Psychophysical Nature

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1 Introduction

In the present chapter we examine two quite distinct ways in which events that we normally think of as "physical" relate in an intimate way to events that we normally think of as "psychological". One intimate relation occurs in exteroception at the point where events in the world become events as-perceived. The other intimate relationship occurs at the interface of conscious experience with its neural correlates in the brain.

Normal exteroception involves an interaction between an event in the world (an event itself) and the perceptual/cognitive systems of an observer, which results in an event as-perceived. Such perceived events are the phenomena that form the basis of empirical science. Taken together, such perceived events also form our everyday "phenomenal worlds". Although we normally think of the world surrounding our bodies as the "physical world", science makes it abundantly clear that this perceived "physical world" is an appearance, whose nature is dependent not only on the nature of the world itself, but also on how information relating to that world is preconsciously processed by sense organs, perceptual systems and cognitive systems in the brain. The world that we actually see results from such preconscious observer-observed interactions, and can be very different in its apparent properties to the world as described by physics (in terms of quantum mechanics, relativity theory, and so on). Given this, is the world that we perceive "physical", "psychological" or somewhere in between?

And this, in turn, raises a second question. Given the dependence of the perceived world on its proximal neural causes and correlates within the brain (as well as on events in the external world itself), what exactly is the ontology of this phenomenal world and its relationship to what is going on within the brain? Is this perceived or experienced world nothing more than a brain state? Is it something quite different to a brain state? Or is it something in between?

To answer these questions we have to grapple with one of the most fundamental issues for consciousness studies: How does consciousness relate to the brain and the physical world? I have dealt with many aspects of this and related issues in the "reflexive monism" that I develop in my book "Understanding Consciousness" (Velmans, 2000) and in various papers such as Velmans (1990, 2007, 2008). As is the case with consciousness studies in general, my own approach to these relationships has been largely guided by how consciousness, brain and the surrounding world manifest macroscopically, for example in the empirical findings of psychology, neuroscience, and classical physics.

However, with the recent availability of the unpublished writings of Wolfgang Pauli (Atmanspacher and Primas, 2006), it has become apparent that there are some interesting points of convergence, as well as some points of divergence, with some of Pauli's prescient thoughts about the "psychophysical" nature of the microworld, that derive from his attempts to understand its nature via quantum mechanics. Most of these points of convergence and divergence have to do with the precise relationship of experienced (psychological) phenomena to their physical correlates in the brain, so this will be the main focus of the present chapter. However, normal exteroception is triggered by events in the world interacting with brain-based perceptual/cognitive systems that result in experienced phenomena which represent those triggering events in the world – and questions can also be asked about how the ontology of experienced phenomena relates to the events that they represent in the world. As this ontology provides a context for the later, more detailed discussion of how experienced phenomena relate to their neural correlates in the brain, I will briefly discuss this first.

2 Is the Perceived World "Physical", "Psychological" or Somewhere in Between?

The ambiguous physical/psychological nature of perceived phenomena can best be understood in terms of the contrasts between three basic ways of making sense of how experiences and brains relate to the external physical world, known as dualism, materialist reductionism, and reflexive monism.

The classical view, which many of us intuitively adopt, is a form of dualism shown in Figure 1 below. This assumes perception to involve a simple, linear, causal sequence (viewed from the perspective of an external observer E). Light rays travelling from the physical object (the cat as-perceived by E) stimulate the subject's eye, activating her optic nerve, occipital lobes, and associated regions of her brain. Neural conditions sufficient for consciousness are formed, and result in a conscious experience (of a cat) in the subject's mind. This model of visual perception is, of course, highly oversimplified, but for now we are not interested in the details. We are interested only in where external physical objects, brains and experiences are placed.

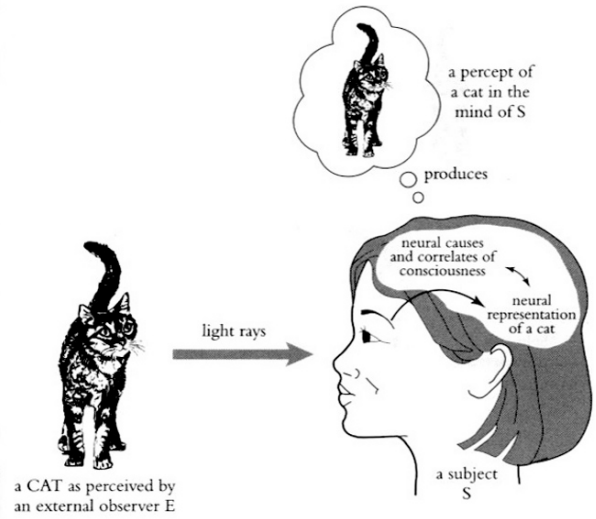

Fig. 1. A dualist model of perception

It will be clear that there are two fundamental "splits" in this model. Firstly, the contents of consciousness are clearly separated from the material world (the conscious, perceptual "stuff" in the upper part of the diagram is separated from the material brain and the physical cat in the lower part of the diagram). This conforms to Descartes' view that the stuff of consciousness (*res cogitans*, a substance that thinks) is very different to the stuff of which the material world is made (*res extensa*, a substance that has extension and location in space). Secondly, the perceiving subject is clearly separated from the perceived object (the subject and her experiences are on the right of the diagram and the perceived object is on the left of the diagram).

In short, on this dualist view, "physical phenomena" have an autonomous existence, location and extension out-there in space – and, although experiences of those phenomena (psychological phenomena) are influenced by physical events in the brain, they have a separate existence in the mind, which has neither location nor extension in space.

It will be apparent to those familiar with modern consciousness studies that a mind that has neither location nor extension in space does not fit easily into the unified, largely materialist explanatory system offered by modern science. As a consequence, 20th century Western philosophy and science commonly tried to "naturalize" dualism by arguing or attempting to show that conscious experiences are nothing more than states or functions of the brain. A reductionist model of visual perception is shown in Figure 2. The causal sequence in Figure 2 is the same as in Figure 1, with one added step. While reductionists generally accept that the subject's experience of a cat seems to be "in the mind", they argue that it is really a state or function of the brain. In

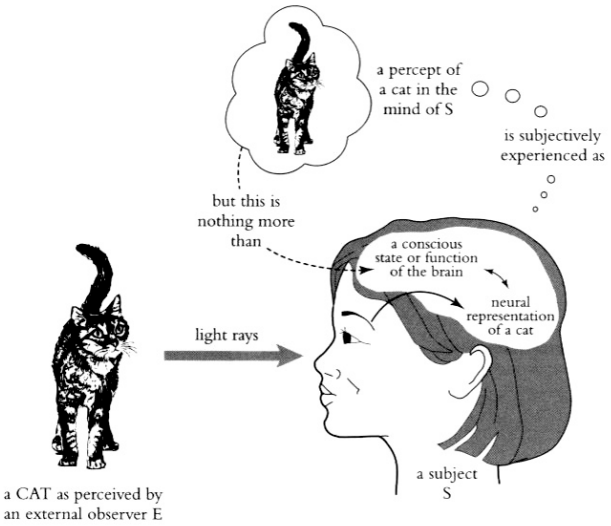

Fig. 2. A reductionist model of perception

short, the reductionist model in Figure 2 tries to resolve the conscious experience – physical world split by eliminating conscious experience or reducing it to something physical that E (the external observer) can in principle observe and measure. But reductionism retains the split (implicit in dualism) between the observer and the observed. The perceived object (on the left side of the diagram) remains quite separate from the conscious experience of the object (on the right side of the diagram).

On this reductionist view, "physical phenomena" have an autonomous existence, location and extension out-there in space, and experiences of those phenomena (psychological phenomena) are not just influenced by physical events in the brain, but *literally* are physical representations in the brain (of physical phenomena out-there in the world) that have their own distinct location and extension.

It will be apparent that dualism and reductionism present sharply conflicting views of the way that conscious (psychological) phenomena relate to physical phenomena – but, as the strengths and weaknesses of these positions have been extensively debated in the literature and as I have given extensive evaluations of both views of consciousness in Velmans (1998a; 2000, Chap. 2–5), I will not repeat this here. For the purposes of the present chapter, we simply need to note that both dualist and materialist explanations of conscious phenomenology claim its ontology to be very different to its appearances, which makes it difficult to explain the subtle ways in which conscious phenomenology appears to relate to events in the external world and in the brain. For example, contrary to dualism, nearly all experienced events appear to have both location and extension in space – yet contrary to materialist

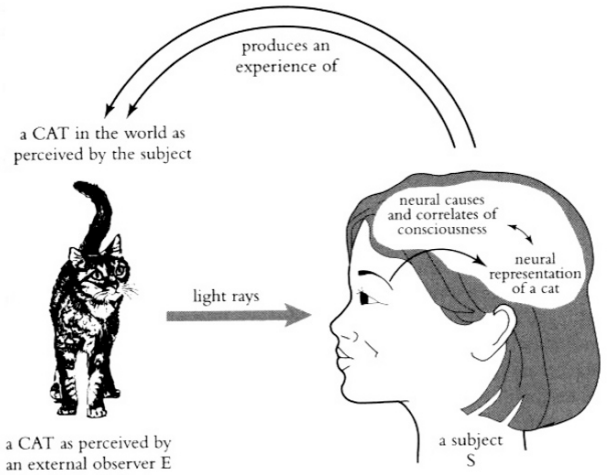

Fig. 3. A reflexive model of perception

reductionism, few experienced events appear to be located and extended in the brain. To give a few obvious cases, if one stubs one's toe one experiences pain, but the pain seems to be in the toe, not "nowhere" or "in the brain" – and if one looks at this print, it seems to be out here in space, but there does not seem to be some added "experience of print" in the mind or brain!

For the purposes of this chapter I will take it for granted that to deal with the subtleties of how conscious phenomenology relates to the brain and external world one has to start with an accurate description of that phenomenology. For this reason, I will focus on a reflexive monist view of consciousness in what follows. In what way does this offer a more accurate phenomenology ? The essential way in which it differs from both dualism and materialist reductionism is illustrated by the reflexive model of perception shown in Figure 3. In most respects Figure 3 is the same as Figures 1 and 2. As before, there is a cat in the world (perceived by E) that is the initiating stimulus for what S observes, and the neural causes and correlates of S's experiences are, as before, located in S's brain. The only difference relates to the way that the model represents S's experience. According to dualists, S's experience of a cat is "nowhere"; according to reductionists, S's experience of a cat is in her brain; according to the reflexive model, both of the former models misdescribe what S actually experiences. If you place a cat in front of S and ask her to describe what she experiences, she should tell you that she sees a cat in front of her in the world – and she has no additional experience of a cat "nowhere" or "in her brain."

It should be easy to grasp the essence of this. The objects that we experience seem to be out there in the world, not in our head or brain. But this immediately presents us with a problem. Given that the neural causes and cor-

relates of what we experience are in the head or brain, how do the experiences get to be out there – an effect that I refer to as "perceptual projection".

3 Perceptual Projection

As I have discussed the scientific status of perceptual projection elsewhere (Velmans, 1990; 2000, Chap. 6; 2008) I will give only a brief introduction here. Crucially, perceptual projection refers to an empirically observable effect, for example, to the fact that this print seems to be out here on this page and not in your brain. In short, perceptual projection is an effect that requires explanation; perceptual projection is not itself an explanation. We know that non-conscious processes within the brain produce consciously experienced events, which may be subjectively located and extended in the phenomenal space beyond the brain. We also know that this effect is subjective, psychological and viewable only from a first-person perspective. Nothing physical is projected from the brain.

While we do not have a full understanding of how perceptual projection occurs, there is a large experimental literature on the cues that are used to construct perception of distance and location. One example is the way three-dimensionality is gradually constructed by the brain from cues laid out in two dimensions in stereograms[1] or, more immediately, from perspective cues displayed on a two-dimensional surface in the way shown in Figure 4.

Virtual realities (VR) provide added ways of studying perceptual projection in operation. In virtual reality one appears to interact with a virtual world outside one's body although there is no actual (corresponding) world there. So, in this situation, there is no danger of confusing the appearance of the virtual world with an actual world that one sees. Yet, objects in a VR world appear to have three-dimensional location and extension. Virtual objects can also be given what appear to be classical "physical" properties such as "hardness"; for example, the observer may wear a gauntlet on her hand which is programmed to resist closing around a visually perceived, virtual object, making the latter feel "solid".

In truth, however, there is nothing solid there. Such virtual appearances do not fit easily into either a dualist or reductionist understanding of consciousness (see Velmans, 1998b). In spite of being nothing more than appearances, they do not appear to be either "nowhere" or "in the brain". But they fit naturally into the reflexive model. When visual inputs from screens in VR headsets are appropriately co-ordinated with head and body movements, they provide information which resembles that arriving from actual objects in the world. The mind/brain models this information in the normal way, and constructs

[1] One can easily create stereograms of one's own with the assistance of Kasuhiko Kondo's program at `www.eyetricks.com/stereograms/onlinetools/stereocreator.htm`

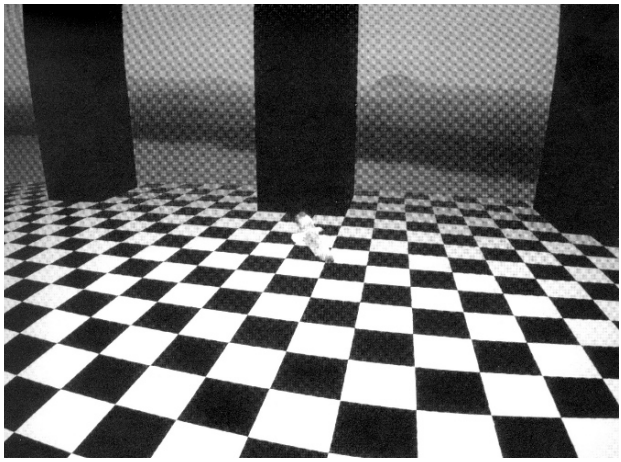

Fig. 4. A painting that uses radial perspective (developed and painted by Peter Cresswell). If one scans this picture through a rolled up tube (avoiding the edges), a strong perception of depth will result, even if the picture is inspected with only one eye.

what it normally constructs when it receives such input – a perceived, phenomenal world located and extended in the three-dimensional space beyond the body surface!

4 Consequences for the Perceived "Physical World"

What are the consequences of thinking about the perceived world in this reflexive way ? Although we normally think of the objects that we see around us as being "physical", they are in another sense "psychological". This is because they are the objects as they appear to us and not the objects as they are in themselves. Although it is natural (and, in a way, correct) to think of these appearances as the appearances of the objects themselves, the fact that they appear to us in the way that they do depends as much on the operation of our own perceptual systems as it does on the nature of the objects themselves. If we did not have color vision they would not appear colored in the way that they do, if we did not have tactile receptors they would not feel solid in the way that they do, and so on. Conversely, modern physics (quantum mechanics, relativity theory, etc.) offers descriptions of the deeper nature of these objects that are very different to their surface appearances.[2]

[2] It follows that once an object appears to us (once it has an appearance) the perceptual processing in our own mind/brain that contributes to that appearance has already operated. In short, the world as it appears to us (the phenomenal world) is the end product of our current (and very recent) perceptual processing

This convergence of psychological with physical phenomena is self-evident in situations where the same phenomenon can be thought of as either "physical" or "psychological", depending on one's interest in it. At first glance, for example, a visual illusion of the kind shown in Figure 5 might seem to present difficulties, for the reason that physical and psychological descriptions of this phenomenon conflict. Physically, the figure consists entirely of squares, sep-

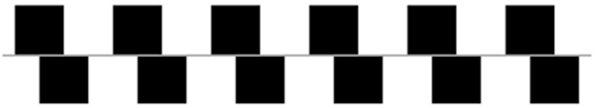

Fig. 5. In what way does the central line tilt ?

arated by a horizontal line. But subjectively, the line seems to tilt down to the left, and the squares do not seem to be entirely square. However, these physical and psychological descriptions result from two different observation procedures. To obtain the physical description, an experimenter E can place a straight edge against each line, thereby obscuring the cues responsible for the illusion and providing a fixed reference against which the curvature and orientation of the line can be judged. To confirm that the line is actually straight, other experimenters (E_1 to E_n) can repeat this procedure. In so far as they each observe the line to be straight under these conditions, their observations are public, intersubjective and repeatable.

But, the fact that the line appears to be bent and to tilt to the left (once the straight edge is removed) is similarly public, intersubjective and repeatable (amongst subjects S_1 to S_n). Consequently, the illusion can be investigated using relatively conventional scientific procedures, in spite of the fact that the *illusion* is unambiguously *mental*. One can, for example, simply move the straight edge outside the figure making it seem parallel to the central line – thereby obtaining a measure of the angle of the illusion.

This basic relationship between what is physical and what is psychological applies not just to perceived lines but also to the entire, external, visually perceived world, and may be summarized in the following way: although we commonly assume the perceived three-dimensional external world to be "physical" and consequently something that is *separate from* consciousness, it

and not the cause of that processing. The true initiating cause of our perceptual processing in this situation is the object (or world) itself. Consequently, although in Figure 3 the initiating cause of what S perceives is labelled as "a cat as perceived by E" the true initiating cause of what S perceives (and of what E perceives) are light reflectances from the cat itself. It is labelled as "a cat as perceived by E" in Figure 3 for the reason that the figure represents the situation as viewed from E's perspective, and the cat itself appears as phenomenal cat when viewed by E (just as it does when viewed by S).

is actually *part of* what we experience, and therefore part of the contents of consciousness. This applies equally to those components of the phenomenal world that we normally think of as "physical phenomena" – and in this special sense the existence and nature of "physical phenomena" are dependent on the existence and nature of conscious experience.

It is important to note, however, that this conclusion, based on observed macrophenomena and classical physics, is tangential to the controversy in quantum mechanics about whether a measurement suffices to collapse superimposed quantum states into a single realized state, or whether human consciousness is somehow required. According to the reflexive model of perception, observed phenomena *represent* things themselves, but are not identical to them. Consequently, at macroscopic scales, things themselves can exist whether or not they are consciously perceived.[3] That said, once a phenomenon is observed, the form that the phenomenon will take is dependent not just on the nature of the observed but also on the nature of the observation arrangements, measuring equipment, and perceptual/cognitive processes available to the observer – and that applies equally within classical physics and quantum mechanics.

5 How the Perceived Physical World Relates to Information Processing in the Brain

It should be apparent from the above that, in cases of normal exteroception, questions about how conscious experience relates to its neural correlates, translate into questions about how an individual's *phenomenal world* relates to its neural correlates (for the simple reason that in terms of *phenomenology* an individual's "conscious experience" and their "phenomenal world" are one and the same). As noted above, the external phenomenal world, viewed from the perspective of an individual observer, appears to have a three-dimensional spatial extension and curvature with a definable topology that is different in a number of respects to that of measured Euclidian space – but that is nevertheless situated outside of the brain. By definition, however, the neural correlates of that experienced world must be located in some neural state space that is located inside the brain. In principle therefore it should be possible to specify the topological mapping of phenomenal space onto neural state space; see for example Lehar (2003) for an initial attempt.

Given that the search for the neural correlates of different conscious experiences is still very much a work in progress (see, for example, Rees and Frith, 2007; Crick and Koch, 2007), can anything general be said about them ? By definition, correlates accompany or co-occur with given conscious experiences. This differentiates them from the antecedent causes of consciousness (such as the operation of selective attention, binding, etc.) which may be thought of

[3] See further discussion of idealism versus realism in Velmans (1990, 2000).

as the necessary and sufficient prior conditions for consciousness in the human brain. And, although we know little about the physical nature of these correlates, there are three plausible, functional constraints imposed by the phenomenology of consciousness itself.

1. *The representational constraint:* Normal human conscious experiences are representational (phenomenal consciousness is always *of* something). Given this, it is plausible to assume that the physical correlates of such experiences are representational states.
2. *The identical referent constraint:* A representational state must represent *something*. For a given physical state to be the correlate of a given experience it is plausible to assume that it represents the *same* thing.
3. *The information preservation constraint:* For a physical state to be the correlate of a given experience, it is reasonable to suppose that it has the same "grain". That is, for every discriminable attribute of experience there will be a distinct, correlated, physical state. As each experience and its physical correlate represent the same thing, it follows that each experience and its physical correlate encode the same information about that thing. That is, they are representations with the same *information structure*.

Although these assumptions have not always been made explicit in theories of consciousness they are largely taken for granted in psychological theory. Psychophysics, for example, takes it for granted that for any discriminable aspect of experience (a just noticeable change in brightness, color, pitch, and so on) there will be a correlated change in some state of the brain. The same is true for the more complex contents of consciousness, in the many cognitive theories that associate (or identify) such contents with information stored in primary (working) memory, or information at the focus of attention. The assumption that experiences and their physical correlates encode identical information also marks an important point of convergence between otherwise divergent theories about the nature of consciousness. This assumption is implicit, for example, in eliminativist, and reductionist theories of consciousness (such as Dennett, 1994, and Sloman, 1997). It is also explicit in the "naturalistic dualism" developed by Chalmers (1996) and in the dual-aspect theory developed in Velmans (1991a,b, 1996) which I elaborate below.

It is important to stress that having an identical referent and information structure does not entail *ontological identity* (as eliminativists and reductionists tend to assume). A filmed version of the play "Hamlet", recorded on videotape, for example, may have the same sequential information structure as the same play displayed in the form of successive, moving pictures on a TV screen. But it is obvious that the information on the videotape is not ontologically identical to the information displayed on the screen. In this instance, the same information is embodied in two different forms (patterns of magnetic variation on tape versus patterns of brightness and hue in individual pixels on screen) and it is displayed or "formatted" in two different ways (only the latter display is in visible form). Consequently the choice between

eliminativism, reductionism, dualism, and dual-aspect theory has to be made on some other grounds, for example on the basis of which theory accounts for *all* the observable evidence in the most elegant way.

6 Creeping up on Consciousness

Eliminativism and reductionism assume that once one has identified the physical causes and correlates of consciousness in the brain, viewed from a third-person perspective, there is nothing else to understand or explain. For them, the neural correlates of consciousness (or the information structure they embody) are consciousness itself. However, this view is *inconsistent* with our first-person evidence about what experiences are like. Consequently its protagonists attempt to denigrate the utility, reliability or even the reality of first-person experience. Given the apparent importance of first-person experience to everyday human life, many find such manoeuvres evasions rather than explanations.

However, if one does not deny the reality of first-person experience, one is left with a conceptual problem. Once one arrives at the end of a third-person physical or functional account of how a brain or other system works one still needs some credible way to cross the "explanatory gap" to conscious experience. Luckily, in the human case, this is not really a *practical* problem, for the reason that we naturally have access to *what lies on both sides of the gap*. We can observe what is going on in the brains of others or in our own brain from an external third-person perspective (via exteroception, aided by a little physical equipment). And we naturally have first-person access to what it is like to have the experiences that accompany such observable brain activity. For many explanatory purposes we just need to switch from one perspective to the other at the appropriate place, and add the first-person to the third-person story in an appropriate way. In psychophysics, for example, one can examine the neural causes and correlates of a given experience in the brain viewed from a third-person perspective. But to complete the causal story, one then has to switch to the subject's first-person perspective to get an account of the perceptual effect.

Note that this common-sense account of how the "explanatory gap" is crossed in practice is nonreductive. Third-person evidence about the workings of the brain retains its full privileged status (about the workings of the brain), and first-person evidence about what it is like to have a given experience retains its full privileged status (about the nature of experience). That said, neither third- nor first-person accounts are incorrigible. Once observations or experiences made from either perspective are translated into *descriptions* (observation statements or phenomenological descriptions) there is always a measure of interpretation required. Interpretation and abstraction is also required to translate such observations/experiences into general *descriptive systems*, typologies, and "maps" – and further inference and inter-

pretation is required to translate first- or third-person evidence into a *theory about* the workings of mind, consciousness or brain. In all this, the normal rules of scientific engagement apply.

7 The Relation Between First-Person Descriptions of Experience and Third-Person Descriptions of Their Physical Correlates

While *perspectival switching* from a third-person account of neural events to a first-person account of correlated experiences allows one to cross the "explanatory gap" we still need to understand how such accounts relate to each other. Suppose, for example, I ask you to look at a cat out in the world while I examine the physical correlates of what you see in your brain (in the way shown in Figure 3). While I examine your brain I simply report what I see (whether or not I am aided by sophisticated equipment), and while you are looking at the cat you simply report what you see. In this situation, we both experience something out in the world that we would describe as "physical". You have a visual experience of a cat, located beyond your body, out in the world. I have a visual experience of the physical correlates of the cat that you see, beyond my body, in your brain.

Following the representational, identical referent, and information preservation constraints suggested above, what you and I see relates to each other in a very precise way. What you see is a phenomenal cat – a visual representation containing information about the shape, size, location, color and texture of an entity that currently exists out in the world beyond your body surface. What I see is the same information (about the cat) encoded in the physical correlates of what you experience in your brain. That is, the information structure of what you and I observe is identical, but it is displayed or "formatted" in very different ways. From your point of view, the only information you have (about the entity in the world) is the phenomenal cat you experience. From my point of view, the only information you have (about the entity in the world) is the information I can see encoded in your brain. The way your information (about the entity in the world) is displayed appears to be very different to you and me for the reason that the "observational arrangements" by which we access that information are entirely different. From my external, third-person perspective I can only access the information encoded in your neural correlates by means of my visual or other exteroceptive systems, aided by appropriate equipment. Because you *embody* the information encoded in your neural correlates and it is already at the interface of your consciousness and brain, it displays "naturally"[4] in the form of the cat that you experience.

[4] I assume that it is simply a "natural" empirical fact about the world that certain physical events in the brain (the correlates of consciousness) are accompanied by

You experience a cat, rather than your neural encodings of the cat, for the reason that it is the information *about the world* (encoded in your neural correlates) that is manifest in your experience rather than the embodying format or the physical attributes of the neural states themselves. As with the TV analogy above, the information encoded on videotape is displayed in the form of a picture on a screen without the magnetic fluctuations on the videotape or the tape itself being displayed upon the screen. I observe/experience the neural encodings of the cat in your brain (rather than the cat) for the simple reason that my visual attention is focused on your brain, not the cat. If I wanted to experience what you experience, I would have to shift my attention (and gaze) away from your brain to the cat.

From my "external observer's perspective", can I assume that what you experience is really nothing more than the physical correlates that I can observe? From my external perspective, do I know what is going on in your mind/brain/consciousness better than you do? Not really. I know something about your mental states that you do not know (their physical embodiment). But you know something about them that I do not know (their manifestation in experience). Such first- and third-person information is *complementary*. We need your first-person story and my third-person story for a complete account of what is going on.[5]

If I cannot reduce your story about what you experience to my story about its neural correlates (or *vice versa*) without loss, are we forced into the conclusion that experiences and their neural correlates are fundamentally different entities or substances? No. While dualism accepts the reality of first-person experience, it misdescribes its phenomenology. Descartes likens *all* experiences to "thoughts" (*res cogitans*) which, if they are verbal thoughts, take the form of "inner speech". However, most of what we experience has little resemblance to thoughts. For example, the way our bodies look and feel is quite unlike the phonemic imagery of inner speech, and the same is true of the look, sound, touch, taste and smell of entities in the external world such as phenomenal cats. Nor does splitting the universe into two, incommensurable (material and mental) substances help us to understand the *intimate relationship* of consciousness to matter.

The above analysis rather suggests a seamless universe, of which we are an integral part, which can be known in two fundamentally different ways. At the interface of consciousness and brain it can be known in terms of how it appears (from the outside) and it terms of what it is like to be that universe (from the inside). This is *ontological monism* combined with *epistemological dualism*.

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experiences. In short, this relationship follows some natural law, however mysterious this presently seems.

[5] An introduction to "psychological complementarity" is given in Velmans (1991a), Sect. 9.3; Velmans (1991b), Secs. 8 and 9; Velmans (1993, 1996).

8 The Nature of Mind

What dwells within the "explanatory gap"? Ontological monism combined with epistemological dualism assumes that there must be some thing, event or process that one can know in two complementary ways. There must be something that grounds and connects the two views we have of it. Let us call this the "nature of mind".

If mind grounds and unifies the first- and third-person views we have of it, what can we conjecture about its nature?

1. Insofar as conscious experiences are of something or about something, it is reasonable to suppose that they, and their neural correlates, encode information. If so, the mind encodes information.
2. To the extent that brain activities and accompanying experiences are fluid and dynamic, the mind can be described as a process, developing over time.

Taken together, these points suggest that mind can be thought of as a form of information processing – and the information displayed in experiences and their physical correlates can be thought of as two manifestations of this information processing. However, this does not fully specify the ontology of the mind. Information processing needs to be encoded in some medium that is capable of carrying out that processing. Given this, what kind of "medium" is the mind?

One can give a very short list of the observable facts:

1. In the human case, minds viewed from the outside seem to take the form of brains (or some physical aspect of brains).
2. Viewed from the perspective of those who embody them, minds take the form of conscious experiences.

If first- and third-person perspectives (on the mind) are complementary and mutually irreducible, then the nature of the mind is revealed as much by how it appears from one perspective as the other. If so, the nature of mind is not *either* physical *or* conscious experience, it is at once physical *and* conscious experience. For lack of a better term we may describe this nature as *psychophysical*. If we combine this with the features above, we can say that mind is a psychophysical process that encodes information, developing over time.

At present, there is little more about "what dwells within the explanatory gap" that can be said with confidence. However, there are some useful pointers to what a more complete theory of mind would look like, that can be drawn from other areas of science. At the macrocosmic level, the relation of electricity to magnetism provides a clear parallel to the form of dual-aspect theory suggested above. If one moves a wire through a magnetic field, this produces an electrical current in the wire. Conversely, if one passes an electrical current through a wire, this produces a surrounding magnetic field. But it does not make sense to suggest that the current in the wire is nothing more than the

surrounding magnetic field, or *vice versa* (reductionism). Nor is it accurate to suggest that electricity and magnetism are energies of entirely different kinds that happen to interact (dualist interactionism). Rather these are two manifestations (or "dual-aspects") of *electromagnetism*, a more fundamental energy that grounds and unifies both, described with elegance by Maxwell's laws.

The struggle to find a model or even a form of words that somehow captures the dual-aspect nature of mind is also reminiscent of wave-particle complementarity in quantum mechanics – although this analogy is far from exact. Light either appears to behave as electromagnetic waves or as photon particles depending on the "observation arrangements". And it does not make sense to claim that electromagnetic waves really *are* particles (or *vice versa*). A complete understanding of light requires both complementary descriptions – with consequent struggles to find an appropriate way of characterizing the nature of light which encompasses both descriptions ("wave-packets", "electron clouds", and so on). This has not prevented physics from developing very precise accounts of light viewed either as waves or as particles, together with precise formulae for relating wave-like properties (such as electromagnetic frequency) to particle-like ones (such as photon energy). If first- and third-person accounts of consciousness and its physical correlates are complementary and mutually irreducible, an analogous *psychological complementarity principle* might be required to understand the nature of mind.

9 Similarities and Differences to Pauli

This dual-aspect theory of information developed from entirely psychological considerations in Velmans (1991a,b, 1993, 1996, 2000) has some interesting similarities and differences to one later developed in the philosophy of David Chalmers (1995, 1996).[6] However, its close relationship to Pauli's thoughts on the subject, written in previously unpublished letters, is even more striking.

[6] As I have reviewed these similarities and differences in Velmans (1995, 1998c, 2000) I will not enter into a discussion of them here. Briefly, Chalmers and I agree that: (1) Phenomenal experiences and their neural or functionally defined correlates share the same information structure. (2) Phenomenal experiences are not reducible to their neural or functionally defined causes and correlates. (3) It should be possible to relate conscious experiences to their correlates via bridging laws. (4) Consciousness is a basic property of the universe. Our theories differ in that: (1) Although Chalmers sometimes calls his analysis "double-aspect theory" (his own term for "dual-aspect" theory), he usually, more accurately, calls it "naturalistic dualism". (2) The reason for the latter term being more accurate is that in Chalmers' theory, there is nothing deeper (ontologically unifying) such as "the nature of mind" of which experiences and their neural correlates are aspects. Consequently, (3) first- and third-person accounts are not "complementary" accounts of a psychophysical mind. Rather, (4) according to Chalmers, experiences "supervene" on their physical correlates – which conflicts with his contention that

In particular, consequent on his discussions with C.G. Jung, Pauli posited a similar, underlying psychophysical reality of which mind and physical matter are complementary aspects. As he wrote (Pauli, 1952; cited by Atmanspacher and Primas, 2006):

> "For the invisible reality of which we have small pieces of evidence in both quantum physics and the psychology of the unconscious, a symbolic psychophysical unitary language must ultimately be adequate, and this is the far goal which I actually aspire. I am quite confident that the final objective is the same, independent of whether one starts from the psyche (ideas) of from physis (matter). Therefore, I consider the old distinction between materialism and idealism as obsolete."

And, on psychological complementarity, Pauli (1952) wrote : "It would be most satisfactory if physis and psyche could be conceived as complementary aspects of the same reality." In their commentary on Pauli, Atmanspacher and Primas (2006, p. 28) make it clear that this amounts to ontological monism (a *unus mundus*) combined with epistemological dualism:[7]

> "The concept of the *unus mundus* provides and ontological level of description without any split of mental and material domains, which is more fundamental than the descriptive level with split domains. One can address the transition from the fundamental level to that with mind and matter separated in terms of emergence, if one thinks of it as an emergence of the distinction of mind and matter (rather than the emergence of mind from matter)."

Given our very different points of departure (quantum mechanics and Jungian depth psychology versus the psychology of perception) there are of course differences in emphasis between Pauli and Atmanspacher and Primas on the one hand, and my own analysis, briefly introduced above. Pauli and Atmanspacher and Primas, for example, give some thought to the formative principles, Platonic universals or archetypes that might underly both psychic and material manifestations of the *unus mundus*, and Atmanspacher and Primas (2006) suggest that mathematical formalism governing symmetry and symmetry breaking might provide a useful entry to an understanding of the way that formlessness might give rise to form.

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consciousness is "basic" (if experiences supervene on the physical, in what sense are they "basic" ?). Finally (5) in Chalmers' formulation, there is no account of psychophysical causation, a major concern of my own dual-aspect theory of mind (see Velmans, 1993, 1996, 2000, 2002a,b).

[7] Note that Pauli, Atmanspacher and Primas, and Velmans agree on these points, but differ from Chalmers. In Chalmers' theory there is neither a "psychophysical *unus mundus*", nor a "complementarity" between mind and physical matter – and, rather than the "emergence of a distinction between mind and matter" from an underlying unity, Chalmers is committed to the view that conscious experiences "supervene" on physical states (see note 6 above).

My own concern with the way that conscious experiences relate both to their neural correlates and to the external entities and events that they represent has led to a focus on *information* rather than principles of formation. However there is no conflict between these differences in emphasis. Information needs to be formatted or encoded in some medium, so an understanding of how information emerges from the *unus mundus* has to be combined with an understanding of the emergence of form.

That said, there are also some genuine differences between reflexive monism and Pauli's thought. For example, there is no hint of the "reflexive" aspect of reflexive monism in Pauli's writings. Consequently, in the following extract he expresses the belief that only modern physics (in the form of quantum mechanics) offers an avenue for unifying the psychological with the physical (Pauli, 1953):

> "It is true that the distinction of 'physical' and 'psychic' is inevitable in the empirical world of phenomena, and it was the mistake of the alchemists to apply a monistic (neutral) language to concrete chemical processes. But since matter has now turned into an abstract, invisible reality for the modern physicist, the prospects for a psychophysical monism have become much more auspicious."

In contrast, reflexive monism suggests that perceived phenomena themselves can be both psychological (insofar as they are appearances) and physical (in so far as they are appearances of independently existing things) – although it is agreed that physical *appearances* have to be distinguished from the abstract realities described by modern physics, e.g. in the mathematical formalisms of quantum mechanics.

10 Similarities and Differences Between Physical and Psychological Complementarity

As noted above there are some genuine similarities between psychological complementarity (a way of understanding the relationship of conscious experiences to their neural correlates in the brain), and complementarity in quantum mechanics. In particular (1) Complementary observations are obtained from different observational arrangements; (2) Complementary descriptions are mutually irreducible; (3) For any complementary pair of observations of a given entity or event one needs descriptions of both observations for a complete account of the observable properties of that entity or event.

However, these tempting similarities should not obscure some genuine differences. In particular: (1) Complementary descriptions in physics are based on third-person observations, but complementary descriptions of phenomenal experiences and their neural correlates are normally based on, respectively, first-person and third-person observations; (2) Complementarity in physics is exclusive in the sense that making one observation of a complementary pair

excludes the possibility of making the other, paired observation. However, complementarity in psychology is normally non-exclusive for the reason that a subject can have a given experience and report on it, while an external observer can simultaneously observe and report on the neural correlates of that experience.

Note however that, unlike physical complementarity, non-exclusive psychological complementarity relies on the possibility of simultaneous observations made by two independent observers (an external observer and a perceiving subject). A closer analogy with quantum mechanics may therefore be a hypothetical "autocerebroscope" experiment, in which an individual observer attempts to observe the neural correlates of his/her own *current* experience. In this situation, the neural correlates of the observer's visual experience are displayed in real-time in a visible form, for example on a monitor screen, and the observer simply looks at the screen. Note that, in principle, there should be no impediment to observing a visual on-screen representation of the neural correlates of one's own *past* visual experience (this is already possible, in limited ways, with imaging equipment). It may also be possible to shorten the delay between current experience and observations of its correlates within limits set by the processing and display time of the measuring system and the processing time of the visual system itself.

But, in real-time, it may be impossible in principle to observe the neural correlates of one's own *current* experience. Even if the delays in the system could be reduced to near zero, like a dog chasing its own tail, one would never quite catch up. In these circumstances psychological complementarity would be, *in this special sense*, exclusive. However, this still falls short of the exclusivity found in quantum mechanics. In quantum mechanics, measurement of one member of a complementary pair confines the accuracy of a *subsequent* (as well as simultaneous) measurement of the other member of that pair, but in psychological complementarity there would seem to be nothing to confine subsequent observation and measurement of the neural correlates of one's own current experience.

11 Conclusions

There appear to be interesting similarities between aspects of Pauli's thought, elaborated by Atmanspacher and Primas (2006), and reflexive monism about the best way to understand the mind-matter relationship at the interface of conscious experiences with their neural correlates in the brain. Given that reflexive monism is largely concerned with psychological issues, and that Pauli's concern is primarily with modern physics, it is significant that both arrive at the view that the relationship of conscious experiences to their neural correlates can be understood in terms of dual aspects of an underlying, unifying wholeness (or *unus mundus*) whose nature can best be described as "psychophysical". There also appear to be points of similarity between the

"psychological complementarity" developed in reflexive monism and complementarity in physics.

While such similarities should not obscure other, genuine differences, for example in the "reflexive" aspect of reflexive monism, and in the non-exclusive nature of psychological complementarity, there appears to be a prospect of some genuine convergence on these fundamental issues between psychology and physics.

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