Introduction

Alfredo Pereira Jr. and Dietrich Lehmann

In this book we present and discuss, in ten chapters, a range of views, theories, and scientific approaches that concern the phenomenon of consciousness. The chapters draw a broad panorama of the diversity of thoughts that characterize this field of studies. While preserving the variety of ideas, this book also makes progress towards a systematic approach that aims to support consciousness science as a general discipline in undergraduate courses, and as the subject of specialized graduate courses dedicated to complete the training of professionals from different fields such as neuroscience, sociology, economics, physics, psychology, philosophy, and medicine.

A consensus appears to be emerging, assuming that the conscious mind and the functioning brain are two aspects of a complex system that interacts with the world. How could this concept of reality – one that includes the existence of consciousness – be approached philosophically and scientifically? Contrary to a majority of publications in this field, this book takes into account both philosophical and interdisciplinary scientific knowledge about consciousness. Our ten chapters – resulting from a three-year online discussion between the authors – present a diversity of perspectives that tend towards a theoretical synthesis.

Issues concerning the unity of minds, bodies, and the world have often recurred in the history of philosophy and, more recently, in scientific models. For instance, in classical Greek philosophy Plato proposed a dualistic view of reality, as composed of a world of ideas and a material world of appearances. The connection between the two worlds was made by the Demiurge. Plato's disciple Aristotle criticized such a dualism and proposed a monistic view – *Hylomorphism* – considering that ideas do not exist in a separate world. He conceived ideas as embodied in a material substrate in nature, composing the *form* of things and processes. Form and matter would work together to shape reality: forms are responsible for the determination of kinds of beings (e.g., biological species), while matter is the principle of individuation (e.g., what makes an individual different from others belonging to the same species).

In occidental philosophy and culture, until quite recently the most influential theory about the relationship of mind and body has been Substance Dualism, proposed by Descartes. The human being, according to this concept, is composed of an immaterial thinking substance and a material body, putatively connected by the pineal gland. Interestingly, one of Descartes' followers, Spinoza, repeated Aristotle's move towards Monism, conceiving of nature as the totality of all that exists with two different but inseparable aspects: the mental and the physical. One of the consequences of this move concerns the status of feelings and emotions: instead of mere perturbations to the flow of clear and distinct ideas, they become central aspects of human personality. This view has re-emerged particularly in the work of Antonio Damasio (2003) who explicitly recognized the influence of Spinoza.

Towards the end of the twentieth century, the appearance of cognitive sciences supported several approaches to understanding minds as physical systems. Many of these approaches assumed that minds are computational functions that could be instantiated not only in brains but also in other material systems such as mechanical robots. Set against this reductionist approach, it was argued that the conscious mind is more than computation, including experiences of qualitative features (Jackson 1986) and a first-person perspective (the lived experience of "what it's like to be" in a given condition; Nagel 1974).

Defenders of reductionist views were then confronted with what Chalmers (1995, 1996) called "the hard problem of consciousness," here summarized in two statements: (1) Conscious processes supervene on (derive from) physical processes, but (2) conscious experiences cannot be causally explained (or deduced) from currently known physical processes, laws, and principles. The "hard problem" builds on the work of a generation of philosophers – including Nagel and Jackson – who addressed the mind-brain problem. Part (1) above was extensively developed by Kim (1993), while part (2) was deeply discussed by Levine (1983).

Since Chalmers' classical paper of 1995, many attempts to solve the problem have been made. Emphasis on conscious phenomenology as advanced by Varela et al. (1991) has revealed the richness of our experiences, thus undermining the reductionist approach – proper of Western sciences – in the domain of consciousness studies. Moving one step further, from phenomenology to ontology, we claim that in a monist perspective it is not necessary to look for causal explanations of how the physical could *generate* the mental, since both mental and physical are two aspects of the *same* underlying reality. Beyond the "hard problem," other questions about consciousness can be posed which are more amenable to a scientific approach. Both the physical and mental aspects of reality are fundamental, but in evolution the appearances of mentality and consciousness require the operation of specific mechanisms (Lehmann 1990, 2004). What are these mechanisms? Which aspects of phenomenology are they expected to explain? How could the inherently different first- and third-person perspectives be about the same world? These are the main questions raised in the book.

The group of authors contributing to this volume has been interacting in a variety of ways, in a common effort to systematize the philosophical foundations of current scientific approaches to consciousness. Some of us have participated in meetings aimed at promoting a scientific approach to consciousness, such as the series *Towards a Science of Consciousness*, and the annual meetings of the Association for the Scientific Study of Consciousness. A public discussion in Nature Network's forum on *Brain Physiology, Cognition and Consciousness* in 2008 was an opportunity to elaborate the very definition of "consciousness" (Pereira Jr. and Ricke 2009). A series of private discussions in 2009 led to a collective publication about current theoretical approaches (Pereira Jr. et al. 2010). In 2010, the *Consciousness Researchers Forum* was formed as a private group in the Nature Network to support the organization of the present book. Its chapters reflect the rapport of philosophers and scientists from different disciplines, collectively discussing philosophical issues crucial for the establishment of a theoretical framework for the emerging field of *Consciousness Science*.

The chapters cover varied perspectives on what a science of consciousness would be. What they have in common is a search for unity, in terms of similarities: some authors look for kinds of brain activity that are analog to mental activities, while others look for perception-action cycles by which mental activity reflects the structure of the world we live in. Philosophically, these views share the conception of *Dual-Aspect Monism* proposed by Max Velmans (2009), the idea that mind and brain activities derive from a common ground, as well as Reflexive Monism (proposed by the same author), the idea that the mind and the world reflect each other.

Our guiding line is that the phenomenon of consciousness is a complex result of the interplay of series of events, which can be organized on two dimensions, corresponding respectively to Reflexive and Dual-Aspect Monism: a "horizontal," mirroring interaction of brains, bodies and their world, and a "vertical," complementary, non-reductive combination of micro and macro processes to form conscious experiences. Eventually, the expressions "Double-Aspect" or "Triple-Aspect Monism" are used in some of our chapters to stress this complementarity of aspects, because the term "Dual" has the unwanted connotation of "Dualism".

According to this line of reasoning, our *Chapter 1*, written by Bjorn Merker, presents an ontological framework for the interaction of brains, bodies and their world, based on the idea of a dynamical interface containing three selection processes. This dynamical activity both generates consciousness and makes the process of generation opaque to introspection.

In *Chapter 2*, Christine Godwin, Adam Gazzeley, and Ezequiel Morsella report and discuss empirical findings in support of the thesis that consciousness is necessary for the execution of coherent actions by animals that interact with their world in complex modalities (as those described by Merker).

Chapter 3, by Ron Cottam and Willy Ranson, departs from the view that the interplay of events that generate consciousness involves multiple scales of description. An approach to meaningful signaling would require the tools of biosemiotics, a discipline derived from the work of Charles Sanders Peirce.

In *Chapter 4*, Wolfgang Baer presents the view that conscious episodes are contained in physical processes and analyzes the metaphysics of quantum theory to show how cognitive operations can be accomplished within a single physical framework.

In *Chapter 5*, Ram Vimal argues that the construction of conscious episodes requires specific mechanisms for the matching of patterns which are found in biological systems (and possibly replicable in other kinds of systems), having the function of transformation of micro potentialities into macro actualities.

In *Chapter 6*, Dietrich Lehmann reviews the state dependency of consciousness. He reports that brain electrical activity is organized in brief, split-second packages, the "functional microstates" that are concatenated by rapid transitions, and that these temporal microstates of the brain electric field incorporate the conscious experiences as "atoms of thought and emotions." In his framework, consciousness is the inner aspect while the electric field is the outer aspect of the brain's momentary functional state. Different microstate field configurations incorporate different modes of thought and emotion; different microstate sequences incorporate different strategies of thinking.

In *Chapter 7*, Arnold Trehub formulates theoretical foundations for a science of consciousness, based on a working definition of the term and a basic methodological principle. In addition, Trehub proposes that neuronal activity within a specialized system of brain mechanisms, called *the retinoid system*, can explain consciousness and its phenomenal content.

In *Chapter 8*, Bernhard Mitterauer argues, based on the philosophy of Gotthard Guenther, that the dialogic structure of subjectivity requires a polymodal mechanism that can be modeled in terms of neuro-astroglial interactions.

In *Chapter 9*, Leonid Perlovsky claims that conscious processes transcend formal logics, thus explaining the act of decision-making ("free will"), and elaborates on a model aimed to cover the main dimensions and activities of a human mind.

In *Chapter 10*, Alfredo Pereira Jr. argues for Triple-Aspect Monism (TAM), a philosophical position holding that reality continuously unfolds itself as the physical world, the informational world, and the conscious world. TAM is claimed to be an adequate theoretical framework for the science of consciousness.

These chapters are the rewarding result of a fruitful cooperation that was a pleasure to experience. We as editors are very thankful to the authors for the creative interaction. We would like to express our gratitude to Cambridge University Press, in particular to Hetty Marx and Carrie Parkinson, to our kind reviewers who displayed the wisdom of criticizing the weak points while calling attention to the strengths, to all who collaborated to make the project a reality – especially Chris Nunn and Kieko Kochi, to Erich Blaich's family for the permission to use his painting on the cover of the book, and last but not least to Maria Alice Ornellas Pereira and Martha Koukkou for their continued support.

REFERENCES

Chalmers D. J. (1995). Facing up to the problem of consciousness. *J Consciousness Stud* 2:200–219.

Chalmers D. (1996). *The Conscious Mind*. New York: Oxford University Press.

Damasio A. (2003). *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*. Orlando, FL: Harcourt.

Jackson F. (1986). What Mary didn't know. *J Philos* 83:291–295.

Kim J. (1993). *Supervenience and Mind*. Cambridge University Press.

Lehmann D. (1990). Brain electric microstates and cognition: The atoms of thought. In John E. R. (ed.) *Machinery of the Mind*. Boston: Birkhäuser, pp. 209–224.

Lehmann D. (2004). Brain electric microstates as building blocks of mental activity. In Oliveira A. M., Teixeira M. P., Borges G. F., and Ferro M. J. (eds.) *Fechner Day 2004*. Coimbra: International Society for Psychophysics, pp. 140–145.

Levine J. (1983). Materialism and qualia: The explanatory gap. *Pac Philos Quart* 64:354–361.

Nagel T. (1974). What is it like to be a bat? *Philos Rev* 83(4):435–450.

Pereira Jr. A. and Ricke H. (2009). What is consciousness? Towards a preliminary definition. *J Consciousness Stud* 16:28–45.

Pereira Jr. A., Edwards J., Lehmann D., Nunn C., Trehub A., and Velmans M. (2010). Understanding consciousness: A collaborative attempt to elucidate contemporary theories. *J Consciousness Stud* 17(5–6):213–219.

Varela F. J., Rosch E., and Thompson E. (1991) *The Embodied Mind: Cognitive Science and Human Experience*. Cambridge, MA: MIT Press.

Velmans M. (2009). *Understanding Consciousness*, 2nd Edn. London: Routledge.

1 Body and world as phenomenal contents of the brain's reality model

Bjorn Merker

1.1 Introduction

The fact that we find ourselves surrounded by a world of complex objects and events directly accessible to our inspection and manipulation might seem too trivial or commonplace to merit scientific attention. Yet here, as elsewhere, familiarity may mask underlying complexities, as we discover when we try to unravel the appearances of our experience in causal terms. Consider, for example, that the visual impression of our surroundings originates in the pattern of light and darkness projected from the world through our pupils onto the light sensitive tissue at the back of our eyes. On the retina a given sudden displacement of that projected image behaves the same whether caused by a voluntary eye movement, a passive displacement of the eye by external impact, or an actual displacement of the world before the still eye. Yet only in the latter two cases do we experience any movement of the world at all. In the first case the world remains perfectly still and stable before us, though the retinal image has undergone the selfsame sudden displacement in all three cases. But that means that somewhere between our retina and our experience, the facts

I am indebted to Louise Kennedy for helpful suggestions regarding style and presentation, and also to Wolfgang Baer, Henrik Malmgren, and Ezequiel Morsella for helpful comments on matters of content.

of self-motion have been brought to bear on retinal information to determine our experience. That in turn implies that the reality we experience is more of a derivative and synthetic product than we ordinarily take it to be.

That implication only grows as we pursue the fate of retinal patterns into the brain. There, visual neuroscience discloses not only a diverse set of subcortical destinations of the optic tract, but an elaborate cortical system for visual analysis and synthesis. Its hierarchical multi-map organization for scene analysis and visuospatial orientation features functional specialization by area (Lennie 1998) and functional integration through a pattern of topographically organized bidirectional connectivity that typically links each area directly with a dozen others or more (Felleman and Van Essen 1991).

From the point of view of our experience, a remarkable fact about this elaborate system is the extent to which we are oblivious to much of its busy traffic. As we go about our affairs in a complex environment we never face half-analyzed objects at partial way stations of the system, and we never have to wait even for a moment while a scene segmentation is being finished for us. We have no awareness of the multiple partial operations that allow us to see the world we inhabit. Instead it is only the final, finished products of those operations that make their way into our consciousness. They do so as fully formed objects and events, in the aggregate making up the interpreted and typically well-understood visual scene we happen to find ourselves in.

So compelling is this "finishedness" of the visual world we inhabit that we tend to take it to be the physical universe itself, though everything we know about the processes of vision tells us that what we confront in visual experience cannot be the physical world itself but, rather, must be an image of it. That image conveys veridical information about the world and presents some of the world's properties to us in striking and vivid forms, but only to the extent that those properties are reflected in that tiny sliver of the electromagnetic spectrum to which our photoreceptors are sensitive, and which we therefore call visible light. The fact that this tiny part of the spectrum serves as medium for the *entirety* of our visual world suggests that somehow the *experienced* world lies on "our side" of the photoreceptors. That would mean that what we experience directly is an image of the world built up as an irremediably indirect and synthetic internal occurrence in the brain. But where then is that brain itself, inside of which our experienced world is supposedly synthesized on this account of things? And indeed, does not the location of our retina appear to lie inside this world we experience rather than beyond it?

These legitimate questions bring us face-to-face with the problem of consciousness in its full scope. That problem, they remind us, is not confined to accounting for things like the stirrings of thoughts in our heads and feelings in our breasts – what we might call our "inner life." It extends, rather, to everything that fills our experience, among which this rich and lively world that surrounds us is not the least. In fact, as we shall see, there are attributes of this experienced world that provide essential clues to the nature of consciousness itself. It may even be that short of coming to grips in these terms with the problem of the experienced world that surrounds us, the key to the facts of our inner life will elude us.

1.2 Stratagems of solitary confinement

Our visual system not only provides us with robust conscious percepts such as the sight of a chair or of storm clouds gathering on the horizon, it presents them to us in a magnificently organized macro-structure, the format of our ordinary conscious waking reality. Our mobile body is its ever-central object, surrounded by the stable world on all sides. We look out upon that world from a point inside our body through a cyclopean aperture in the upper part of the face region of our head. This truly remarkable nested geometry, in three dimensions around a central perspective point, is a fundamental organizing principle of adult human consciousness (Hering 1879; Mach 1897; Roelofs 1959; Merker 2007a, pp. 72–73). It requires explanation despite – or rather, exactly because of – its ever-present familiarity as the framework or format of our sensory experience. As such it provides unique opportunites for analysis, because it offers *specificities of structure* whose arrangement simply cries out for functional interpretation.

The key to that interpretation, I suggest, is the predicament of a brain charged with guiding a physical body through a complex physical world from a position of solitary confinement inside an opaque and sturdy skull. There it has no direct access to either body or world. From inside its bony prison, the brain can inform itself about surrounding objects and events only indirectly, by remote sensing of the surface distribution of the world's impact on a variety of receptor arrays built into the body wall. Being fixed to the body, those sensors move with it, occasioning the already mentioned contamination of sensory information about the world by the sensory consequences of self-motion. But even under stable, stationary circumstances, primary sensory information is not uniquely determined by its causes in the world. Thus an ellipsoid retinal image may reflect an oval object seen head-on, or a circular one tilted with respect to our line of sight, to give but one example of many such problems occasioned by the brain's indirect access to the world (Helmholtz 1867; Witkin 1981, pp. 29–36).

Nor is the brain's control of its body any more direct than is its access to circumstances in the world on which that control must be based. Between the brain and the body movements it must control lie sets of linked skeletal joints, each supplied by many muscles to be squirted with acetylcholine through motor nerves in a sequence and in amounts requisite to match the resultant movement to targets in the world. In such multi-joint systems, degrees of freedom accumulate across linked joints (not to mention muscles). A given desired targeting movement accordingly does not have a unique specification either in terms of the joint kinematics or the muscle dynamics to be employed in its execution (Bernstein 1967; Gallistel 1999, pp. 6–7).

On both the sensory and motor sides of its operations the brain is faced, in other words, with under-specified or ill-posed problems in the sensing and control tasks it must discharge. We know, nevertheless, that somehow it has managed to finesse these so-called inverse problems, because we are manifestly able to function and get about competently even in quite complex circumstances. The brain has in fact mastered its problems in this regard to such an extent that it allows us to remain oblivious to the difficulties, to proceed with our daily activities in a habitual stance of naive realism. We look, and appear to confront the objects of the world directly. We decide to reach for one or another of them, and our arm moves as if by magic to land our hand and fingers on the target. Much must be happening "behind the scenes" of our awareness to make such apparent magic possible.

Reliable performance in inherently underconstrained circumstances is only possible on the basis of the kind of inferential, probabilistic, and optimization approaches to which engineers resort when faced with similar problems in building remote controllers for power grids or plant automation (McFarland 1977). In such approaches a prominent role is played by so-called forward and inverse models of the problem domain to be sensed or controlled, and they have been proposed to play a number of roles in the brain as well (Kawato et al. 1993; Wolpert et al. 1995; Kawato 1999). In effect they move the problem domain "inside the brain" (note: this does not mean "into our 'inner life'") in the form of a neural model, in keeping with a theorem from the heyday of cybernetics stating that an optimal controller must model the system it controls (Conant and Ashby 1967).

There is every reason to believe that a number of these neural models contribute crucially to shaping the contents of our experience. They may be involved, for example, in the cancellation of sensory consequences of