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Opinion

Are There Levels of Consciousness?

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The notion of a level of consciousness is a key construct in the science of consciousness. Not only is the term employed to describe the global states of consciousness that are associated with post-comatose disorders, epileptic absence seizures, anaesthesia, and sleep, it plays an increasingly influential role in theoretical and methodological contexts. However, it is far from clear what precisely a level of consciousness is supposed to be. This paper argues that the levels-based framework for conceptualizing global states of consciousness is untenable and develops in its place a multidimensional account of global states.

Trends

The notion of a conscious level plays an increasingly important role in the science of consciousness, but there has been little conceptual analysis of the notion and it is typically left unexplained.

The standard conception of conscious levels identifies them with changes in a creature's degree of consciousness, but this conception is theoretically problematic and fails to do justice to the multifaceted nature of levels.

Global states of consciousness are multidimensional phenomena that capture the cognitive and behavioural dimensions of consciousness, such as the ways in which conscious contents are gated and their functional roles.

Two Aspects of Consciousness

Consciousness is typically taken to have two aspects: **local states** (see Glossary) and **global states**. Local states of consciousness include perceptual experiences of various kinds, imagery experiences, bodily sensations, affective experiences, and occurrent thoughts. In the science of consciousness local states are usually referred to as '**conscious contents**', for they are typically distinguished from each other on the basis of the objects and features that they represent. By contrast, global states of consciousness are not typically distinguished from each other on the basis of the objects or features that are represented in experience. Instead, they are typically distinguished from each other on cognitive, behavioural, and physiological grounds. For example, the global state associated with alert wakefulness is distinguished from the global states that are associated with post-comatose conditions such as the vegetative state (VS) and the minimally conscious state (MCS), and these states are themselves distinguished from the states that are associated with light-to-moderate degrees of sedation, dreaming, hypnosis, and epileptic absence seizures.

Compared with the amount of attention that has been devoted to the contents of consciousness, global states of consciousness have been relatively neglected (although see [1–6]). This neglect might be justified if the notion played only a marginal role in the science of consciousness, but it is puzzling given the increasing prominence of global states in consciousness studies. The neglect of global states might also be justified if their nature was self-evident, but that is not the case either. Indeed, the standard conception of global states equates them with 'levels of consciousness', but it is far from clear what a level of consciousness is supposed to be. This paper argues that the levels-based conceptions of global states of consciousness is untenable, and offers in its place a multidimensional analysis of global states.

Levels of Consciousness

The term 'levels of consciousness' derives from the clinical literature on disorders of consciousness, where it was introduced in connection with the disorders of consciousness that occur following coma, such as the VS [7]. With the introduction of the category of the MCS in 2002 [8], clinicians now operate with a taxonomy of global states of consciousness that are taken to be scalable along a single dimension: MCS patients have a higher level of consciousness than

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VS patients do, and **emerged from minimally conscious state** (EMCS) patients in turn have a higher level of consciousness than MCS patients. (The recent distinction between MCS+ and MCS– patients introduces a further level of consciousness within the MCS category [9]).

Over the past decade the notion of a conscious level has been extended beyond the post-comatose disorders of consciousness, and is now routinely applied to the global states of consciousness associated with sedation [10–12], sleep [10,13], and epileptic absence seizures [14–16]. Indeed, the term has even been applied to consciousness as it occurs in human infancy and non-human animals [17], with the suggestion that infants and non-human animals have lower levels of consciousness than neurotypical adult human beings (Box 1).

We grant that many global states of consciousness can be ordered in a rough and ready manner, and that appeals to the notion of a level of consciousness has a certain utility in clinical contexts. However, the notion of a level of consciousness is no longer employed as a merely informal device, but has become a key theoretical construct in the science of consciousness. The integration of a clinical understanding of levels with theoretical approaches to consciousness is exemplified by a recently developed measure of consciousness, the perturbational complexity index (PCI), which is explicitly presented as a measure of levels of consciousness ([18], see also [19]). The PCI is inspired by one of the major theories of consciousness, the Integrated Information Theory, which is expressly designed to explain the 'classic distinction between level and content of consciousness' [20].

We think that the science of consciousness has been overly hasty in employing the notion of a conscious level as a central theoretical construct. Although global states of consciousness clearly exist, there are serious – and perhaps even fatal – problems with treating such states as involving changes in a level of consciousness. If the notion of a level of consciousness has no sound basis, then it is unclear whether even highly sophisticated attempts to measure it or develop theories of it will be successful.

Levels as Degrees of Consciousness

To describe global states as levels of consciousness is to imply that consciousness comes in degrees, and that changes in a creature's global state of consciousness can be represented as changes along a single dimension of analysis. This idea is frequently expressed in consciousness science. For example, consciousness is described as involving 'a scale ranging from total unconsciousness (e.g., death and coma) to vivid wakefulness' [21]; as a 'continuous variable' [22]; and as 'being graded' rather than being an 'all-or-none property' [23]. Are these claims plausible? Can individuals be ordered on the basis of how conscious they are, just as they can be ordered on the basis of their age, height, or blood pressure?

Box 1. Infants and Animals

A number of theorists have used the term 'levels' in connection with consciousness in infants and non-human animals, suggesting that infant and animal consciousness involves low levels of consciousness (e.g., [4,17]). The analysis of levels presented here problematises such claims, for although there may be conscious contents and capacities that infants and non-human animals fail to share with 'us', infants and non-human animals can also have conscious contents and capacities that adult human beings lack. Dogs can detect odours that we cannot [42], and young children experience less sensory integration than adults and are thus better able to exploit information in individual sensory modalities [43]. The restrictions in content and cognitive/behavioural capacities that is captured by appeal to the notion of a global state of consciousness needs to be understood in relation to the organism's ordinary capacities. A mouse that cannot report its perceptual experiences does not thereby have an abnormal global state of consciousness, whereas a human being who cannot report her perceptual experiences because she is undergoing an absence seizure does. Non-human animals and infants can of course have non-standard global states of consciousness for the same kinds of reasons that human adults can (e.g., sedation, epileptic seizures), but there is no reason to suppose that the global states of consciousness had by infants and non-human animals when they are alert and awake are distinct from those had by neurotypical adult humans.

Glossary

Conscious contents: the features of consciousness that account for its subjective or phenomenal character, such as experiences of pitch or of motion. Paradigmatic contents are sensory, but many theorists think that non-sensory states of various kinds (such as thoughts) can also contribute to the contents of consciousness.

Consuming system: a system (e.g., attention or working memory) that employs the contents of consciousness in the service of some cognitive or behavioural goal.

Emerged from minimally conscious state: a post-comatose state that is characterised by the capacity to engage in functional communication or use objects appropriately.

Global availability: contents are globally available when they can be used to guide a wide variety of cognitive and behavioural processes, such as verbal report, reasoning, inhibitory control, and memory consolidation. The notion is closely related to the notion of 'access consciousness' and 'cognitive accessibility'.

Global states of consciousness: states of consciousness that characterise an organism's overall conscious condition. An organism can be in only one global state of consciousness at a time. Not to be confused with global availability.

Local states of consciousness: to be contrasted with global states of consciousness. Local states of consciousness are individuated in terms of their contents or phenomenal character.

We think not. There are two problems with this proposal. The first problem is conceptual: the notion of degrees of consciousness is of dubious coherence. According to the standard conception of consciousness, a creature is conscious if and only if it possesses a subjective point of view [24]. Arguably, the property of having a subjective point of view is not gradable–it cannot come in degrees. In this way it resembles being a member of the United Nations rather than being healthy, which clearly can come in degrees. One person can be conscious of more objects and properties than another person, but to be conscious of more is not to be more conscious. A sighted person might be conscious of more than someone who is blind, but they are not more conscious than the blind person is. Similarly, someone in a state of normal alert wakefulness might be conscious of more than someone who is mildly sedated, but they are not thereby more conscious.

One might respond to the foregoing by suggesting that the notion of a level of consciousness should be understood in terms of the degree to which local contents (rather than global states) are conscious [4]. In our view, this strategy is no more promising than the standard treatment of levels. Not only is it controversial whether the contents of consciousness can be graded in terms of their degree of consciousness, equating a creature's level of consciousness with the 'clarity' of its most conscious contents fails to capture the notion of a conscious level as it is actually understood but at best introduces a novel construct into the debate (Box 2).

The second problem with the level-based analysis of global states is that there is good reason to doubt whether all global states can be assigned a determinate ordering relative to each other. Consider the relationship between the global conscious state associated with rapid eye movement (REM) sleep and that which is associated with light levels of sedation. Although the level-based analysis entails that one of these states must be absolutely 'higher' than the other, we see no reason to grant that claim. Perhaps states can be compared with each other only relative to certain dimensions of analysis: the global state associated with REM sleep might be higher than that associated with sedation on some dimensions of analysis, whereas the opposite might be the case on other dimensions of analysis (Figure 1A). Consider the following

Box 2. Graded Consciousness?

Some theorists have suggested that the notion of a conscious level should be understood in terms of the degree to which local contents (rather than global states) are conscious (e.g., [4]). This proposal presupposes that some contents are highly conscious (and are thus experienced as 'clear and distinct'), whereas other contents enjoy only low levels of consciousness (and are thus experienced as 'degraded' or 'vague') [44,45]. A creature's level of consciousness is then equated with how conscious its most conscious contents are.

There are two main problems with this proposal. Firstly, it is controversial whether contents can be graded in this way. In our view, reports of 'degraded' or 'vague' perception can be accounted for without supposing that consciousness itself is graded. One possibility is that when subjects report 'intermediate' levels of awareness they mean only to be expressing uncertainty about whether or not they saw the stimulus. Indeed, such an interpretation is highly plausible given the epistemic terms in which the various response categories are described. (For example, the category of an almost clear experience is explained in terms of a 'feeling of having seen the stimulus, but being only somewhat sure about it'.) A second possibility is that subjects are reporting the amount of information they take themselves to have about the stimulus. For example, they might understand the difference between a clear experience and an experience that is almost clear in terms of the difference between having a fine-grained perception of the stimulus and having a coarse-grained perception of it. This is certainly a legitimate contrast, but it has nothing to do with degrees of consciousness. There is, however, ongoing and lively debate about this and other approaches to degrees of conscious content (see, e.g., [46–49])

Setting aside our concerns about whether contents can be graded in terms of their degree of consciousness, we doubt whether a creature's level of consciousness should be equated with how conscious its most conscious contents are. This account entails that a VS patient with even a single 'clear and distinct' experience of pain has the same level of consciousness as any other individual with a 'clear and distinct' experience of pain. In our view this consequence is highly problematic, for patients are not assigned to a particular level of consciousness on the basis of the clarity and distinctness of their most conscious content. We conclude that this proposal does not capture the notion of a conscious level as it is employed in the science of consciousness.

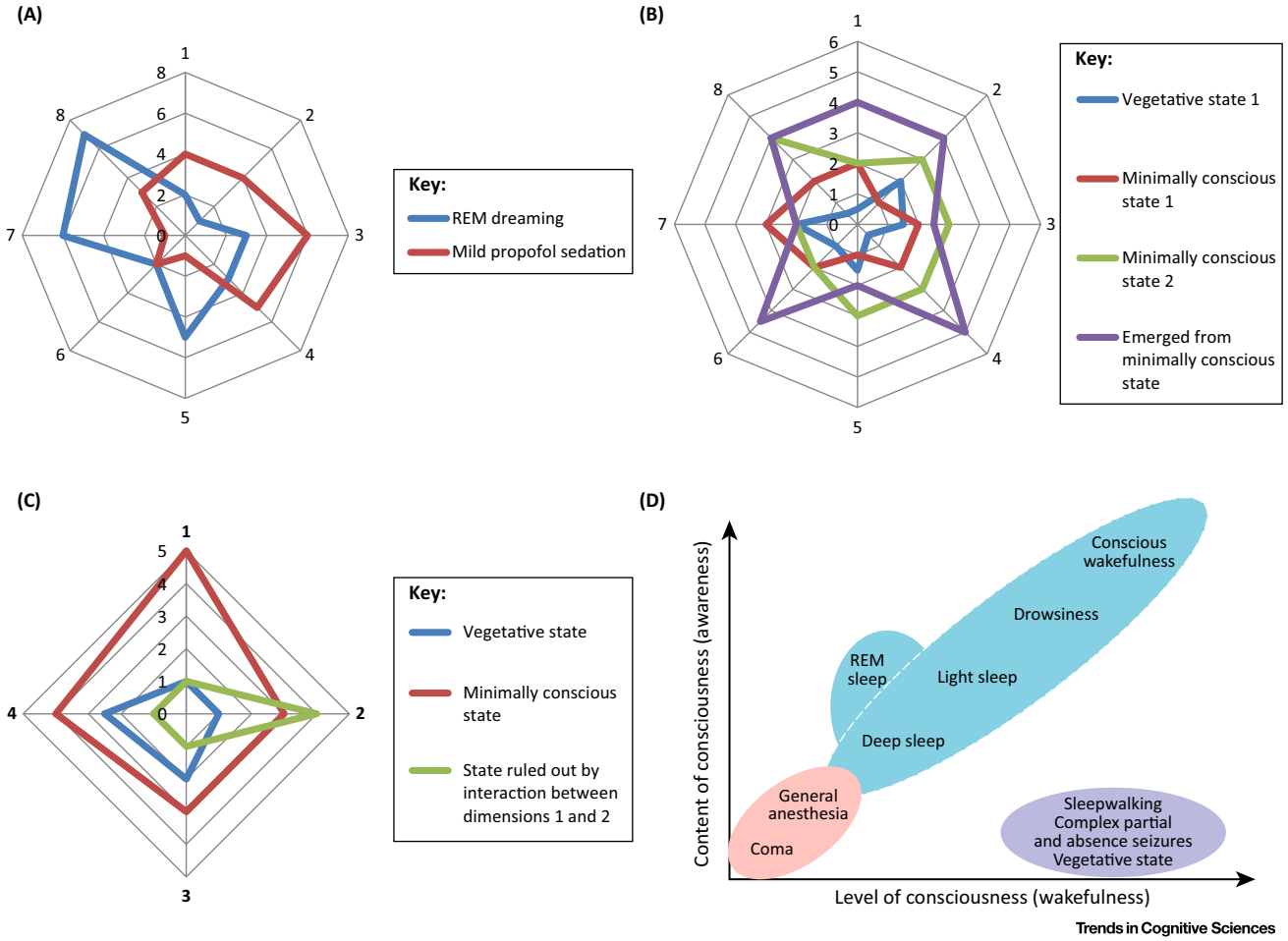

Figure 1. Conceptual Sketch of Multidimensional Global States of Consciousness. The radar charts depict regions in a multidimensional space that reflect different states of consciousness. Numbers at the radii are placeholders for the dimensions of consciousness, they may correspond to a family of content-related (e.g., content gating and content range) and functional dimensions (e.g., relating to attentional control, memory consolidation, verbal report, reasoning, action selection, etc.). The figures here do not portray empirically grounded results but are merely illustrative of possible dimensional analyses of states of consciousness. For further discussion, see main text. (A) Global states may not possess an absolute ordering if they differ in different dimensions; for example, rapid eye movement (REM) dreaming and mild sedation could be high and low in roughly opposite dimensions. (B) Multidimensionality raises the possibility of considerable variability within categories that are currently assumed to involve a single global state of consciousness; for example, the global conscious states of certain MCS patients might resemble those of certain VS or EMCS patients more closely than they do other MCS patients. (C) Interactions between dimensions may lead to non-linear transitions between states, raising the possibility of regions that cannot be occupied; for example, for the difference between VS and MCS, it could be that being low in one dimension forces a low score in another dimension, ruling out certain intermediate states. (D) The traditional two-dimensional representation of consciousness (e.g., [1,41]), which obscures scenarios such as those represented by (A–C) and discussed in the main text. Reproduced from [1].

analogy. The Chinese economy might be healthier than the Brazilian economy on some dimensions, whereas the opposite might be the case when other dimensions are considered. Is there any sense in which one of these two economies is all-things-considered healthier than the other? Perhaps not. Attempts to impose an absolute ordering on global states of consciousness may be as futile as attempts to impose such an ordering on economies.

The lesson to be drawn from the foregoing is that although the notion of a conscious level serves a useful heuristic function insofar as it draws attention to certain relations between global conscious states, it should not be treated as a legitimate theoretical construct in the science of consciousness. Attempts to model global states of consciousness in one-dimensional terms are no more plausible than attempts to model (say) intelligence in one-dimensional terms. Just as

multiple dimensions of analysis are needed in order to account for the various ways in which intelligence is manifest in astronomy, architecture, and arithmetic, so too multiple dimensions of analysis are needed to capture the various ways in which consciousness is manifest in different global states. We turn now to consider what some of these dimensions might be.

Global States: Content-related Dimensions

Providing an account of the dimensions that are needed to model global states of consciousness requires a much more detailed understanding of consciousness than that which we currently possess. At present we can only sketch two of the many dimensions – or perhaps families of dimensions – that structure global states. Filling in the details of this sketch will require a significant research project.

The first of these two dimensions concerns the contents of consciousness. Although global states of consciousness are distinct from local, content-involving states, it is likely that some of the dimensions in terms of which global states can be modelled involve relations to conscious contents. In particular, we suggest that global states differ from each other in terms of how they gate conscious content. Normal waking experience allows for a wide range of contents to enter consciousness. In addition to the 'low-level' features of objects such as their colour, motion, texture, pitch, and so on, one can also be conscious of many of their high-level features. We see chairs as chairs, taste coffee as coffee, and hear police sirens as police sirens; we also have various capacities for conscious thought. However, in many global states the contents of consciousness appear to be gated in various ways, with the result that individuals are able to experience only a restricted range of contents. MCS patients, patients undergoing absence seizures, and mildly sedated individuals can consciously represent the low-level features of objects, but they are typically unable to represent the categories to which perceptual objects belong, nor are they typically able to entertain complex thoughts about them. For example, an MCS patient might be aware of motion, but be unable to recognise the moving object as the kind of object it is.

Variation in the gating of conscious contents is likely to provide one dimension along which certain global states can be hierarchically organised. For example, one can distinguish post-coma patients who produce no fMRI response to spoken speech from patients who respond to speech more than to other non-speech sounds, and from patients who respond to the meaning of the speech itself [25]. Similarly, at low levels of sedation the awareness of low-level auditory properties of speech is retained but the awareness of high-level semantic properties (such as ambiguity) is lost, whereas the awareness of both low-level and high-level properties is lost at higher levels of sedation [26]. Thus, one can order these patients in terms of a content-based dimension of analysis. Note, however, that this result is in no way an exoneration of the level-based account of global states. For one thing, it does not entail that all global states can be ordered with respect to the ways in which contents are gated. In addition, this ordering applies only to this content-related dimension, and it is entirely possible that these same patients will be ordered in very different ways when other dimensions of analysis are taken into consideration. We turn now to consider one such dimension: the functional dimension.

Global States: Functional Dimensions

Consciousness is associated with various forms of cognitive and behavioural control. In ordinary waking awareness the contents of consciousness are typically available to guide a wide range of cognitive and behavioural processes, such as those involved in verbal report, intentional agency, attentional control, reasoning, executive processing, memory consolidation, and so on. This facet of consciousness is often captured by saying that the contents of consciousness are globally available for the control of thought and action.

Although **global availability** is sometimes taken to be an essential feature of consciousness [27–29], there is good reason to think that it is compromised in a number of pathologies of consciousness (that is, pathologies in which consciousness is presumed not to be totally absent). For example, patients undergoing absence seizures can engage in perceptual-driven motor responses even though their capacities for reasoning, executive processing, and memory consolidation are typically limited [30–32]. Similarly, mildly sedated patients can engage in some kinds of cognitions and behaviours but not others [33,34]. Of course, as the literature on post-comatose disorders of consciousness attests [35–39], it can be difficult to tell whether an individual is completely unconscious or whether they are in a state of consciousness in which many of the cognitive and behavioural systems associated with consciousness are 'off-line' (Box 3).

The fact that cognitive and behavioural control can fragment in these ways provides us with another dimension – or, perhaps, family of dimensions – for modelling consciousness, for certain cognitive and behavioural capacities are more preserved in some global states of consciousness than others. With respect to this dimension, the global state of consciousness associated with the EMCS is 'higher' than that which is associated with the MCS, for EMCS patients have access to a wider range of cognitive and behavioural **consuming systems** than MCS patients do.

Note, again, that nothing in the foregoing exonerates the level-based analysis of global states. For one thing, appeals to functionality might enable us to order only some global states with respect to each other. In particular, it is possible that there are two global states which both exhibit functional impairments, but where there is no sense in which the functional impairments is worse in one of the two states than in the other. (Consider, for example, the fact that certain post-comatose patients can imagine playing tennis on command but cannot imagine moving around their house, whereas other patients can imagine moving around their house but cannot imagine playing tennis on command [35]). Secondly, even when global conscious states can be ordered relative to a certain dimension of functionality, it is a further question whether this ordering reflects their absolute relations, or whether it applies only to this dimension of analysis.

From Levels to Multidimensional States

We can now begin to see what an alternative to the level-based conception of global conscious states might look like. The central idea is that global states can be thought of as regions within a multidimensional state space (Figure 1). Although the dimensions of the state space are still unknown, we have suggested that one dimension tracks the gating of contents and another

Box 3. Levels and the Detection of Consciousness

The report-based methods for measuring consciousness employed in dealing with cognitively intact adult human beings in a state of alert wakefulness can be used only with difficulty (if at all) in contexts involving impaired states of consciousness. Thus, measuring consciousness in such contexts requires non-report-based methods. One alternative to reports appeals to the capacity to produce responses to command. This capacity is often used to probe for consciousness in post-comatose patients, anaesthesia, and (more controversially) epileptic absence seizures. Command-following has traditionally been probed by examining overt behaviour, but we can now probe command-following by using fMRI and electroencephalography (EEG) to detect covert command-following – that is, command-following that is not behaviourally manifest [50]. Other proposed measures of consciousness include the capacity to follow the plot of a movie [51,52], and the representation of violations of global regularities [53].

In attempting to validate these novel measures of consciousness we face the following dilemma. On the one hand, we should not restrict our measures of consciousness to processes that require high-level cognition, for taking consciousness to require high-level cognition risks withholding ascriptions of consciousness to creatures who are in impaired global states of consciousness. On the other hand, anything less than high-level cognitive access will not be regarded as compelling evidence of consciousness. Finding a way between the two horns of this dilemma remains an ongoing challenge for the science of consciousness [36,54,55].

dimension (or family of dimensions) tracks the functional capacities associated with consciousness.

The foregoing prompts a number of questions, the most pressing of which concerns the nature of the dimensions that structure global states. In addition to gating, might other content-related dimensions have a role to play here? Might there be a role for attention in structuring global states? Do different types of functional capacities structure consciousness in different ways? For example, do the functional capacities related to mind-wandering and endogenous cognitive control correspond to one dimension whilst those relating to exogenous cognitive control correspond to another dimension?

A second question concerns the relationship between our current ways of taxonomising global states and the picture of consciousness that emerges from the multidimensional approach (Figure 1B). At present, theorists tend to assume that one global state (or 'level') corresponds to the MCS, another corresponds to EMCS, a third corresponds to REM dreaming, and so on. The reality, of course, is likely to be significantly messier [38,40]. Perhaps the global states of consciousness associated with patients correctly categorised as MCS are heterogeneous, with the global states of some MCS patients resembling those associated with certain (say) VS and EMCS patients more than they do other MCS patients. The global states of consciousness associated with sedation might also turn out to be very heterogeneous, and perhaps differ depending on the sedative used. In other words, the multidimensional account might reveal variation within our current categories that has gone unrecognised. It might also reveal commonalities between our current categories that have also gone unrecognised. We can ask how closely related the global state(s) associated with REM dreaming are to those that are associated with light levels of ketamine-induced sedation, or how closely related the global state(s) associated with the waking MCS patients are to those that are associated with light levels of propofol-induced sedation. The cartography of consciousness that is likely to emerge from addressing these questions may look very different from that which is currently assumed in consciousness science (Figure 1D).

A third question concerns the possibility of interaction between some of the dimensions that structure consciousness. Although some dimensions may be completely independent of each other, others are likely to modulate each other, with the result that certain regions in this multidimensional space will be empty (or at least, inaccessible to creatures like us). For example, there might be interactions between the gating of contents and functionality such that consciousness cannot be high on the gating dimension but low on certain dimensions of functionality (Figure 1C).

If there are such interactions how might they be explained? It is natural to appeal to arousal at this point. Arousal is often mentioned in connection with global states of consciousness, and indeed many authors come close to equating global states of consciousness with states of arousal (see, e.g., [1,41]). But any discussion of arousal in connection with global states of consciousness must proceed with caution. VS patients can have high levels of arousal but they are typically unconscious (and thus have no level of consciousness). By contrast, in the widely reported phenomenon of anaesthetic awareness [11,34], patients have a high level of consciousness despite the fact that standard physiological measures of arousal are low. The relationship between global states of consciousness and arousal is multifaceted, in part because the notion of arousal is itself multifaceted. If arousal is conceptualised in behavioural terms then it might function as one dimension along which global states differ. If, however, it is conceptualised in neuroanatomical terms – for example, in terms of activity in the brainstem 'arousal system' – then it might function as a common cause of variation in multiple dimensions of consciousness and in so doing provide a partial explanation of certain aspects of global states of consciousness.

The existence of interactions between various dimensions might account for many of the intuitions that underpin the widespread appeal of the level-based conception of global states. For example, if it turns out that consciousness (where it occurs) in the VS is both more strongly gated and more functionally impoverished than consciousness in the MCS, then there would be a clear sense in which the global state of consciousness associated with the VS is 'lower' than that which is associated with the MCS (Figure 1C). Similarly, if it turns out that consciousness at low levels of sedation is less strongly gated and less functionally impoverished than consciousness at higher levels of sedation (as is very plausibly the case), then it would also follow that the global state of consciousness associated with low levels of sedation is 'higher' than that which is associated with higher levels of sedation. But although the multidimensional account might vindicate a number of the intuitions that motivate the levels-based approach, it is clearly at odds with the central tenets of the view.

Concluding Remarks

As the science of consciousness matures it is increasingly in need of constructs to guide research and theorising. Our central aim in this paper has been to argue that the notion of a level of consciousness is ill-suited for this function, for it implies that global states of consciousness can be ordered in terms of a single dimension – an implication that we have argued is at best uncertain and at worst false. Global states of consciousness, we have argued, are best understood as regions in a multidimensional space. The task of identifying the dimensions of this space is an urgent and necessary one that will lead ultimately to a better understanding of consciousness itself (see Outstanding Questions).

Outstanding Questions

How are changes in arousal related to changes in a creature's global state of consciousness? What kinds of interactions occur between arousal and the dimensions that structure global states of consciousness?

How might the multidimensional account of global states developed here apply to altered states of consciousness due to psychedelics, hallucinogens, trance, and meditation?

Are there clear and distinct boundaries between global states, or does one kind of global state 'blend' into another?

There are two types of global states: occurrent global states (such as REM dreaming), which are defined in terms of the individual's current conscious experiences, and dispositional global states (such as MCS), which are defined in terms of the conscious capacities that an individual has. How are these two types of global states related to each other?

What are the dimensions that structure global states of consciousness? What kinds of dimensions might structure global states over and above the content-involving and functional dimensions that are described here?

How might current theories of consciousness account for global states of consciousness? For example, can the Integrated Information Theory of consciousness account for global states of consciousness by appealing to phi? Can the Global Neuronal Workspace Theory account for global states of consciousness by appealing to modulations in the activity of the global workspace? Or do these theories of consciousness need to invoke additional factors to fully account for the multidimensional nature of global states of consciousness?

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