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Foundationalism and neuroscience; silence and language

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Abstract

Neuroscience offers more than new empirical evidence about the details of cognitive functions such as language, perception and action. Since it also shows many functions to be highly distributed, interconnected and dependent on mechanisms at different levels of processing, it challenges concepts that are traditionally used to describe these functions. The question is how to accommodate these concepts to the recent evidence. A recent proposal, made in *Philosophical Foundations of Neuroscience* (2003) by Bennett and Hacker, is that concepts play a foundational role in neuroscience, that empirical research needs to presuppose them and that changing concepts is a philosophical task. In defending this perspective, *PFN* shows much neuroscientific writing to be dualistic in nature due to our poor grasp of its foundations. In our review article we take a different approach. Instead of foundationalism we plead for a mild coherentism, which allows for a gradual and continuous alteration of concepts in light of new evidence. Following this approach it is also easier to deal with some neurological conditions (like blindsight, synaesthesia) that pose difficulties for our concepts. Finally, although words and concepts seem to seduce us to thinking that many skills and tasks function separately, it is language skill that – as neuroscientific evidence shows – co-emerges with action/perception cycles and thus seems to require revision of some of our central concepts.
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1. Introduction

Neuroscience shows that much brain activation is common to language, perception and action. From infancy, it seems, most of the human nervous system is recruited to the service of talking bodies. Given the lesion studies that pioneered 19th-century work on the brain, this is surprising. Language, we discover, is neurally distributed. Far from being exclusively 'produced' by neurons in Broca's area, this ill-defined part of the inferior frontal cortex subserves also action, speech and other functions (Lindberg et al., 2007). In macaques, a

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partly homologous F5 area exploits *mirror neurons* that integrate action with perception. As activation spreads to other brain parts including the insula (Gallese et al., 2004), these seem to set off empathy. For theories that posit language-specific modules, the findings are disappointing. While brains cannot be shown to *lack* language-dedicated areas, it is beyond dispute that perception, action and language are neurally highly integrated. This, we believe, matters to all who undertake research into language.

In seeking a way into the field, some will turn to *Philosophical Foundations of Neuroscience* (*PFN*). Since this book promises to overview human mental faculties, this will seem sensible. The promise, however, remains unfulfilled. Indeed, as we wrote this paper we came to think that what *PFN* excludes is at least as important as what is included. Selection is of course inevitable because, like neuroscientists, philosophers write in accordance with their opinions. Further, since brain-scanning and other empirical techniques cannot capture much real-time detail, theoretical issues have a major influence on the discussion of findings. This can be exemplified by a case where, let us say, a task like colour naming is traced to neural correlates. No empirical factors bear on whether this is to be described in terms of, say, a *mental lexicon* or of *verbal behaviour*. Correlations must be interpreted in the light of one's views. Our concern with *PFN*, however, is not a matter of interpretation. We broadly accept how the authors characterize neural function, but object to their strict foundationalism. Accordingly, a central goal of this paper is that of presenting examples to show how their foundationalism blinds them to conceptually important neuroscience.

The authors propose that conceptual analysis should delimit neuroscience. Philosophy is presented as the foundation for the study of *consciousness* and of *the human faculties*. By implication, what analysis excludes is of merely technical interest. This is an extraordinary view. Not only does it ignore the empirical basis of concepts, but the authors favour views *because* they are established. To restore balance, we examine the logic of this and, having done so, turn to important matters that *PFN* passes over in silence. Concurring that language is *partly* constitutive of thought, we accept much of the critique while proposing a coherentist alternative that allows for a more dynamic and continuous interaction between conceptual analysis and empirical exploration. To this end we sketch how neuroscience challenges concepts such as *action*, *perception* and *language*. While admiring *PFN*'s elegance, clarity and confidence we deny that, in itself, conceptual analysis can provide a foundation for science.

1.1. An overview

Philosophical Foundations of Neuroscience is by M.R. Bennett, an eminent neurophysiologist, and P.M.S. Hacker, a renowned Wittgensteinian. As shines from every sentence, they seek to show good sense. This noble goal, we find, affords a clear view of brains that shapes a sobering view of neuroscience. Many issues, however, disappear beneath the polished prose that serves to critique neuroscientific writings. Viewing the conceptual as *a priori*, *perception* is deemed passive, *action* voluntary or involuntary, and the *meaning of words* is seen as purely determined by 'rule-governed use' as accepted by 'the community of speakers' (2003, p. 382) and independent of the brain. Such conservative positions blind them to work that is inconsistent with their view of how we interact with the world such as, on the one hand, theories that describe language as emerging from complex and distributed action–perception–expression interactions and, on the other, theories that ascribe a language faculty to human brains.

PFN is in four main parts. Sensibly, B&H begin with the historical roots of neuroscience (102 pp.). Later, they give a conceptual analysis of *human faculties* (127 pp.) followed by a similar treatment of consciousness (109 pp.). Next, they present a discussion of method (55 pp.). Finally, in appendices, they criticize work by Dennett and Searle. In using analytical philosophy to scrutinize neuroscience B&H disregard the methodology of scanning, barely mention lesion studies, and play down empirical findings. As *strict* foundationalists, they boldly ignore many concerns of working scientists. For example, not only is consciousness separated from sensation and perception but, without argument, they dismiss any human faculty of language. Further, they do not fear controversy. In part, this is because, rather than seeking connections between mental phenomena, they aim to refute the 'mereological fallacy in neuroscience'. Given this goal, they present their work as the product of a *method*. In contrast to neuroscientists, they eschew theoretical issues such as how human powers arise in neural activations. For example, while B&H identify language with rule-following, neuroscience seeks out interdependencies between language, perception, memory, and action.

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The *PFN* view is a logical consequence of the authors' semantics. This leads to surprises even with respect to what brains are not. While tracing their work to Wittgenstein and Aristotle, B&H defend neither foundationalism nor semantic purism. Rather, they try to dissolve conceptual puzzles by clear writing. Concern with presentation thus permeates the text. While the book's length– and thoroughness – might be daunting, neither coloured images nor neurophysiological terms distract the reader. Once the conceptual house is in order, B&H think, adornments are unnecessary. Neuroscience deals with detail: especially by examining disorders, it can show what processes undergird mental concepts.

In linking *PFN*, brains and language, we too write in four parts. First, we contrast B&H's foundationalism with Aristotle's. In so doing, we show how B&H's semantic purism cuts free from empirical debate. Second, we consider the critique of dualism, the mereological fallacy, and ontological reductionism. Here we generally applaud B&H. Third, we use anomalies to show the limits of the theory. Fourth, we turn to neuroscientific work on perception, action and language to show B&H's blindness to recent, conceptually challenging work. While B&H are silent, neuroscience stretches the semantic web. Applied to language, we argue, investigations of the brain are challenging how we conceptualize the (dialogical) activity that we routinely analyse as texts, sentences and word-forms.

2. Neuroscience and foundationalism

We begin with the logic of foundationalism. This, indeed, is crucial for the intended audience of scientists who study brain and mind. Indeed, without a grasp of the history, or the theory's controversial status, *PFN*'s polished prose may mask their radical conservatism. As shown by lack of argument, B&H take foundationalism for granted:

> It [*PFN*] is concerned with the conceptual foundations of cognitive neuroscience – foundations constituted by the structural relationships among the psychological concepts involved in investigations into the neural underpinnings of human cognitive, affective and volitional capacities. Investigating logical relations among concepts is a philosophical task. Guiding that investigation down pathways that will illuminate brain research is a neuroscientific one. Hence our joint venture. (p. 1)

The venerable tradition of foundationalism is rightly traced to a view of science which we find more subtle than that of *PFN*. This approach, we stress, is merely one *possible* basis for science. B&H overlook the Aristotelian consideration that the field may be unready or unsuited to systematization based on talk about human faculties.

2.1. Foundations and coherence in science

Aristotle paved the way for reflection on many scientific and philosophical matters. Indeed, his *Analytica Posteriora* remains a seminal treatment of scientific foundations, i.e. in the form of axiomatizing science. The prime example of its application – almost certainly based on Aristotle – lies in Euclid's *Elements*. In modernity, foundationalist views recur not only in mathematics, physics and cybernetics, but also in metaphysical and ethical works by, among others, Hobbes, Descartes, Spinoza, Russell and von Neumann.

Foundationalism posits that every scientific proposition somehow builds on other propositions. Since the stability of a building rests upon the definiteness and truth of foundations, the starting point lies in formulating *founding* propositions. One can thus avoid an infinite regress of propositions about empirical facts building upon other empirical facts that build upon (yet) other empirical facts, etc. Founding propositions are to guarantee the truth of the whole. In Aristotle's work, these are undemonstrable definitions and postulates that underpin a (propositional) building. The model thus assumes certainties and, by extension, even a small change in foundations can have devastating consequences. Development thus depends on deduction rather than continuous empirically driven correction. Little room remains for debate. A classic Euclidian example is the triangle. Indeed, if this is not defined so that the sum of its angles is precisely 180 degrees, we either move into nonsense or, in another setting, non-Euclidean geometry. B&H *assume* that just as mathematics relates to physics, philosophical elucidation antecedes neuroscience and that whether a wording makes sense can be judged independently of facts about the brain (p. 385, 402).

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Since foundations delimit a domain, at times revision is necessary. In his *Eudemian Ethics* (II,6 1222b, lines 23–41) Aristotle applies this view to geometric principles:

> Immovable principles such as those of mathematics do not possess absolute authority (kurion) although they are admitted as having similar force; for even in mathematics, if the principle were changed, almost all the propositions proved by it would be altered. ... [I]f the triangle changes [and has not two right angles] so must the square; if the sum of the angles is equal to 3 right angles for the triangle it will be six for the square.

More recently, non-Euclidean geometry has fulfilled the prediction.[1] In other words, in order to advance, geometry exploited conceptual plasticity. Further, Aristotle's flexible foundationalism combines with tolerant practice. As Barnes (1975, p. x) argues, axiomatization may for Aristotle be more applicable to a completed enterprise than to work in progress. Viewing foundationalism as aimed at education is consistent with the opening of the *Posterior Analytics*:

> All teaching and all intellectual learning come about from already existing knowledge. This is evident if we consider it in every case; for the mathematical sciences are acquired in this fashion, and so is each of the other arts. (71a, lines 2–5)

Neuroscience may be too young to draw on 'already existing knowledge'. First, we still lack clear and complete accounts of relevant empirical findings. Second, we do not find it obvious *which* foundational concepts or definitions (if any) would shape such work. By contrast B&H judge it self-evident that neuroscience needs to be founded on conceptual analysis of human faculties and consciousness. Not only does this analytical emphasis strike us as one-sided, it limits the possible functions of empirical judgements. To restore balance we draw on another dialogue between philosophy and neuroscience by proposing to 'combine semantic tolerance with semantic criticism' (Changeux and Ricoeur, 2000, p. 40).

Without combining semantic criticism and tolerance, science can be held back. We do not, however, downplay analysis. Careful analysis of concepts is essential, we believe, to identify a coherent object of investigation. In Bechtel's (2002) terms, a first 'decomposition' can invite investigation of mechanisms or properties at a level below what is decomposed. In using lower-level description together with decomposition, one aims neither at collecting fragmentary information nor providing a final account. Rather, the goal is a hypothetical identity between the levels. Quantum physics is a well known example. At one level, physicists use a quantum model and, at another, a classical explanation of matter and force. Even though the interpretations are incompatible, the model is accepted. While *neither* is foundational, the two-level solution shapes both theory development and technological application. Far from building on a single set of axioms, physics relies on coherence between propositions in two domains. Stability uses propositions based in probability or plausibility to unite empirical, conceptual and practical findings. Rescher (1974) calls a coherentist approach like this one a *network model*. Where successful, it permits the progressive integration of predictions and applications into an established knowledge system. Provided that effective outcomes arise, the model is successful. Far from defining the enabling conditions for *a priori* concepts, the approach favours progress and alteration. Instead of separating the conceptual and the empirical, these are used to shape each other's validity and distinctness. Davidson (1997) presents a coherentist view around an image of triangulation:

> The primitive triangle, constituted by two (and typically more than two) creatures reacting in concert to features of the world and to each other's reactions, thus provides the framework in which thought and language can evolve. Neither thought nor language, according to this account, can come first, for each requires the other. (p. 27)

While compatible with strict conceptual analysis, there is a crucial difference. Correction is made not just from the conceptual side but also by using observations about features of the world. We call the approach *mild coherentism*.

[1] Gauss saw that disentanglement of geometrical foundations from finite (earthly) space geometry would have consequences for dimensions and relations of geometrical figures (see e.g. Gray, 1989).

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2.2. A foundationalist project in neuroscience?

Most concur that, in science, one needs both coherence and foundationalism. It is thus surprising that B&H focus exclusively on 'logical relations among concepts'. It is even more surprising that their work is presented as 'guiding that investigation down pathways that will illuminate brain research' (p. 1). By making the neuroscientist into a consumer of logical investigation, they seek to narrow the scope of science. Remarkably, the move is deemed so straightforward that B&H offer no discussion of its pros and cons. Nor do they consider methodological and related philosophical questions which, we submit, matter to neuroscience. They fail to discuss how to interpret the results of imaging, the value of animal models or, indeed, computer simulations. Equally, they underplay the status and (limited) relevance of lesion studies and other pathologies and, indeed, how neuroscience is combined with cognitive psychology. Whatever others think, B&H believe that, alongside logical analysis, these are 'minor issues'. This, we are sure, will disappoint neuroscientists or others concerned with empirical studies of brain and mind.

One reason B&H view cognitive neuroscience as founded in conceptual analysis is that the field has a propositional basis. This is clearly stated in relation to consciousness:

> Philosophy is concerned with elucidating the defining features of consciousness (its *a priori* nature). [...] Neuroscience, presupposing the concept of consciousness as given, has the task of investigating the empirical nature of consciousness [...] (p. 403)

Rather than seek out reciprocal relations between concepts and evidence, they posit that we know what consciousness is and, given analysis, can define it in *a priori* terms. On conceptual grounds, it is separate from action, perception and language. But are they right in thinking that empirical work adds nothing to semantics?[2] Whatever the reader's view, B&H emphasize that, without conceptual analysis, there is a risk of circularity. In their defence they invoke mathematics: 'Empirical facts cannot determine the truth of a mathematical theorem, and facts about the brain cannot determine whether a form of words, such as ''the brain remembers'', makes sense either (cf. 7, 402; 385)'[3] While that is true, Aristotle saw that even truths about triangles could alter in accordance with circumstances. As history shows, interaction between empirical and conceptual – or foundational – work often leads to revisions in our thinking. In 'The unreasonable effectiveness of mathematics in physics', Wigner (1960) shares his astonishment at how these dynamics play out again and again as mathematical theorems are applied to physics. Reversing this, mathematical problems have recently been established and resolved using results from physics. Relations between the fields are irreducible to correspondence or to unidirectional guidance. In spite of this – and without comment – B&H posit a transparent parallel between clear language and human faculties.

PFN is based on the premise that neuroscientists, psychologists and philosophers alike are dedicated to understanding the faculties of mind. In fact, were this not so, analysis could not be used to detect neuroscientific nonsense. Remarkably, B&H also endorse the reverse argument. Given strict foundationalism they suppose that empirical neuroscience will be led astray by errors in the foundational starting points of description. Unless based on philosophical conceptual analysis, such writing will lead to misunderstanding, misguided questions, misconceived research and misrepresentation of experimental results and implications (p. 106). Accordingly B&H protest vehemently against allowing scientific progress to draw on conceptual change that, even momentarily, permits confusion. Instead they present words as 'instruments of thought and reasoning' and insist that we should 'ensure that they are clean' (p. 381). As regards philosophy of language the authors take a narrow representationalist view. Words are determinate symbols with 'a rule-governed use' (p. 146). Not only does a grammar determine 'intelligible combinatorial possibilities' but it is elucidated by 'explanations of meaning that are used and accepted by a community of speakers' (p. 146). Language becomes a transparent medium that limits what can be said. This *purist semantics* contrasts with any co-emergent view of

[2] In an earlier article, Bennett (1999) praises Aristotle for introducing the concept of 'vital pneuma' that solves the riddle about how the heart and muscles could be connected: strikingly, the concept is tailored to solving an empirical problem.

[3] By analogy, mathematics and philosophy deliver concepts or theorems that are *a priori* or 'antecede experience'. The authors overlook the disputed status of this in mathematics (see e.g. Lakatos, 1976).

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language and thought. Although this is not made explicit, B&H aim to protect foundational concepts from continuous and gradual change. Their philosophy of science depends on a *theory* of language.

For B&H deviations from the established use of words are crucial flaws in neuroscientific discourse. While sensible enough to accept that 'conceptual entanglement *can* co-exist with flourishing science' (p. 5), they do not allow such entanglements to function as e.g. heuristics for scientists. To cure the weaknesses, they diagnose the symptoms. That is, they seek out a particular (flawed) structure and logic in the nonsensical formulations they criticize (and, presumably, would like to banish). While their critique is sharp, we find their complaints exaggerated. In claiming that science is founded on more than concepts, we proceed by using the history of neuroscience to defend mild coherentism.

2.3. Evidence for neuroscientific coherentism

Neuroscience focuses on the properties of cells known as *neurons*. These were first invoked by Wilhelm Waldeyer in 1891 in describing a structure common to neurology, psychology, physiology and anatomy. To show how foundationalism can co-exist with coherentism, we build on the work of Fridtiof Nansen, Sigmund Freud, Camillo Golgi and Santiago Ramón y Cajal. These scientists used anatomy and physiology to develop a structured view of the brain long before we had any knowledge of brain functions. For many, indeed, it seemed that the brain could never be decomposed or mental functions correlated with parts. Although this was a crucial issue, scientific progress was not hindered by debating it. Just as in quantum mechanics, it had the effect of driving a corrective process that was based in seeking to link conceptual claims to empirical evidence (Laudan, 1977).

In the long debate about its object, neuroscience focused on – not a human faculty – but the neuron. This culminated at the Nobel Prize ceremony in 1906 for Medicine or Physiology. Camillo Golgi and Santiago Ramón y Cajal, both neurophysiologists and anatomists, were awarded the prize. Their work had started off research on the *neuron doctrine*: this was regarded as fundamental and brain functions were seen as based on neuronal properties. Even at the ceremony, however, Golgi raised the foundational issue by denying Cajal's claim that neurons were actually discrete cells. Rather, he argued, the brain is a continuous structure or a reticulum, a web of nerve fibers. In his Nobel speech he opposed change in the meaning of the word, saying: 'I am against giving a meaning to a word which differs from that given it by the person who introduced the word into science' (Golgi, 1906). Although the laureates differed on such a crucial conceptual matter, they both contributed to specifying and localizing structures associable with specific mental actions. Were the brain a singular and continuous structure, it would be impossible to designate functions to particular brain areas. Generally, singular and continuous structures preclude decomposition and are thus inimical to scientific investigation.

Neuroscientific practice may impact on our conceptual network. Of course, challenges over psychological or mental phenomena attract even more non-specialist attention than work on, say, the atom or the gene. Misunderstandings in neuroscience may thus lead to incorrect self-understanding among scientists and laypeople alike. In that respect, B&H's project is worth pursuing, even if attention to flaws could have been balanced by reference to empirically driven debates. However, far from just evaluating neuroscience, the authors adopt a didactic and even schoolmasterly tone. For those unacquainted with current issues this creates an illusion of comprehensivity compounded by writing that resembles a Who's Who of popular neuroscience. *PFN* invokes Baars, Churchland, Crick, Damasio, Edelman, Gazzaniga, Kandel, LeDoux, Libet, Marr, Penrose, Sperry, Weiskrantz, Zeki and others. Notwithstanding claims to the contrary, B&H write as if their agenda were to show that, especially in texts aimed at a wider audience, much neuroscience is confused and likely to mislead.

3. What brains are not

Foundationalism enables an investigator to scrutinize the structure and logic of the propositions that constitute a text. Given solid foundations, these are sufficient to identify nonsensical formulations. B&H thus use neuroscientific writings to give new emphasis to flaws of dualism and mereological reasoning.[4] Although they

[4] Dennett (2007, p. 75) rightly complains that they overlook his (and other) earlier presentations of this view.

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ignore the diversity of mereology, the critique is valuable. Indeed, they show that – at times – neuroscientists treat groups of cells as carrying out the activities of a whole person (or organism). It is our view that working neuroscientists will agree with B&H that, if taken unconditionally, such forms of expression are misleading. Clearly, brains are not (and do not contain) little people.

3.1. Dualism: the relation between mind and brain

Brains are sometimes described in ways that make little sense. Indeed, B&H catch many neuroscientists using flawed descriptions or interpreting work as ascribing remarkable things to brains. Just to mention a few examples, they quote Blakemore as saying that the brain 'constructs its hypothesis of perception' (p. 136), Edelman and Tononi as invoking a 'human head within which we have no doubt that thoughts occur' (p. 179) and Gazzaniga observing that 'this interpreter is located in the left hemisphere' (p. 390). We sincerely doubt that these authors all think they are writing literally. The brain does not construct hypotheses like those of scientific articles, thoughts do not occur autonomously in a head and there is no smallish interpreter in the brain. At times, these are 'semantic short-circuits', as Ricoeur (Changeux and Ricoeur, 2000) calls them, or heuristics that demand research or, at least, comprehensive description. While short-circuits present dangers, B&H do not promote investigation. Instead, they stress – rightly – that brains are not all-encompassing. In themselves, these apparatuses – or isolated parts of them – are incapable of psychological and mental activities. Writers who overlook this commit the mereological fallacy. To acquaint readers with this claim, we present B&H's view of dualism and then use Aristotelian sources to refocus discussion.

Cognitive neuroscientists generally explain mental activities by relating them to neural activation. They link cognitive psychology with neuroscience by seeking correlations between occurrences in the brain and specific mental, cognitive or behavioural tasks. The methods include brain imaging, studies of single cells and work with animal models. These can be applied to patients suffering from brain damage or to normal controls. In computational neuroscience simulations are used to test predictions about neural activity. Unfortunately B&H do not discuss the serious difficulties that beset designing and interpreting such studies.[5] Rather, focusing on presentation, they seek evidence of dualism. Given that neuroscience generally aims to bridge the mind–body gap, this may seem surprising. Nonetheless, *PFN* convincingly demonstrates a form of dualism in neuroscientific writings. While rejecting Descartes's distinction between the mental and the material or physical, neuroscientists often bridge the (supposed) gap by creating a new one. As B&H recognize, they often separate the mind/brain from the rest of the body or, strictly, the whole person. Where Descartes limited mental activities to a part of the person – the mind, not the extended body – neuroscientists sometimes identify the mind and the brain. Instead of ascribing mental activity to a person, they treat the mind/brain as a body-part that speaks, feels, perceives, decides, etc. 'It replaces the immaterial Cartesian mind by the material brain. But it retains the fundamental *logical structure* of dualist psychology' (p. 111, italics in original). Appeal to dualistic structure raises Cartesian difficulties by opening a conceptual gap between the brain and the body-in-an-environment. This problem is analogous to that resolved by Descartes' famous claim that bodily sensations and mental activities connected across the pineal gland. Present-day neuroscientists, we are told, face the problem of relating mental activities, as they conceive them, to complete persons. 'It is the person who is in a *mental state* of concentration, excitement or anxiety (these *are* genuine mental states), not his brain or its parts' (p. 112, italics in original).

3.2. Mereology: the relation between whole and parts

Dualism is a form of the mereological fallacy. Indeed, while dualism itself is given little space, B&H devote an entire chapter to the fallacy as such. It is central to their enterprise in that it functions as 'a convention that determines what does and does not make sense' (p. 81). While we find their objections overstated, the authors deserve credit both for reopening the issue and recognizing dualism as a form of the fallacy.

[5] For discussion see e.g. Machamer et al. (2001).

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Where Descartes left us with the dubious heritage of dualism, the authors honour Aristotle for pointing out such mistakes. Indeed, he may have been the first to offer extensive discussion of difficulties raised by relating parts to wholes. Thus *mereology* deals with the logical relation between a part (*meros*) and that of which it is a part. Since this can take many forms, the relation has different properties. For instance, the logical properties of '2 is a part of 3' differ from those of saying 'a cell is a part of an organ' or 'this nuon is a part of the earth'. Mereological investigations thus include the properties and applications of transitive relations. This, moreover, can be a matter of semantic analysis. For example, if a cell is a part of an organ and the organ part of a person, can we say that the cell is a part of the person? Whatever the answer, the cell can be subtracted from the person without the logical consequences that arise from subtracting 2 from 3. Aristotle deserves credit for discussing such questions in, for instance, the locus classicus of *Metaphysics Delta* (1023 b, lines 12–25). The ambiguity of part–whole relations is shown in that, for example, *genus* can be both a part or a whole. Whereas genus is part of the definition of a species, the species is part of a higher-level class of genus.

Concepts can exploit more than one logical relation. The same argument applies equally to scientific propositions. Indeed, Aristotle shows that part–whole relationships include various dependency relations – others include object and property, genus and species, relation and collection and, finally, order. B&H, however, seem unfamiliar with Aristotle's views on the ambivalence of mereological relations. In fact, Aristotle objected to the Platonic dialectics because each proposition or property was given a separate definition. This created the problem of substantivation or *hypostatization* of each property and, Aristotle noted, metaphysical proliferation of ideal substances:

> because we suppose every predicate of anything to be an individual thing, and we understand it as being one thing: for it is to that which is one and to substances that individuality and being seem especially to belong. For this reason, too, this type of fallacy is to be ranked among those that depend on language. (Soph. El. 169 a, lines 34–37)

Such criticism, however, did not lead Aristotle to a narrow view of the correct use and misuse of mereological relations. As his works show, there are times when, without claiming any independent existence, it is fruitful to establish a separate branch of science for a feature of reality (number and form, for instance).[6] Indeed, Rubin suggests that 'mereological explanations are common, both in science and in ordinary life' (1990, p. 221). Rather, than banish them, science can show their value. Where this is done, such a separate science focusing on a specific feature, can make a useful contribution to describing and explaining relevant objects and events. Further, given the power of analogy, similar forms of logic may also account for other features of reality.

Although it is closely related to the axioms of foundationalism mentioned above, we do not pursue the issue.[7] Rather, given this complexity, we stress the variability of mereological relations. Indeed, Aristotle wrestled with how this can be formulated. Thus, B&H quote (p. 15) in assent to Aristotle's *De Anima*: 'For it is surely better not to say that the soul pities, learns or thinks, but that the man does these with his soul' (408 b, line 15). Aristotle, however, was well aware of the fact that in denying the soul independent functioning this description invites other misunderstandings. Therefore he also emphasized that the soul should not be considered as an instrument of man. Describing, analysing and explaining mental functions presuppose the use of dependency and mereological relations. Cognitive functions demand description in terms of how parts relate to wholes – terms that can easily be confused.

3.3. Avoiding reductionism through semantics?

Reductionism is an extreme form of misidentifying a part with the whole. Indeed, in the final part of *PFN – On Method* – B&H connect dualism and mereology with two main varieties of this problem. First, *ontological*

[6] As Aristotle writes: 'Each question will be best investigated in this way – by supposing separate what is not separate, as the arithmetician and the geometer do'. (Metaphysics. 1078 a, line 22) The accusation of Aristotle's being a 'reocentric surrogationist' (Harris, 2005, p. 16) shows a lack of comprehension of Aristotle's conscious exploitation of linguistic means *without* making ontological commitments.

[7] The relevance of this issue for empirical science is noted in Rescher's (1955) early contemporary discussion of mereology.

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reductionism implies a reduction of a kind of beings, (e.g. mental states) to more basic beings (e.g. cells). Second, *explanatory reductionism* is a widely used scientific strategy. Leaving aside the ontology of mental states, one nonetheless pursues empirical investigation. For Bechtel (2002), one step is to decompose the behaviour into subtasks. Once this has been done explanations will be sought in mechanisms and properties that can be described at a lower level.

B&H reject ontological reductionism in the writings of, among others, Francis Crick. For example, in one setting, Crick writes that it does not 'come easily to believe that I am the detailed behaviour of a set of nerve cells' (p. 355). It is, as B&H suggest, overstated to say that the properties of cells can meaningfully explain the properties, relations etc. of Crick's person. Nevertheless, decomposition (as described above) serves to analyse and explain processes. Far from collapsing levels of analysis, the goal of this kind of reductionism is to allow each level to retain functional and explanatory powers (Bechtel, 2002). We can, therefore, investigate cognitive events in the brain. The price to be paid, however, is that the results may affect the molar description (of the entire being). We may have to change our view to fit descriptions of how nerve cells and their properties alter experiences and affections. Of course, neuroscientists find it hard to evaluate how these relate to the properties of nerve cells. Since they do not map directly onto experiences or activities, they are, rather, described as *neural correlates* of what we do. While systematic examination of that term would therefore have been useful, it is missing in the index of *PFN*.

Neuroscientists seek correlates by relating brain activities to experiences or actions. This is not the same, however, as reducing higher-level experiences to cell activity (no one says: 'love and anger are nothing but particular neural activities of the limbic system'). In seeking correlates, neuroscientists do not rely exclusively on reports or behaviour but, rather, they supplement these with investigations of psychological experiences, actions or, in other cases, animal and computer models, etc. Neuroscientists thus formulate hypotheses about relations that may be causal, functional or explanatory. At least in principle, such research can use mutually correcting findings to establish new coherence. In some cases, we believe, this *can* result in conceptual adjustments. At the same time, conceptual analysis is needed in deciding e.g. whether neural activity was inhibitory or excitatory – a difference we cannot judge by imaging techniques. Equally, it can serve to suggest how to distinguish an enabling condition from one that is sufficient and necessary. For example, while heartbeat correlates with brain activity, its activities lack cognitive powers. Thus while it is difficult to say how psychological experience exploits the neural functioning, we should be wary of taking for granted the *a priori* view that neural systems enable precisely the same conditions as are captured by accurate conceptual analysis.

B&H limit neuroscience to supplying knowledge of the empirical conditions of experiences or actions. In their view, philosophy decides when conceptual claims are sensical and nonsensical. Not only does conceptual analysis have priority over empirical work but, as shown below, it opens up novel conceptual distinctions. Ironically, in spite of foundationalism, they promote semantic revision. Generally, semantic revisions are motivated not by conceptual analysis but by observations of the world. Further, terms like *caloric*, *telekinesis*, *purgatory*, etc. show that empirically driven revisions often have a short lifespan. Nonetheless, in Vanderwolf's (1998) terms, neuroscience offers conceptual challenges to the subdivision of the soul presented in *De Anima*. In spite of usage, human beings may lack separate faculties of *emotion*, *cognition*, *memory* and *perception*. While we later turn to questions that bear on the underlying integrative processes, for now we stress only that this may be interdependent with the mental events that can also be described by using (logico-grammatical) rules. While against strict foundationalism, we do not think this would have worried Aristotle. Rather, he would have examined such issues and, we think, weighed them up against both conceptual and empirical arguments.

3.4. Semantic tolerance and intolerance: a matter of debate

It is hard to find generally accepted semantic or conceptual foundations for 'normal' phenomena such as consciousness or emotions. While this has fortunately not hindered scientific investigation, the absence of such foundations may have prompted neuroscientific interest in pathologies and abnormalities. In such cases, at least at one level, agreement is easier to reach. Be they caused by tumors or infarcts, by bullets or by accidents like that of Phineas Gage, there is a long history of seeking to correlate neural anomalies with altered

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behaviour, etc.[8] Specific abnormalities are often hypothesized to depend on specific (damaged) brain areas. Starting perhaps with observations in a Hippocratic treatise *On the Sacred Disease*, which correlates epilepsy with the brain's moistness, impetus developed following Broca and Wernicke's work on language. That said, one-to-one relations between brain areas and abnormal functions almost always need to be supplemented by reference to other areas and functions as well as to the extraordinary developmental plasticity of the brain (Deacon, 1997).[9] Specific functions rarely, if ever, depend on specific brain locations. Today few think that abnormalities can direct us to how specific brain locations enable cognitive functions. In spite of this, while B&H deny that neuroscientists can reduce normal human behaviour to neural enabling conditions, they can, it is asserted, 'brilliantly explain why patients cannot behave as normal humans can in a multitude of different ways' (p. 365). Given their framework, they ascribe radically different theoretical roles to the neural correlates of normal and abnormal behaviour.

Let us consider cases where a person's behavioural expression is incompatible with its verbal counterpart. A famous example is provided by the example of blind-sight described by Weiskrantz and discussed in Section 14.3.1 of *PFN*. A patient called D.B. with a damaged V1 area showed 'good visual discrimination capacity in the absence of acknowledged experience' (Weiskrantz, 1997, p. 19). Although he reported 'not seeing' half of his visual field, when making forced guesses on the orientation of geometrical objects, he performed better than chance. In a curious case like this, it is unclear which concepts best describe the event or, indeed, the person's experience. Given purist semantics, B&H regard notions like *blind-sight* and *unconscious awareness* as paradoxical. On conceptual grounds, they reject them as making nonsense of *seeing* or *being blind*. Rather, they argue that:

> the normal convergence of indices of sight – namely, appropriate affective response, behavioural reaction, reoriented movement, verbal description, answers to appropriate questions, etc. – is subtly disrupted. But such convergences constitute the framework within which verbs of vision are taught and used. (...) The consequence of this conflict of criteria is that one can neither say that the patient sees objects within the scotoma nor say that he does not. (p. 396)

Does this help us in describing the phenomenon? And does this logic apply to a patient who is conscious but unable to use any voluntary muscle – one who cannot move or speak? Must we say that sufferers of 'locked-in syndrome' lack *perception*? We find the question absurd. We see not a conceptual problem but a need to redescribe the indices that shape judgements. Even vision is ill-served by *a priori* analysis. In our view Weiskrantz (1997) shows that we refer to sight using inherently ambiguous verbal and behavioural criteria. While having many applications, our first point is negative. *Contra PFN*, normal cases and abnormalities alike raise *general matters of fact*. Brain activities and functions – like behavioural (and verbal) correlates – are interdependent. Before showing how reciprocal relations can drive (judicious) semantic innovation, we bring out another implication of B&H's failure to see this contrast:

> New formation rules would have to be stipulated, the conditions for the correct application of these innovative phrases would need to be specified, and the logical consequences of their application would have to be spelled out. Of course, if this were done, the constituent words of these phrases would no longer have the same meaning as they have now. So neuroscientists would not be investigating the neural conditions of thinking, believing, perceiving and remembering at all, but rather those of something else, which is as yet undefined and undetermined. But this is patently not what neuroscientists wish to do (p. 384)

Such proposals are, we submit, of no practical value. They indeed seem far removed from Wittgenstein's discussion of conceptual innovation – also of psychological concepts – since he describes a rather pragmatic process, including the use of analogy and comparison (e.g., 1980, Section 950–951).[10] Scientists cannot wait

[8] For discussion of how forebrain damage affected Phineas Gage's life, see e.g. Wagar and Thagard (2004).

[9] A famous example of neurodevelopmental flexibility is that of Hoover the talking seal. Deacon, 1997, 225ff. reports how a seal raised by a fisherman could repeat utterances of, say, 'Hey! Hey! Get outa there'. This echoed the 'gravelly voice' of the Maine fisherman who had raised the pup.

[10] This is not to deny that Wittgenstein was critical about the possible contribution of science to the solution of philosophical problems. His position on this issue was ambivalent, however, as is being discussed in e.g. (Klagge, 1989).

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until philosophers agree on logical re-conceptualization. Indeed, B&H fail to grasp how research programmes get off the ground. Rather we can use *semantic short-cuts* to devise experimental methods that serve in teasing out novel lower-level descriptions.

B&H oppose ontological reductionism. Rightly, we think, they oppose attempts to 'eliminate' traditional, imprecise folk psychological concepts (see, Churchland, 1986; Churchland, 1988, 1995). Whatever science shows, our everyday language cannot be replaced by one that correctly describes neural events. Thus, if experience of pain depends on a focus of attention, this does not show *that pain is distinct from attention*. In principle, an eliminativist would replace this ambiguity by describing unambiguous (brain-) facts. Instead of using a semantic yardstick, neuroscientific criteria would become the criteria for usage. This view, we suggest, represents the other end of the spectrum. In advocating mild coherentism we reject this extreme just as we do that of *PFN*. Both views overestimate the chances of mapping semantics on to the brain and, conversely, underestimate the ambiguous relations between semantics and neural function. If neurobehavioural observations are to serve in revising concepts, conceptual instability can be a valuable heuristic. While facing dangers of circularity, instability can drive empirical work that examines complex neurobehavioural relations.

3.5. Conceptual innovations: on what basis?

While B&H deny conceptual conservativism (Bennett et al., 2007), they nonetheless draw a sharp divide between the empirical and the conceptual. For this reason they confidently apply foundationalist logic to consciousness and the emotions. Pursuing this, we show that, ironically, they are obliged to innovate. For working scientists, by contrast, this is normal. Thus Baars notes in discussing consciousness: 'science often begins with operational definitions, not conceptual ones' (Baars, 2007, p. 236). Even behaviourists accept *accurate voluntary report* as such an operationalization. Report of what, one may ask? For B&H the phenomena divide into dispositional and occurrent transitive consciousness, perceptual, somatic and kinaesthetic consciousness, affective consciousness and consciousness of one's emotions and actions, and, finally, self-consciousness (see B&H, Section 9.3). Not all of these terms are in common usage nor, for that matter, are they frequent in philosophical literature. They relate in various ways to the concepts of knowledge, receptivity and attention (Sections 9.3 and 9.4). Although extensive, the classification features a conspicuous absence. A complete and dynamic picture of consciousness can hardly be expected once *temporal consciousness* is excluded.[11] This is also related to lack of discussion of recent work on the relation between *consciousness* and *attention*.

Other problems arise. How do B&H decide to indicate a phenomenon with a single term? What kind of analysis is this? How do they identify agential consciousness as a 'different kind of attentional consciousness'? (p. 257) We are not told. Nor indeed do they show how they avoid the error of substantivating properties. Further, much empirical and conceptual work *has* examined the relations between attention and consciousness. While a foundationalist would reject work reviewed by, say, Posner (1994) as based on conceptual error,[12] Hardcastle (2003) uses it to propose conceptual revision. Specific observations show, it is suggested, that neural activation can be used in clarifying how *consciousness* differs from *attention*. Given the conceptual instability, the field can move forward. Lamme (2003) correlates the terms to *separate* neurobiological networks and, using other empirical work, Dehaene et al. (2006) use the evidence to support the transitive/intransitive distinction. In this way, conceptual discussion can be freed from attempting to resolve issues on *a priori* – or purely analytical – grounds.

Given their foundationalism, B&H must also treat emotions idiosyncratically. In a chapter of 25 pages (they dedicate 30 to self-consciousness), B&H make a peculiar subdivision of affections into emotions, agitations and moods (p. 199). They further suggest that there 'is no single paradigm of an emotion which can

[11] Given the binding problem of, roughly, *how brains enable us to perceive each experience as unified*, this is widely discussed (for review, see Dawson, 2003). The topic has generated views as different as those proposed by, on the one hand, Edelman and Tononi (2000) and, on the other, Varela (1999). As Bergson noted long ago, it raises issues that can be read as discrediting the whole analytical enterprise (Hoy, 1976).

[12] Hardcastle (2003) refers to Posner's (1994) conclusion that an understanding of consciousness must depend on an understanding of the brain networks that subserve attention, in much the same way as a scientific analysis of life without consideration of the structures of DNA would seem vacuous (Posner, 1994, p. 7398).

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serve, as it were, as a conceptual prototype' (p. 205). In this B&H are unlikely to be challenged. But does it follow that conditioning rats to fear an electric shock (cf. LeDoux's important research) throws no light on human emotion? Why should an experiment be devalued by its non-foundational status? We do not think this reduces its power to show how emotional functions influence experience. While not a paradigm or prototype, that is not the point.[13] Nor, indeed, do we think that 'the conceptual complexity and diversity of emotion' would in principle prevent such a simple fear-response from being a paradigm or prototype. Rather, the diversity of emotional experiences and their subserving neural correlates – including many modulatory neural mechanisms – may perhaps explain this complexity.[14] It is one thing to deny the existence of a single prototype for emotions, it is another to accept a particular variety of emotions as a starting point. Indeed, this is why we are surprised that B&H introduce a semantic subdivision of emotion so blithely. In the 'community of speakers', emotions and moods are common concepts but, we think, agitations are not.[15] That is, in ancient and early modern thought (e.g. Descartes, Locke) agitations are not uncommon and, more recently, Ryle distinguished them from inclinations (1949, p. 90). Not all results of 'armchair psychology' (Corbett, 1955), however, find a way into philosophical, psychological or everyday language. Again, if the neuroscience of emotion depended on *a priori* categories, to add or distinguish a category would have devastating results.

The authors do stress that the 'boundaries between emotion, agitation and mood are not sharp' (p. 202). This is wise because the 'generalizations concerning the concepts within the three subcategories' may have more value in discussing psychological and mental predicates than foundationalist science. Further, B&H fail to clarify what is meant by denying that sharp *boundaries* can be drawn. Indeed they say nothing about how to discover this, whether empirical research can play a role, or if it results from philosophical analysis. Nor, alas, do they say what consequences it might have. This is unfortunate because, on our reading, neuroscientific work gives a more dynamic perspective on the relation between established concepts and empirical description.

3.6. Conceptual anomalies matter

Given neural plasticity (and cultural variation), it is difficult to define what is normal. While B&H tackle the issue conceptually, we also link it to empirical investigation. Given their theory of language, B&H claim that 'the criterion for feeling a sensation lies in a person's behaviour and what he says' (p. 124). In a footnote, however, they suggest that feeling a sensation can produce a 'curious anomaly' if attention is distracted from a pain. For the authors, this is a singularity ('in the mathematical sense') in the grammar of sensation (p. 121, note). Since a sensation cannot exist unfelt, they do not distinguish *having a sensation* from *feeling a sensation*. Why, given this background, is it anomalous to distract attention from a pain? Does the sensation of pain not depend on reporting or otherwise displaying it through behaviour? Does not the formula 'distraction of attention from a pain' show a logical fallacy? It seems to us that the pain and the attention are separate phenomena that establish a relation – even if the pain can be felt and displayed without the person's attending to it. According to the authors' standards, unattended pain should not be called a *pain* in the sense of a sensation which is felt and reported. To our view, this complexity is not anomalous at all. *Pain*, we suggest, is a complex, distributed phenomenon which, not surprisingly, exhibits phenomenal variability.

PFN identifies a few exceptional psychological predicates that apply to the body or its parts. For example, we say 'my hand hurts' (p. 73). Clearly, this is not to be interpreted in relation to a brain that perceives (or similar mereological fallacies). Unfortunately, however, B&H underestimate the flexibility of language. They forget that, on a given occasion, a person chooses whether to say 'you're hurting me' or 'you're hurting my hand' or 'you're hurting my finger'. Once again, by treating the case as an exception they mask the variability

[13] Many scientists have long since abandoned the passivity and non-cognitive view of emotions (see e.g., Panksepp, 2005).

[14] The authors may overstate the claim that, as non-language-users, animals lack many emotions (e.g. de Waal, 2006; Savage-Rumbaugh et al., 2000).

[15] Ironically, we think that this division is proposed on empirical grounds. Thus, in discussion Nico Frijda – author of *The Emotions*, and *The Laws of Emotions* – remarked that if 'agitations' are a useful concept, "it is not because it is a concept but because empirical data suggest that it may be a useful concept." Frijda, however, does not believe 'agitations' to be a useful addition. (Reactions to Peter Hacker's comments on neuroscience and emotion theory, Amsterdam, April 6, 2004).

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of mereological relations. We, by contrast, regard these examples as showing the complexity of how such relations can be expressed by using a coherent conceptual web. Indeed, we would apply the same logic to the pain example. Although we have distinct concepts that can be described by different 'rules', *pain* and *attention* also identify experiences that are *not* prescribed by a unique set of rules. Simply put, we have a linguistic flexibility that enables us to speak about events by interlinking the conceptual and empirical domains. B&H perform an act of faith in positing that their conceptual analysis identifies true 'wholes'.

Semantic conservatism also shows in the discussion of *phantom pain*. Characteristically, faced with this abnormality, B&H propose redescription. The surprising experience should be reframed, they suggest, as 'pains felt outside the body (in the "phantom limb") *where the limb still seems to be*' (p. 124). This move would follow rules for using the word *pain* and, crucially, save us from mistrusting the subject as the source of information about experiences. Nonetheless, redescription leaves a riddle. While it is odd to feel pain where an absent limb *seems* to be, B&H do not see the problem as a matter of fact. Rather, it is an empirical mater. The subject (honestly) reports a sensation in a body part that is no longer in place. To this, however, the strict foundationalist is blind. Given a theory that reduces concepts to following (logico-grammatical) rules, such a description is seen as off-limits. Language describes normal cases, therefore we cannot – they think – capture what is meant by phantom pain. We disagree. There are dangers in clinging to logico-grammatical restrictions and, at times, empirical findings can be used to make conceptual adjustments to a phenomenon under investigation, without implying that a totally different phenomenon is at stake – as B&H proclaim (p. 384).

Perhaps the most interesting anomaly occurs in discussion of synaesthesia. B&H refer to the restrictions as characterising '[W]hat kinds of things *can* be coloured – that is, what are *intelligible* subjects of colour predicates' (p. 130, italics in text, cf. p. 133). Therefore, they write, it 'needs no science to tell us that it is senseless to ascribe colours to numbers'. While this may seem reasonable, experience of synaesthesia produces what B&H see as a logico-grammatical difficulty. Synaesthetic subjects report seeing coloured numbers or smelling sounds or hearing letters. How do we adjudge this? Are they mistaken? The alternative, of course, is to ask empirical questions. Thus Ramachandran (2003) set out 'to show that synesthesia is a real sensory phenomenon, not mere imagination or memory'. Instead of treating it as a logico-grammatical problem, positing that synaesthetes are crazy or drawing attention to themselves, anomalies are traced to the brain. In work that many (ourselves included) find convincing, they can be shown to correlate with neural 'crosswiring' (cf. Rouw and Scholte, 2007). Subjects, on this view, accurately report sensory phenomena *in spite of how language is ordinarily used*. Synaesthesia is indeed a curious anomaly, an exceptional feature for which neuroscience can offer us an explanation. The example is revealing for two reasons. First, anomalous ways of speaking are shown to be separable from logico-grammatical confusion. Second, we can learn about the brains of synaesthetic subjects by contrasting empirical descriptions with observations of how brains ordinarily function. The case shows the advantage of abandoning strict foundationalism in order to make space for work that depends on semantic tolerance.

The strength of *PFN* is its negative argument. Since brains cannot, in themselves, undertake psychological activities, we should reject the dualism of some neuroscientific writing. This applies to ontological reductionism and claims that brain-based concepts can replace their everyday counterparts. Strikingly, B&H seek to restrict neuroscience to studying the neural conditions of mental functions that can be completely clarified by *a priori* conceptual analysis. Not only does this depend on an unwarranted belief in linguistic transparency but it runs against the spirit of Aristotle. B&H's extreme view, however, prevents them from clarifying *blindsight*. Overlooking linguistic flexibility, they merely rule against any such description. Further, given the complexity of mereological relations, when B&H innovate, they fail to justify their views. For theoretical reasons, they are forced to disregard neural correlates that suggest, for example, how *consciousness* relates to *attention*. In fact, work on synaesthesia shows that, in all of us, even vision depends on neural integration. Anomalies matter because brains function by regulating how we act.

4. Perception and action: from anomalies to complexity

In PFN, action and perception are separate. While action is said to be voluntary (in just three pages), perception is passive. Although a traditional view, many emphasize interdependence (e.g. Panksepp, 2005). Further, neuroscience builds on the work of both phenomenological philosophers (e.g. Husserl and

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Merleau-Ponty) and non-cognitive psychologists (notably J.J. Gibson). Enthusiasm abounds for non-foundationalist approaches like enacted perception, embodied cognition, action–perception–coding, which emphasize the coherence of action with other functions. In an influential synthesis, Clark (1997) suggests that 'the traditional divisions among perception, cognition, and action look increasingly unhelpful' (Clark, 1997, p. 221). Although freer of dualism or the mereological fallacy than writings highlighted in *PFN*, even these *activist* views of cognition are ignored by B&H.

The chapter on sensation and perception begins with the foundationalist claim that human beings possess 'the passive power (susceptibility or liability) to have bodily feelings from the perceptual powers of the five senses' (p. 121). For B&H, the passivity of perception is foundational. This chapter explores – not human actors in a complex world – but contrasts between perception and sensation. Predictably, we are warned against mereological confusions, like thinking that 'pain in the knee' relates two independent objects – pain is not an object but a sensation. Specifically, the subject's behaviour or utterances indicate where pain is. In the case of phantom limb pain, it is where 'the sufferer sincerely indicates it to be' (p. 125) even if this is where a foot would have been. The authors object to asserting that a subject could be wrong about his sensation by saying that he or she has a pain which she in fact cannot have. This is to be expected, since a subject's utterances and behaviour are seen as the prime indicator of mental states. As noted, B&H admit that brain activities can sometimes be out of line with normal use of concepts or indices. Especially if we are talking about exceptional, singular, anomalous situations, we should not question established conceptual boundaries. We have challenged this by showing how an unusual case like synesthesia throws light on normal brain function.

There is nothing exceptional about relations between perception and action. Self-evidently, activities pertain to a subject – not a brain – and can be described by semantic rules. Without these, it would be impossible to follow B&H in viewing perception as a 'passive' power. This, however, does not mean that the description holds. First, neuroscience shows the inseparablity of perception and action both in cases like pain or synaesthesia, and for normal subjects in normal situations. Further, in spite of our concepts, this is equally marked in both phenomenology and behaviour. Although matters are not often not described this way, we perceive *actively* by using the body's perceptual systems (e.g. turning our heads, scanning with our eyes, etc.). *Contra PFN*, perception and action are behaviourally, structurally and neurally interdependent. Further, in ways to be determined, this unified experience must depend on temporal integration. For B&H this arises because 'otherwise the person or animal will not see a coloured, moving object of the relevant shape'. Moreover, 'the simultaneous activity of these cell groups (responding to motion, shape, colour, etc.) had better be connected to the centres that control recognition, movement and co-ordination' (p. 141). In treating the 'binding problem' in an information-theoretical way they overlook other views. Specifically, they fail to note how those writing on embodied or enactive perception view *experience*. For Noë (2004), it is not 'something that happens in us. It is something we do; it is a temporally extended process of skillful probing' (Noë, 2004, p. 216). It is unfortunate that B&H do not question the traditional doctrine of the 'passive power' of perception.

It is increasingly claimed that perception and action share a 'common coding system' (Prinz, 1997; Hommel et al., 2001). Using the Simon task, it can be shown that a subject who does something with his right hand is typically delayed in perceiving an object on the left, and vice versa.[16] Since a simple action can be facilitated or impeded by specific – compatible or incompatible – aspects of perception, it is argued that they use common codes for, among other things, left and right. While perception and action cannot be easily recruited to contrasting tasks (Prinz, 1997), Hommel et al. (2001) trace these relations to spatial, symbolic and temporal codes. It is claimed that the dominant cognitive view underestimates, and fails to account for, how action-related processes reciprocally impact on both processing perceptual information and perceptual learning. In these terms, B&H too make the cognitivist's error of overlooking interference between perceptual and action tasks. Far from functioning separately – which might allow for separate conceptual foundations – perception and action

[16] This is a simple reaction-time task where one has to identify the colour of a stimulus that appears in one of two positions on a screen and respond by pressing a button with either left or right hand. Although location of the stimulus is irrelevant to the task, the response time is influenced by the compatibility of stimulus location with the location of the button (see, Simon, 1990; for discussion, Hommel and Proctor, 2004).

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interconnect at behavioural, phenomenal and neuronal levels. Viewing perception as passive blinds B&H to conceptually interesting work.

Much other relevant neuroscientific research is ignored. For example, in recent years, there has been much interest in mirror neurons (e.g. Rizzolatti et al., 1996; Rizzolatti and Arbib, 1998; Gallese and Goldman, 1998). These neurons, first discovered in macaque monkeys, are active in a range of perceptual and behavioural tasks. By refuting the single-function view of neurons, this shows that observations of brain activity can have conceptual consequences. While debate continues, Rizzolati's group claims that mirror neurons both allow an animal automatically to prepare an action like a competitor's while also enabling understanding (Rizzolatti and Arbib, 1998). The proposal has evoked interest beyond neuroscience in, for instance, philosophy, ethology, psychology and linguistics (see e.g. Preston and de Waal, 2002; Adolphs, 2002; Gallese and Goldman, 1998). Discussions stress the immediacy and the automaticity of integrated emotional, perceptual and action processes. In spite of intuitions, action and perception enjoy immediate reciprocal relations. Indeed, perceptual experiences enable certain actions to be performed with ease. Finally, the converse may also hold. More recently a study comparing experienced and inexperienced dancers has shown that the former displayed enhanced neural activity when observing dancing like that they had experienced (Calvo-Merino et al., 2005). Indeed, similar findings have been reported for amateur musicians using practiced or unpracticed notes (Lahav et al., 2007). Perception is also modulated by previous motor experience.

Foundationalism throws little light on active, experience-driven human perception. Some invoke not only common codes or mirror properties but also *shared representations for actions* (Gallese et al., 2002; Prinz, 2003). These are common to actions that are observed, performed, imitated or even imagined. They are internally 'simulated' by subjects in each of the conditions. Given similarities across simulations, Jeannerod (2003) summarizes a review by saying that these actions are similar 'except for the muscular contractions and the joint rotations' (p. 1). Further, there are mechanisms where, by monitoring signals from bodily movements, a person can recognise herself as both possessor of a body and the agent of actions. Such complexity is in stark contrast to B&H's simple concept of *voluntary action*. Use of internal simulation of action and shared representation matters for learning, joint action and imitation. It features in interactions where subjects undertake perceptual and behavioural tasks (Becchio et al., 2006; Gallese and Goldman, 1998; Georgieff and Jeannerod, 1998). Both simulation theory and its rivals can explain errors or misattributions or hallucinations in schizophrenic or psychotic patients. Specifically, many misattributions depend on representations that underpin observed and imagined actions. Failure in the self–other discrimination used to ascribe the represented action to the correct subject may explain these striking facts (Jeannerod and Pacherie, 2004). Finally, normal subjects also make similar misattributions in everyday settings. These are not 'anomalies' like those against which we are warned in *PFN*.

The interlinking of perception and action argues for conceptual adjustment. Neurally, they share more than any foundationalist proposes. In itself this need not interest someone who uses only behavioural or verbal criteria to decide if perception or action occurs. The neurophysiological similarities (or shared representations) do, however, explain action/perception interdependence at behavioural, phenomenal and verbal levels. For example, as we speak we also *experience* our speaking. Self-monitoring may prompt new thoughts rather as, in hearing others, we may simulate (aspects of) their thinking. In sum, recent neuroscience shows that, while distinct, our modes of perception connect up with action. Since perceiving is not passive, this is reason to discard B&H's prescriptive view of the concept. Semantic purism, in other words, may derive not from empirical findings but from the Aristotelian subdivision of the soul.[17] On close scrutiny, however, our everyday concepts cannot be applied without reservation to behaviour, phenomenology or at the level of the brain. To calibrate the concept, therefore, neuroscientists can examine its interdependency with action. Plainly, scrupulous and elegant linguistic analysis cannot be *foundational*. Rather, this is a field where conceptual change can arise from a judicious combination of empirically driven semantic tolerance with semantic criticism.

[17] Although Aristotle himself highlights this, referring to different proposals for the subdivision of the soul. Cf. *De Anima*, Section III, par. 9.

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4.1. Language in the perception–action cycle

The discovery of interdependencies associated with *language* are especially likely to lead to conceptual synergies. For example, in a major review Van Lancker Sidtis (2006) denies that brains could distinguish syntactic from semantic patterns. Traditional linguistic categories are thus 'more useful as an educational and analytical heuristic' than in describing the biology of language. Such claims may prefigure changes in our concepts of language (and linguistics). Indeed, in another review, Willems and Hagoort conclude:

> ...language and action are not two isolated systems in the brain. Rather, language and action recruit overlapping parts of the brain and information coming from both can be used in qualitatively similar ways (2007, p. 286).

They suggest that integration draws on analogies (or homologies) to layers of structure based on neurons, coding and perhaps (actional) representations. Since language occurs in time, hierarchical organization is needed. In all species, brains self-organize to give organisms (a degree of) context-sensitive control over behaviour. As Christensen and Tommasi (2006) stress this can be modelled by neuroeconomics even if events depend on perception–action cycles that occur 'not only in series but also in parallel' (Fuster, 2004, p. 145). Deacon (1997) stresses that the prefrontal cortex gives humans unusual flexibility that is likely to have co-evolved with language-dependent practices. Just as for perception/action, B&H's framework permits contact with such ground-breaking work only on the condition of the logico-grammatical alterations, as mentioned above – with the consequence of no longer discussing the same phenomenon.

The *PFN* approach seems naive even at the level of the cell. Mirror neurons respond to both visual cues and their auditory and verbal counterparts. Since they are found in the macaque homologue (F5) to part of Broca's area (Molnar-Szakacs et al., 2006), this is unsurprising. They almost certainly connect action (and speech) to social events. Evidence for this is consistent with the finding that the inferior frontal cortex subserves action by hands, speech (Rizzolatti and Arbib, 1998), facial imitation, motion imagery and motor observation (Lindberg et al., 2007). In the brain, action production and observation exploit a distributed network that gives 'object knowledge' (Grèzes and Decety, 2001). Not only do action and linguistic sequencing exploit (some of) the same networks but linguistic tasks feature significant dissociations. Nonetheless B&H are correct that it is the whole person that perceives, acts and speaks. Indeed, no one uses formulations like 'the brain speaks' or 'the brain hears' because, in neuroscience, language is treated as a unified phenomenon. Brains integrate events in social, behavioural, phenomenal and other time-scales. Plainly, no language 'part' (or faculty) could possibly have priority over the person.

As B&H aim to delineate the 'logical space within which facts are located', they separate language from action and perception. For this reason *PFN* disregards 19th-century attempts to trace language to localized functions and, equally, challenges to such views (for review, see Lindberg et al., 2007). Indeed, B&H studiously ignore theoretical and empirical work about linguistic cognition. Strikingly, they ignore theories that posit neural modularity to explain an (alleged) language faculty. They overlook the fact that, unlike neuroscientists, linguists often invoke the brain to 'explain' language (e.g. Pinker, 1994; Lakoff and Johnson, 1999; Jackendoff, 2002). Consequently, they fail to notice that empirical neuroscience seems incompatible with this view. Even Chomsky signs up to viewing language production and understanding as intrinsic to the action–perception cycle. With colleagues he writes: 'a neuroscientist might ask: What components of the human nervous system are recruited in the use of language in its broadest sense? Because any aspect of cognition appears to be, at least in principle, accessible to language, the broadest answer to this question is, probably, "most of it"' (Hauser et al., 2002). In spite of purist semantics, cognitive functions are inseparable from public language.

B&H are characteristically silent. Indeed, they mention Chomsky only as a source of the expression '"mind/brain" – as if mind and brain were (or might be discovered to be) one and the same entity' (p. 104). Steven Pinker, who might be seen as a victim of the mereological fallacy, is ignored. In part, we think, this is because neural correlations between language and the brain arise in social, developmental, cultural contexts. Given that brains are not little people, this makes ontological reduction unthinkable. However, we suspect there may be a deeper reason for neglecting such work. Strikingly, B&H echo the formalists in treating language as transparent. While not claiming that brains *represent* words, B&H hypostasize verbal patterns by binding verbal formulations to the dictates of a (semantic) grammar. In contrast, neuroscientists view language as

inseparable from tasks and report occurrences that can challenge any rule-based model. At the level of the brain, language is a complex, distributed phenomenon that constrains how whole people (inter)act. Next, let us contrast this with how mainstream linguists approach neuroscience.

A recent issue of *The Linguistic Review* aims to reconnect linguistics with the brain. Starting with Jackendoff's (2002) formalisms, linguists discuss how to map language on to neuroscience. Results are thin. Walenski and Ullman (2005) note that if we work 'in isolation from the study of other cognitive functions', there can be 'no science of language' (p. 327). This applies, they think, to both processing and neural structure. Representing minimalism, Maranz (2005) views linguistic intuitions as *behavioural* data that can be used to overthrow 'static aspects of linguistic representations' (p. 437). No one at all defends the classic (generativist) view of a (non-minimal) language module. As editor, Ritter (2005) puts it that 'language emerges out of a collected network of brain circuits or systems' (p. 117). Linguists must ask if it is 'legitimate to abstract away from social interaction and general cognitive processes'. We find it striking that neuroscience drives linguists to follow those who investigate signalling in primates.[18] Prefiguring our conclusions, Lieberman (2005) stresses that language is regulated by neural structures that also contribute to 'motor control, cognition and other aspects of behaviour'. Indeed, he draws the harsh conclusion that generative linguistics has made a negative contribution to cognitive science. Not only do we find this broadly compatible with Van Lancker Sidtis's (2006) conclusion but we think it explains Pulvermuller's (2003) struggle to specify neural circuits for *words*, *meaning* and *syntax*. In seeking correlates, he finds no unity. While words are distributed by cell assemblies, their semantic properties mirror a brain's cortical topography. In verb semantics, for example, brains use motor regions corresponding to body parts (e.g. the mouth for *talk* and the leg for *walk*). Syntax, he suggests, is an interplay between specialized neuronal units, sequence detectors, and dynamics that regulate cortical activity. Finally, the most damaging challenge to formal linguistics may be what Grèzes & Decety dub the 'most interesting' (2001, p. 15) part of their meta-review. Silent rehearsal, they find, is *more* localized in the brain (and the dominant hemisphere) than speaking the same 'words' (e.g. Perani et al., 1999). Quite different neural processes underpin the *same thoughts*.

Neural activation is distributed during linguistic tasks. Given the brain's plasticity, language-related activation is sensitive to task, individual and even kind of language. As Fabbro (1992) shows, during simultaneous translation experts may learn to associate *one* language with the non-dominant hemisphere. In monolingual settings, when using the same language, activation ceases. Plainly, brains do not simply encode or follow rules.[19] In spite of beliefs to the contrary, lateralization is complex and language exploits both hemispheres. Further, while centred in the cerebral cortex, sub-cortical structures – and emotion systems – are necessary to speech and listening. As activation spreads across the brain, we exploit the world and, of course, what is (and has just been) heard. Such findings destabilize the view that language is identifiable with verbal patterns. Indeed, given mirror neurons speech can draw on perceptual activity. Not only does this undermine appeal to linguistic modularity, but it shows the monological bias of many established concepts. Given brains in our heads, we imagine that they 'contain' a language faculty (e.g. Pinker, 1994) or, perhaps, embodied concepts (Gallese and Lakoff, 2005). In contrast, neuroscientists emphasize what happens in cultural and physical environments. This view maps on to – not everyday conceptualizations of language – but activist views of cognition. We are given reason for emphasising that utterances are spoken and heard *in a shared present*. Language exploits brains that connect human experience with both bodies and our common social worlds (see e.g. Hutchins, 1995; Jeannerod, 2003; Gallagher, 2005; Wheeler, 2005).

Since brains neither speak nor hear, the mereological fallacy appears in the (classic) view that they generate linguistic forms. Linguists often fall foul of brain–body dualism and, dramatically so, when they link genes to grammar (see e.g. Pinker, 1994). In neuroscience, by contrast, language is integral to an action/perception signalling cycle. While utterances permit formal analysis, they also draw on an evolutionary history of interaction (Locke and Bogin, 2006). There is much common evolutionary, developmental and cultural history to perceiving, acting and talking. In comparative neurophysiology the plasticity of language is traced to how we came to

[18] See Savage-Rumbaugh et al. (2000).

[19] It could be argued that this fits with Love's (2004) conceptual arguments, Ross's (2007) use of game theory and the biocognitive critique of Kravchenko (2007). Elsewhere, Cowley (in press) seeks to re-conceptualize neural coding as a dynamical process where semantic synthesis emerges from a history of past experience.

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control vocalizations (Deacon, 1997). While other primates (but not whales or birds) vocalize automatically, humans use expression to control what we and others think, feel and do. The dialogical brain controls joint behaviour in experiential time (Linell, 2007). Indeed, not only is the human brain biocultural but the phenotype is designed to adjust to the body's changing world. Emergent neural hierarchies place language and perception–action in complex mereological relations. While the nature of this interdependency is complex it leads to brain sculpting (based on neural Darwinism) which, as Mesulam (1998) suggests, sustains *selectively distributed processing*.

Foundationalism also fails to clarify development. B&H therefore overlook the view, shared by Trevarthen (1979, 1998), Stern (1985, 2004) and Bråten (1998), that neural change is partly driven by human expression. Culturally attuned intersubjective behaviour arises as we integrate behaviour with objects, language and our changing motives. In early life, language is indexical. The self-organizing brain exploits – not semantics – but how percepts relate to motives. While serving for re-presentation (we hear repetitions of words, themes and ideas), this is only part of language. Given a life history, what we hear has to be integrated with the functions of first-person phenomenology (how we hear *words* and *attitudes*). Indeed, we learn to shift between automatic and deliberate forms of action. Although used in thinking, language serves, just as crucially, to manage social life. Real-time dynamics shape what Menary (2007) calls the *cognitive integration* that allows us to use a meshwork of public linguistic resources (Cowley (2007a,b)). This view of the uniqueness of human cognition is strikingly anticipated in Mesulam's (1998) view of action–perception cycles. These depend on 'distributed computations where each individual intelligence can become incorporated into an interactional lattice that promotes the transgenerational transfer and accumulation of knowledge' (Mesulam, 1998, p. 1014). It also maps onto Davidson's suggestion that, at a behavioural level, the *only* possible basis for language is 'two (and typically more than two) creatures reacting in concert to features of the world and to each other's reactions.' Learning to talk – and think – may draw on high-level control systems that develop as a result of integrating action and perception with public linguistic resources.

4.2. Against strict foundationalism

PFN is based on the belief that the *a priori* analysis of human faculties can be used to understand and promote neuroscience. We maintain that the promise cannot be fulfilled. First, the logic of *PFN* is at odds with empirical facts about perception, language and action. Since these are not faculties that can be comprehensively described by established concepts, the authors can do no more than offer *one* description of mental states. Explanatory reduction, we have argued, ensures that neural investigation is also possible. Far from depending on faculties, mental states are distributed phenomena that depend on our remarkable powers for real-time integration. Far from clarifying the human faculties, we find that B&H cover their eyes to the flexibility of psychological concepts. This happens, we think, because their semantic purism ignores the flexibility of language. Reversing this logic, we posit that neuroscience can both do without foundationalism while also using empirical work constructively to destabilize established views of our mental powers.

For B&H language is a transparent medium. Not only is it separate from action and perception but their theory depends on distinguishing automatic and (non-conscious) behaviour from deliberate action. To make sense, language depends on conscious rule-following. Like the cognitivists, B&H endorse narrow representationalism. As noted, words are determinate units used in accordance with a grammar whose combinatorial possibilities are made intelligible by the explanations used and accepted in a community. Such descriptions allegedly capture an *a priori* conceptual reality. For B&H, they are irreducible. Finding this indefensible, we defend a mild coherentism. First, we stress the value of semantic tolerance. Second, using Bechtel (2002), we treat neuroscience as an example of *explanatory* reduction. Instead of reducing action, perception and language to functional descriptions we trace functions to descriptions based in empirical work. The results underpin our final claim – which is that real-time dialogue and experience of language is integral to human cognition.

Instead of hypostatizing human faculties, we look at how linguistic and other tasks play out at the lower neural level. First, focusing on perception, we used empirical evidence to show that these powers are – not passive – but constitutive of a distinct mode of action. Brains function by prompting organisms to exploit action–perception cycles. Next, we argued that language is constrained – not just by established concepts –

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but also by the social events that colour experience. This depends on perception–action cycles, processes which, drawing on temporal integration, give rise to whole experiences. Language, we conclude, is distributed as a result of complex cognitive integration. The neuroscience that prompts us to such views is in itself, we suggest, free of brain/body dualism. It endorses activist cognition by tracing perception and action to how the organism responds to experience of the world. The same also applies, we think, to speech and understanding. Cognitive integration thus forestalls not just a general ontological reductionism but also a naive appeal to traditional psychological faculties in the neurosciences. Rather, emphasis falls on dynamical relations whereby concepts serve in exploring empirical events such that subsequent results can be used to destabilize and, later, restabilize human concepts.

5. Neuroscientific adolescence

Science comes of age when everyday concepts begin to draw on their scientific counterparts. Today, old views of mental functions are being challenged by work on the brain. Far from being organs that 'contain' human faculties, they enable us to act by drawing on interdependent, distributed processes. To an extent, this finding is altering our views of *action*, *perception*, *language*, etc. Above all, we can begin to recognize the importance of how language dynamics are integrated in multiple time-scales. This is, we think, the neuroscientific challenge to semantic purism. In practice, once we investigate linguistic cognition, we are bound to note the interdependencies between systems. Linguistic forms are thus unlikely to be represented distinctly or separately and, if they are, the key must lie in integrating them with action/perception. Neuroscience thus challenges a web of established concepts. Language, as Pulvermuller, Arbib and Linell and others suggest, is based in (dialogical) action during which brains co-function in real-time.

Although B&H treat language as a transparent medium, we see this as no more than a strategy for avoiding unsettling discussion. Even if we concur in rejecting brain–body dualism, we think neuroscience can do without foundationalism. This is because what B&H present as inviable wholes (e.g. perception, language) can often be decomposed to reveal many interconnections at different levels. There are, as we emphasize, many kinds of dependency. The mereological flexibility provides us with semantic short-cuts, for example, that allow us to distinguish consciousness from attention while still relating them. Although we enjoy B&H's presentation and applaud some of their critique, their descriptions of human faculties disappoint. Semantics cannot throw much light on brains. Using logico-grammatical rules to describe mental concepts can be valuable sometimes, we think, in critiquing empirical work. However, if the prosperous field of neuroscience has to rely exclusively on established concepts, progress would be hindered. Even in adolescence, the field lacks certainties. *PFN*, we conclude, tells us less about neuroscience than about the risks of disguised dualism and the powerful logic of *strict foundationalism*.

B&H view language as a conceptual system where, at best, words are used correctly. This conservative view parallels formalist theories. It blinds B&H to how thought and language arise in concert as we react to both features of the world and each other's reactions. It blinds them to the action–perception cycles that enable talking persons to use indices and concepts which alter in historical time. Conceptual change can be tracked not just by talk about mind but also by studying how experience is integrated across evolutionary, developmental, cultural and individual histories. Neural investigations serve to challenge established concepts in a mutually correcting process. While conceptual foundationalism may protect us from ontological reductionism, it should not preclude using semantic *short-circuits*. Modes of description can pursue both conceptual clarity and increased coherence. For this reason, we stress that there is (and can be) no single description of perception, language, action, etc. An established view of our human powers such as that presented in PFN is elegant but partial and incomplete. Given bodies and history, this is inevitably so. While language is conceptual, thinking also interacts with action, perception and emotion. As it spreads, our brains self-organize as we adopt various roles. Gradually and without reaching a final state, we master both artefacts that represent linguistic patterns and, of course, the connotation-rich musical expression that gives so much sense to our lives.

References

Adolphs, R., 2002. Neural systems for recognizing emotion. Current Opinion in Neurobiology 12 (2), 169–177.

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Baars, B.J., 2007. The global workspace theory of consciousness. In: Velmans, M., Schneiders, S. (Eds.), The Blackwell Companion to Consciousness. Blackwell, Oxford.

Barnes, J., 1975. Aristotle's Posterior Analytics. Clarendon Press, Oxford.

Becchio, C., Adenzato, M., Bara, B.G., 2006. How the brain understands intention: different neural circuits identify the componential features of motor and prior intentions. Consciousness and Cognition 15 (1), 64–74.

Bechtel, W., 2002. Decomposing the mind–brain: a long-term pursuit. Brain and Mind 3 (2), 229–242.

Bennett, M.R., 1999. The early history of the synapse: from Plato to Sherrington. Brain Research Bulletin 50 (2), 95–118.

Bennett, M., Dennett, D., Hacker, P., Searle, J., 2007. Neuroscience and Philosophy: Brain, Mind, and Language. Columbia University Press, New York.

Bennett, M.R., Hacker, P., 2003. Philosophical Foundations of Neuroscience. Blackwell, Oxford.

Bråten, S., 1998. Infant learning by altercentric participation: the reverse of egocentric observation in autism. In: Bråten, S. (Ed.), Intersubjective Communication and Emotion in Early Ontogeny. Cambridge University Press, Cambridge, pp. 105–124.

Calvo-Merino, B., Glaser, D.E., Grezes, J., Passingham, R.E., Haggard, P., 2005. Action observation and acquired motor skills: an fMRI study with expert dancers. Cerebral Cortex 15 (8), 1243–1249.

Changeux, J.P., Ricoeur, P., 2000. What Makes us Think? A Neuroscientist and a Philosopher Argue about Ethics, Human Nature, and the Brain. Princeton University Press, Princeton, NJ.

Christensen, W.D., Tommasi, L., 2006. Neuroscience in context: the new flagship of the cognitive sciences. Biological Theory 1 (1), 78–83.

Churchland, P.S., 1986. Neurophilosophy: Towards a Unified Science of the Mind/Brain. MIT Press, Cambridge MA.

Churchland, P.M., 1988. Folk psychology and the explanation of human behaviour. Aristotelian Society Supplement 62, 209–221.

Churchland, P.M., 1995. The Engine of Reason, the Seat of the Soul: A Philosophical Journey into the Brain. MIT Press, Cambridge MA.

Clark, A., 1997. Being There: Putting Brain, Body and World Together Again. MIT Press, Cambridge, MA.

Corbett, J.P., 1955. Metapsychology. Mind 64 (256), 534–538.

Cowley, S.J., 2007a. The cradle of language: making sense of bodily connexions. In: Moyal Sharrock, D. (Ed.), Perspicuous Presentations. Palgrave MacMillan, Basingstoke, pp. 278–298.

Cowley, S.J., 2007b. The cognitive dynamics of distributed language. Language Sciences 29 (5), 575–583.

Cowley, S.J., in press. The codes of language: turtles all the way up? In: Barbieri, M. (Ed.), The Codes of Life, Springer, Berlin.

Davidson, D., 1997. Seeing through language. Royal Institute of Philosophy 72 (Suppl.), 15–28.

Dawson, K.A., 2003. Temporal organization of the brain: neurocognitive mechanisms and clinical implications. Brain and Cognition 54, 75–94.

Deacon, T., 1997. The Symbolic Species: Co-Evolution of Language and the Brain. Norton, London.

Dehaene, S., Changeux, J.P., Naccache, L., Sackur, J., Sergent, C., 2006. Conscious, preconscious, and subliminal processing: a testable taxonomy. Trends in Cognitive Science 10 (5), 204–211.

Dennett, D., 2007. Philosophy as naive anthropology: comment on Bennett and Hacker. In: Bennett, M., Dennett, D., Hacker, P., Searle, J. (Eds.), Neuroscience and Philosophy: Brain, Mind, and Language. Columbia University Press, New York.

Decety, J., Grèzes, J., 2001. Functional anatomy of execution, mental simulation, observation, and verb generation of actions: a meta-analysis. Human Brain Mapping 12 (1), 1–19.

Edelman, G.M., Tononi, G., 2000. A Universe of Consciousness: How Matter Becomes Imagination. Perseus, New York.

Fabbro, F., 1992. Cerebral lateralization of human languages: clinical and experimental data. In: Wind, J., Chiarelli, B., Bichakjian, B., Niocentini, A. (Eds.), Language Origin: A Multidisciplinary Approach. Kluwer, Amsterdam.

Fuster, J.M., 2004. Upper processing stages of the perception–action cycle. Trends in Cognitive Sciences 8 (4), 143–145.

Gallagher, S., 2005. How the Body Shapes the Mind. Oxford University Press, Oxford.

Gallese, V., Goldman, A., 1998. Mirror neurons and the simulation theory of mind-reading. Trends in Cognitive Sciences 2 (12), 493–501.

Gallese, V., Ferrari, P.F., Umiltà, M.A., 2002. The mirror matching system: a shared manifold for intersubjectivity. Behavioral and Brain Sciences 25 (1), 35–36.

Gallese, V., Keysers, C., Rizzolatti, G., 2004. A unifying view of the basis of social cognition. Trends in Cognitive Sciences 8 (9), 396–403.

Gallese, V., Lakoff, G., 2005. The brain's concepts: the role of the sensory-motor system in conceptual knowledge. Cognitive Neuropsychology 22 (3/4), 455–479.

Georgieff, N., Jeannerod, M., 1998. Beyond consciousness of external reality: a "who" system for consciousness of action and self-consciousness. Consciousness and Cognition 7 (3), 465–477.

Golgi, C., 1906. The neuron doctrine – theory and facts. (Nobel prize lecture). <http://nobelprize.org/nobel_prizes/medicine/laureates/1906/golgi-lecture.html>.

Gray, J.J., 1989. Ideas of Space: Euclidean, Non-Euclidean and Relativistic. Oxford University Press, Oxford.

Grèzes, J., Decety, J., 2001. Functional anatomy of execution, mental simulation, observation, and verb generation of actions: a meta-analysis. Human Brain Mapping 12, 1–19.

Hardcastle, V., 2003. Attention versus consciousness: a distinction with a difference. In: Osaka, N. (Ed.), Neural Basis of Consciousness. John Benjamins, Amsterdam, pp. 105–120.

Harris, R., 2005. The Semantics of Science. Continuum, London.

Hauser, M., Chomsky, N., Fitch, T., 2002. The faculty of language: what is it, who has it, and how did it evolve? Science 298, 1569–1579.

Hommel, B., Musseler, J., Aschersleben, G., Prinz, W., 2001. The theory of event coding (TEC): a framework for perception and action planning. Behavioral and Brain Sciences 24 (5), 849–937.

Hommel, B., Proctor, R.W., 2004. A feature-integration account of sequential effects in the Simon task. Psychological Research 68, 1–17.

Hoy, R.C., 1976. A note on Gustav Bergmann's treatment of temporal consciousness. Philosophy of Science 43, 610–617.

Please cite this article in press as: Keestra, M., Cowley, S.J., Foundationalism and neuroscience; silence and language, Lang. Sci. (2007), doi:10.1016/j.langsci.2007.09.004

Hutchins, E., 1995. Cognition in the Wild. MIT Press, Cambridge, MA.
Jackendoff, R., 2002. Foundations of Language: Brain, Meaning, Grammar, Evolution. Oxford University Press, Oxford.
Jeannerod, M., 2003. The mechanism of self-recognition in humans. Behavioural Brain Research 142 (1–2), 1–15.
Jeannerod, M., Pacherie, E., 2004. Agency, simulation and self-identification. Mind and Language 19, 113–146.
Klagge, J.C., 1989. Wittgenstein and Neuroscience. Syntese 78, 319–343.
Kravchenko, A., 2007. Essential properties of language, or, why language is not a code. Language Sciences 29 (5), 650–671.
Lahav, A., Saltzman, E., Schlaug, G., 2007. Action representation of sound: audiomotor recognition network while listening to newly acquired actions. Journal of Neuroscience 27 (2), 308–314.
Lakatos, I., 1976. A Renaissance of Empiricism in the Recent Philosophy of Mathematics. British Journal of the Philosophy of Science 27, 201–223.
Lakoff, G., Johnson, M., 1999. Philosophy in The Flesh: The Embodied Mind and Its Challenge to Western Thought. Basic Books, New York.
Lamme, V., 2003. Why visual attention and awareness are different. Trends in Cognitive Science 7 (1), 12–18.
Laudan, L., 1977. Progress and Its Problems. University of California Press, Berkeley.
Lieberman, P., 2005. The pied piper of Cambridge. The Linguistic Review 22 (2–4), 289–301.
Lindberg, R., Fangereau, H., Seitz, R., 2007. Broca's area as a collective term. Brain & Language 102, 22–29.
Linell, P., 2007. Dialogicality in languages, minds and brains: Is there a convergence between dialogism and neuro-biology? Language Sciences 29 (5), 605–620.
Locke, J., Bogin, B., 2006. Language and life history: a new perspective on the development and evolution of human language. Behavioral and Brain Sciences 29/3, 259–279.
Love, N., 2004. Cognition and the language myth. Language Sciences 26, 525–544.
Machamer, P.K., Grush, R., McLaughlin, P., 2001. Theory and Method in the Neurosciences. University of Pittsburgh Press, Pittsburgh PA.
Maranz, K., 2005. Generative linguistics within the cognitive neuroscience of language. The Linguistic Review 22 (2–4), 429–445.
Menary, R., 2007. Writing as Thinking. Language Sciences 29 (5), 621–632.
Mesulam, M., 1998. From sensation to cognition. Brain 121, 1013–1052.
Molnar-Szakacs, I., Kaplan, J., Greenfield, P.M., Iacoboni, M., 2006. Observing complex action sequences: the role of the fronto-parietal mirror neuron system. NeuroImage 33 (3), 923–935.
Noë, A., 2004. Action in Perception. MIT Press, Cambridge.
Panksepp, J., 2005. Affective Neuroscience: The Foundations of Human and Animal Emotions. Oxford University Press, New York.
Perani, D., Schnur, T., Tettamanti, M., Gorno-Tempini, M., Cappa, S.F., Fazio, F., 1999. Word and picture matching: a PET study of semantic category effects. Neuropsychologia 37, 293–306.
Pinker, S., 1994. The Language Instinct. Penguin, Harmondsworth.
Posner, M., 1994. Attention: the mechanisms for consciousness. In: Proceedings of the National Academy for Science USA, 91, pp. 7398–7403.
Preston, S.D., de Waal, F.B., 2002. Empathy: its ultimate and proximate bases. Behavioral and Brain Sciences 25 (1), 1–20.
Prinz, W., 1997. Perception and action planning. European Journal of Cognitive Psychology 9 (2), 129–154.
Prinz, W., 2003. Neurons don't represent. Consciousness and Cognition 12 (4), 572–573.
Pulvermuller, F., 2003. The Neuroscience of Language: On Brain Circuits of Words and Serial Order. Cambridge University Press, Cambridge.
Ramachandran, V., 2003. The Emerging Mind. Profile Books, London.
Rescher, N., 1955. Axioms for the part relation. Philosophical Studies 6 (1), 8–11.
Rescher, N., 1974. Foundationalism, coherentism, and the idea of cognitive systematization. The Journal of Philosophy 71 (19), 695–708.
Ritter, N., 2005. On the status of linguistics as a cognitive science. The Linguistic Review 22 (2–4), 117–133.
Rizzolatti, G., Arbib, M.A., 1998. Language within our grasp. Trends in Neurosciences 21 (5), 188–194.
Rizzolatti, G., Fadiga, L., Gallese, V., Fogassi, L., 1996. Premotor cortex and the recognition of motor actions. Cognitive Brain Research 3 (2), 131–141.
Ross, D., 2007. H sapiens as ecologically special: what does language contribute? Language Sciences 29 (5), 710–731.
Rouw, R., Scholte, H.S., 2007. Increased structural connectivity in grapheme-color synesthesia. Nature Neuroscience 10, 792–797.
Rubin, D., 1990. Explaining Explanation. Routledge, New York.
Ryle, G., 1949. The Concept of Mind. Hutchinson, London.
Savage-Rumbaugh, S., Mintz Fields, W., Taglialatela, J., 2000. Ape consciousness-human consciousness: a perspective informed by language and culture. American Zoology 40 (6), 910–921.
Simon, J.R., 1990. The effects of an irrelevant directional cue on human information processing. In: Proctor, R.W., Reeve, T.G. (Eds.), Stimulus-Response Compatibility. Elsevier, Amsterdam, pp. 31–86.
Stern, D., 1985. The Interpersonal World of the Infant. Basic Books, New York.
Stern, D., 2004. The Present Moment in Psychotherapy and Everyday Life. Norton, New York.
Trevarthen, C., 1979. Communication and cooperation in early infancy: a description of primary intersubjectivity. In: Bullowa, M.M. (Ed.), Before Speech. Cambridge University Press, New York, pp. 321–347.
Trevarthen, C., 1998. The concept and foundations of infant intersubjectivity. In: Bråten, S. (Ed.), Intersubjective Communication and Emotion in Early Ontogeny. Cambridge University Press, Cambridge, pp. 15–46.

Please cite this article in press as: Keestra, M., Cowley, S.J., Foundationalism and neuroscience; silence and language, Lang. Sci. (2007), doi:10.1016/j.langsci.2007.09.004

Vanderwolf, C.H., 1998. Brain, behavior, and mind: what do we know and what can we know? Neuroscience and Biobehavioral Reviews 22, 125–142.

Van Lancker Sidtis, D., 2006. Does functional neuroimaging solve the questions of neurolinguistics? Brain and Language 98, 276–290.

Varela, F., 1999. The specious present: the neurophenomenology of time consciousness. In: Petitot, J., Varela, F.J., Pachoud, B., Roy, J.M. (Eds.), Naturalizing Phenomenology. Stanford University Press, Stanford CA, pp. 266–314.

de Waal, F., 2006. Joint ventures require joint payoffs: fairness among primates. Social Research 73 (2), 349–362.

Wagar, B.M., Thagard, P., 2004. Spiking Phineas Gage: a neurocomputational theory of cognitive–affective integration in decision making. Psychological Review 111 (1), 67–79.

Walenski, M., Ullman, M., 2005. The science of language. The Linguistic Review 22 (2–4), 327–346.

Weiskrantz, L., 1997. Consciousness Lost and Found: A Neuropsychological Exploration. Oxford University Press, Oxford.

Wigner, E., 1960. The unreasonable effectiveness of mathematics in the natural sciences. In: Communications in Pure and Applied Mathematics, vol. 13, No. 1. Wiley, New York.

Wheeler, M., 2005. Reconstructing the Cognitive World: The Next Step. MIT Press, Cambridge MA.

Willems, R., Hagoort, P., 2007. Neural evidence and the interplay between language, gesture and action: a review. Brain and Language 101, 278–289.

Wittgenstein, L., 1958. Philosophical Investigations (second ed.) Blackwell, Oxford.

Wittgenstein, L., 1980. In: Remarks on the philosophy of psychology, vol. I. Blackwell, Oxford.

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