic explanation should recognize the autonomy of higher-level (psychological) investigations (Bechtel, 2007). The higher level inquires and reductionist inquires have the potential to complement each other, and often provide heuristic guidance to each other. I agree with these claims in a sense that mental level of explanation is valuable despite its implausibility of having a genuine causal power in human behavior.

The intra-level causation in the brain is argued to simultaneously operate at various levels. At the lowest level (that we consider), a neuron (causally) affects the behavior of another neuron it projects to. At a somewhat higher spatial level, (acti-

vation of a) voxel A in certain brain area affects a voxel B in another brain area, if the effective A-to-B connection has been identified (using appropriate mathematical methods applied to empirical data). The same argumentation could apply to G level: one global brain state leads to another global brain state (we can also consider M level/perspective, as acknowledged above).

3.2 Inter-level causation

The concept of inter-level causation (both in bottom-up and top-down directions) that relates parts of the system (components) to the whole remains a topic of continuing debates. According to some experts (e.g. Craver & Bechtel, 2007), causal relations should only remain within levels and the relations across levels should rather be referred to as “mechanistically mediated effects”, based on what they call constitutive relations. In other words, they treat a mechanism (describing the interactions among system components) as operating at a particular level, not involving causation across levels. Nevertheless, many philosophers (Anderson et al., 2000; Thagard, 2009) and scientists (e.g. Campbell, 1974; Sperry, 1986) assume the existence of top-down (or downward) causation (with mental causation being a specific example). Emmeche et al. (2000) hypothesize the inter-level effects in more detail by discussing the conditions for three types of top-down causation – strong, medium or weak, each presuming the co-existence of multiple levels of description. The paper length constraints do not allow a more detailed analysis of their view, but stated briefly, the authors exclude the strong causation, as the substance dualism, and leave options open for both medium and weak types. In medium causation, the higher-level entity emerges through a realization of one amongst several possible states on the lower level (their interactions) whereas the previous states of the higher level constrain conditions for the coming higher-level states. Weak downward causation is interpreted as the formal causation based on principles of self-organization using the theory of dynamic systems (where the above constraint does not apply). Given my understanding of their theory, I see both accounts compatible with my view.

Examples of top-down (mental) causation can be found in the empirical literature: As long as half a century ago, Penfield and Jasper (1954) described a patient whose epileptic seizures in the parietal lobe always stopped when he started to solve a mathematical task. This means that a specifically evoked mental state (encompassing presumably the whole brain) must have caused the suppression of the local neural activation in the parietal lobe of the subject’s brain (for related arguments, see Schmid-Schonbein, 1998). Similarly, Le Van Quyen et al. (1997) showed in a case study that perceptual states (M) can function as modulators of (local) epileptic activations in the brain and they interpreted their finding as an example of top-down causation (by analyzing the EEG measurements) using the dynamic systems theory. Specifically, the authors analyzed temporal characteristics of neurons in the focus

(i.e. intervals between firings) and found that they changed as a consequence of perceptual changes.⁴

I think that examples of inter-level causation can be found in the social domain as well. Imagine an audience, having just watched the enjoyable performance. Initially, independent claps are eventually converted into a synchronized applause, which is an example of bottom-up causation. And reversely, imagine yourself entering a classroom submerged into a dense atmosphere that can be “sensed in the air.” You are likely to become immediately affected by this global social state. I suggest that top-down causation can also be viewed as an intra-level causation where many parts *simultaneously* affect another single part (which differs from sequential, uncoordinated peer-to-peer interactions in the intra-level case).

4 Interactions within collective systems

The inter-level causation is consistent with the (recurrent) connectionist and with dynamic systems (DS) approaches. Unlike symbolic accounts, the two approaches belong to the category of collective systems and share features, embracing both lower and higher levels of description. They both challenge the idea that the best abstraction of cognitive systems is in terms of “classical”, discrete computation and distinct functional modules. Instead of static modules, symbols, logic, and rule-based reasoning, they emphasize the language of dynamical systems and attractors, visited via activation dynamics in the state space.

Connectionist models, in particular, emphasize distributed representations, and mechanisms for parameter (weight) modification via learning algorithms. Actually, they are the models with intertwined faster activation dynamics (as in a DS) and a slower adaptation dynamics. Unlike psychological explanations that involve causal links between discrete elements (A causes B), the connectionist explanation implies *scattered* causation (Clark, 2001) distributed among elements of the system. The criticism against this type of causation, termed total causal holism (Stich, 1991, p. 181) that everything in a connectionist network is caused by everything, has been repeatedly defended by the fact that distributed representations do have an internal structure, as typically analyzed by the clustering analysis in high-dimensional state spaces. As a virtue, scattered connectionist causation can be said to be grounded in the substrate while symbolic cannot (Harnad, 1990). It is true that even connectionist representations are an abstraction, but clearly this level is closer to the neural architecture and mechanisms than the symbolic level. In addition, can the hypothesis labeled by Clark (2001) as *cognitive incrementalism* be true? That is, can higher-level mental processes be best explained using the same cognitive mechanisms as the lower level (sensorimotor) processes? Given the conservative nature of evolu-

⁴ Some cases, referred to as top-down causation, can be seen as examples on intra-level causation (at some higher G level), as in attention-boosted visual perception (Fries et al., 2001). This is probably due to conventional use of the “vertical” metaphor for frontal-posterior information flow.

tion and its invented mechanisms (at various levels of physical organization), I am inclined to be positive about the answer.

With regard to the proposed sketch, L level corresponds to concrete nodes in a graph, and G level to global (distributed) patterns of activation. L→L refers to the individual causal effects between neurons, whereas G→L becomes effective if individual causal links leading to the same node become temporally aligned (which makes it different from “uncoordinated” individual effects).⁵ G→G can be interpreted as Clark’s scattered causation mediated by individual local links (if this type of causation can truly be demonstrated, then this would point to medium causation, mentioned above). Finally, an example of L→G causation is the emergence of various self-organized global patterns such as a map of orientation selectivity in V1.

The other type of collective systems, the DS approach focuses on concepts of continuous state spaces, attractor and bifurcations (e.g. Van Gelder & Port, 1995; Kelso, 1995). The emphasis is put on how, in a process called self-organization (which also applies to connectionist systems), a complex pattern that can be described using the “order parameters” (a kind of collective variables) can emerge spontaneously when simple units interact. The interaction between the parts and the whole leads to the so-called “circular causality:” As Kelso (1995) explains, the order parameters are created by the cooperation of individual parts of the system, and conversely, they constrain the behavior of the individual parts.⁶ For example, when a system reaches an attractor region, it can no longer move around freely in the state space, but is constrained to stay in that region. Kelso sees this as a strange kind of new causality in a self-organizing system but along with Bakker & Den Dulk (1999) I do not share this view, because circular causality does not conflict with temporal order and can be viewed in terms of inputs and outputs operating in feedback circuits (what Kelso objects). Kelso (1995) postulates the theory of cortical coordination dynamics, according to which the normal brain operates in the metastable dynamic regime, permanently switching from one stable mode to another (G→G).

This DS approach is closely linked to the theory of complex systems: Metastable dynamics is distinguished by a balanced interplay of integrating and segregating influences, and metastable systems rank high when their degree of complexity is measured. Various proposed measures of complexity (Seth et al., 2006) were not only proposed to quantify the behavior of a complex system but also with an ambition to serve as computational explanations of conscious experience (Seth, 2009).

5 Neural correlates of conscious experience

The recent endeavor in the neurosciences has focused on finding neural correlates of conscious experience (Metzinger, 2000). The search for neural correlates spans

⁵ Salinas and Sejnowski (2000) show in the model how the neuron sensitivity to temporal resolution improves if it manages to balance excitatory and inhibitory inputs.

⁶ It remains to be found out what these order parameters could be in the brain, and whether they could be related to brain activations at G level.

various dimensions (see, e.g. suggestions for paradigms in Frith et al., 1999). Neural correlates became augmented with the search for computational correlates of consciousness (Cleeremans, 2005). For instance, Atkinson et al. (2000) propose that the theories can be divided according to two features: (1) whether they focus on vehicles (representations) or processes, (2) whether they assume specialized or non-specialized mechanisms. Examples can be found for each combination of the two features but what can be interestingly concluded is that they all converge toward assuming the following: “Conscious representations differ from unconscious representations in that the former are endowed with certain properties such as their stability in time, their strength, or their distinctiveness” (Cleeremans, 2005).

It is widely accepted that the brain simultaneously runs both unconscious and conscious processes (Dehaene & Naccache, 2001), which means that not all neural processes (G) avail corresponding subjective properties (M). Conscious mental states are not a homogeneous subclass, as we witness in our everyday experience, and as also suggested by various taxonomies of consciousness (Chalmers, 1986; Block, 1995). While more difficult (phenomenal) aspects of consciousness elude the experimental study of their neural correlates, in the context of primary (sensory) consciousness, several criteria have already been identified (at the level of the EEG signal), that can also be verified experimentally (Seth et al., 2006). However, the main problem, coined by Chalmers as a hard problem (Block’s phenomenal consciousness), as exemplified by a thought experiment with zombies, remains a puzzle, because it is unlikely to be solved by the proposed mechanistic view. Since Chalmers himself admits that zombies are implausible (p. 96), he suggests to treat phenomenal experience (a subset of M level properties) as fundamental. According to others, however, consciousness is a purely biological phenomenon (e.g. Dennett, 1996; Searle, 1999) and hence should be approachable by science (including both third- and first-person methods). A problem to decide which of the two hypotheses is true, has been formulated by Clark (2001) as the meta-hard problem.

Whatever answer may eventually turn out to be correct, the search for neural correlates, and hence for causal mechanisms (expressed computationally in formal models) is justified. The participation of M level is of crucial importance here.

6 What could be the role of mental properties?

I see the advocated view as a form of non-reductive physicalism. Physicalism presupposes the completeness of physics (physical closure) in wider sense (i.e. including the biological level of organization) and it is mental properties that supervene on the physical matter (brain). Non-reductiveness means that properties at M level have their own, albeit not independent (supervening) ontological status and are not, in principle, reducible (or transformable) to G level. Although G and M refer to the same level (or organization) they are not the same thing but different descriptions. This makes their relationship *unique* within the spectrum of assumed levels. When

going either down (to more local biological levels) or up (to a social level), no such relationship can be found.

If the criterion for acknowledging the existence of mental causation is the causal efficacy of mental properties, then mental causation is an epiphenomenon. However, this does not imply that mental properties are also an epiphenomenon. The relationship between the physical level and the mental level, mediated by their corresponding properties, is inherently *asymmetric* (the latter requires the former, but not vice versa). Crane (1995) sees non-reductive physicalism as problematic but his account of mental causation draws on allowing multiple causes (physical and mental) of a physical effect, leading to overdetermination. Kim (1998) wavers to deny the existence of mental causation, because psychological explanations of behavior work remarkably well, probably resulting in our tendency to believe that mental causation is causally potent. However, I interpret this type of causation as a convenient usage of the term, as a *metaphor* that arose from the commonsense (folk) psychology. The phenomenon of mental causation exists only in the sense of top-down effects of corresponding physical properties within the brain. In addition, we know that the mind can be tricked in various ways, and that subjective experience of mental causation (or conscious will) has been challenged by empirical evidence (Wegner, 2002). The illusion of the mental causation, of course, does not imply that mental properties themselves are an illusion (or an epiphenomenon).

What is the role of mental properties if they are causally irrelevant? Why do we experience them? Some may not buy this potential purposelessness of mental properties but compared to the alternatives, allowing some kind of (what is interpreted as) mental causation, this view seems less controversial. Even if the purpose of mental properties may remain unknown, given the above, M level remains: (1) an inevitable ingredient for complete scientific appreciation of certain experience X; that is, even the (eventually) complete knowledge about neural (or computational) properties (G level) related to X will not be sufficient; (2) inevitable also for learning about G level, i.e. for distinguishing conscious from unconscious mental states (Kinsbourne, 1997; Seth et al., 2005; Cleeremans, 2005). In addition, since M level cannot exist without “simultaneous” existence of G level, one interesting possibility can be to reliably evoke M simply by inducing an appropriate state in G. For instance, with a goal to provide a desirable, yet unknown, phenomenal experience to the human subject in an appropriate therapeutical context.

7 Conclusion

For the problem of mental causation I propose a view, consistent with the philosophical position of non-reductive physicalism which emphasizes the asymmetry between the physical entities and mental entities. The physical closure assumption primes the matter over mind, but the mental properties are acknowledged to have a separate ontological status, because they are not reducible to their physical correlates. The mechanistic explanation based on principles of self-organization, operat-

ing at different spatial levels of the physical brain provides room for both bottom-up and top-down effects which I interpret as real causation that occurs in the brain. Since mental properties are claimed to lack causal power, mental causation is in conventional philosophical sense to be treated as a convenient metaphor and it can only refer to the top-down effects in the brain. It is also argued that the lack of causal power does not diminish the ontological importance of mental properties that are unavoidable for identification of neural and computational properties that underlie conscious states (or processes).

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