

# On the correlation/constitution distinction problem (and other hard problems) in the scientific study of consciousness

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**Objective:** In the past decade, much has been written about ‘the hard problem’ of consciousness in the philosophy of mind. However, a separate hard problem faces the scientific study of consciousness. The problem arises when distinguishing the neural *correlates* of consciousness (NCC) and the neural *constitution* of consciousness. Here, I explain this correlation/constitution distinction and the problem it poses for a science of *phenomenal* consciousness. I also discuss potential objections to the problem, outline further hard problems in the scientific study of phenomenal consciousness and consider the ontological implications of these epistemological issues.

**Methods:** Scientific and philosophic analysis and discussion are presented.

**Results:** The correlation/constitution distinction does indeed present a hard problem in the scientific study of phenomenal consciousness. Refinement of the ‘NCC’ acronym is proposed so that this distinction may at least be acknowledged in the literature. Furthermore, in addition to the problem posed by this distinction and to ‘the hard problem’, the scientific study of phenomenal consciousness also faces several other hard problems.

**Conclusion:** In light of the multiple hard problems, it is concluded that scientists and philosophers of consciousness ought to (i) address, analyze and discuss the problems in the hope of discovering their solution or dissolution *and* (ii) consider the implications of some or all of them being intractable. With respect to the latter, it is argued that ultimate epistemic limits in the study of phenomenal consciousness pose no threat to physicalist or materialist ontologies but do inform our understanding of consciousness and its place in nature.

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## The scientific study of consciousness

‘Consciousness’ refers to a range of phenomena associated with minds and brains: the waking state, awareness, arousal or attention, altered or pathological states, higher order functions such as a sense of self or self-awareness, higher order conscious attributes such as the possession of propositional attitudes (beliefs and desires), an awareness of the possession of propositional attitudes in others, and awareness within a population or group of people of a certain issue or belief. Another sense of consciousness that has been widely discussed in the latter 20th century, and that is the concern of the present

paper, is *phenomenal consciousness* – the experiential or subjective element of our conscious states. The study of consciousness, in these various senses, has traditionally engaged the philosophy of mind, psychophysics, psychology and psychiatry. However, developments in the cognitive neurosciences, also in the latter 20th century, have led to a surge of interest in what is now appropriately deemed ‘the scientific study of consciousness’. Entire journals and associations are dedicated to such study and it is not uncommon to see papers on consciousness appearing in mainstream high-profile journals.

The scientific study of consciousness has to date been dominated by investigation of a variety of

phenomena in the most accessible and well-studied modality – vision [reviewed in Kim & Blake (1), Lamme (2)]. Thus, studies in normal subjects of various masking phenomena, inattentional and change blindness, attentional blink, and perceptual rivalries such as ambiguous figures, bistable motion illusions and binocular rivalry (BR) have all contributed to empirical consciousness research. Experiments in subjects with neurological damage have also provided exploratory avenues such as the split-brain, unilateral attentional neglect, blindsight, visual agnosia, locked-in syndrome and the vegetative state. Investigative techniques used in the study of consciousness, in addition to behavioural and psychophysical approaches, include invasive and noninvasive electrophysiology, various brain-imaging techniques, and a range of brain stimulation methods [see Miller & Ngo (3), this issue].

While vision has been the dominant modality in the scientific study of consciousness, the dominant strategy has been the search for ‘neural correlates of consciousness’ (NCC). This approach is well captured by Crick and Koch [(4), p. 97] when they suggest, ‘It is probable that at any moment some active neuronal processes in your head correlate with consciousness, while others do not’. Based on such a premise, the search for the NCC is now well under way and has already met with substantial success. The visual phenomenon of BR clearly illustrates the NCC programme. BR involves perceptual alternation between two different images that are simultaneously presented, one to each eye. As if to acknowledge that there cannot be two different objects in the same place at the same time, the brain perceives each image in alternation, every few seconds. While perceptually sampling one image, the rival image is completely suppressed from conscious vision (despite remaining presented to an eye) until perceptual reversal occurs, and so on [see Fig. 1 in Miller & Ngo (3), this issue]. The psychophysical properties and underlying mechanisms of these perceptual alternations have been extensively studied [reviewed in Logothetis (5), Blake & Logothetis (6); see also Ngo et al. (7), and Miller & Ngo (3), this issue] and have intrigued such historical notaries as Helmholtz, Hering, James and Sherrington. In the past 10 years, BR research has provided direct (real-time) evidence for Crick and Koch’s NCC premise.

BR is an important phenomenon in the scientific study of consciousness for several reasons. From a practical point of view, it consists in abruptly alternating perceptions, distinct both in time and character. This enables accurate behavioural tracking of a subject’s visual consciousness over time.

Thus, during BR, correlations can be made between alternating perceptual states on the one hand and activity of single neurons in various stages of the visual pathway or of particular brain regions on the other. Furthermore, the choice of images with which to induce BR can capitalize on the identified or known stimulus selectivity of particular single neurons and particular brain regions. Most importantly, BR is a powerful tool in the scientific study of consciousness because it enables the identification and comparison of neural activity correlated with physical stimulus *presentation* and neural activity correlated with a subject’s *perception*. This exciting prospect has indeed been realized, though the strategy leads to a serious problem for the scientific study of consciousness.

Nikos Logothetis, David Leopold and David Sheinberg recorded single-unit electrophysiology in alert macaque monkeys that were trained to report their perceptions during BR. These investigators showed that the activity of most low-level (V1/V2) neurons reflected physical stimulus presentation during BR, with only around 20% of neurons exhibiting firing that was correlated with the monkey’s perception (8). They found higher percentages of perception-dependent activity as they progressed through the visual pathway [~40% of neurons in V4 and the middle temporal (MT) area]. However, when they reached inferotemporal (IT) cortex and the superior temporal sulcus (STS), high in the visual pathway, around 90% of neurons exhibited firing that was correlated with the monkey’s reported percepts [(9); reviewed in Logothetis (5)]. For researchers interested in the scientific study of consciousness, immediate questions arise. Do the BR data from Logothetis’ group imply that the activity of most low-level neurons, given their modulation according to physical stimulus presentation, plays no direct role in visual consciousness during BR (whatever supportive role it may play)? Conversely, can we conclude that high-level IT and STS neuronal activity, being instead modulated according to perception, does in fact play a direct role in the conscious visual states? And what of V1/V2, V4 and MT neurons that are in fact perception dependent?

Further NCC research can be envisaged, refining the details of correlations between neural activities and conscious states, eventually enabling approaches to the question posed by Crick and Koch [(4), p. 97, original italics] who, having noted that there will be neuronal processes that do and do not correlate with consciousness, go on to ask: ‘*what is the difference between them?*’ They further question, ‘Are the neurones involved of any particular

neuronal type? What is special (if anything) about their connections? And what is special (if anything) about their way of firing? We might add, what is special (if anything) about the neurophysiological properties of the distributed circuits in which they lie? These questions are indeed relevant and fascinating and are of great interest to participants in the scientific study of consciousness. They all appear tractable to further scientific investigation. However, even if we possessed answers to such questions, there would remain a significant challenge facing the scientific study of consciousness, one that is generally overlooked or perhaps set aside by the NCC research programme.

### The correlation/constitution distinction

A major concern for the scientific study of consciousness arises when considering the distinction between the neural *correlates* and the neural *constitution* of consciousness (10). This distinction presents a challenge for which, I argue, even an impression of a strategic solution is not yet apparent. It can be outlined as follows. If we imagine that through the employment of all current and future neuroscientific methods (in all contexts, under all conditions and with all methodological constraints overcome), we were able to obtain a complete, real-time and multi-modal description of all the NCC and all observable properties of such, would we be satisfied that we had obtained a comprehensive understanding of the neuroscience of consciousness? I assert not, because *not every neural correlate of a conscious state is necessarily constitutive of that state*. Only an understanding of the neural constitution of consciousness could ultimately satisfy a science of consciousness.

Like consciousness, the term ‘constitution’ has several context-dependent senses. The sense in which I use it is that which is roughly akin to ‘composition’. Thus, we might ask, ‘Of what is that object constituted?’ (‘Of what is that object composed?’) or ‘What constitutes that object?’ In addition we might state, ‘substance *x* constitutes (or, is constitutive of, or is a constituent of) that object.’ Notions of constitution apply not only to objects (things) but also to systems, states, events and processes [often with overlap between these categories; see Mahner & Bunge (11) for an excellent source on ontological fundamentals]. Thus, on a system level, we might ask, ‘What constitutes the cardiovascular system?’ and answer, ‘the heart and blood vessels (and their constituent tissues) constitute the cardiovascular system’.

Similarly, for a particular state of the cardiovascular system we might ask, ‘What constitutes ventricular tachycardia?’ and reply, ‘rapid contraction of the ventricles with three or more consecutive premature ventricular beats constitutes ventricular tachycardia.’ For events, ‘What constitutes a myocardial infarction?’ is answered by, ‘damage or death of heart muscle as a result of interrupted blood supply constitutes myocardial infarction’, while for processes, ‘What constitutes tissue perfusion?’ is answered by, ‘the supply of arterial blood (with nutrients and oxygen) to tissues constitutes tissue perfusion’. Constitution can therefore be seen to be compositional in one sense and essential in another (the latter referring to the essence, meaning or definition of a thing, system, state, event or process), and there are still other senses of the term (eg, a country’s constitution). The constitution relation (in the compositional sense as I use it) may not be the only relevant relation with respect to consciousness, but these issues are deferred until the last section (The Epistemology and Ontology of Phenomenal Consciousness)<sup>1</sup>.

To grasp what I mean by constitution with respect to consciousness (in particular phenomenal consciousness), consider *the experience of* tasting a fine wine, smelling ground coffee, hearing your favorite song or having pain in your knee. There are a myriad of central, peripheral and environmental factors that contribute to these experiences. Yet, the experiences themselves are not located in your environment or even in your periphery but rather centrally (ie, in your brain)<sup>2</sup>. If it is indeed granted, as it must be, that not every neural activity in your brain plays a constitutive role in such experiential (conscious) states, we can borrow from Crick and Koch and state that it is probable (in fact, certain) that at any moment some active neuronal processes in your head are constitutive of your consciousness (experience),

<sup>1</sup>There is a great deal more to the constitution relation than is implied by the above cardiovascular examples. Such discussion can be found by sourcing the relevant citations in The Epistemology and Ontology of Phenomenal Consciousness.

<sup>2</sup>This is of course a straightforward *internalist* conception, but it should be noted that within modern philosophy of mind, internalist views are vigorously disputed. While mine is a straightforward internalist view of consciousness, it is not, however, a view that invites homunculi or favors localized over distributed processing (though I am happy to reject the notion of distribution across the *whole* brain). Internalist views are consistent with the notion that peripheral and environmental factors affect the character or contents of consciousness and that, conversely, brain processes (such as attentional selection) also affect the character or contents of consciousness. Internalism merely holds that whatever factors determine the character or contents of consciousness, consciousness itself (the experience itself) is located *in the brain*.

while others are not: *what is the difference between them?* A scientific study of consciousness ought to strive to answer *this* question. However, among the neuronal processes in your head that are *not* constitutive of your consciousness, many may nevertheless be correlated with your consciousness. Therein we face the problem posed by the correlation/constitution distinction<sup>3</sup>.

Consider again the case of BR to illustrate the problem. We currently possess a detailed (though still incomplete) understanding of the NCC during BR across a variety of visual processing regions. The electrophysiological studies show that perception-dependent neural activity occurs in all visual areas but much more so in higher areas and much less so in lower areas. How might we address the question of whether our conscious visual states during BR are constituted by all or only some of these correlated neural activities? Furthermore, if we looked outside visual cortex, say, for example, in nuclei dealing with eye movements (such as the nucleus of the optic tract and the dorsal terminal nucleus of the accessory optic tract) during motion rivalry with accompanying optokinetic nystagmus, we would indeed expect to find correlated neural activity. Yet, would we be comfortable in ascribing a constitutive role to neural activity underlying eye movements during BR? Probably not [though granted, there is a close relationship between mechanisms of attention and mechanisms of eye movement control; (12)]. Regarding activity in different visual cortical regions during BR, how confident would we be including them in, or excluding them from, the set of constitutive neural activities? We may wish to propose ways to define the boundaries of such a set, based perhaps on corroborating evidence, but directly testing such hypotheses does not, by current scientific strategies, seem feasible.

Moreover, while subcortical neural activities dealing with eye movements during BR may seem unlikely candidates for constitutive activities, the case of subcortical activity dealing with the waking state, arousal and attention is not so clear. Are activities in brainstem or thalamic nuclei and their projections constitutive of visual states during BR (and during normal vision, for that matter)?

<sup>3</sup>Note that by referring to a particular neural activity being constitutive of a conscious state, I do not mean to imply that such an activity *alone* constitutes the conscious state in question. Rather, I mean to imply that such activities are included among all the neural activities (the set of neural activities) that together constitute that conscious state. Some neural activities in your brain will be constitutive of only certain conscious states, others will be constitutive of all conscious states (see main text) and still others will never be constitutive of any conscious states.

Granted some subcortical activities may be correlated with visual consciousness insofar as visual consciousness requires the subject be awake (notwithstanding visual consciousness during dreaming), but these may be *necessary supportive* activities without being actually constitutive activities (or they may in fact be actually constitutive activities). A functioning cardiovascular system, for example, also plays a necessary supportive role for visual consciousness but is hardly likely to be considered in any serious way, constitutive of the visual states<sup>4</sup>. If we hypothesize an answer either way on the issue of whether subcortical activity plays a merely supportive or an actually constitutive role in visual consciousness, how might we test such hypotheses?

Crick and Koch realize that there is indeed a correlation/constitution distinction problem when they note, 'it does not follow that these particular neurons are the real seat of awareness. They may by their firing, influence other neurons ... that are the true correlates of awareness' [(14), p. 218; see also Crick & Koch (4)]. By referring to 'correlates' and 'true correlates', Crick and Koch imply a correlation/constitution distinction. However, their choice of terminology is awkward. After all, if a correlate correlates, then is it not a true correlate? Logothetis [(15), p. 541] similarly asks, 'Do neurons responding only when a stimulus is perceived actually mediate the conscious experience of this stimulus?' He goes on, 'The current data, although they favor such an interpretation, cannot prove it unequivocally.' I ask, 'What data could prove this unequivocally?' The problem posed by the correlation/constitution distinction is most closely referred to by Revonsuo [(16), p. 60, original italics] who asks, 'What is the relation between the neural *correlates* of consciousness and the actual neural *constituents* of consciousness?' Revonsuo subsequently dealt more explicitly with this distinction in a special issue of *J Consc Studies* in 2001 (Vol. 8, No. 3) which appeared at the same time as my own presentation of the problem (10). Other authors appreciate something like the problem I describe, but in terms of 'causation' rather than constitution. Thus, for example, Baars [(17), p. 31, original upper case] states that 'The goal is therefore to understand the Neural CAUSE

<sup>4</sup>It is worth noting, however, that while some necessary supportive functions (such as an intact cardiovascular system) can be said to support the existence of *any* conscious states, other necessary supportive functions may in fact contribute to the specific character or content of conscious states. By the latter I refer, for example, to the notion of peripheral 'somatic markers' (13) that may intimately contribute to (but are not, in my view, constitutive of) emotions and feelings.

of Consciousness, and that goal is coming closer to realization every year'<sup>5</sup>.

Despite being alluded to in the literature, few investigators seem to appreciate or are willing to admit the profound problem that the correlation/constitution distinction poses for the scientific study of consciousness (as Baars' optimistic statement illustrates). Correlates are certainly valuable [indeed an indispensable part of the comprehensive story; see Kirkcaldie & Kitchener (19), this issue], and it is true that we learn more about the neurobiology of consciousness every year. However, no amount of data on the NCC will suffice to identify the neural constitution of consciousness (or indeed the neural 'cause' of consciousness). It is not that we simply lack the data or the methods to settle the issue [cf. the view of Revonsuo who argues, with appropriate caution, that technological advances and an empirical biological approach to levels of organisation in the brain may lead us to complete understanding]. Rather, we are in need of a wholly new strategy to move from correlates to constitution when it comes to consciousness, and such a strategy does not yet exist. The problem posed by the correlation/constitution distinction is thus a hard problem indeed. Only if we understand and acknowledge it might we hope to solve it.

### The middle C in 'NCC' – a note of caution regarding terminology

The utility of the 'NCC' terminology lies in the methodological practicality it entails. Thus, as

<sup>5</sup>The distinction between correlation and *causation* has been widely appreciated since Hume (see The Epistemology and Ontology of Phenomenal Consciousness for further discussion of relational issues). In general terms, science has been very successful in moving from correlation to causation through testing of postulated mechanisms that arise from correlative observations. This general scientific process, and its equivalent in 'constitution' terms, is not in question in the present paper. It is rather the difficulty of applying this process to the scientific study of phenomenal consciousness that I wish to elucidate. Baars' comment is taken from his reply to a target article by Noë and Thompson (18) who argued, using BR as their main example, that the NCC programme was flawed because of the failure of the matching-content doctrine, the minimal neural substrate thesis and the internalist conception of the content of perceptual experience. I do not here address these arguments but instead note only that while these authors do not explicitly address the problem posed by the correlation/constitution distinction, their analysis leads them to postulate that 'the task for neuroscience should not be to investigate consciousness according to the classical framework of psychophysical correlation, whose modern incarnation is the NCC programme, but rather to study the neurobiological processes that causally enable (but do not constitute) our embodied mental life' (p. 19). Why they desire to see neuroscience study the causally enabling but not the constitutive processes of our mental life is not clear to me (see also the many replies to Noë and Thompson's paper in the same issue in which it appears). It is noteworthy also that in Baars' reply, he argues against unwarranted 'attacks' on the scientific study of consciousness. Although he distinguishes correlation and causation, he appears confident this distinction will not present any major empirical problems.

outlined above, the scientific study of consciousness moves forward by seeking and identifying the NCC. However, I have argued that despite their value and necessity, neural correlates are not what the scientific study of consciousness really wishes to understand. Reflecting this contention, it is now common for investigators to refer to the NCC in a manner that implies that the term's referent *is in fact* the neural constitution of consciousness (rather than the lesser neural correlates). This error may of course be implicit acknowledgement of the empirical obstacle posed by distinguishing correlates from constituents of consciousness, but nevertheless it remains an error<sup>6</sup>.

To prevent the ongoing misuse of the NCC terminology in this way, I suggest adoption of the following acronyms. When referring to the neural correlates of consciousness, the acronym 'NC<sub>r</sub>C' should be used. This is likely to be used in an empirical sense such as during, for example, discussions of electrophysiological and brain-imaging findings in studies of BR. When referring to the neural constitution of consciousness, on the other hand, the acronym 'NC<sub>n</sub>C' should be used. This is more likely to appear in ontological contexts in the philosophy of mind but should also be used by investigators in the scientific study of consciousness who wish to seriously consider the implications of their correlational findings. Depending on the context, the 'C<sub>n</sub>' in 'NC<sub>n</sub>C' might refer to either constitution or 'constituents'. In adopting such acronyms, discussion of the distinction between the neural correlates and the neural constitution of consciousness can then refer to the 'C<sub>r</sub>/C<sub>n</sub>' distinction. (The suggested acronyms are used below. Other authors may choose alternatives, but the

<sup>6</sup>Some authors have attempted to clarify the NCC notion. Thus, Chalmers (20) refers to 'core', 'direct' and 'minimally sufficient' NCC. Identifying the minimally sufficient NCC may help the scientific study of consciousness to some extent (see Objections to the C<sub>r</sub>/C<sub>n</sub> Distinction Problem), but it does not help to identify the neural constitution of consciousness. Indeed, the closer notions of core NCC or minimally sufficient NCC approach notions of constitution, the more there is equally an empirical problem in distinguishing mere NCC from actual core or minimally sufficient NCC (in other words, a correlation/constitution distinction problem by a different name). Chalmers [(20), p. 37, original italics] certainly realizes this, or something like it, when he says:

'An NCC is defined to be a *correlate* of consciousness. From this, it does not automatically follow that an NCC will be a system solely or mainly dedicated to consciousness, or even that an NCC will be the brain system most responsible for the generation of consciousness. It certainly does not follow that an NCC will yield an explanation of consciousness, and it is not even guaranteed that identifying an NCC will be the key to understanding processes underlying consciousness. If one were to define an NCC in these stronger terms, it would be far from obvious that there must be an NCC, and it would also be much less clear how to search for an NCC'.

important point is that the distinction is considered and somehow denoted.)

Reference to the  $NC_nC$  (however denoted) might be considered philosophically loaded and objected to on such grounds. Philosophical issues surrounding the epistemology and ontology of minds and consciousness are discussed in more detail in *The Epistemology and Ontology of Phenomenal Consciousness*. Here it is noted, however, that authors in scientific and philosophical circles use a large array of terminologies when referring to the relationship between minds (or mental states, conscious states) and brains (or brain states/processes, neural states/activities). Thus, the literature contains reference to conscious states being 'identical' to brain states; conscious states 'emerging' from brain states; conscious states being 'epiphenomena' of brain states; conscious states 'supervening' upon brain states; conscious states being the 'result' of brain states; conscious states being 'realized' by brain states; conscious states being 'caused' by brain states; conscious states being 'generated' by brain states; and conversely, brain states 'underlying' or 'underpinning' conscious states; brain states 'consistent' with conscious states; brain states being the 'neural basis' of conscious states; brain states being the 'neural mechanism' of conscious states; brain states being the 'neural substrate' of conscious states; brain states 'responsible' for conscious states; brain states 'mediating' conscious states; and so on. As is by now clear, my preference is to talk of conscious states (or consciousness, mind, mental states) being 'constituted' by brain states (or brain processes, neural activities), brain states 'constitutive' of conscious states and the neural constitution of consciousness. Relational issues regarding consciousness, in particular with respect to constitution, causation and identity, are dealt with in *The Epistemology and Ontology of Phenomenal Consciousness*.

### Objections to the $C_r/C_n$ distinction problem

Potential objections to the  $C_r/C_n$  distinction problem could be lodged on grounds of philosophical (ontological) loading as mentioned above but also on philosophical analyses of notions of constitution (see *The Epistemology and Ontology of Phenomenal Consciousness*). However, here I consider potential scientific objections. For example, perhaps my contention that no amount of data on the  $NC_rC$  will lead us to an understanding of the  $NC_nC$  is false. Crick and Koch (4), for example, refer to future powerful methodologies that might enable precise interruption of specific neural pathways by molecular techniques. If we

were in fact able to disrupt, in a very precise manner, specific pathways at various stages of neural processing, might the  $NC_nC$  not simply 'fall out' of many rounds of such experiments?<sup>7</sup>

These approaches, I suggest, may yield interesting conclusions on the minimally sufficient  $NC_rC$  but not on the  $NC_nC$ . Consider the following [see also Chalmers (20)]. It is granted that the presence of a particular conscious state when a particular (usually correlated) neural circuit is disabled suggests that that particular neural circuit is not part of the minimally sufficient  $NC_rC$  for that conscious state. However, such a finding says nothing about whether that particular (usually correlated) circuit is in fact part of the  $NC_nC$  when there are no disabling interventions in place. Similarly, the absence of a particular conscious state following a disabling intervention might suggest that the disabled (usually correlated) circuit is indeed part of the minimally sufficient  $NC_rC$  for that conscious state, but does not in fact speak to the issue of constitution. Thus, such a circuit might play an important and necessary supportive role (see *The Correlation/Constitution Distinction*), the disabling of which prevents the conscious state, but the same circuit still may not play any constitutive role in the normal case.

The same arguments can be applied to experimental stimulation methodologies. If we precisely stimulate particular neurons or a particular circuit and a conscious state occurs, does that imply that the activity of those neurons or that circuit, in the normal case, is necessarily constitutive of the conscious state? As mentioned above, as Crick [(14), p. 218] states, such neurons 'may by their firing, influence other neurons ... that are the true correlates of awareness' (read '... that are the actual  $NC_nC$ '). It might then be argued that by looking downstream to these 'other influenced' neurons or circuits (perhaps prefrontal), we will eventually identify the  $NC_nC$  and perhaps to test this identification we could disrupt these neurons/circuits to see what effect this has on consciousness. But whether we record from, disrupt or stimulate (or combinations thereof) the other influenced neurons or circuits, what will make us confident that these

<sup>7</sup>It is worth noting the impressive level of precision that investigators have already achieved in single-unit recordings (eg, Logothetis and colleagues as discussed above) and in microstimulation studies (21,22). Other current stimulation and/or inhibition methods, less precise than the molecular-level interventions postulated by Crick and Koch (4), include transcranial magnetic stimulation, deep-brain stimulation (itself a precise method), vagus nerve stimulation, vestibular stimulation and related techniques [see Miller & Ngo (3), this issue], brain lesioning, reversible brain cooling, and neurochemical stimulation/blockade.

downstream activities in the normal case are the  $NC_nC$  and that the upstream activities are not?

The point then is that by recording from, disabling and stimulating various  $NC_rC$ , there do not seem to be any obvious corollaries regarding the  $NC_nC$ . It might also be objected that localized recording, stimulation and disablement studies all miss the important fact that it is recurrent processing [recently reviewed in Lamme (2); see also Vickery (23), this issue] or other candidate neurophysiological mechanisms or signatures [see eg, Engel et al. (24)] that is the key to the  $NC_nC$  rather than simply this or that neuron, distributed circuit or brain region. But again, even if we accepted recurrent processing, for example, as being the important  $NC_rC$ , we still cannot readily proceed from this  $NC_rC$  to the  $NC_nC$ . In this case, we would be left wondering whether all sets of recurrent processes are constitutive or only some, if the latter then which and how might we test our contentions?<sup>8</sup>

Is the problem posed by the  $C_r/C_n$  distinction therefore intractable? I have more to say about potentially intractable problems below; however, here I note that some proponents of the scientific study of consciousness urge the setting aside of hard problems until further experimental results are in [eg, Crick & Koch (4)]. As outlined above, however, it is not clear that further experimental data will in fact solve or dissolve the  $C_r/C_n$  distinction problem. Nevertheless, it is worth bearing in mind the possibility that future scientific work may shed enough light on the problem that any remaining uncertainties regarding the  $NC_nC$  will appear trivial rather than substantial. Similarly, future scientific work may show that the notion of the  $C_r/C_n$  distinction is somehow fundamentally misguided (in a way that cannot yet be appreciated because the science is not yet done).

Indeed, some may wish to argue that the history of science is littered with examples of what were previously considered intractable problems that have subsequently been shown to be perfectly tractable when enough scientific understanding

<sup>8</sup>My own scientific work (with colleagues) on stimulation and disruption of particular brain regions during BR, using caloric vestibular stimulation and transcranial magnetic stimulation, respectively [see Miller & Ngo (3), this issue; Ngo et al. (7); Miller (10); Miller et al. (25); Ngo et al., submitted], illustrates that while such studies certainly help in exploring neural mechanisms of phenomena such as BR, they do not have obvious corollaries for the scientific study of consciousness. Thus, with respect to this work (which draws on an involuntary attention conception of BR), it is not clear to what extent the neural mechanisms constitutive of visual consciousness overlap with, or are distinct from, those constitutive of attentional selection [Miller (10); and see Koch & Tsuchiya (26) for a correlation-based discussion of such issues]. The difficulty in determining this is just another example of the problem posed by the  $C_r/C_n$  distinction.

emerged. That may be true but it does not follow from this truth that there cannot possibly exist any intractable problems for science. I therefore suggest that we proceed by acknowledging both of the following: (i) the  $C_r/C_n$  distinction problem may be tractable, and as such strategic methodological approaches to its solution should be sought, discussed and developed, along with analytic approaches to its underlying assumptions and contentions and (ii) the  $C_r/C_n$  distinction problem may be intractable after all, and this intractability may add to our overall understanding of consciousness and its place in nature<sup>9</sup>.

### 'The hard problem' and the problem of direct intersubjective exchange

Above I have presented a hard problem in the scientific study of consciousness. Here I discuss other hard problems associated with the study of consciousness. It is not clear that all of these should be considered hard problems for the *scientific* study of consciousness, so I will attempt to focus on the elements that do in fact challenge the scientific pursuit. The problem posed by the  $C_r/C_n$  distinction was explicated with reference to the visual modality but it presents difficulties for the scientific study of phenomenal consciousness in all modalities. Recall that phenomenal consciousness refers to our experiential or subjective states, commonly and collectively referred to as the first-person perspective. When talking about phenomenal consciousness, as alluded to in The Correlation/Constitution Distinction, we are talking about the experiences or feelings associated with phenomena such as seeing, hearing, touching, tasting, smelling and pain, in all particulars (seeing red, hearing a birdsong, touching sand, tasting chocolate, smelling a rose, feeling the pain of an insect bite). Phenomenal consciousness also entails the experiences or feelings associated with phenomena such as love, kinship, happiness, sadness, fear, anger, disgust, reverence, desire, laughter, to name but a few [for a good introduction to the varieties of phenomenal experience, see Chalmers (27)]<sup>10</sup>.

Experiential states such as those just mentioned are isolated examples of an individual's entire experiential or phenomenal space. Subjectivity is of course global, multimodal, temporally extended and dynamic. The referents of phenomenal consciousness

<sup>9</sup>This is certainly fence-sitting, but by sitting on the fence we can at least concurrently grasp (and work on) issues either side of it, without presupposing which side is true.

<sup>10</sup>Ignoring observable peripheral and behavioural factors, it is arguable how usefully distinguishable the experiential component of affective and cognitive phenomena is from the phenomena themselves (especially with respect to affect).

are well captured by engaging the famous phrase, ‘what it is like’ to be a subject (28,29). For example, consider any aspect of what it is like or feels like to be you, or what it was like or felt like to be you in the past, the quality of those feelings (qualia) and how such feelings change through time, and you are considering your phenomenal consciousness. Chalmers (27) presents a detailed account of phenomenal consciousness in the context of modern philosophy of mind. His central thesis is controversial. He proposes that there is one hard problem of phenomenal consciousness, a really hard problem, different from all others implied by notions of phenomenal consciousness<sup>11</sup>. He further argues that it is in fact, so hard that it may require the development of new psychophysical bridging laws.

Chalmers’ hard problem can be explained in the following way. We are all aware of the what-it-is-like nature of our own phenomenal consciousness. Indeed, there is perhaps nothing else quite so familiar to us. While many of us might acknowledge that what it is like to be an individual human is simply due to the relevant brain processes occurring in that individual<sup>12</sup> (and the individual’s history, see below), we perhaps fail to ask why it is that being an individual human should feel like anything at all? Why indeed is all that (constitutive) activity in the brain accompanied by feeling? In short, why does phenomenal consciousness exist? Perhaps even more vexing than this issue is, *how* does phenomenal consciousness come to exist? We may be happy to assert *that* phenomenal consciousness is constituted by neural activity but can we not still wish to know how (and *why*) phenomenal consciousness is constituted by neural activity?

I do not consider here responses to Chalmers’ hard *existence* problem (ie, the why and the how) of phenomenal consciousness. This has been done in great detail elsewhere [see eg, Shear (35)] and it is fair to say, the matter is not yet settled. I also refrain from taking a position on whether these hard how and why existence problems are in fact problems for science. Instead, I have briefly described ‘the hard problem’ as Chalmers posed it, to point out that reference to it in this singular sense could imply that the other problems discussed in the present paper

must in fact be tractable (or somehow easier problems)<sup>13</sup>. Yet, we have no grounds for confident tractability claims, just as we have no grounds for confident intractability claims. Consider further though, that Chalmers’ hard existence problem of phenomenal consciousness has a sister problem that questions the specific *character* of various states of phenomenal consciousness. This problem presents a somewhat different challenge, one that is more clearly relevant to the scientific study of consciousness. Chalmers asks us to consider why it is that *this* particular brain activity feels like *this* and not like *that*. In other words, what is it that makes particular neural firing/organization kinds feel like particular phenomenal kinds (of a particular phenomenal character), and not like other phenomenal kinds (of a different phenomenal character)? What indeed bridges neural states (activities) and phenomenally conscious states?

The relevance of this hard character problem to the scientific study of consciousness is not, in my view, in its answering but rather in its sharpening. We can sharpen the problem by addressing the exclusivity or otherwise of neural–phenomenal relationships. Do all (constitutive) neural firings/organizations of a particular kind feel a particular way? Or might it be possible that the same neural firing/organization

<sup>13</sup>For a discussion of ‘hard’ vs. ‘easy’ problems in the study of consciousness, see Chalmers (27) and several papers in the volume edited by Shear (35). Indeed, it could be argued that Chalmers’ conception of ‘easy’ problems (ie, those susceptible to scientific explanation, and for which such explanation will not solve the hard problem) suggests another objection to the  $C_r/C_n$  distinction problem – an objection based on the possibility that it is a general problem for neuroscience, not one limited to the study of consciousness. That is, to what extent does the  $C_r/C_n$  distinction also apply to the easy problems? Can the distinction apply to studying how the brain reacts to and processes environmental stimulation, how it integrates this information and how it reports its internal states and controls behaviour (examples of Chalmers’ easy problems)? We might also ask if the distinction applies to other targets of the cognitive neurosciences such as memory, attention, propositional attitudes and self-consciousness. I have only an intuitive reply to these issues in that I consider it likely that these ‘nonphenomenal’ targets of scientific investigation will yield more fully, if not completely, to scientific investigation. I cannot, however, intuit the same for phenomenal consciousness (though nor do I rule it out). Thus, our imaginary ideal neuroscience seems to me likely to include a full mechanistic account of the brain functions commonly studied by cognitive neuroscience and of higher order senses of consciousness but may not include a full mechanistic account of phenomenal consciousness (or indeed of the phenomenal aspects of the other accounted-for brain functions). Thus, I would consider it likely that the neural constitution of attention, for example, will in fact ‘fall out’ of many rounds of correlative studies. However, this view should not be seen as undermining an appreciation of just how slippery some of the easy territory will be (36). What underlies my concern that the case of attention (and other easy problems) may be different from that of phenomenal consciousness, is phenomenal consciousness’ inherent first-person perspective or subjectivity (exactly, among other thorny issues, what has kept philosophers of mind so busy for so long) and the problems this poses for the scientific study of consciousness (as the present paper is attempting to outline).

<sup>11</sup>See also Levine (30) on the notion of a phenomenal consciousness explanatory gap.

<sup>12</sup>This point may seem obvious to many neuroscientists but it is a matter of enormous debate within philosophy of mind. It is thanks to the ‘Australian materialists’, Place (31), Smart (32) and Armstrong (33), proponents of identity theory (ie, brain states are identical to mental states), that this view achieved substantial voice within philosophical circles in the middle of the 20th century [Note: Place considered E.G. Boring (34) to be the originator of identity theory; see The Epistemology and Ontology of Phenomenal Consciousness].

kind in two distinct subjects constitutes different phenomenal kinds in the two subjects? Conversely, might two different neural firing/organization kinds in distinct subjects nevertheless constitute the same phenomenal kind? If we had answers to these issues of neural multiple realizability<sup>14</sup>, or to use the terminology of identity theory, answers to issues of the strength of neural–phenomenal type-identities, we might consider Chalmers’ hard character problem in a different light. We would certainly understand more about the relationship between neural firing/organization kinds and phenomenal kinds. While scientifically addressing neural multiple realizability could sharpen Chalmers’ hard character problem, it could not solve it because it does not further address why or how it is that certain neural multiple-realizability scenarios do or do not pertain.

Insofar then as neural multiple realizability is an issue for the scientific study of phenomenal consciousness, so too is the sharpening of Chalmers’ hard character problem. Neural multiple realizability is indeed an issue within the purview of science. Consider again an ideal neuroscience that understood all neurophysiological processes with all current methodological constraints overcome. With such powerful investigative tools, we could legitimately ask, and empirically assess, how many neural firing/organization kinds could be constitutive of a particular phenomenal kind, say seeing red? And if the answer is one, two or many, is it the same answer as for say, feeling anger or happiness? Science could similarly address whether effectively identical neural firing/organization kinds in two distinct subjects could constitute different phenomenal kinds<sup>15</sup>. Neural multiple-realizability problems are therefore at least conceivably within science’s purview, in a manner, it may be argued, that Chalmers’ hard questions of how and why may not be. But might neural multiple-realizability problems be nevertheless equally hard problems to answer despite their being more easily conceived as scientific problems?

Considering in more detail how the science might be done on these issues reveals another problem. With our ideal neuroscience, let us presume we have an

understanding of the NC<sub>r</sub>C for all conscious states (phenomenal kinds) in a particular subject. Setting aside the problem posed by the C<sub>r</sub>/C<sub>n</sub> distinction, we would wish to assess whether the same NC<sub>r</sub>C existed for a different subject reporting the same phenomenal kind. This sort of scenario is possible for say, seeing red, though it is debatable whether it is really possible for reporting the quality of that redness (here we are constrained by language). Is it less difficult to envisage this scenario with respect to the reporting of anger or happiness? Perhaps, but language constraints still seem to apply. Either way, the point I wish to make is how are we to compare the redness or the anger/happiness experienced by two distinct subjects? Addressing the issue of neural multiple realizability for phenomenal consciousness is therefore only possible within the limits of the next hard problem we encounter – the problem of *direct* intersubjective exchange.

The problem of direct intersubjective exchange has been a perennial one in the philosophy of mind (see the literature on the ‘other minds’ problem). It relates specifically to comparing the character of phenomenal consciousness between subjects. Is it possible for one adult human subject to know what it feels like to be another (ie, to know *directly*, not merely through language reports or behaviour)? Does my experience of seeing red or being angry or happy feel the same as another’s experience of seeing red or being angry or happy? Science can of course successfully investigate the NC<sub>r</sub>C for color perception and anger or happiness by proceeding according to behavioural and verbal reports (see below). But we are still left uncertain of the level of phenomenal similarity in two different subjects with the same behavioural or verbal reports<sup>16</sup>.

Furthermore, the problem of direct intersubjective exchange could also be logically flawed. Consider that for one subject to experience what

<sup>16</sup>Here the notion of an individual’s history is relevant, but I have more to say on this elsewhere; Miller, in preparation). Regarding this issue, Crick and Koch [(4), p. 104; see also Crick (14)] make the following comments (note their appropriate reliance on notions of plausibility and inference):

‘Is there any sense in asking whether the blue color you see is subjectively the same as the blue color I see? If it turns out that the neural correlate of blue is exactly the same in your brain as in mine, it would be scientifically plausible to infer that you see blue as I do. The problem lies in the word “exactly”. How precise one has to be will depend on a detailed knowledge of the processes involved. If the neural correlate of blue depends, in an important way, on my past experience, and if my past experience is significantly different from yours, then it may not be possible to deduce that we both see blue in exactly the same way’.

It is important to note also that knowledge constraints regarding the precise degree of phenomenal continuity between subjects do not imply the absence or improbability of phenomenal continuity between subjects.

<sup>14</sup>The issue of multiple realizability appears more commonly in the philosophical literature with respect to organic vs. nonorganic realizability. Thus, the issue is not whether more than one neural firing/organization kind could constitute the same phenomenal kind or the converse, but rather whether the appropriate organization of nonneural material (such as silicon or famously, even Swiss cheese) could actually constitute any phenomenal kind. The idea, a functionalist one, is that there is nothing special about the stuff of brains and neurons. Instead, it is in the organizational structure and functions performed that phenomenal consciousness lies, irrespective of substrate (see *The Epistemology and Ontology of Phenomenal Consciousness*).

<sup>15</sup>I say ‘effectively’ because no two brains or sets of brain processes are ever truly identical.

it would be like to be another, they would need to initially cease being their own first person. Otherwise, subject  $x$  would be experiencing what it would be like for subject  $x$  to be subject  $y$ , rather than what it would be like for subject  $y$  to be subject  $y$ . If subject  $x$  must first cease being to truly know what it is like for subject  $y$  to be subject  $y$ , then it hardly seems possible that subject  $x$  could in fact know what it is like to be subject  $y$ . If direct intersubjective exchange is impossible empirically and flawed logically, we cannot sharpen Chalmers' hard character problem (because we cannot answer questions on neural multiple realizability) and we are therefore left to face further hard problems in the scientific study of consciousness.

However, to end this section on an optimistic note, it must be reiterated that issues of neural multiple realizability, though constrained by the problem of direct intersubjective exchange, do in fact suggest potentially fruitful empirical strategies in the scientific study of consciousness. Thus, within the boundaries of observed behaviour and verbal reports, methods that have served the cognitive neurosciences well to date (methods of *indirect* intersubjective exchange, or to use Dennett's term, heterophenomenology), science can indeed address issues of neural multiple realizability. Furthermore, it can begin to do so now, well prior to reaching any ideal correlative neuroscience. Such advances may not entirely satisfy us though they are (like identification of the NC<sub>r</sub>C) advances nonetheless<sup>17</sup>.

<sup>17</sup>Thus, I would agree with Dennett ([37], p. 28] when he says that 'Let us see what happens when we try to cantilever this third-person methodology of science as far into the private interiors of minds as it will go'. However, he goes on, too confidently in my view, to proclaim that (p. 29, original italics) 'The third-person methods of the natural sciences suffice to investigate consciousness as completely as any phenomenon in nature can be investigated, without *significant* residue'. In Dennett's view, the residue in studying consciousness is no different to that in studying any natural phenomenon and is therefore insignificant. If so, he would presumably consider that the problems I pose in the present paper will (i) certainly find solution/dissolution, (ii) have been misguided in their construction or (iii) not find solution, and this failure will be of no significance. Another point worth making regarding the scientific study of consciousness proceeding according to the methods of heterophenomenology (including identification of NC<sub>r</sub>C) is that such a pursuit may well generate substantial powers of *prediction*. Thus, within the constraints of the problem of direct intersubjective exchange, it is already the case that science has identified NC<sub>r</sub>C that are highly predictive of the contents of a subject's consciousness. Thus, to give just one example, during perceptual rivalry with the Rubin's vase-faces illusion (see fig. 1 in Miller & Ngo (3) this issue), fusiform face area (FFA) activity as measured by functional magnetic resonance imaging (fMRI) is statistically predictive of a subject's perception of faces (38). Predictability is indeed a measure of scientific advance but can exist, however impressively, in the absence of understanding constitutive mechanisms [see Ngo et al., submitted, on brain stimulation during Rubin's illusion, which helps illustrate this point; see also Vickery (23), this issue, for a discussion of scale considerations with respect to face perception and FFA activity].

### The problem of identifying phenomenal consciousness in ontogeny and phylogeny

Two other hard problems in the scientific study of consciousness are worth briefly outlining. These relate not to the character of phenomenal consciousness in other subjects but to its existence. Along with wondering what it is like to be another adult human subject, we can wonder what it would be like to be a young child, and so on to infants and fetuses (and embryos?) until we realize that we are in fact also wondering whether there is anything it is like to be an infant or a fetus. Because we know that human subjects at some stage during their development become phenomenally conscious, we can justifiably wish to know at which stage of fetal or infant central nervous system development this occurs. We can assert that it feels like nothing to be a human zygote and that it feels like something to be a 3-year-old child. There is no denying that 3-year-old children develop from zygotes, so there is no denying that phenomenal consciousness develops at some stage in this process. The problem is how to identify this point of critical neural complexity (critical neural firing and organization) at which phenomenal consciousness is first constituted.

There have been suggestions as to how this might be done (usually using nonphenomenal senses of consciousness). I do not here address these but instead make the point that they invariably rely on inference and coherence with other evidence, rather than direct testing of proposed hypotheses<sup>18</sup>. As such, while it can

<sup>18</sup>Consider one example (albeit that draws on both ontogenetic and phylogenetic issues). Mellor and Diesch (39) propose that sheep embryo-fetuses do not become conscious until birth, at which time electroencephalography (EEG) recordings indicate a change from sleep-like to non-sleep-like patterns. These authors further explain that prior to birth, a range of neuroinhibitory mechanisms that involve, for example, sleep-inducing adenosine, are present. Such mechanisms are then withdrawn after birth that coincides with the presence of neuroactivators such as noradrenaline from the locus coeruleus. This type of argument relates to the sense of consciousness that involves the waking state vs. unconsciousness. It does not get to grips with phenomenal consciousness. Thus, once 'awake' at birth, does that feel like anything? Or does feeling like something really only occur with further neural development (hard to imagine as it is that being a hungry human infant for example, feels like nothing)? As Mellor and Diesch further question, as many philosophers and ethicists have, when might the animal gain the capacity to suffer? And prior to being 'awake', do the dream-like (rapid eye-movement-like) EEG patterns that do occur as an embryo-fetus suggest phenomenal consciousness (despite the absence of waking consciousness) prior to birth? And even if we went back further in ontogeny to a stage where there may be no dream-like EEG activity, could we really be comfortable in ascribing or denying some sort of protophenomenal consciousness in the very early stages of neural development? In other words, exactly where in ontogeny is the point of critical neural complexity for phenomenal consciousness, and will this point be necessarily (and conveniently) associated with a neurophysiological signature for science to observe?

be proposed that point *a* or point *b* in ontogeny heralds the onset of phenomenal consciousness for this or that reason, we are left wondering just how to test such proposals. Note the difference between this type of scientific scenario and regular scientific experiments. Generally speaking, science starts with the phenomenon of interest and seeks explanations and mechanisms by studying that phenomenon with various methods at various explanatory levels. Alternatively, if seeking the location of a phenomenon, we usually have markers on which to base our search. In the case of trying to identify phenomenal consciousness in ontogeny, we have neither the phenomenon (for we are trying to find it) nor markers of it (except for inferential markers that may support or imply the existence of phenomenal consciousness, but fall short of direct evidence for it).

Perhaps we could work backwards from the adult case to identify the onset of phenomenal consciousness in development? Suppose the adult  $NC_nC$  was identifiable (or even if we accepted the lesser  $NC_rC$ ) and was defined by some neurophysiological signature. If we then located that signature in the developmental context, might we be reasonably confident that we had identified the onset of phenomenal consciousness? However, it is not adult phenomenal consciousness we are looking for in the infant or the fetus but rather infant or fetal phenomenal consciousness. Thus, it would still be tempting to wonder (as with the case described in Footnote 18) whether the developmental stages prior to the emergence of the signature would really feel like nothing and, conversely, whether the presence of the signature guaranteed the existence of phenomenal consciousness. While we might nevertheless be comfortable extrapolating backwards to generate hypotheses, we again face the (now repetitive) problem of how to test such hypotheses. Working backwards may hit or miss the mark in accurately identifying the onset of fetal or infant phenomenal consciousness, but it is not clear how to tell either way<sup>19</sup>.

<sup>19</sup>Other hard ontogenetic phenomenal consciousness problems include the following: does phenomenal consciousness develop at precisely the same stage in different individuals? Even if the threshold varies between individuals, might the development of phenomenal consciousness within an individual occur across a window of developmental processes? In other words, might there be a gradual change from phenomenally unconscious to phenomenally conscious stages in brain development? If so, could this be reconciled with the fact that either there is something it is like to be in a certain stage of human development (irrespective of exactly what), or there is not? (Note, I am not referring here to the obvious sense of gradual change from fetal/infant phenomenal consciousness to fully developed adult phenomenal consciousness but rather the perplexing case of considering gradual change from none to some phenomenal consciousness.)

Just as it appears impossible (or not yet possible) to identify where in ontogeny phenomenal consciousness begins, so too in phylogeny it does not seem possible (or not yet possible) to identify which species possess phenomenal consciousness and which do not. As Humphrey [(40), p. 17] states, ‘Today there are literally billions of animals with minds inhabiting the planet, and the world has become very widely experienced and very widely known .... The fact remains that whatever the Big Bang was like, there was no phenomenal bang at the time it occurred. Having fixed both ends, the big question must be what happened in the period in between’. While we may be incapable of determining an accurate phylogeny of phenomenal consciousness, the fact remains that organisms with phenomenal consciousness evolved from ancestors lacking phenomenal consciousness. As in the case of ontogeny, the transition presumably occurred when central nervous systems evolved a critical neural complexity<sup>20</sup>.

For the phylogenetic ascription of phenomenal consciousness, as for the ontogenetic ascription, there can be proposals that rest on theoretical consistency and coherence, and that rely on indirect evidence [see eg, Edelman et al. (41), though also note their definition of consciousness]. However, directly testing such proposals remains elusive. The phylogeny case again runs into problems of trying to locate the phenomenon without a reliable marker. We can again attempt to work from the adult human  $NC_nC$  (were it possible) or  $NC_rC$  but we face an analogous problem of trying to locate human consciousness signatures in non-human species<sup>21</sup>. This approach might nevertheless be worthwhile despite some

<sup>20</sup>This again raises the perplexing issue of how a gradual evolution of phenomenal consciousness could be reconciled with the idea that either there is something it is like to be a particular organism (or in the species-specific sense, to be an organism of a particular species) or there is not. Thus, a ‘phenomenal bang’ may have occurred in between the two fixed ends of evolution, as occurs each time an individual human develops. Whether the initial evolution of phenomenal consciousness occurred (and it may have occurred more than once) by natural selection or by chance is a difficult question (unlike higher order notions of consciousness that may be more readily understood in terms of biological function and selective advantage), and one that were the former case to hold, might bear on Chalmers’ hard *why* problem of phenomenal consciousness (but not on the hard *how* problem).

<sup>21</sup>Note that asking about the character issue in phylogenetic terms, regarding what it is like to be a bat, for example (29), is a special case of the problem of direct intersubjective exchange, as it would also be in the ontogenetic case if we were asking what it would be like to be a full-term fetus. Dennett [(42), p. 160] cautions that we should not accept without further consideration that we necessarily know what Nagel means in asking his (character) question about bat phenomenal consciousness. However, it is not clear whether Dennett would agree that asking the existence question (ie, whether there is anything it is like to be a bat, or any other organism) is a less murky issue.

degree of uncertainty<sup>22</sup>; however, it becomes more and more inferential when moving phylogenetically further and further from humans [though see Edelman et al. (41)]. That is not to say that developmental, phylogenetic and evolutionary proposals, and their integration, have no role to play in consciousness and cognitive neuroscience research [on the contrary, see Kirkcaldie & Kitchener (19), this issue, and Hannan (43), this issue], nor that we are precluded from proposing general principles of phenomenal continuity and variation within and between species of phenomenally conscious organisms (Miller, in preparation). However, as many philosophers and scientists have long known, the accurate ascription of *phenomenal* consciousness to particular developmental stages in humans and to particular species of organism presents science with hard problems indeed.

### The epistemology and ontology of phenomenal consciousness

It is important to be clear about ontological implications of potentially intractable problems in the scientific study of consciousness. Ontology refers to the study of the nature of things, of what there is or what exists. There are of course philosophers and scientists who deny that there are any substantial limits to a complete understanding of consciousness in neural terms. Among philosophers who do, however, appreciate the epistemic limits entailed in the study of consciousness, it is not uncommon to see ontological positions based on these limits. Below I argue that ontological conclusions can indeed be drawn on the basis of epistemological claims when ontology is concerned with what there is or what exists (a taxonomic sense of ‘ontology’). However, with respect to a metaphysical sense of ontology, the nature of things, I suggest that ontological conclusions are *not* warranted on epistemological grounds when ‘nature’ refers to the constitution

(composition) of things, though *are* warranted when nature refers to the *organization* of things.

Consider the central problem in the philosophy of mind, the mind–brain (or mind–body) problem: ‘What is the relation between mind (mental states, conscious states) and brain (brain states/processes, neural states/activities)?’ The way this question is answered, utilizing one or another of the relational terms listed earlier (see The Middle C in ‘NCC’ – A Note of Caution Regarding Terminology), can characterize schools of philosophical thought on the issue. Thus, positions in the philosophy of mind may be defined by, for example, the ontological view that mental states and brain states are identical (identity theory), that mental states supervene on brain states (supervenience theory) or that mental states are epiphenomena of brain states (epiphenomenalism), and so on. I do not here review the many schools of thought in the philosophy of mind but note simply that they are often characterized by their answer to the question, ‘What is the relation between mental states and brain states?’<sup>23</sup>

Another way to ask the central ontological question in the philosophy of mind is, ‘What is the nature of consciousness or of things with consciousness?’ Here we find answers such as, ‘things with consciousness are purely physical things’ (ie, physicalism or materialism, and their varieties such as eliminativism, reductionism, functionalism, biological naturalism etc.). Alternatively, ‘consciousness and conscious states are ontologically distinct from brain states’ (ie, dualism). Note that when asking the ontological question in this way, we could just as easily rephrase the question and ask, ‘Of what is consciousness *constituted*?’ or, ‘Of what are things with consciousness constituted?’ A physicalist or materialist answer would be, ‘of physical or material things (or stuff or substance)’<sup>24</sup>. Therefore, reference to the phrase ‘the *neural* constitution of consciousness’ may be seen to imply an ontological position in the philosophy of mind. It implies the physicalist or materialist position that consciousness is constituted by neural stuff (more precisely, neural activity). Notions of conscious

<sup>22</sup>Recall that the electrophysiological BR data from Logothetis and colleagues were collected from macaque monkeys. In relation to this, and in contrast to the view proposed by Edelman et al. (41), I do not consider the existence of BR in an organism to imply that the organism must be phenomenally conscious. An organism could conceivably lack phenomenal consciousness but nevertheless alternately sample conflicting sensory input. It could also further exhibit neural processes correlated with the conflicting input and other neural processes correlated with alternating perception, but the existence of this sensory conflict resolution strategy does not itself imply phenomenal consciousness (even though in the case of macaque monkeys, phenomenal consciousness probably does exist). Specifically with respect to phenomenal consciousness, identifying *affect*-based homologies, though still inferential, may provide more plausible phylogenetic hypotheses than sensory- or cognitive-based approaches (see Footnote 10).

<sup>23</sup>I also herewith refrain, except where necessary, from reference to mind and mental states, instead referring only to consciousness and conscious states, and by this I mean phenomenal consciousness. This is because many arguments surrounding notions of mind and mental states and their relationship to brain and brain states pertain to propositional attitudes such as beliefs and these are not the concern of the present paper.

<sup>24</sup>By ‘physicalism’ in the following discussion, I mean to imply substance monism, and not to imply reference to the discipline of physics as opposed to say, biology or chemistry. In this way, physicalism is not importantly different to ‘materialism’.

states being constituted by neural activities, and of neural activities constitutive of conscious states, do of course also imply a relation between conscious states and brain states, the relation being one of constitution (though see below).

That the NC<sub>n</sub>C terminology implies an ontological position in the philosophy of mind would particularly be of concern to those who find physicalist or materialist ontologies objectionable. This is perhaps why Chalmers [(20), p. 37] states, ‘Defining an NCC solely in terms of correlation ... also means that the search for an NCC can be to a large extent theoretically neutral rather than theoretically loaded’. However, neuroscientists engaged in the scientific study of consciousness may feel comfortable adopting the terminology proposed in the present paper knowing that the ontological position it implies is physicalism or materialism and that the entailed relational commitment is one of constitution (and probably also identity; see below). It is a matter for those philosophers of mind, philosophers of science and neurophilosophers interested in notions of constitution, to address the ontological and semantic issues surrounding such notions, particularly with respect to the C<sub>r</sub>/C<sub>n</sub> distinction problem. Such analyses of the problem’s construction and underlying assumptions may shed light on the veracity or otherwise of my claim that it poses a serious, perhaps intractable, challenge for the scientific study of consciousness.

Baker (44) is one philosopher who has explicitly addressed notions of constitution and in the process has provided an overview of how such notions have appeared in the philosophical literature. Although her ‘constitution view’ involves the first-person perspective, her central thesis focuses on constitution with respect to the person rather than consciousness. Indeed for Baker, the notion of the first-person perspective relies more on personhood and self-consciousness than on phenomenal consciousness (as I use it). Thus, she distinguishes strong and weak first-person perspectives, respectively. Baker’s analysis, in addition, focuses on arguing that a constitution relation can hold without an identity relation also holding (see below), and it quickly becomes technical ground for nonphilosophers. However, she states the following early in her thesis (p. 12, original italics):

‘One further question that is conspicuous by its absence is this: “What is the relation between the mind and the brain, or between mental states and neural states?” Since the question of the mind/brain relation has occupied many philosophers in

recent decades, let me explain why I say so little about it. In brief, I do not discuss ‘the’ relation between minds and brains because I doubt that there is a single relation for a philosopher to detect (such as identity or constitution). Rather, I think that the question of the (probably numerous) relations between brain states and mental states is an empirical issue to be investigated piecemeal by neuroscientists. The brain is implicated in all aspects of human life, but to describe just how is beyond the reach of philosophy. Acknowledging both the brain’s importance for mental life and our ignorance of the details of the relations between particular brain states and particular mental states (such as Fay’s feeling that she has been treated unfairly by her supervisor or Hank’s jealousy of the new employee), I shall rest content to say that the brain *sustains* mental states without hazarding details. So, instead of asking, “How do minds fit into the material world?” I shall ask, “How do persons fit into the material world?”

Baker’s reluctance to apply notions of constitution to the mental–neural relation (or relations, as she would have it) stands in contrast to my own view and the view I suggest might be appealing to neuroscientists (though to be sure, the examples she gives in the passage above involve higher order mental states such as feeling hard done by and jealousy, as opposed to phenomenal consciousness *per se* or the purely phenomenal aspects of such higher order states; see Footnote 13). She perhaps also too quickly dismisses the contribution that philosophers might make in fleshing out the potential obstacles (or lack thereof) that face a neuroscience of consciousness. On the contrary, philosophers in possession of such detailed understanding of notions of constitution could apply their analytic skills to problems in the scientific study of consciousness, specifically the problem posed by the C<sub>r</sub>/C<sub>n</sub> distinction<sup>25</sup>.

Relational issues in the philosophy of mind are sufficiently complex for a separate dealing elsewhere; however, some brief points are worth mentioning here. First, consider that Smart [(32), p. 142] objected to the notion of correlation between sensations and brain processes because

<sup>25</sup>Perusal of Baker’s formal analysis and level of detailed argument, however, shows that it will be a challenge for such philosophers to make their analyses intelligible to neuroscientists (a challenge for any interdisciplinary endeavor). Indeed, this level of analysis might make neuroscientists hope for a scientific rather than a philosophic solution to, or dissolution of, the C<sub>r</sub>/C<sub>n</sub> distinction problem. It should also be noted that Baker has more recently extended the idea of constitution to properties in addressing the issue of nonreductive causation (45). On this view, she considers that brain processes may in fact constitute mental states, though she also strongly adheres to an externalist conception of mind (Baker, personal communication).

‘You cannot correlate something with itself. You correlate footprints with burglars, but not Bill Sikes the burglar with Bill Sikes the burglar’. Place (46), on the other hand, drawing on Boring (34), considered that a perfect correlation is identity. It is along similar lines that I consider constitution to be a more relevant relation than causation in discussing consciousness. Thus, in facing a large array of NC<sub>r</sub>C for a particular conscious state, it does seem reasonable to ask which of these correlations *cause* that state. However, it seems just as reasonable to ask which of these correlations *constitute* that state. If a constitution relation holds, can a causation relation also hold? If an object is constituted by substance *x*, does it make sense to further claim that *x* causes the object? Bill Sikes might have caused the footprints but does it make sense to say that the physical stuff of Bill Sikes causes Bill Sikes? It makes more sense, admittedly on this simplistic level, to say that the physical stuff of Bill Sikes constitutes Bill Sikes. As Place [(47), p. 36] states, ‘Following Hume ... if two things are causally related they must be, to use his phrase, “distinct existences”. They cannot be two descriptions of one and the same thing’<sup>26</sup>.

Turning to constitution and identity relations (and their relation to each other), such analyses are common in metaphysics and personal identity literature [eg, Baker (49), Johnston (50), Noonan (51) and Rea (52)]. Somewhat surprisingly, however, these issues are far less often applied in the philosophy of mind and to the mind–brain problem (for some examples though, see Snowdon (48) and Noonan (53); and in particular, Place (31,47,54), relies on a compositional notion of ‘is’ in identity statements). While these issues cannot be addressed in detail here, consider briefly that in the case of the NC<sub>n</sub>C, we need to distinguish physical constituents of neurons (atoms and molecules arranged into cell bodies, axons, dendrites, membranes, ion channels, receptors etc.) on the one hand, and activities of neurons (action potentials) and their distributed systems (eg, recurrent processing) on the other. Constitution here applies in the compositional (mereological) sense of parts constituting wholes, but in two ways. It applies in the sense relevant to ontological questions such as, ‘Of what is consciousness constituted?’ or ‘Of what are things with consciousness constituted?’ and to answers such as, ‘of physical constituents’. It also, however, applies to constitutive neural activities or

processes (which entail the physical constituents, or are the physical constituents in process).

Irrespective of how difficult it may be in practicality, if we possessed knowledge of the entire set of neural activities that constitute consciousness, might it be that with respect to *all* these activities (ie, all the partially constitutive activities together), the relation to consciousness is really one of identity? Thus, we could state that ‘consciousness is identical to all partially constitutive neural activities *together*’. The compositional constitution relation does not disappear when we make such an identity statement, for there are clearly still parts involved in the whole that is consciousness (the parts being both physical constituents and partially constitutive activities, with the latter of more direct relevance). But once this is acknowledged, we might ask what significant difference exists, if any, between the above identity-based statement and the following constitution-based statement, ‘consciousness is constituted by all partially constitutive neural activities *together*’<sup>27</sup>. We might additionally ask whether considering consciousness as opposed to say, tissue perfusion, impacts on our assessment of the similarity or difference between these identity- and constitution-based statements (see below regarding the uniqueness of things with consciousness). Regardless of these interesting relational issues, the finer points of constitution and identity, their coexistence or otherwise, are at least not particularly important for the physicalist (compositional, substance monist) vs. antiphysicalist debate<sup>28</sup>.

Returning to epistemological issues, I have above described several hard problems in the scientific study of consciousness. I have further argued that these may in fact be intractable problems (though I have taken great care not to assume or proclaim this). What do ultimate epistemic limits have to say about the ontology of consciousness? As mentioned above, there are philosophers who argue that epistemic limits with respect to consciousness do have implications for the ontology of consciousness. A widely discussed example is Jackson’s [(55), p. 291, original italics] challenge to physicalism based on Mary, a neuro-

<sup>26</sup>One important difference between causation and constitution is that the former entails the taking of time, whereas the latter (in the compositional sense) does not [see Snowdon (48)].

<sup>27</sup>I am here talking generally, rather than referring to particular states of phenomenal consciousness (see Footnote 3). If we wished to make the statement with respect to a particular conscious state, we could say, ‘consciousness, at any one time, is identical to all partially constitutive neural activities, at that time, *together*’ and similarly for the constitution-based statement.

<sup>28</sup>I have of course said nothing about issues such as reduction, necessity and supervenience with respect to constitution and consciousness (nor causation with respect to action and behaviour).

scientist who has all her life been confined to a black and white room and who ‘knows all the physical facts about us and our environment, in a wide sense of “physical” which includes everything in *completed* physics, chemistry, and neurophysiology, and all there is to know about the causal and relational facts consequent upon all this, including of course functional roles. If physicalism is true, she knows all there is to know’. Mary then leaves the room and discovers the experience of color. She had previously known completed facts in the physics, chemistry and neurophysiology of color perception but had never experienced color, and therefore the completed facts of physics, chemistry and neurophysiology leave something important out – the experiential or phenomenal aspect. Thus, it is argued, physicalism fails because of the incomplete description provided by the physical facts<sup>29</sup>.

It is true that the phenomenal aspect is left out but the crucial error in such arguments is that the phenomenal aspect could not be left out of the *completed* facts of physics, chemistry and neurophysiology. Indeed, the phenomenal aspect is required to complete the facts of physics, chemistry and neurophysiology when referring to things (organisms) with consciousness. So Mary, before leaving the room, could not possibly have come to know the completed facts of physics, chemistry and neurophysiology. Upon leaving the room, she comes to know more of the facts of physics, chemistry and neurophysiology, by coming to know what it is like (for her) to experience color. She still however does not possess the completed facts of physics, chemistry and neurophysiology because she remains uncertain of the following: what it is like for others to experience color, or to experience anything for that matter; when in ontogeny her offspring begin to experience anything at all (and what that is like); which of her fellow biological organisms experience anything at all (and what that is like); which of the NC<sub>r</sub>C she has successfully and comprehensively identified are actually constitutive of consciousness; what scenarios pertain with respect to neural multiple realizability (and even

nonorganic multiple realizability); why it is that one particular neural firing/organization kind is constitutive of one particular phenomenal kind and not another; and how and why there is any phenomenal consciousness at all. Answers to all these questions (perhaps with the exception of those involving the logically flawed notion of direct intersubjective exchange, and the hard how and why problems that may or may not be problems for science) would complete the facts of physics, chemistry and neurophysiology, and would thus also satisfy the scientific study of consciousness<sup>30</sup>.

In my view, potentially intractable problems associated with studying consciousness do not legitimately imply any nonphysical or nonmaterial constitution of consciousness or conscious things, despite contrary knowledge arguments against physicalism and materialism. Thus, I consider the epistemic limits of studying consciousness have no bearing on the ontic status of things with consciousness insofar as ‘ontic status’ refers to the nature of things and nature refers to the constitution (composition) of things. I therefore contend that despite potential epistemic limits, things with consciousness are physically or materially constituted, indeed *only* physically or materially constituted<sup>31</sup>. However, insofar as ontology refers to the study of what there is or what exists (in a taxonomic sense, describing what sorts of things there are by virtue of what sorts of properties such things possess), the epistemic properties of things with consciousness can have ontic implications. The specific ontic implication is that things with consciousness belong to a unique set of things. The uniqueness of this set of things,

<sup>29</sup>Jackson, I understand, no longer holds this view. Other philosophers who have discussed ultimate epistemic limits include Nagel (29) and McGinn (56). Nagel (29) did not wish to imply that physicalism was false because of the difficulty in knowing what it would be like to be a bat, instead considering that (p. 446) ‘It would be truer to say that physicalism is a position we cannot understand because we do not at present have any conception of how it might be true’. McGinn (56) was more concerned with cognitive closure, the notion that our own cognitive apparatus prevents us from truly understanding consciousness.

<sup>30</sup>It could be argued that if Mary knew all there was to know about the facts of physics, chemistry and neurophysiology, she must also have known the answers to the hard problems of consciousness (excluding those entailing the logically flawed notion of direct intersubjective exchange, and perhaps the hard how and why problems) *before* she left the room. However, this objection presupposes that these (remaining) hard problems are tractable for science and, as I have argued, we cannot be confident that this is so. Other issues relevant to Jackson’s knowledge argument include, for example, what exactly a ‘fact’ is considered to be. Thus, can a fact that cannot be identified be considered a fact at all? Similarly, one could call into question what is meant by ‘physics, chemistry and neurophysiology’ or more broadly, ‘physical’ [see my Footnote 24; note further that the issue of what a ‘fact’ is, is also of relevance to discussions of physicalism; see Snowdon (48)]. Such issues, and related matters such as different ways of knowing, are dealt with in far greater detail in the knowledge argument literature. For more sophisticated discussions of the problem, see, for example, Loar (57) who is a physicalist and Chalmers (58) who is not.

<sup>31</sup>This might of course be a platitude for many neuroscientists but anyone seriously discussing hard problems of consciousness runs the risk of being misunderstood if they do not clearly state their position on such issues.

however, is not defined by its members being in any way nonphysically or nonmaterially constituted, but rather by their epistemic properties (the limitations associated with their study). In other words, there are aspects of things with consciousness that cannot be known, presuming any of the hard problems I have discussed are in fact intractable. If so, things with consciousness would evade complete description (and the facts of physics, chemistry and neurophysiology *could not be completed*). This epistemic uniqueness property would then define things with consciousness as unique things, as belonging to a unique set of things, but does not, to reiterate, suggest that the (compositional or constitutional) nature of such things is somehow nonphysical or nonmaterial<sup>32</sup>.

However, while the set of phenomenally conscious organisms is unique by virtue of its epistemic properties, it is also unique by virtue of ontic properties if by 'ontic properties' we mean 'the nature of things' and by 'nature' we mean the *organization* of things. Thus, although physically or materially constituted, things with consciousness, more specifically their brains, are organized in a unique way, such that they possess phenomenal properties. The possession of phenomenal properties thus also marks the set of phenomenally conscious organisms as a unique set. Indeed, the existence of phenomenal properties is what justifies the epistemic uniqueness property. Acceptance of phenomenal properties

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<sup>32</sup>I am suggesting that the set of phenomenally conscious organisms does not differ from the broad set of all physical (material) things in the sense of physical vs. nonphysical constitution, whereas the set of phenomenally conscious organisms does differ *epistemically* from the broad set of all physical (material) things. Because, as I have argued, we may be unable to precisely distinguish organisms with phenomenal consciousness from those without, it could be suggested that an 'unknowability' element applies equally to non-phenomenally-conscious organisms. However, what we do not know about non-phenomenally-conscious organisms is whether there is anything about them that is, in principle, unknowable (this is effectively the phylogenetic phenomenal consciousness ascription problem; here call it 'first-order' unknowability). The same can be said for phenomenally conscious organisms, except that in addition to first-order unknowability, we *further* do not know the character of what it is that makes them, in principle, unknowable (this is the problem of direct intersubjective exchange; here call it 'second-order' unknowability). Second-order unknowability, being based on a logical flaw rather than an empirical constraint, makes possible the claim of epistemic uniqueness for organisms with phenomenal consciousness, even in the absence of answers to the tractability or otherwise of the other hard problems. Qualification regarding the above unknowability discussion is also needed to account for the fact that there are a host of things we cannot know about past things/events or things/events outside one's direct or indirect purview. These temporal and spatial qualifications are just as applicable however, to non-phenomenally-conscious organisms, and so do not tell us anything interesting about what it is that is unique about phenomenally conscious organisms.

may conceivably invite the label of 'property dualism' (ie, the existence of both physical properties and phenomenal properties for one and the same system). However, this sort of property dualism is metaphysically distinct from the property dualism posed by Chalmers [(27); who has abandoned physicalism/materialism] precisely because the property dualism outlined here relies on organizational notions of ontic and nature rather than compositional or constitutional notions of these terms<sup>33</sup>.

Finally, there is no 'mysterian' agenda to the present identification of potentially intractable problems in the scientific study of consciousness. There is no desire or need to hold that consciousness *must* forever remain a mystery. I have instead tried to outline the very real challenges facing the scientific study of consciousness so that they may be understood, acknowledged, studied and perhaps overcome. In doing so, I have argued that if any of the problems prove intractable in the long run (or even just considering the logical flaw in the problem of direct intersubjective exchange), epistemic limits have ontological implications only insofar as determining what types of things exist (by virtue of epistemic properties and organizational ontic properties) but not regarding matters of constitution (compositional ontic properties). Ultimate epistemic limits and the existence of phenomenal properties therefore pose no threat to physicalism or materialism. Whether the hard problems of consciousness are intractable or not, only time will tell. Facing the problems head-on, however, must surely mean that the scientific study of consciousness will either solve/dissolve them or at least better understand the phenomenon it examines. Either outcome should count as having advanced the field.

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<sup>33</sup>Two last points of clarification. First, it must be noted that there is a tight relationship between the composition of a thing and the thing's organization, but this relationship does not unravel the distinction between the compositional sense of 'nature' and 'ontic properties' (in the substance monist vs. substance dualist context) and the organizational sense of these terms. Second, this composition/organization distinction invites consideration of nonorganic multiple realizability because of functionalism's emphasis on organization and disregard for (organic) composition (see Footnote 14). While it is not clear whether a computer or machine could ever truly replicate the complexity of neural constituents in process (Swiss cheese we all know certainly could not do it), even if we thought we had created a sufficiently complex computer or machine, it will certainly be hard, perhaps impossible, to test our creation for phenomenal properties. We may therefore never come to know whether a sufficiently complex, appropriately organized but nonorganically composed thing (in process) could constitute phenomenal consciousness.

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