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Minding matter: how not to argue for the causal efficacy of the mental

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Abstract

The most fundamental issue of the neurosciences is the question of how or whether the mind and the body can interact with each other. It has recently been suggested in several studies that current neuroimaging evidence supports a view where the mind can have a well-documented causal influence on various brain processes. These arguments are critically analyzed here. First, the metaphysical commitments of the current neurosciences are reviewed. According to both the philosophical and neuroscientific received views, mental states are necessarily neurally based. It is argued that this leaves no room for a genuine interaction of the mental and the neural. Second, it is shown how conclusions drawn from recent imaging studies are in fact compatible with the fully physicalistic notion of mental causation and how they can thus be easily accommodated to the received view. The fallacious conclusions are argued to be a result of an overly vague grasping of the conceptual issues involved. The question of whether the fundamental physical principles exclude outright the ability of mental states to have causal influence on the physical world is also addressed and the reaction of appealing to the apparent loophole provided by quantum physics is assessed. It is argued that linking psychology to quantum physics contradicts many basic tenets of the current neurosciences and is thus not a promising line of study. It is concluded that the interactionist hypothesis benefits from neither conceptual nor empirical support.

Keywords: dualism; interactionism; mind-body problem; neuroimaging; physicalism; placebo; psychotherapy; quantum physics.

Introduction

It is generally taken for granted that our thoughts, feelings and intentions can influence our behavior and have an effect on the material world. Nothing is more obvious to us than the fact that by conscious decisions we can control our actions and either bring about things or prevent them from happening.

But then we have learned from the neurosciences that conscious decisions and subjective sensations play causal roles only as neural activities in our brains. Even more disturbing is the fact that the physical events and processes of our brains and bodies seem to be completely self-contained: no matter how closely we study our nervous system, what we find are physical interactions of molecules, cells, tissues and organs. No extraphysical input from consciousness has been observed.

Because neither of these perspectives is possible to renounce, the two are in irrevocable conflict with each other. The issue is not merely esoteric or semantic. The question of how the mind and the body interact with each other is conceived to be one of the major issues of modern-day medicine. For example, a recent call for applications by the US National Institutes of Health stresses that many of the leading causes of morbidity and mortality are attributable to social, behavioral and psychological factors and consequently invites 'applications in support of research on mind-body interactions and health' (grant PA-07-046). Psychosomatic medicine and psychoneuroimmunology – often generalized as 'mind-body medicine' – produce arguments and results at a constant rate that show the indispensability of the mental aspect in understanding human health (Solomon, 1987; Sheikh et al., 1996; Sternberg, 1997; Sternberg and Gold, 1997; Watkins, 1997; Ray, 2004a,b). Whether and how the mind and the body can interact is a question of both philosophical and practical significance.

It would be a tempting idea to try to settle these fundamental questions once and for all by consulting the currently available techniques of neuroimaging that allow us to obtain a concrete picture of the associated brain activities, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET) and single photon emission computed tomography. Through these techniques we can spatially and temporally follow the processes of brain activation and simply consult this imaging data in trying to find out whether mental phenomena have concrete effects. If the effects appear on the screen, the mental has an undeniable effect on the brain and on the subsequent behavior of the subject. If the effects fail to appear, we have to admit that the mental is nothing but a subjective puff with no real physical and objective effect on the brain and is consequently void of behavioral impact. Because these options seem to exhaust the logical space of alternatives, the case seems rather clear-cut; all we need to do is to get on with the experiments and see which of the hypothesis is empirically supported.

This line of research has recently been proposed in several studies (Schwartz and Begley, 2002; Paquette et al., 2003; Beauregard, 2007, 2009). What is problematic with such an approach is that because it is admitted (explicitly or implicitly) that every mental state has a neural basis, one cannot reach the desired conclusion simply by observing the neural effects of changes of mental states. The fact that every mental state has a neural correlate implies that there is a neural antecedent to the observed neural effects. To reach the conclusions suggested, one would have to show that the observed neural effects are underdetermined by the antecedent neural states. However, the studies do not provide such data. In effect, the results are in fact compatible with all the traditional views on the mind-body relationship.

There are two general lessons to be learnt from this. First, there are no empirical short cuts to settling the ultimate questions of philosophy of mind. The results of neurosciences have a tremendous impact on the fundamental psychological and philosophical issues and on the very image of ourselves. Not only are the ancient questions touched by new results but new, previously unimaginable conceptual and ethical issues are being constantly raised as the data keep on piling and technologies keep on evolving (cf., e.g., Farah, 2005; Gazzaniga, 2005). It would be a serious mistake to ignore the results and developments of the neurosciences in philosophical argumentation. The issue is not whether or not empirical studies should be taken into account when fundamental questions are being addressed. They clearly should. The problem is rather that the opposite does not receive enough attention: in reviewing the empirical results and drawing the profound conclusions, it is often the philosophical reasoning that is neglected. Given the seriousness of the issues and their extensive historical and conceptual scope, this negligence is inexcusable. If your ultimate aim is at drawing philosophical conclusions, you need to be prepared to exercise rigorous philosophical analysis, no matter how diverse and novel techniques you are using or how impressive datasets you are presenting.

Second, even if the issue itself or the conclusions aimed at are not particularly philosophically laden, one should exercise caution when dealing with neuroscience explanations. Neuroscience studies are rife due to multidisciplinary relevance and constant attention by the media and general public. One is tempted to conceive every aspect of human life from the neural perspective, from sexual intercourse (Cahill, 2006) to philosophical contemplation (Churchland, 1986, 2002, 2008). Again, the question is not whether or not the neurosciences deserve such widespread attention, both scientifically and publicly, or whether or not some areas of human psyche and life should be categorically protected from the degrading influences of the neurosciences. Because our emotions, thoughts and actions happen to be dependent on our brains, no section of our psyche or life is eligible for *a priori* exemption from the empirical study of the brain. The attention that the neurosciences receive from the media and public is well deserved. But the self-evident relevance and widespread interest of the neurosciences can also be led astray. Now that we have all these wonderful methods and techniques at our disposal, one can feel compelled to use them even if their importance to the questions at hand is not at all clear. One can easily slip into thinking that any explanation can be improved by appealing to neuroscience data, even when such data are logically irrelevant to the given explanatory task (cf., McCabe and Castel, 2008; Weisberg et al., 2008). A particularly strong will is needed to fight the irresistible lure of the colorful images.

It is argued here that in explaining the causal efficacy of the mental by appealing to neuroimaging studies and other empirical results one commits exactly the sin of explaining by irrelevance. Given the conceptual background of the issue, the data presented do not provide any logical reasons to draw conclusions one way or another. It is not that the data are inconclusive or misrepresented; it is rather that when the most basic philosophical commitments of the neurosciences are carefully taken into account, it is difficult to see how the proposed lines of study can be expected to shed any new light on the fundamental issues they claim to be concerned with.

Philosophy of the neurosciences

The metaphysical underpinnings of the modern-day neurosciences

Let us start with two philosophical theses that enjoy a practically unanimous acceptance in the neurosciences. First, the neurosciences are thoroughly materialistic. Their domain of study consists of tissues, cells, molecules and their electrochemical interactions. Note that the materialism of the neurosciences is not just a blunt metaphysical denial of dualism and idealism; it is rather that the neurosciences are committed to certain empirical and quantitative methods that amount to affirming the reality of entities and processes that we conceive as physical. Materialism is not a dogmatic starting point of research but a practical outcome of the sciences in action. And despite the thorough materialism, the neurosciences are rather liberal in terms of the diversity of entities they treat as real. This is the second widely accepted philosophical thesis in the neurosciences: the neurosciences study entities and processes at different levels of biological organization, from ionic interactions to functional operation of organs and organisms. One classic textbook on animal physiology states: 'the animal physiologist investigates the mechanisms that operate in living organisms at all levels' (Randall et al., 2002, p. 3). In this hierarchy, each level is *prima facie* irreducible to another. Even if entities and processes on one level are constituted or realized by entities at a lower level, each level benefits from a certain degree of metaphysical integrity; each level is considered to be as real as any other.

The issue of reductionism is complicated. From one point of view, it would be natural to characterize the neurosciences as reductionistic (Bickle, 1998, 2003a,b, 2006, 2008): first, a psychological function is identified, such as memory, and second, its neural implementation and ultimately molecular realizers are pinpointed, such as long-term potentiation and long-term depression (Bliss and Lømo, 1973), and long-lasting high or low frequency synaptic stimulation resulting in Ca^{2+}-induced increase or decrease in the AMPA receptor activity in the postsynaptic membrane (Malenka and Nicoll, 1999; Malinow and Malenka, 2002; Song and Huganir, 2002; Bredt and Nicoll, 2003). If one thing is realized by another, is the latter thing not more real than the former? Many debates are constantly raging on whether the neurosciences are reductionistic or not, and whether they should be such or not. This is not the place to announce the final verdict. In the midst of the arguments it is important to keep in mind that even if a large part of the neurosciences is occupied with the study of the entities and processes at the molecular level, the field as a whole operates at all levels of biological organization. As with the issue of materialism, to the practicing neuroscientist there is no *a priori* dogmatic stand on reductionism. There is the psychological phenomenon of memory, and there are the neural processes of long-term potentiation and long-term depression and their molecular implementations. Both are real and important objects of study. If one insists that the realization of the former by the latter amounts to reductionism, then so be it. Nevertheless, the fact remains that the practical attitude of the neuroscientist is non-reductivistic: all the diverse entities and processes at the different organizational levels are genuinely out there to be studied.

The philosophical stance depicted here amounts to what in the current philosophy of mind has been characterized as 'non-reductive physicalism', a position embraced by both the majority of current philosophers and the majority of scientists engaged in empirical research. On the one hand, dualism and idealism are rejected and monistic metaphysics of physicalism affirmed. On the other hand, reductionism is rejected and a stratified view of the world affirmed. One can eat one's cake and have it too, it is thought, by construing reality hierarchically so that each lower level realizes the phenomena appearing at the higher level. Organisms are made out of organs and tissue, which are made out of cells, which are made of molecules, which are made out of atoms, which are made out of elementary particles, and so on. The essential point is that phenomena at a higher level necessitate the appearance of phenomena at a lower level: whenever a phenomenon at a higher level appears, there is a lower level mechanism that realizes this phenomenon. This is what the 'physicalism' part of non-reductive physicalism amounts to: higher level entities and processes do not hover in their own detached realm of reality. They are necessarily tied to the concrete physical reality like a kite to its flyer.

'Non-reductive physicalism' is a philosophical term of art. In the empirical sciences more or less the same idea is more familiar under the notion of 'emergence' and 'emergent materialism'. It may well be impossible to find such an immaculate corner of current science that would not have been said to be touched by emergence. Emergence is summoned to account for quantum oddities (Kronz and Tiehen, 2002), appearance of classical world (Joos and Zeh, 1985; Joos, 2006), phase transitions and other meso- and macroscopic phenomena (Anderson, 1972; Laughlin and Pines, 2000; Laughlin et al., 2000; Berry, 2001; Laughlin, 2005), biochemical processes (Bruggeman et al., 2002; Boogerd et al., 2005; Westerhoff and Hofmeyr, 2005), ontogeny (Gilbert and Sarkar, 2000), evolutionary novelties (Reid, 2007), life and the uniqueness of biological phenomena (Weiss, 1969; Mayr, 1982, 1997, 2004; Luisi, 2006), biological agency (Kauffman, 2000; Kauffman and Clayton, 2006), intelligent behavior (Brooks, 1991b; Steels, 1991), mind and consciousness (Sperry, 1965, 1975, 1978, 1980, 1998; Bunge, 1977, 1980; Popper and Eccles, 1977; Searle, 1992, 1997; Scott, 1995; Newman, 2001; Libet, 2003, 2004), psychosomatics (Køppe, 2000), language acquisition (Hollich et al., 2000), personal identity (Hasker, 1999; O'Connor and Jacobs, 2003), free will (Sperry, 1998; O'Connor, 2000a,b; Libet, 2002, 2004) and social dynamics (Sawyer, 2005) – among others. A variety of phenomena and processes are said to underlie emergence: chaotic behavior (Newman, 1996, 2001; Holland, 1998; Solé and Goodwin, 2000; Scott, 2007), self-organizing and complex dynamics (Kauffman, 1995, 2000; Bar-Yam, 2004), component-with-component and system-with-world interactions (Brooks, 1991a; Steels, 1991), singular limits (Berry, 2001, 2002; Batterman, 2002), synergetics (Corning, 2002) and non-linear dynamics (Scott, 1995, 2003, 2007; Solé and Goodwin, 2000; Bruggeman et al., 2002; Boogerd et al., 2005; Westerhoff and Hofmeyr, 2005; Westerhoff and Kell, 2007). Two issues seem to be characteristic to emergent features. First, it is often stressed how the emergent properties are unpredictable in relation to the basal properties. That is, given the basal features, properties of the particles out of which the emergent features are made, the resulting emergent phenomena are entirely new, unpredictable and surprising: different, irreducible concepts and theories are needed to take account of the behavior of the emergent phenomena. Second, it is almost impossible to find a reference to emergence that is not followed by the slogan 'the whole is more than the sum of its parts' in the same breath. That is, some sort of holism seems to be an essential feature of emergence: the features of the parts are not enough to account for the features of the whole.

Again, 'emergence' is a complicated concept. To some, it refers to vitalistic, spiritualistic or in other ways dubious dualistic metaphysics. To others, it refers to the fairly down-to-earth idea that in order to understand a system you need to take account both the parts of the system and the interactions of the parts (Smart, 1981; Crick, 1994). Thus, a variety of metaphysical theses can be entertained under the notion of emergence. Nevertheless, it is safe to say that the term has a fairly well-entrenched use in science as a concept that denotes the *prima facie* gaps that seem to separate the different levels of organization.

The majority of scientists are indifferent to the metaphysical disputes on reductionism and emergence. But in practice, regardless of whether one has mastered the terminology of 'non-reductive physicalism' or 'emergentism', most scientists are committed to the common-sense view that reality stratifies itself into autonomous levels. Whatever the terminology, the essential content of this view is the idea that the higher and lower level features are correlated in such a way that changes in one level are reflected as changes in other levels. That is, even if the higher level features are somehow unexplainable in terms of the lower level features – even if you cannot predict the behavior of the higher level simply by taking account the lower level features – the higher level is constituted out of entities at the lower level and whatever happens at the lower level is reflected as a change in the higher level. The mere mechanisms of these correlations are obscure to us. If you want to make changes to one level, you inevitably have to make changes to the lower level constituting the higher level you are primarily focused on. This is what the denial of idealism and dualism amounts to: 'higher levels' of reality do not float in their own realm of reality but are made out of concrete entities at lower levels which need to be touched if changes are to be made.

Interactionism and the classical problem of mental causation

There are three main historical responses to the question of whether the mind can be causally efficacious. According to interactionism, mental and physical (neural) states are distinct and genuinely real and can have an effect on each other. The leading exponent of interactionism in the history of philosophy is Descartes (1641). According to parallelism, both mental and physical states are genuinely real but they subsist in their own realms of reality which are not in interaction with each other. There is a pre-established harmony between the states: one is always faithfully accompanied by the other but their paths never cross; in explaining the transition from one state to another one needs to appeal only to the preceding states of the same kind. Parallelism was Leibniz's reaction to the problems brought against Cartesian interactionism (Leibniz, 1714, 1764). According to epiphenomenalism, both mental states and physical states are real, at least on the face of it, but only physical to physical causation is genuine; mental states are causally inert. Given a suitable physical setting – brain – distinct mental features appear, on a higher level of organization, if you will. As such, the mental features are out there to be observed and acknowledged. But the dynamics of the grounding physical system is accountable wholly in its own terms. Mentality is a side effect of the system, not a true causal factor in it. The most eminent proponent of epiphenomenalism is Huxley (1868) who infamously quipped that mind seems to have as much causal influence on the body as a steam whistle has on the operation of a locomotive engine.

Much of the current debates are carried under the notions of reductionism (Fodor, 1975, 1997; Kim, 1989, 1992, 1998, 2005; Bickle, 1998, 2003b, 2006), eliminativism or eliminative materialism (Rorty, 1970; Churchland, 1981, 1986; Stich, 1983, 1996; Ramsey et al., 1990) and psychophysical identity theory (Place, 1956; Feigl, 1958; Smart, 1959; Pepper, 1960; Lewis, 1966, 1972; Armstrong, 1968a,b, 1973). Whereas reductionism reduces the mental to the physical and identity theory claims that the mental and the physical are identical, eliminativism holds that mentalistic notions (the so-called 'folk psychology') should or will inevitability be replaced by neural notions. It is largely a matter of terminological taste (at least in this context) whether one wants to draw a distinction between reductionism, eliminativism, identity theory and epiphenomenalism. Especially so, as each approach advises us to eschew mentalistic notions more or less on the grounds of the seeming impossibility of finding a causal role for mentality. Thus save the novel settings and the terminologies, philosophical debates can still be seen to be bestridden by the classical accounts. Even parallelistic tones can be recognized in much of the current argumentation in the representational theory of mind (cf., Dennett, 1990, 1998). But the real issue is the conflict between interactionism and epiphenomenalism; the apparent obviousness of the mind's causal efficacy and the unchallengeable sufficiency of the physicochemical interactions of the brain and the body in accounting for the behavior of the individual.

Let us recall the fundamental problem of the Cartesian interactionism. According to Descartes (1641), there are two fundamentally different and distinct substances: the material body and the spiritualistic mind (soul). The defining feature of the former is spatial extension, thought of the latter: the cogito argument intends to show the genuinely autonomous existence of the person as a mental substance, distinct from the body. Immediately after the publication of this thesis, in 1643, Princess Elizabeth of Bohemia raised the question:

> 'How the human soul can determine the movement of the animal spirits in the body so as to perform voluntary acts – being as it is merely a conscious substance? For the determination of movement seems always to come about from the moving body's being propelled – to depend on the kind of impulse it gets from what sets it in motion, or again, on the nature and shape of this latter thing's surface. Now the first two conditions involve contact, and the third involves that the impelling thing has extension; but you utterly exclude extension from your notion of soul, and contact seems to me incompatible with a thing's being immaterial.' (Anscombe and Geach, 1954, pp. 274–275.)

This is the classical problem of interactionism: if you want to draw a distinction between the mind and the body, you seem to be ruling out the possibility of genuine interaction (at least on part of the features that define the distinction). The bodily movements seem to go together only with bodily causes.

Despite the classical hopelessness of interactionism it has not been left without renowned modern-day proponents. Even clear-cut dualistic interactionism has been embraced (Popper and Eccles, 1977; Eccles, 1979, 1990, 1994), but perhaps a more typical approach has been to try to find a way to avoid explicit dualism but preserve interaction (Sperry, 1980; Velmans, 1991, 1993; Libet, 1994, 2006; Beauregard, 2007, 2009). In addition to 'emergence', these approaches typically employ notions such as 'complementarity', 'translation', 'transformation' or 'dual-aspectness' in explaining how the mind and the body can be distinct enough to avoid reduction or identity but yet in some way dependent on each other so that full-blown dualism and its problems are evaded.

The chances of a successful separation of interactionism from dualism seem conceptually very bleak. If you turn over the notion of interaction in your mind you will notice that it implies some sort of segregateness or separateness, some sort of distinctness of the interacting entities: only two or more separate entities can be said to 'interact' – one thing has to interact with something else. Interaction is procedural: at a certain point in time an entity affects another entity and inflicts a change on its state (which is typically quantitatively characterized in modern science) which leads, at a later point in time, to further changes in the system (i.e., states of its components and their relations), and so on. What this amounts to is a picture where, at t_1, a state of 'material entity' inflicts a change in a state of a 'mental entity' which, at t_2, inflicts a change in a state of a 'material entity', and so on. If you wish to paint a stratified picture of this process, you would need to say that at t_1 a state of 'lower level entity' inflicts a change in a state of a 'higher level entity' (an arrow goes diagonally up) which, at t_2, inflicts a change in a state of a 'lower level entity' (an arrow goes diagonally down), and so on. For a genuine interaction you would seem to need to characterize all the parties of the interaction independently of each other. Otherwise you would not be dealing with interaction – one thing having an effect on another thing – but with a spontaneous evolution of a single isolated entity (such as a radioactive decay of an atom).

A pure form of interactionism is not a feasible view on mental causation for a neuroscientist because it contradicts the basic assumptions of neuroscience. According to the received view, the neural basis of consciousness and the conscious mental states occupy different (separate) levels of biological organization; equally natural, yet different. Nevertheless, the latter is constituted out of the former: to change a state of the higher level you are inescapably bound to change the state of the lower, constituting, level. Thus, the two parties of the interaction are not independent of each other after all. Whether one can, by some completely miraculous philosophical wiggling, make a pure version of interactionism work is not of concern at the moment. It is essential merely to realize that if you are committed to a view where the mental and the neural are necessarily (metaphysically) correlated, genuine interaction between the two is smothered.

Note that there is no problem with a purely physical – 'normal' – interaction. Physics is a science that studies the interactions of bodies; its main subject is to specify the properties of interacting bodies, formulate laws that govern the interactions and predict the evolution of the system by taking into account the specified properties, appropriate laws and the initial state of the system. The Earth-Moon system consists of two bodies in interaction; this interaction is in no way mysterious or incomprehensible. Thus, the notion of interaction itself is not dodgy. The notion is rather useful as long as the interactions are purely horizontal (diachronic) interactions of entities on the same organizational level.

The functionalistic response and its drawbacks

There is an obvious and popular way of getting around these issues. The most characteristic attitude, both in the today's neurosciences and in philosophy, towards the problem of mental causation is to claim that there is such a thing as genuine mental causation but it just is something that always realizes as physical (neural) causation. Thus, strictly speaking, the mental and the physical are not in a causal interaction with each other; only physical causes bring about physical effects. Nevertheless, the idea is that one can clear room for genuine causal role for mentality as a 'higher level notion' in the scientific vocabulary.

The modern account of philosophy of mind that most clearly subscribes to these theses is functionalism (Putnam, 1960, 1967; Fodor, 1968; Block and Fodor, 1972; Block, 1996a). The central idea of functionalism is to identify mentality, not with its own type of a substance, but with the system's propensity to entertain systematic input-output connections: to be in pain is to show avoidance, grimace and groan when stung, etc. Note that according to this view these input-output connections are not merely indirect evidence of mentality lurking beneath the behavioral shell; these connections are the mental state. Any system that is able to entertain the appropriate input-output relationships is considered to have the corresponding mental state. Thus, at least theoretically, animals, robots and aliens can entertain mental states as legitimately as humans.

Functionalism is thought to imply the denial of reductionism in the following way. If mental states are essentially functional, they are 'implementation independent': the one and the same function can be realized in indefinitely different physical constructs (humans, animals, robots or aliens). It has become a habit to compare, more or less concretely, the relationship of the mind and the brain to the relationship of the software and the hardware (Fodor, 1981; Searle, 1990; Block,1995a; Clark, 2000; Jackendoff, 2002; Piccinini, 2010); as the one and the same software can be run in indefinitely different computers, the one and the same mental state can be realized in indefinitely different physical substances. Thus, 'multiple realizability' has become the catchphrase of non-reductive physicalism. Although mental states are always realized in some physical system, the one and the same mental state can be realized in an indefinite variety of physical systems. That is why, the claim is, reductionistic research strategies – study of a particular physical realization of mentality – are not bound to be enlightening.

It is a welcome clarification to the stratified view to note that the levels of organization are essentially functional. Once grasped, it is easy to see the whole hierarchy of sciences in this light. On the basis of functional hierarchies such as this, one can argue for the autonomy of the variety of sciences (Fodor, 1974, 1997).

This type of reasoning has been used to argue that although mental states are in some sense nothing but neural states, psychological notions are scientifically legitimate and useful (Cummins, 1983; Feest, 2003; Looren de Jong, 2003). Those at the more cognitive end of the neurosciences often stress that they are dealing with 'functional organization' as opposed to neural implementation and that this separates the cognitive sciences from neurobiology (Chomsky, 1980; Pylyshyn, 1984; Jackendoff, 1994, 2002; Pinker, 1997). The mind is what the brain does, and it is these abstract psychological functions, detached from their implementation in the brain, that forms the correct object of study for psychology and cognitive science. In accordance with this, Chomsky (1965) (cf. Lyons, 1996), for instance, defines the study of psycholinguistics as a study of abstract computational 'competence' as opposed to contingently constrained 'performance': the object of study is an ideal speaker-listener who 'is unaffected by such grammatically irrelevant conditions as memory limitations, distractions, shifts of attention and interest, and errors (random or characteristic) in applying his knowledge of language in actual performance' (Chomsky, 1965, p. 3). The contingent implementational constraints should not be let to stand in the way of studying the computational capacities of the language user. To take another example, in his influential study on vision, Marr drew a distinction between computational, algorithmic and implementational levels of study emphasizing the primacy of the computational point of view in the study of information-processing devices (Marr and Poggio, 1977, Marr, 1982): 'trying to understand perception by studying only neurons is like trying to understand bird flight by studying only feathers: it just cannot be done' (Marr, 1982, p. 27). If we concentrate on what function the system is carrying out, we can often largely ignore how the function happens to be biologically implemented. Multiple realizability is not a mere figment of philosophical imagination: in the tangible natural world biological functions (communication, perceiving, flying) are often implemented in a variety of ways depending on the structural resources of the organism; natural selection sets functional challenges to organisms which resolve them in diverse ways.

Whether this approach saves the autonomy of psychological descriptions is one thing; at least it should be granted that it provides an explanation why all the variety of different sciences are indispensible even if we feel that the ultimate reality is solely physical: the contingent implementational details are often irrelevant to the functional questions of higher level sciences. But it seems that this does not bring us any closer on the resolution of the traditional problem of mental causation. There are many reasons for this.

First, recent discussion in philosophy of mind has started to pay attention to the fact that even if the functionalist approach legitimizes the use of psychological notions in an abstract sense, in each concrete case of particular behavior, there is always a complete physical (neuromuscular) account for that behavior (Kim, 1989, 1992, 1998, 2005). This is a straightforward result of admitting that even though mental states are abundantly realized, in each case it is either this or that concrete physical state of the system that brings about the particular behavior. Adding a mental state on top of the physical state would be totally superfluous because the physical state is already sufficient for the given behavioral effect to appear. If one would not take it to be such, one would fall back on dualistic interactionism and its inconceivability. The appeal to functional organization and multiple realizability saves our way of talking about thoughts and feelings; it explains the practical usefulness of psychological concepts. But that is all there is to it.

Second, if we take the mind to be essentially a computational system (realized in brain), it seems difficult to find any causal role for the semantic contents of mental states. We typically assume our thoughts and feelings to be about something. According to the widely received view in the cognitive sciences, mental processes are manipulations of mental representations; i.e., there are symbols in the computational system we call 'mind' (realized as neural codes in brains) that stand for events and entities outside of themselves, and thinking is conceived as manipulation of such symbols (Fodor, 1975, 1978, 1985, 1987, 1998a,b, 2003, 2008; Chomsky, 1980; Pylyshyn, 1984, 1989, 1991, 1999; Fodor and Pylyshyn, 1988; Sterelny, 1990; Jackendoff, 1992; Von Eckardt, 1993; Crane, 1995; Pinker, 1997; Gallistel, 1998, 2001, 2006, 2008). But because computation is (*per definitionem*) a wholly syntactic procedure, the semantic contents of mental states seem to be left without a causal role: the brain will compute according to the given input, data and rules; it will care as little for the 'meaning' of these symbols as a pocket calculator cares for what the numbers stand for that it crunches. Whether and how mental states can acquire and operate on semantic content – this is the notorious issue of psychosemantics and intentionality in the philosophy of cognitive science (Harman, 1973; Fodor, 1980, 1984, 1987, 1993, 1998b; Searle, 1980, 1984, 1990, 1999; Dretske, 1981, 1988, 1990, 1995, 1998, 2004; Millikan, 1984, 1986, 2004, 2005; Block, 1986; Papineau, 1987; Katz, 1990; Baker, 1995; Devitt, 1996; Jacob, 1997; Price, 2001; Jackendoff, 2002). Although most of the energy has been burned off on working out more and more elaborate positive theories, some (Dennett, 1969, 1971, 1981, 1983, 1987, 1990, 1994, 1998; Churchland, 1981; Stich, 1983; Ramsey et al., 1990; Brooks, 1991a,b; Bickle, 1998) have succumbed to the logical conclusion that mental processes are completely syntactic and that intentional, 'folk psychological' idioms are, if not downright false, mere temporarily useful figures of speech or heuristic tools.

Third, if mental states are to be identified with certain systematic relationships between inputs and outputs, the qualitative contents of conscious mental states seem to be left out of the picture. We typically regard qualitative contents of our experiences, e.g., unpleasant feelings associated with pain sensation, as causes of our behavior: it was the unpleasant feeling that made me move my arm. Yet, when complete neuromuscular accounts of such actions are given, the subjective qualitative feelings do not appear in them. We seem to have unique personal feeling associated with every experience we have, but our physiology is completely indifferent to them. This is a delicate issue. Of course our physiology reflects systematically our thoughts and feelings: your body and your brain are in a certain state when you are angry, different to a state when you are happy. But it is not your subjective feeling of angriness or feeling of happiness that figure as a causal factor in the physiological changes in your body and brain. This again is one of the major issues in the current philosophy of mind and a plethora of arguments exists to prove the peculiarity and inertness of the qualitative contents of conscious mental states (Nagel, 1974; Block, 1980a,b; Jackson, 1982; Levine, 1983; McGinn, 1991, 1999; Chalmers, 1996).

One aspect of this argumentation deserves to be highlighted in this context. Although the traditional metaphysical dualism has had to settle for a walk-on part for the past decades, if not for centuries, some recent arguments around the problem of consciousness have drawn dualistic conclusions (Jackson, 1982; Chalmers, 1996, 2007a). It needs to be made clear that these conclusions have nothing to do with interactionism, but exactly the opposite: the qualitative aspects of our experiences seem – according to these arguments – to be 'a further fact' about the world, something that cannot be derived from simpler (physical) facts, but needs to be just added to them by hand; the physical world could very well do without the qualitative aspects of our experiences. Hence the question: 'why are we not zombies?' (Chalmers, 1996). But because these subjective qualitative aspects of our experiences happen to be there, dualistic conclusions follow exactly because there is no way to assign a causal role to these aspects. If such a role was assigned to them, they would be assimilated to the physical world and they would lose their status as 'a further fact'. Thus, although interactionism seems to imply dualism, the converse is not true; one can also be a proponent of epiphenomenal dualism.

At first hand, the functionalist approach seems to offer a promising way out of the classical problems of philosophy of mind. But on closer inspection it gives only an abstract legitimation for psychological notions, and it threatens to leave us completely hollow: in the functionalistic framework neither the semantic nor the qualitative contents of our experiences, thoughts and feelings guide our behavior.

What is the problem of mental causation?

The problem of mental causation is a hydra. Many different issues are at stake and one is often faced with a mess where questions and answers fly pass each other. The discussion is centered too abstractly around the problem of mental causation when in reality there are many separate problems. This section finishes with an attempt to summarize the issues and sharpen the problematic.

The following question should serve as a guideline: what, exactly, sets the mental and the physical apart from each other? What, exactly, are the features that mentality is supposed to have that seem to be so impossible to incorporate into the physicalistic world-view? What, exactly, calls for explanation? The issue is often phrased in terms of 'mental properties', 'mental states', 'mental events' or 'mental processes' vs. 'physical properties', 'physical states', 'physical events' or 'physical processes'. But it is not clarified what the 'mental properties' or 'mental states' are as opposed to 'physical properties' or 'physical states'. What, exactly, is supposed to create the insuperable juxtaposition between the 'mental' and the 'physical'? Let us carve out three separate issues.

First, there is the issue of intentionality or psychosemantics. Mental states – experiences, thoughts, feelings – are about something, they refer to things displaced both in time and in place. This is a feature that minds (or 'intentional systems') have, but physical systems as such lack. Now, as already discussed, it is in no way problematic to devise physical systems – computers or brains – whose functioning is based on symbolic information processing. The problem is that semantics does not appear as a causal factor in such processing. So even if it is easy to grant that minds operate on symbols that refer outside of themselves (or outside of the physical system – brain – in which they are embedded), it is difficult to see how the semantics of these symbols could take part in the functioning of the mind: information processing, computation, is a completely syntactic procedure. The situation is nicely illustrated by an analysis of the operation of a vending machine (cf., Dretske, 1998). We typically perceive the vending machine to operate on the grounds of the value of the money inserted. But actually the machine does not care about the value of the money one bit: all it cares about are the crude physical characteristics (size, shape, weight) of the physical object inserted. We may find it useful to talk about 'value' when discussing the operations of a vending machine, but when the inner workings of the system is concerned, 'value' is an epiphenomenon: the machine moves from state to state regardless of it.

Second, there is the issue of consciousness. The term 'consciousness' is highly ambiguous and many different issues are discussed under it (cf., e.g., Zeman, 2001, 2006). Let us concentrate on two of the most relevant in the current context. As already discussed, the qualitative features of our experiences seem to be impossible to incorporate into the physical description of the world. What, exactly, constitutes the impossibility here? The problem, it seems, is that if the neurosciences are essentially committed to analyzing the systematic functional relationships of physical stimuli and physical responses (whether on intracellular, synaptic, cortical or behavioral level), the qualitative contents of such stimuli and responses are eschewed because they are incapable of contributing to such functional relationships. This is a fairly straightforward result of the fact that what we acknowledge as scientifically legitimate phenomena are quantitative interactions – changes that can be quantitatively measured and documented. In neurobiology, this amounts to theorizing and experimenting consisting of physical stimulation of nerves and tracking the electrochemical responses of this stimulation in neurons and synapses. The fact that these physical stimulations and responses happen to give rise to qualitative experiences in the object of the experiment does not appear as a variable in the experimental set-up or as a number in the results.

One could think that the qualitative nature of conscious experiences is enough to create the juxtaposition of the mental and the physical. But there is an even more serious warp: the problem that the qualitative features of conscious experiences are supposed to be thoroughly subjective. Another element that we acknowledge as indispensable for scientific legitimacy is that the experiments, their set-ups and results are objective and repeatable; that they can be publicly scrutinized, criticized and reproduced. Even if it is readily admitted that our conscious experiences are necessarily dependent on their neural basis – that it is impossible for the experiences to exist without some corresponding neural activity – it is a further step to claim that these two are identical: you claim to have an image of the big blue sky in your mind but if we take a look, there is nothing big and blue inside your skull. Nothing is more evident to us than the concrete reality of our own experiences. But owing to their private nature, these experiences are neurobiologically non-existent. Their neural correlates are out there to be objectively and quantitatively studied, but the experiences themselves are completely out of the scientific (physical) domain. There is no way to obtain to them publicly.

Third, there is the notorious issue of free will or volition. We have a feeling that we can, by conscious decisions, actively control our behavior. By a simple change of mind, we can make things happen. And it is exactly the conscious change in the state of mind, not the correlative changes in the neural basis, that is supposed to function as the causal originator here. The problem can again be traced to our intuitions about the criteria of scientific legitimacy of our physicalistic world view. One of its elements is the conviction that given the same initial conditions and the same relevant (deterministic) laws, the same outcome follows necessarily. Translated to a neurobiological context this means that given the initial state of the nervous system and the (deterministic) laws that govern its dynamics, the same outcome (behavior) follows necessarily: if all else is equal and you feed the same electric current to the nerve leading to a frog's leg muscle, the leg will twitch exactly the same way. There is no place for 'the mind' to cut in and change the physical course of events. Note that the ultimate conflict is not with determinism, but with the idea that physics is all-encompassing in such a way that for every physical effect there is a physically sufficient cause for it. This is the so-called principle of causal closure and it is a derivative of the first law of thermodynamics. From this point of view, a volitional intervention into the physical course of events would be completely miraculous and hence incomprehensible. Here, the conflict between the mental and the physical is perhaps at its most sharpest: in order for the mind to figure as a genuinely autonomous causal factor, it is forced to present itself as a physical anomaly (cf., e.g., Wilson, 1999).

These three issues, at least, are at stake in the problem of mental causation. Although 'mental properties' and 'physical properties' are often pitted against each other too abstractly, philosophers are usually reasonably careful not to mix these separate facets of the problematic. Unfortunately, it is somewhat typical in the neurosciences to deal with all these issues under the notion of 'the problem of consciousness'. Although the explicit focus is often on addressing 'the' problem of phenomenal consciousness, one immediately slips to a discussion on (visual) awareness and attention, which are strictly speaking only basic psychological prerequisites of the subjective conscious phenomenal experiences themselves. Although many studies have recently addressed the issue of the separateness of consciousness and attention (Block, 1995b, 1996b, 2001, 2005; Baars, 1997, 1999; Hardcastle, 1997; Lamme, 2003, 2004; Koch and Tsuchiya, 2007), it would be more apt to describe the focus of these studies to be on the distinction between awareness and attention. The function of awareness and attention is no mystery: by being aware of one's surroundings – via perceptions and memories – the organism is able to guide its behavior, survive and reproduce. Because such a function is easy to pinpoint, there is no reason in principle why these phenomena would not be neatly empirically and neurally tractable, and, in consequence, seamlessly embeddable in the physical world-view. Because such a pathway of research is in sight (at least in principle), the problems of awareness and attention are often deemed 'easy', in contrast with the difficult problem of explaining the function and nature of subjective phenomenal experiences (Chalmers, 1995, 1996, 2007b; Shear, 1997).

Another common mix-up is to link the problem of consciousness to the issue of volition and free will (Sperry, 1976, 1978; Popper and Eccles, 1977; Libet, 1985, 2003, 2004; Velmans, 1991, 1993, 2000, 2002; Beck and Eccles, 1998, 2003; Pockett et al., 2006). Conscious decisions are typically necessary antecedents of willed actions: we have to be aware of what we are doing in order for it to be possible to say that we chose to do what we did. But it is again consciousness in the sense of awareness that is in focus here. As awareness is functionizable and thus neurally comprehensible, the real philosophical problem of volition does not lie with awareness but with the question of how anything that is not completely physically characterizable could intervene in the physical courses of events.

There is no point in waging an orthodox argument over what is 'the' correct formulation of the problem of consciousness. Slapping a ban on discussions on these various consciousness-related issues would not do any good, of course, and the significance of the issues and the studies conducted on them is not be downplayed. But it is equally important to be disciplined enough to keep different issues separate and make sure that questions and answers correlate with each other. Otherwise everybody is not on the same page and the discussions and studies are hopelessly insensible. And foremost, it is crucial to have a clear and adequate understanding of what the nature of the problem is that one aims to address. Otherwise one simply fails to study the issue one claims to be studying.

Mind-body interactions in empirical focus

Synopsis

Animals, humans in particular, have the capability of reacting to environmental stimuli swiftly and coherently. What sets simpler and more complex organisms apart from each other, in this regard, is the degree of the directness of the route from the stimulus to the response. 'Lower animals' react to stimuli in a direct and predictable manner; 'higher animals' are capable of reacting more flexibly. Humans have a particularly wide span of judgment: apart from reflexes, we have practically limitless ability to control our behavioral responses to environmental stimuli. We can choose to experience pain even if alleviation is close at hand; we can choose to stay hungry even if food is readily available; we can refrain from sexual intercourse even if perfectly suitable and willing mates would be on offer. We can choose to ignore the stimuli that normally dictate the behavior of biological organisms.

Even if our ability to control our reactions may be at an extraordinary level, it nevertheless represents just the one end of the continuum of controlling capabilities found in the animal kingdom. That animals respond to stimuli and are able to mold their behavior accordingly is the basic fact of animal physiology. This capability is facilitated by a nervous system, and in more evolved species by a central nervous system. The biological function of nerve cells and, ultimately, brains, is to receive information from the environment and guide behavior in a manner that is coherent with the information received.

These are trivial facts of neurobiology. Yet, they are easily ignored when the discussion turns to the issue of the mind-brain relationship. If mental phenomena are necessarily neurally grounded, then any changes in the mental features are reflected in changes in the physical features of the brain and *vice versa*: the constant nervous stimulation impinged on us by the environment imposes changes on our nervous systems and our brains and, hence, on our minds. Thus, if there are changes in the environmental stimuli, there are changes in the nervous system and in the mental features upheld by that system. A simple appearance of a novel feature in the visual field and the resulting perception (subjective visual experience) is a typical example. But the opposite is also true: if there are changes in certain mental features, there are corresponding changes in the nervous system upholding those features that possibly manifest themselves behaviorally. That is, whether there are changes in the environmental stimuli or changes in the subjective consciousness, these changes are necessarily reflected in changes in the physical features of the nervous system.

This picture, based on a reflection of the basic assumptions of the neurosciences, does not amount to interactionism. Changes in the mental features do not cause changes in the physical features of the nervous system, or *vice versa*. Changes in the mental features are changes in the physical features of the nervous system, and *vice versa*. This is the lesson of 'neural grounding'.

But why does one so easily slip into thinking that changes in the mental features cause changes in the nervous system? Why is it that we keep using these distinct concepts and are tempted to treat their referents as distinct entities? Why do we let our terminology lead us astray? The main reason for this is the fact that 'change in mental features' and 'change in the physical features of the nervous system' are qualitatively and operationally rather different things. That is, one uses different techniques and methods to ascertain changes in these two domains. The subjective states of conscious experience are qualitatively so different from the neural states that uphold them that we have to use two different routes to ascertain a linkage between them: even if we know, for example, that visual experiences are systematically associated with neural activity in the occipital lobe, we do not know this from simply studying the brain but from a successful linking of the neural data with verbal and behavioral reports of the testees. To link the mental variables with the neural variables, we need to determine their values independently of each other. Once the neural activity in question is being observed, we need to verbally consult the patients or testees or observe their behavior to affirm that the corresponding psychic activity is present. Because the values of these two variables need to be independently fixed, it is natural to slip into thinking that the change in a value of one variable causes the change in the other variable.

The illusion of interaction created by this methodological dualism built into the practice of the neurosciences is somewhat common. In an extensive review, Beauregard (2007) claims that the results of neuroimaging studies support a 'psychoneural translation hypothesis', where mind and brain 'represent two epistemologically and ontologically distinct domains that can interact' so that 'mental events/processes, which are neurally grounded, are selectively translated […] into neural processes/events at the various levels of brain organization' (Beauregard, 2007, p. 233) and *vice versa*. The trouble with such claims is that ultimately no clear evidence of the 'translation' or related phenomena is brought up. The neural effects of mental stimulation, such as psychotherapy, are uncontestedly shown. But this does not amount to 'translation'. What is missing is a clear description of the antecedent of the 'translation': what is translated into these neural effects, and how does this translation happen. It seems that it is just taken for granted that awareness, expectations, beliefs, conscious emotions, etc., constitute distinctly non-physical causes in the mental domain that somehow have an effect on the physical domain. Yet the more moderate strategy would be to study first the neural correlates of the cited antecedent 'mental events' and track the path from these correlates to the neural effects. Whether a 'translation hypothesis' can be accepted or not depends on how well we are able to capture the antecedents and the pathway in physical terms. If there is a completely physical description, then it seems that the hypothesis should be rejected.

It has to be stressed that the fundamental mistake here is to think that the issue is straightforwardly empirical; that we can draw these sorts of conclusions from imaging studies. If we subscribe to the thesis that mental states are necessarily neurally grounded it is difficult to see what function the supposed 'translation' or 'interaction' could serve: both the antecedent and consequent mental states are continuously neurally grounded and the consequent neural effects can be unresidually accounted for by the antecedent neural events. To make the suggested picture work, one would have to loosen the thesis of neural grounding and claim that the antecedent neural events do not determine completely the consequent neural effects – that there is something 'more' in the mental states compared with the corresponding neural states. But that would be a step towards dualism and a step away from the received view of the neurosciences.

In what follows, studies and arguments on the issue of the mind-brain relationship in the recent neuroscientific literature is reviewed. It is argued that if the basic assumptions of the neurosciences are carefully taken into account, the provided lines of argumentation and the conclusions reached at can be seriously questioned.

A case study: psychotherapy

Psychotherapy is an interpersonal psychological therapy to treat mental disorders and various psychic problems of a patient. Psychotherapy can take various forms: patients can be treated individually or in groups, the approach of the therapist can vary from behavioral and cognitive to psychodynamic, among others, and the content of the therapy can vary from discussion or analysis to active exercises. Many studies have indicated the clinical effectiveness of psychotherapy (Seligman, 1995; Wampold, 2001; Lambert and Ogles, 2004; Pfammatter et al., 2006). Cognitive-behavioral therapy (CBT) is the most extensively studied form of psychotherapy and its effectiveness in treating a variety psychic disorders and illnesses is well documented (Dobson, 1989; Scott, 1996; Gloaguen et al., 1998; Sperry, 1998; DeRubeis et al., 1999, 2005; Devilly and Spence, 1999; Chambless and Ollendick, 2001; Rector and Beck, 2001; Parker et al., 2003; Deacon and Abramowitz, 2004; Zimmermann et al., 2005; Norton and Price, 2007; Rathold et al., 2008).

To study the neurobiological effects of CBT, Paquette et al. (2003) conducted an fMRI scan on subjects suffering from spider phobia. The subjects viewed film excerpts of spiders and were asked to assess the level of fear they experienced during the viewing. The results indicated significant activation in the right dorsolateral prefrontal cortex, the parahippocampal gyrus and the visual associative cortical areas in phobic subjects during the viewing of the excerpts. The results are in line with previous PET studies on the neurobiology of spider phobia (Fredrikson et al., 1995; Johanson et al., 1998). After CBT treatment no significant activation was found in the dorsolateral prefrontal cortex or the parahippocampal gyrus. CBT had clear effects on neural activity.

The interpretation of the results depends on two variables whose values need to be determined in two stages. First, the subjective level of fear of the subjects must be assessed and the correlative neural activity must be determined. Second, the values of both variables must be shown to be sensitive to CBT. Paquette et al. (2003) report that viewing the film excerpts induced significantly more intense states of fear in the phobic subjects than in the non-phobic controls (mean rating of 6.3:8 compared with the mean rating of 0.4:8, respectively). The authors also report discrepancy in the neural activity during the viewing of the film excerpts between the phobic subjects and the non-phobic controls: the controls were showing significant neural activity only in the left middle occipital gyrus and the right inferior temporal gyrus. A significant reduction in the intensity of the states of fear of the phobic subjects after CBT treatment is also reported (mean rating of 0.1:8). Correlatively, after CBT, significant neural activation was not additionally found in the dorsolateral prefrontal cortex or the parahippocampal gyrus. In summary, there was a definite mental state which had an identifiable neural correlate; these two variables were systematically linked in such a way that after CBT both of them had undergone measurable changes, i.e., CBT had an effect on both of them.

According to Paquette et al. (2003), these results support the conclusion that CBT has the potential to modify the neural activity associated with anxiety disorders and thus show how changes in the mental level are able to evoke changes in the neural level: 'these findings indicate that the changes made at the mind level are able to functionally 'rewire' the brain' (Paquette et al., 2003, p. 408). 'Change the mind and you change the brain' is the catchphrase the authors are selling. In a conclusion of a review of imaging studies on psychotherapies, Kumari (2006) states that the results suggest that 'a change in patients' symptoms and maladaptive behavior at the mind level with psychological techniques could potentially change (normalize) the brain at the functional level' (Kumari, 2006, p. 67). Do the results support conclusions like these?

There is no shortage of studies that document the neurobiological responses of psychotherapy (Shear et al., 1991; Baxter et al., 1992; Joffe et al., 1996; Brody et al., 1998, 2001; Schwartz, 1998; Thase et al., 1998; Viinamäki et al., 1998; Martin et al., 2001; Goldapple et al., 2004; Johanson et al., 2004; Praško et al., 2004; Linden, 2006, 2008). There is no reason to doubt the basic result of these studies: psychotherapy has measurable effects on neural activity. But these results are hardly surprising: the psychic and behavioral effectiveness of psychotherapy was already known; given our conviction that mental activity is necessarily grounded by neural activity, the fact that there are well documented psychic and behavioral effects should lead us straight to the conclusion that there will also be correlative neural effects.

It is noticeable that the interesting feature of these neurobiological studies is not typically taken to be the simple finding that there is neurobiological responses to psychotherapy; focus is rather on the question of what kind of neurobiological responses psychotherapy has, e.g., on the fact that often the neurobiological responses of psychotherapy and pharmacotherapy are similar (Baxter et al., 1992; Brody et al., 2001; Martin et al., 2001; Sackeim, 2001; Thase, 2001). Although one can also be critical towards the enthusiastic attitude in some of these conclusions – because it was already known that both psychotherapeutic and pharmacological treatments have similar effects on patients (namely, recovery, the disappearance of psychic and behavioral symptoms), it should not come as a surprise that the underlying neurobiology would be quite similar in both cases – they are in line with the paradigmatic conclusions of these types of studies and do not in any way make an issue of the basic fact that some neurobiological responses were found in the first place.

Thus, it seems that it is generally taken for granted, as it should be, that there are neurobiological responses to psychotherapy. Yet some make an issue of the simple fact that we are able to capture these responses on screen (Kumari, 2006; Porto et al., 2009) and even argue that these results indicate, at last, how the mind is able to influence the functioning of the brain (Schwartz and Begley, 2002; Paquette et al., 2003; Beauregard, 2007, 2009). Yes, it is true that if you 'change the mind you change the brain'. But that is a metaphysical truism that does not call for empirical backing. If, by contrast, one wants to claim, as one clearly does, that there is a causal influence emanating from the mind to the brain, the empirical evidence does not support such a conclusion.

What the study of Paquette et al. (2003) showed is that under the influence of CBT the psychic and neural variables vary in a systematic way. But this systematic connection between the values of the variables can be interpreted in various ways. One is the way Paquette et al. (2003) are suggesting: CBT influences the psyche which in turn influences the neural activity. Another way is to reverse the order of the influence: CBT influences the neural activity which in turn influences the psyche. Still another way is to take these two variables to be dependent of each other: CBT influences both variables because they designate the same phenomenon. Does the data provided allow us to make a decision between these alternatives? No, if we consider the systematic behavior of the variables in isolation: all alternatives are logically possible. Yes, if we embed the results in a larger context: the values of the psychic and neural variables vary in a systematic way because psychic activity is always accompanied by neural activity. The variables are dependent on each other.

It is an elementary lesson of statistics that one cannot jump from a systematic connection of variables to a causal connection between them. First, one has to exclude the possibility of correlation. Whenever we are able to produce effects that are sensitive to our manipulation, we have to run additional tests before we can begin to draw conclusions about causal relationships. If, by doing *D*, I am able to inflict changes both in the value of a variable *X* and in the value of a variable *Y*, this information by itself is not enough to tell me whether *X* causes *Y* or the other way around or whether *X* equals *Y* or whether there is a third factor on which the value of both *X* and *Y* are causally dependent and there is no causal interaction between *X* and *Y* at all. These sorts of issues are determined by tests in which some of the values of variables in question are held constant and the results of the manipulation are being observed. No such tests are conducted by Paquette et al. (2003).

It is worth the effort to try to imagine how one could establish a conclusion that Paquette et al. (2003) are suggesting. To show that CBT influences neural activity via influencing the psyche, one would first need to show the influence of CBT on psyche and then the influence of psyche on neural activity. Because the issue is whether the neural activity CBT produces is a result of the psychic or the neural variable, one would need to assess this by keeping the other variable constant while varying the other. But that cannot be done: psychic activity is necessarily correlated with neural activity. Note that Paquette et al. (2003) cannot withdraw to a claim that it would be incorrect to ask whether the neural activity CBT produces is a result of the psychic or the neural variable. If that question is not justified, then one does not need to appeal to the empirical evidence in the first place: they would have had to admit from the start that psychic and neural activity go hand-in-hand and the provided 'empirical results' that CBT has an influence on neural activity would be entirely trivial. The conclusions Paquette et al. (2003) are suggesting make sense only if one is tacitly prepared to detach the two variables from each other. Or, to put it the other way around: it does not make sense to claim that there is causal interaction between the two variables but refuse to treat the variables independently of each other. Interaction implies duality; interactionism implies dualism.

Now, everybody is in a hurry, of course, to claim to be subscribing to the received view that every psychic feature always has a neural correlate and that it is thus unfair to pin such whether or questions on studies like these. Beauregard (2007) claims that the recent imaging studies support the 'psychoneural translation hypothesis', where 'mental events/processes, which are neurally grounded, are selectively translated […] into neural processes/events' (Beauregard, 2007, p. 233). Thus, the hypothesis admits right from the start that mental activity is always neurally grounded. Now questions pose themselves. What is translated into what in the suggested hypothesis? How does such a translation take place? If one starts off with the assumption that every mental state has a neural correlate, what role is there left for the 'translation' to play? There is already a continuous chain of neural states; the appearance of each link in the chain is sufficiently explained by the previous links. If one wants to give an independent role to the mental state – if one claims that the links in the chain of neural states would not appear without intervening translations from mental states, at least from time to time – one would have to renounce the thesis that every mental state is always neurally grounded. Simply saying that every mental state is neurally grounded does not fix any problems. One also has to mean what one says. If there is a continuous correlation between mental and neural states, there is no room for 'translation' to cut in; if there is room for translation to cut in, there is no such correlation. Either one treats the mind and the brain as a unified entity or one separates the two. This exhausts the options. Magic words cannot make logic go away.

Similarly sloppy conceptualizations are fairly common in the current neurosciences. Reflecting on imaging studies on psychotherapy, Brenner et al. (2006) suggest that recent 'research findings underline the concept of the brain as a kind of transformation organ' and that 'mental illness is the product of a circular causality between neurophysiological, subjective, social, and other environmental variables constantly interacting with each other' (Brenner et al., 2006, p. S11). Consider an organ that is a transformation organ *par excellence*: the liver. One of the transformation functions of the liver is to break down xenobiotics, drugs and toxic substances. The enzymatic processes of the liver transform drugs into water-soluble chemical compounds by increasing their polarity. In fact, on a general level every organ, tissue and cell is a 'transformation organ': they receive chemical compounds and transform them in enzymatic processes to different chemical compounds. The brain is no exception is this sense. But is there a further psychoneural transformation function to the brain? If one believes in the idea of neural grounding, the answer must be negative: if every mental state is neurally grounded, the mental outputs of neural activity are always unresidually accompanied by neural outputs and it is thus a complete mystery what function the 'transformation' from neural activity to mental state and back is supposed to serve. The biochemical transformations that constantly go on in our bodies are causal processes in time: at one point in time a product is formed which serves as a reactant in another biochemical reaction which results in another product at a later point in time and so on. Whatever the relationship of the mind and the brain is, it is not a process in time: at each point in time the mental state is correlated with a neural state.

What this analysis suggests is that the use of notions such as 'translation' and 'transformation' is an attempt to smuggle interactionism back to neuroscience. And interactionism is untenable because it requires separation of the interacting entities. And such dualism is untenable because it contradicts the fact that every mental state is neurally realized. This does not mean that there are no such things as 'translation' or 'transformation' in neuroscience. It is just that these 'translations' and 'transformations' are wholly notational. For methodological reasons we need to deal with two variables and thus occupy ourselves with 'translating' them to each other. But this practical attitude should not obscure the theoretical fact that the variables do not designate separate entities.

A case study: the placebo effect

The placebo effect is another seductive place to look for evidence for the mind-brain interaction (Kihlstrom, 2002, 2008; Velmans, 2002). After all, in placebo/nocebo cases, it is the subject's state of mind rather than the physical substance consumed (in the case of pharmacological placebo) that brings about the concrete physiological responses. The key distinguishing factor between placebo treatment and 'really effective treatment' (pharmacological, physical or psychological intervention) is that for the placebo treatment to work, the subject must believe in the effectiveness of the treatment, when no such requirement pertains to 'really effective treatment'. According to Melmed (2001), the placebo effect leads us to ask 'how the energy of anticipation and belief may be captured and harnessed to affect the functioning of cells, tissues, and organs' (Melmed, 2001, p. 130).

There are many problematic issues surrounding the placebo effect. First, giving an adequate definition of 'placebo' is a delicate issue. Placebo effects are supposed to be 'real' but at the same time they are not supposed to be 'as real' as the effects a 'real' drug would bring about. Furthermore, placebo 'recovery' has to be distinguished from 'spontaneous' or 'natural recovery' in order for it to pass for 'real placebo'.

This leads to the question of whether there is such a thing as 'real placebo effect' at all. In a classic study, Beecher (1955) reported that 35% of 1082 patients suffering from various diseases were satisfactorily relieved by placebo treatment. However, the trouble with this conclusion (and many further studies and interpretations) is the very fact that the studies reviewed did not include control groups: there was no way to distinguish the 'real placebo effect' from 'spontaneous recovery' (or other possible contributing factors). This fact, and subsequent studies with control groups, have led some to conclude that there is no such thing as 'real placebo effect' at all (Kienle and Kiene, 1997; Hróbjartsson and Gøtzsche, 2001, 2004).

One has to be very careful in drawing conclusions from these arguments. Even those who doubt the power of placebo do not deny that there is such a thing as placebo response. (The dispute over placebo concerns mainly the clinical effectiveness of placebo, not the issue of placebo response as such.) The mildest type of such a response is the subject-expectancy effect: the patient is expected to recover so she is prone to report, think and act like she is undergoing recovery (but there is no objective physiological indication that she actually is). A more substantial position is to claim that placebo induces a feeling of recovery. This amounts to admitting that placebo treatment truly alleviates at least some subjective psychic symptoms. Note that reporting and feeling are conceptually and psychologically separate things: for various reasons one can report to be feeling in one way even if one is actually feeling differently. In fact, some recent imaging studies indicate that the placebo treatment decreases neural activity in the pain-sensitive regions of the brain (thalamus, insula, anterior cingulate cortex), which suggests the conclusion that placebo treatment may affect the subjective experience of pain rather than mere pain behavior (Wager et al., 2004; Wager, 2005). Even studies that are most skeptical towards the reality of the placebo effect admit that there is statistically significant evidence of the analgesic effects of placebo (Hróbjartsson and Gøtzsche, 2001, 2004).

The most substantial position is to claim that placebo treatment has the power to induce measurable physiological changes comparable to 'real' treatment. For example, a study by Benedetti et al. (2004) indicates that, after being conditioned to a drug treatment, patients suffering from the Parkinson's disease show a similar decrease in muscle rigidity when treated with placebo drug as they were when treated with clinically effective apomorphine. Another study shows that if subjects are preconditioned to morphine in the training phase of a sport, their pain endurance and physical performance can be boosted by a placebo drug in competition (Benedetti et al., 2007). In cases such as these clearly identifiable and quantitative physiological variables (muscle rigidity, physical performance) are being influenced by placebo treatment. These variables are independent of what the subjects are saying or feeling, i.e., the effects are not merely subjective and qualitative but objective and quantitative: the effects do not exist solely in the 'minds' of the subjects but are 'physical'.

Does the placebo phenomenon demonstrate the mind's ability to influence neural activity? It is certainly very tempting to think so. There is a clear connection between the subject's mental state and the physiological responses. And it is exactly the subject's belief in the effectiveness of the treatment that triggers these responses. The psychic variable seems to have a power to affect the physical variable.

The trouble with this conclusion is that it again ignores the basic assumptions of the neurosciences. If every mental state is necessarily neurally grounded, the belief in the effectiveness of the treatment that is supposed to be exerting the causal influence on the body is also neurally grounded, and the resulting physiological changes should be able to be accounted for by this neural activity. If the physiological responses cannot be accounted for solely by the underlying neural activity, this amounts to there being mental features that are not neurally realized, which would contradict the thesis of neural grounding.

Note that even though some of the results of the placebo studies are rather striking, this conclusion is not actually affected by the level of the physiological gravity of the responses. Even if it would be concluded that placebo responses are in fact mere subject-expectancy effects, this would not change the fact that there are neural responses of placebo for a neuropsychologist to ponder on: if the subject is disposed to act and speak in a certain way, this disposition can (in principle) be correlated with some neural activity. Because there are these responses to placebo, the simple fact that they show up in brain scans should not come as a surprise to anybody. Similarly, a mere subjective feeling of recovery should be grounded on some physical state of the brain: if the subjective feeling is there, so is the corresponding brain state of the subject. Even if one is skeptical towards the 'reality' of placebo effects, one should not doubt the fact that the patient is really responding to placebo in some way – such as having an illusion – that is ultimately grounded on the patient's brain. Open up the hood and you will see it.

This does not mean that the imaging studies of placebo are totally pointless, of course. Some results can shed light on the mechanism of placebo and genuinely settle psychological disputes – such as studies that show how the placebo response is realized in neural activity that typically corresponds to subjective pain alleviation rather than in activity that would correspond to the mere pretending of such alleviation (Wager et al., 2004; Wager, 2005). And no doubt studying the placebo response is a fruitful phenomenon for studying the neurobiology of consciousness and intention. What the placebo response does not provide, however, is evidence for the causal efficacy of the mental.

A case study: environmental influences and social interactions

Organisms are integrally connected to their environments. In many ways, an individual organism, taken as a unit separate from its environmental context, is an abstraction. If you cut the individual organism out of its surroundings, it will wither away instantly.

The fact that organisms are dependent on their surroundings and react to changes in them is as a trivial biological fact as it gets. Yet, studies showing results of environmental influences on neural functioning are often portrayed as startling. We have been entertained *ad nauseam* with studies that show how brain structures and functions differ between string players and non-string players (Elbert et al., 1995), Braille readers and sighted (Sterr et al., 1998), taxi drivers and non-taxi drivers (Maguire et al., 2000), musicians and non-musicians (Gaser and Schlaug, 2003), jugglers and non-jugglers (Draganski et al., 2004), pedophiles and non-pedophiles (Cantor et al., 2007), hetero- and homosexuals (Ponseti et al., 2007; Savic and Lindström, 2008), among others. One is often led to wonder the point of these studies: because we already knew that mental activity is necessarily tied to neural activity and that the nervous system is responsive to environmental influences, what new information do these studies provide? We know that people differ in their psychological features and capabilities; we know that the psychological features and capabilities are dependent on brain functioning; and we know that we undergo psychic changes by experiencing and learning new things; so we know that our nervous system must also undergo changes. It is as if we did not know that people are different before we took a look at their brains.

An unanalytical attitude towards these studies is also reflected in conclusions concerning the issue of the mind-brain relationship (Andreasen, 1997; Kendler, 2005; Brenner et al., 2006; Beauregard, 2007, 2009). According to Andreasen (1997) 'mental phenomena arise from the brain, but mental experience also affects the brain, as is demonstrated by the many examples of environmental influences on brain plasticity' (Andreasen, 1997, p. 1586). How exactly can the fact that our nervous system is responsive to environmental influences be evidence of the mind's power to affect the brain? Is the fact that the retinal cells, the optic nerve and the visual cortex react to the incoming light a demonstration of how the mental experience affects the brain?

This issue is often phrased in terms of whether we can understand the mind wholly in biological (neurological) terms. Environmental influences on brain plasticity are supposed to serve as evidence against 'reductionistic' neuroscience. But a reductionist does not need to dispute the results of these studies: it is in no way an anti-biological view to claim that brains are dependent on and responsive to their environmental surroundings. But note that this truism also works the other way around: the fact that we can point to the neural changes that ensue from environmental, psychological and social change does not make the environmental, psychological or social factors any less real. We know that we are different. We do not need to crack our skulls to see this. This fact also sheds curious light on some of the arguments for interactionism (Schwartz and Begley, 2002; Paquette et al., 2003; Beauregard, 2007, 2009): why would we need to appeal to imaging studies to demonstrate how the mind is really affecting the brain? It is certainly paradoxical that what these arguments offer as an ultimate proof of the indispensability of the psychic or social factors is the fact that their influences can be seen in the brain. You would expect anti-reductionists to argue that mental features cannot be identified with neural activity?

In our current intellectual atmosphere, the biological notions of neural and gene activity and related notions that seem to refer to the inner functions of the body are often put in confrontation with environmental, social and other external notions. One cannot help to feel that the former notions are somehow considered 'more real'. No doubt this attitude is influenced by our tacit tendency to conceive the whole hierarchy of the sciences to lie on top of the fundamental facts of chemistry and physics. But even if it is true that we can trace all the scientific facts back to fundamental physics, it is a serious error to think that all the biologically and psychologically relevant phenomena are physicochemical phenomena within the bodies of individuals. Biological organisms function in environmental contexts; what happens in the bodies are responses to environmental stimuli. Bodies – and nervous systems in particular – are not monolithic structures cut out from the surrounding reality. They react and change as the environment changes.

Similarly, the current enthusiasm in gene studies props up the false picture that the only scientific attitude towards human biology and psychology is the one that focuses on inner functions of the body. But genomes are also reactive, genes function in our bodies constantly, in association with environmental stimuli. Every function in our body has a genetic component; every function in our bodies has an environmental component. If we identify a genetic component of a medical condition, for example, it does not mean that the condition is genetically determined, and it does not mean that 'gene therapy' is the only cure: we can also make changes in the environment in which the gene is expressed and thus affect the expression. Neither choice is more 'scientific'. The matter is often wholly political, economical and pragmatic.

None of this bears on the issue of reductionism in the neurosciences. The reductionist can, and will, admit that our bodies and brains function in environmental contexts. But it is true that the neurosciences are too often advertised in terms that emphasize the functioning of the brain at the expense of its context. According to Crick (1994) 'our minds – the behavior of our brains – can be explained by the interactions of nerve cells (and other cells) and the molecules associated with them' (Crick, 1994, p. 7); Kandel et al. (2000) state that 'the task of neural science is to explain behavior in terms of the activities of the brain' (Kandel et al., 2000, p. 5). Even if it is true that our minds are wholly dependent on the functioning of nerve cells, there is little point in trying to understand the functioning of the mind solely in terms of them. Such a crude eliminativism that seeks to replace 'folk psychology' with solely neural notions is not credible. A neuroscience that does not link the nervous system to its ecological setting has little prospects of proving enlightening. The function of the nervous system is to represent its environment and respond to changes in it. Studying the nervous system in isolation of its context is as futile as studying the content of a book by studying solely the physical characteristics of the paper and the ink marks that make up the book.

The tendency to equate all mental activity with the neural activity of the brain has very unfortunate consequences. According to Kandel et al. (2000) 'all the behavioral disorders that characterize psychiatric illness – disorders of affect (feeling) and cognition (thought) – are disturbances of brain function' (Kandel et al., 2000, p. 5). Yes, mental illness and disorders are grounded in neural activity of the brain. But are they essentially 'disturbances of brain function'? Often the environments in which such brains reside are also 'disturbed'.

Thus, it is no wonder that CBT works, for example, and it is a mistake to pit it against pharmacological treatments. If the issue is whether we should talk to people, reason with them or give them drugs; or whether the one or the other is more effective or 'scientific'; if this is the real issue that we are facing with the mind-body problem today, the reply should be obvious. Our brains have evolved to receive certain type of signals; they have evolved to respond to environmental cues, inanimate, animate and social. It is clear that it is an effective strategy to utilize these pathways. And it is clear that it is often pragmatically much more prudent to use these pathways rather than pharmacological or other type of neural manipulation.

These are important issues but should not be conflated with the issue of interactionism. All of the above is perfectly consistent with the thesis that mental activity is always based on neural activity. The fact that nervous systems are responsive to environmental influences is a straightforward result of their biological function. There is no need to make metaphysical rearrangements. It is trivially true that 'a change in patients' symptoms and maladaptive behaviour at the mind level with psychological techniques could potentially change (normalize) the brain at the functional level' (Kumari, 2006, p. 67). This is trivially true because the mind is the functional level of the brain and it is supposed to react to environmental changes.

Note that there is a difference between interactionism of environment and body and 'interactionism' of mind and body. There are interactions, literally, between environment and the inner elements of human body, such as genes and the brain. Often there are feedback procedures between environments and genomes so that certain gene variants are susceptible to be exposed to environmental contexts and evoke responses in their surroundings that affect the expression of these genes (Scarr and McCartney, 1983; Kendler and Karkowski-Shuman, 1997; Jaffee and Price, 2007; Burt, 2008). Typically, an individual with a genetic tendency for a certain characteristic is liable to passively or actively find her way in an environment that enhances the expression of this characteristic. In such processes, two distinct entities (environment and genome) interact and alter the states of each other. There is no fundamental difference to the physical interactions in the Earth-Moon system in such processes. Their natures are worth both empirical and conceptual clarification, but they are not metaphysically perplexing.

There is, however, an issue here that deserves to be acknowledged from the perspective of the mind-body relationship. The human mind is responsive to social and cultural factors – environmental cues with semantic contents. People may respond to the same social environment in different ways because they understand it differently. No doubt this is the fundamental reason why many (Andreasen, 1997; Kendler, 2005; Brenner et al., 2006) feel that the unearthing of environmental influences on brain plasticity and gene expression demonstrate the mind's ability to affect the body. In a certain sense this is so: because the human mind is responsive to social factors, functionalities and symbols in its environment, the neural level is often somewhat of an unenlightening level of analysis. The symbolic, representational level constitutes the natural ecological setting of the human mind and thus provides the background to which its functioning is to be understood and evaluated (cf., e.g., Zachar, 2000; Kendler, 2005). Consider a simple example: the perception of lexical homonyms. Two people may act totally differently on the basis of the same physical stimulus (pressure changes in their ears); they do so because they understand the stimulus differently, they perceive it to signify different things. In fact, it would be potentially interesting to see an imaging study on the perception of lexical homonyms.

But one should not let this obscure the fact there is no genuine causal interaction between mind and body. Because it makes sense to suggest an imaging study on the perception of lexical homonyms, it means that we understand that when individuals differ psychically or behaviorally there are also neural differences (for us to take a peek into). And if we want, we can, in principle, trace the physical stimulus from the ears of these individuals and see how the differences arise in brain areas that have been disposed to associate the stimulus with different responses. That is, the neural pathway from the stimulus to the response is closed in such a way that there is no reason to evoke extraphysical causes to understand how the response follows from the stimulus. We would need to depart from the thesis of neural grounding if we would conceptualize the issue differently.

Taking account of environmental interactions creates the illusion that there is such a thing as mind-body interaction because the neural processes in cases such as these are so complex and diverse that it is expedient for us to use psychological variables when referring to them. Many different physical stimuli (e.g., synonyms) can fulfill the same functional role; many identical physical stimuli (e.g., homonyms) can fulfill different functional roles. Functions are implementation-independent. And it is the functional similarities or dissimilarities in our environment to which our minds respond. But our minds respond to these stimuli only because there are the physical vehicles (e.g., pressure changes in our ears) that materialize these functions and to which our brains respond. Minds never cut into these physical processes but follow them at their own level. Yet, psychological notions are irreplaceable because they capture these processes at the functional level.

Interactionism and fundamental physics

The discussion on the relationship of the mind and the brain often turns on issues concerning fundamental physics. The idea that there could be genuine interaction between the mind and the brain clashes with physics: a causal intervention by the mind into the physical course of events would have to present itself as a physical anomaly. Interactionism seems to breach the 'completeness of physics' or the principle of the 'causal closure'; the idea that physics is closed or self-contained in such a way that every physical effect is preceded only by physical causes.

There is a fairly obvious, and quite frequently utilized, response to these worries: in fact, modern physics is not 'closed', but needs to take account of extraphysical 'measurements' at a quantum level to complete itself. To get the physical courses of events started, so to speak, we have to make active observational interventions to the physical realm.

There are many elaborate theories that link various mental features and processes to quantum physics (Eccles, 1994; Penrose, 1994; Hameroff and Penrose, 1996; Beck and Eccles, 1998, 2003; Stapp, 1999, 2001, 2009; Schwartz et al., 2005). One strong motivation for such approaches is the fact that quantum theory is indeterministic: one cannot uniquely determine the state of a quantum physical system on the basis of (complete) information of an earlier state of the system. The ramifications of this physical fact to philosophy of mind are all but clear. First of all, even if quantum physics is genuinely indeterministic, it is difficult to see how this fact should bear on neuroscience and psychology. Classical physics works fine at the resolution that is adequate for neurobiology. Second, even if quantum physics would bear on neuroscience and psychology, a simple appeal to indeterminism of fundamental physics does not take us closer to the solution of the problem of free will and volition that often seems to be the ultimate target of these arguments. Free will and volition are as incompatible with indeterminism as they are with determinism. They are incompatible with determinism because if our actions are completely determined by past events, we do not seem to be free to choose the course of our actions. They are incompatible with indeterminism because if our actions are completely independent on past events (at least past psychological events) then our actions are totally arbitrary. Action is committed intentionally only when it is determined by some psychological factors of the agent. Arbitrary, random behavior is not willed. So quite paradoxically determinism is a prerequisite of free will.

There are many technical difficulties in linking fundamental psychological issues to quantum physics (cf., e.g., Wilson, 1999; Tegmark, 2000). These could be summarized here as the 'problem of synchronization'. Although current neurobiology operates largely on the molecular level it is taken for granted that phenomena and processes that we conceive psychological are materialized at a cellular – neural – level (this is sometimes referred to as 'the neuron doctrine'). Whatever goes on in the mind, it is realized in the brain as action potentials of neurons. True, action potentials are realized at the molecular level as ionic currents across the cell membranes, and are in that sense dependent on microphysics. But when we are interested in mental phenomena and processes, we need to look at the electrochemical functions at the level of neurons or their assemblages. Thus, if we want to have an influence on the physical basis of mental phenomena and processes, we need to intervene on the initiation of action potentials and/or their propagation across synaptic clefts. From a quantum physical point of view, the trouble is that both the initiation and the propagation of action potentials depend on many physical and chemical variables. Consider the initiation of action potential in the axon hillock. Whether a depolarization threshold is reached or not depends on the spatial and temporal summation of several (typically hundreds) postsynaptic signals arriving from the dendrites. At the initiation of the action potential an innumerable amount of Na^+ ions pool in from innumerably many ion channels; the propagation of an action potential is a mass movement. The transmission of the signal across a synaptic cleft is again a result of a successful combination of many different factors: massive flow of Ca^{2+} into the presynaptic terminal, the movement of numerous neurotransmitter vesicles and their fusion to the presynaptic membrane, the release and diffusion of neurotransmitter molecules to and across the cleft, the opening of numerous postsynaptic ion channels and the flow of ions across the postsynaptic membrane. The fact that the initiation and propagation of an action potential is a result of summation of numerous electrochemical events and processes means that no matter how genuine quantum indeterminacies there may be at the level of single ions or molecules, they even out at the level that is relevant for neuroscientific perusal.

A further point deserves to be highlighted. Consciousness, intentionality and volitional action are dependent on large assemblages of neurons, on the coherent function of neural networks. Sophisticated behavioral patterns depend on the harmonious functioning of complex neural circuitry between afferent and efferent pathways and the central nervous system. According to one well-known hypothesis, conscious experience is correlated with coherent oscillations of neural action potentials in many different parts of the brain (Gray and Singer, 1989; Crick and Koch, 1990a,b; Gray, 1999; Singer, 1999, 2007; Fries, 2005). The problem here is not merely that numerously many action potentials would have to be coordinated to trigger at the same time. The fundamental problem is that the behavior of the neural assemblages is harmonious; neural networks do not function randomly. This is exactly the fundamental problem that linking quantum physics to psychology faces: psyche, behavior and the functioning of the nervous system are not based on random or stochastic occurrences, but exactly the opposite. Random functioning of neurons and neural networks would be a disturbance rather than an assistance to our thinking and acting.

There is also a more metaphysical issue to draw attention to. We typically treat consciousness and other mental phenomena and processes as entities of higher levels of organization. Some take this idea rather literally (Searle, 1992, 1995; Revonsuo, 2006). But it is also materialized in the ongoing quest for locating 'neural correlates' of various mental features. In such research we are trying to tie the mind to areas of the brain, not single cells, let alone their microphysical parts. And the conventional anti-reductionistic philosophy of mind stresses the 'multiple realizability' of mental features and functions. Whether this is interpreted concretely or merely notationally, the mind is in any case conceived to be on a higher level to its physical realizers. Cramming the mind into microphysics deviates radically from the empirical and philosophical commitments of the neurosciences.

Of course the doctrine that the mind is somehow on a higher plane to neural processes need not be dogmatically held onto. If there are strong empirical and conceptual reasons to think otherwise, there is no point in resistance. The idea of mental states being on a higher level to neural states is vague in any case. However, the layered view is thoroughly entrenched in the discussion and one cannot just simply disregard it. And furthermore, if one subscribes to the received idea that mental states are 'neurally grounded', one seems to be inescapably committed to the view that the mental states are somehow on top of the neural structures and processes, that they rise out of or are built upon them. It seems impossible to adhere both to the idea that mental states are neurally grounded and to the idea that mental states are fundamentally associated with minute parts of the neurons themselves. The quantum hypothesis is not merely peculiar; at least some formulations of it (Beauregard, 2007) seem contradictory.

An obvious difficulty in linking quantum physics to psychology is to give an account of how the mind is able to influence microphysics. Even if there is genuine indeterminacy at the quantum level, it is quite a leap to claim that one can somehow consciously control the evolution of quantum systems. Again, it is in the fundamental nature of quantum mechanics that it is indeterministic; this contradicts our desire to have control over physical reality. Even if we can generate the collapse of the wave function 'at will' (by making a measurement), we cannot control the value that results from such an action. But it is even hard to conceive how the mind could inflict the collapse in the first place. There is no conception of how the indeterminate (superposition) quantum state is transformed into a state with determinate value at the point of measurement. It is an open question of physics, the so-called 'measurement problem' (Albert, 1992). But whatever way acts of measurement affect the superposition state there is no fundamental reason why consciousness (or awareness) would have to be involved. Typically, the quantum states collapse when they interact with their physical surroundings. There is no reason to postulate 'mind' as a trigger of the collapse.

One can press the issue here and claim that no measurement is carried through until some conscious creature verifies the result. But how do we verify the result: by using our macroscopic senses and nervous system. If we connect visual awareness to harmonic oscillations of action potentials, for example, how does such a macrophysical phenomenon relate to the collapse of the wave function? Note that it has to be related to it if one adheres to the thesis that every mental state is neurally realized. That is, at the point of the conscious verification of the result the state of mind of the person carrying out the measurement changes (she becomes aware of the result), so there has to be a change in the brain state of the person as well. But if that is the case, why not account for the collapse solely in terms of the physical interaction between the quantum system and the brain state? What does the 'conscious awareness' add to the picture? And, moreover, if it does add something, then the thesis of neural grounding must be discarded.

Again, there is one sense of 'interaction' here that we can comprehend and another sense that we cannot. The interaction of the quantum system with its surroundings and the resulting decoherence are perfectly comprehensible, although complex and problematic, physical interactions of two physically separate entities. The 'interaction' of the mind and the brain does not make sense because the entities that are supposed to do the interacting are not separate (on the basis of the thesis of neural grounding). This type of interactionism does not become any bit more sensible if one claims that it happens via quantum physical operations. Either the interface between the mental and the physical is a variant of the perfectly physical decoherence process, in which case there is a mere interaction of two physical variables. Or there is an extraphysical ingredient in the process, in which case mentality has a neurally independent impact on the physical course of events and the thesis of neural grounding must be given up. If it is hard to conceive how the Cartesian interactionism could work through the pineal gland, it is equally hard to conceive how it would work through microphysical particles. Interactionism is as incomprehensible no matter which level of physical reality you tie it to.

Many are seduced by quantum physics because it uses concepts that seem to fit in with the dichotomous situation in the philosophy of mind. According to the traditional interpretation, there is inherent complementarity in quantum physics: quantum physical entities occupy states that are (classically) incompatible, such as behaving as a wave and as a particle at the same time. The opportunity of exploiting the notion of complementarity in the philosophy of mind has not gone unutilized (cf., e.g., Velmans, 2000, 2002; Walach and Römer, 2000; Walach, 2005; Beauregard, 2007). The mind and the brain are simply 'complementary aspects of the same underlying reality' (Beauregard, 2007, p. 233). Now, even if the notion of complementarity is necessary in quantum physics (or for its interpretation), it is a further thesis to claim that it has a role in deciphering the relationship of the mind and the brain. Simply saying that the two are 'complementary aspects' will not do much. If this is the terminology, we can just rephrase the original issue and ask: if the 'physical aspect' is already enough to cause the physical effects of the mental, what causal work is left for the 'mental aspect' to do? The notion of complementarity is introduced into quantum physics because there are physical results (such as interference patterns) that impose such a notion on us. There are no similar results in neuroscience: we can account for our behavior solely in physical terms. That is the very idea of neuroscience and the source of the mind-body problem!

If we wish, we can say that there is a complementary 'mental aspect' to the neural processes, but simply noting this is fully compatible with parallelism or epiphenomenalism. The very trouble with interactionism is that it would have to present itself as a physical anomaly (something comparable to the interference patterns of photons). That would show us that our physical conception of reality is incomplete. Because we have not encountered situations where a mental state would not have been correlated with a neural state and the transitions from a neural state to another would not have been physically tractable, there is no evidence of physical anomalies in our brains and the hypothesis of interactionism has no empirical impetus to get off the ground.

Conclusions

The neurosciences occupy a peculiar place among the sciences. On the one hand, its subject matter includes thoughts, feelings and other subjective mental features. On the other hand, the data and results of studies refer to objective physical events and processes of the nervous system and body. Concepts and methods from both perspectives are used and recognized as indispensable. Nevertheless, the latter perspective tends to be conceived 'more' or 'ultimately' real.

This creates methodological and conceptual tensions. Even though the starting point of the study is the apparent reality of subjective mental states and functions, ultimately mental features earn their status as genuine entities only through identification with neural states and functions. We have a strong tendency to equate 'only in mind', 'only in imagination' with 'unreal'; the placebo effect is unreal because the cure exists only in the mind of the patient. The trouble with such juxtapositions is that whatever exists 'only in mind', 'only in imagination' is neurally realized: it has an objective, physiological role. That is what the denial of dualism and the idea that every mental state is neurally grounded entail.

The tendency of preferring the neural at the expense of the mental is unfortunately well-entrenched. It is even tacitly present in many studies that aim to argue for the causal efficacy of the mind (Schwartz and Begley, 2002; Paquette et al., 2003; Beauregard, 2007, 2009): mental features are real, after all, because we can observe them through neuroimaging. It is not enough that we know the psychic responses of emotional self-regulation, psychotherapy or placebo; these have real effects only if we can point to the corresponding neural responses. If there would not have been these responses, what would we have had to conclude? That there are psychic and behavioral responses without neural correlates? There is no room for such a conclusion if we subscribe to the thesis of neural grounding.

Because we acknowledge the existence of both mental features and neural features and the fact that the former are always realized by the latter, it is futile to empirically study whether the mind can have a causal influence on the brain. Both the cause and the effect are neurally realized. If we wanted to show that it is the mental features of the cause that brings about the neural responses, we would have to provide evidence that the neural features of the cause are insufficient in bringing about the neural responses. No such evidence has been presented. And chances of such evidence being presented are very bleak. It would mean that mental states do not map unresidually to neural states after all. It would mean that in doing neuroscience we could not rely solely on neurobiological variables. There would be changes in neural states and functions that could not be accounted for by antecedent neural activity or received stimuli.

Interactionism implies that there are two separate entities that have an effect on each other in turn. It seems that for most neuroscientists it is fairly easy to understand how one is compelled to reject the idea that the mind could have an independent effect on the body on the grounds of the fact that there is a continuous match between the mental and the neural. But interactionism implies that there is also causal influence in the other direction. Thus, the rejection of interactionism should bring with itself the rejection of the idea that the body could also have a causal influence on the mind. In fact, it seems that it is this side of interactionism that is actually harder to root out from the current neurosciences. When specific psychic or behavioral features are successfully linked to neural features it is difficult to resist the conclusion that it is the latter – which are, after all, 'more real' – that are the cause of the former. But what we are inspecting are neural correlates of the mental features. Conclusions about causal interaction in either way cannot be drawn from such studies.

This does not mean that the mind does not have a function. There is a grain of truth in functionalist philosophy. The functional or semantic level is separate from the neural level because different physical vehicles can realize the same function (and the other way around). We do not even have to cite exotic thought experiments involving aliens and robots to get a grasp of this: we know that neurons and neural networks of our very own brains can take up new functions in response to stimuli, learning and injury. That is, the functional requirements can mold the brain: rewire it, if you like. The environment imposes functional challenges on us, and the brain and the neurons constituting it are in service of the functional responses with which the mind meets these challenges. But there is always some physical vehicle that is recruited to the functional role in question. The mind feels and thinks and experiences; these are processes carried out by the brain. Thus, even though it is true that the brain also feels and thinks and experiences, this is only contingently so. It does these things because it has been programmed to do so; it could have been programmed to do something else – as it constantly is.

Thus, there definitely is a sense in which the mind is separate from the brain. And there is even a sense in which the mind should claim metaphysical priority over the brain: it is the information processing demands of the mind that drive the functioning, development and evolution of the brain. This is why psychology and the cognitive sciences are bound to stay as autonomous disciplines in relation to neurobiology. They are indispensible because they tell us what the brain is doing. How the brain does what it does may also be an interesting question, but it is a different question with its own type of replies.

It is against this setting that a large part of our intuitions about interactionism is explained. Because our minds solve functional challenges by using the brain, it is understandable that it is natural to give causal priority to this level: it is the higher level features that the mind responds to and it is this higher level response that triggers the behavioral responses. Even though there always is a complete physical chain of events from the stimulus to the response, these are constrained by the higher level functional demands. What constitutes the identity of the stimulus and the response is their functional relationship, not the stuff they are made out of: one can have identical responses to physically unidentical stimuli (as in the case of lexical synonyms).

This is how higher level environmental and social cues can have an effect on our behavior and our bodies. And it is understandable that one is tempted to couch this in terms of interaction between the mind and the body. But because the functioning of the mind has a neural basis and the mind does not enjoy an independent existence, there is no genuine causal interaction between the two. If you change your mind in response to environmental and social cues, you will change your brain activity. But that is not so because your mind changes your brain activity. It is so because your mind is realized by your brain activity. A change in one can be observed as a change in the other, not because there is a causal path from the one to the other, but because the two are constitutively linked.

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