

CHAPTER 4

Global workspace theory of consciousness: toward a cognitive neuroscience of human experience?

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Abstract: Global workspace (GW) theory emerged from the cognitive architecture tradition in cognitive science. Newell and co-workers were the first to show the utility of a GW or “blackboard” architecture in a distributed set of knowledge sources, which could cooperatively solve problems that no single constituent could solve alone. The empirical connection with conscious cognition was made by Baars (1988, 2002). GW theory generates explicit predictions for conscious aspects of perception, emotion, motivation, learning, working memory, voluntary control, and self systems in the brain. It has similarities to biological theories such as Neural Darwinism and dynamical theories of brain functioning. Functional brain imaging now shows that conscious cognition is distinctively associated with wide spread of cortical activity, notably toward frontoparietal and medial temporal regions. Unconscious comparison conditions tend to activate only local regions, such as visual projection areas. Frontoparietal hypometabolism is also implicated in unconscious states, including deep sleep, coma, vegetative states, epileptic loss of consciousness, and general anesthesia. These findings are consistent with the GW hypothesis, which is now favored by a number of scientists and philosophers.

Introduction

Shortly after 1900, behaviorists attempted to purge science of mentalistic concepts like consciousness, attention, memory, imagery, and voluntary control. “Consciousness,” wrote John B. Watson, “is nothing but the soul of theology.” But as the facts accumulated over the 20th century, all the traditional ideas of James (1890) and others were found to be necessary. They were reintroduced with more testable definitions. Memory came back in the 1960s; mental imagery in the 1970s; selective attention over the last half century; and consciousness last of all, in the last decade or so.

It is broadly true that what we are conscious of, we can report with accuracy. Conscious brain events

are therefore assessed by way of reportability. We now know of numerous brain events that are reportable and comparable ones that are not. This fact invites experimental testing: why are we conscious of *these words at this moment*, while a few seconds later they have faded, but can still be called to mind? Why is activity in visual occipito-temporal lobe neurons reportable, while visually evoked activity in parietal regions is not? Why does the thalamocortical system support conscious experiences, while the comparably large cerebellum and basal ganglia do not? How is waking consciousness impaired after brain damage? These are all testable questions. The empirical key is to treat consciousness as a controlled variable.

A growing literature now compares the brain effects of conscious and unconscious stimulation. Precise experimental comparisons allow us to ask what conscious access does “as such.” Many

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1 techniques are used for this purpose. In visual
 3 backward masking, a target picture is immediately
 5 followed by a scrambled image that does not block
 7 the optical input, but renders it unconscious
 9 (Dehaene et al., 2001). Binocular rivalry has been
 11 used for the same reason: it shows that when two
 13 competing optical streams enter the two eyes, only
 15 one consistent interpretation can be consciously
 17 perceived at any given moment (Leopold and
 19 Logothetis, 1999). Most recently, several studies
 21 have demonstrated inattention blindness, in
 23 which paying attention to one visual flow (e.g., a
 25 bouncing basketball) blocks conscious access to
 another one at the very center of visual gaze (e.g.,
 a man walking by in a gorilla suit) (Simons and
 Chabris, 1999). These studies generally show that
 unconscious stimuli still evoke local feature
 activity in sensory cortex. But what is the use of
 making something conscious if even unconscious
 stimuli are identified by the brain? More than a
 score of studies have shown that although
 unconscious visual words activate known word-
 processing regions of visual cortex, the same
 stimuli, when conscious, trigger widespread addi-
 tional activity in frontoparietal regions (e.g.,
 Dehaene et al., 2001).

27 A rich literature has arisen comparing conscious
 29 and unconscious brain events in sleep and waking,
 31 general anesthesia, epileptic states of absence, very
 33 specific damage to visual cortex, spared implicit
 35 function after brain damage, attentional control
 37 (also see Posner, this volume), visual imagery,
 39 inner speech, memory recall, and more (Crick and
 Koch, 2003). In state comparisons, significant
 progress has been made in understanding epileptic
 loss of consciousness (Blumenfeldt and Taylor,
 2003; Blumenfeld, this volume), general anesthesia
 (Fiset et al., 2001; John et al., 2001; Alkire and
 Fiset et al., this volume) and sleep¹ (Steriade, 2001;
 Maquet, this volume).

41
 43 ¹At the level of cortical neurons, bursting rates do not change
 45 in deep sleep (Steriade, 2001). Rather, neurons pause together
 47 at <4Hz between bursts. Synchronous pausing could disrupt
 the cumulative high-frequency interactions needed for waking
 functions such as perceptual continuity, immediate memory,
 sentence planning, motor control, and self-monitoring. It is
 conceivable that other unconscious states display similar
 neuronal mechanisms.

The global access hypothesis

1 The idea that consciousness has an integrative
 3 function has a long history. Global workspace
 5 (GW) theory is a cognitive architecture with an
 7 explicit role for consciousness. Such architectures
 9 have been studied in cognitive science, and have
 11 practical applications in organizing large, parallel
 13 collections of specialized processors, broadly
 15 comparable to the brain (Newell, 1994). In recent
 17 years, GW theory has been found increasingly
 19 useful by neuroscientists. The theory suggests a
 21 *fleeting memory capacity that enables access*
 23 *between brain functions that are otherwise separate.*
 25 This makes sense in a brain that is viewed as a
 27 massive parallel set of specialized processors. In
 29 such a system, coordination and control may take
 31 place by way of a central information exchange,
 33 allowing some processors — such as sensory
 35 systems in the brain — to distribute information
 37 to the system as a whole. This solution works in
 39 large-scale computer architectures, which show
 41 typical “limited capacity” behavior when informa-
 43 tion flows by way of a GW. A sizeable body of
 45 evidence suggests that consciousness is the primary
 47 agent of such a global access function in humans
 and other mammals (Baars, 1988, 1997, 2002). The
 “conscious access hypothesis” therefore implies
 that conscious cognition provides a gateway to
 numerous capacities in the brain (Fig. 1). A
 number of testable predictions follow from this
 general hypothesis (Table 1).

A theater metaphor and brain hypotheses

1 GW theory may be thought of as a theater of
 3 mental functioning. Consciousness in this meta-
 5 phor resembles a bright spot on the stage of
 7 immediate memory, directed there by a spotlight
 9 of attention under executive guidance. Only the
 11 bright spot is conscious, while the rest of the
 13 theater is dark and unconscious. This approach
 15 leads to specific neural hypotheses. For sensory
 17 consciousness the bright spot on stage is likely to
 19 require the corresponding sensory projection areas
 21 of the cortex. Sensory consciousness in different
 23 modalities may be mutually inhibitory, within

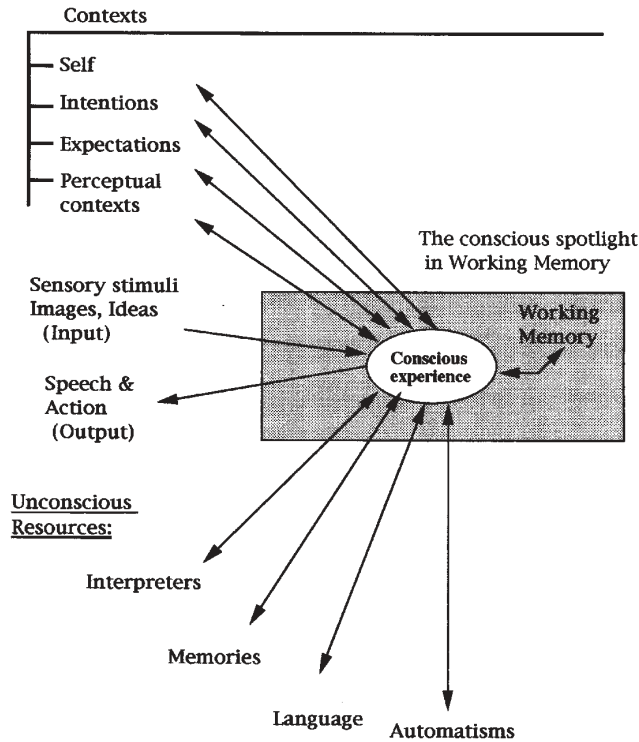


Fig. 1. A schematic diagram of GW theory, viewed metaphorically as a theater of mind. Conscious contents correspond to the bright spot on the stage of working memory. Once conscious, they activate many unconscious regions of the brain, including interpreters, memories, language capacities, and automatisms. In brain terms, those would be involved in certain cortical regions, hippocampus, and basal ganglia, which are believed not to directly support conscious experiences. However, conscious cognitions themselves are always shaped by unconscious contexts. Executive functions (self) may be considered as one set of such contexts (Adapted from Baars, 1997).

Table 1. Theoretical claims: brain capacities enabled by conscious events

1. Conscious perception enables access to widespread brain sources; unconscious sensory processing is much more limited
2. Conscious perception, inner speech, and visual imagery enable working memory functions; there is no evidence for unconscious access to working memory
3. Conscious events enable almost all kinds of learning: episodic and explicit learning, but also implicit and skill learning
4. Conscious perceptual feedback enables voluntary control over motor functions, and perhaps over any neuronal population and even single neurons
5. Conscious contents can evoke selective mechanisms (attention) and be evoked by it
6. Consciousness enables access to the “observing self” — executive interpreters, involving parietal and prefrontal cortex

approximately 100 ms time cycles (Baars and Franklin, 2003). Sensory cortex can be activated internally as well as externally, resulting in the “internal senses” of conscious inner speech and imagery. Once a conscious sensory content is established, it is distributed widely to a decentralized “audience” of expert networks sitting in the

darkened theater, presumably using corticocortical and corticothalamic fibers. The transfer of information from conscious visual episodes to the (unconscious) hippocampal system is a clear example of such distribution of conscious information in the brain (Moscovitch, 1995). This is the primary functional role of consciousness: to allow

QA:1

1 a theater architecture to operate in the brain, in
 3 order to integrate, provide access, and coordinate
 5 the functioning of very large numbers of special-
 7 ized networks that otherwise operate auton-
 9 omously. All the elements of GW theory have
 11 reasonable brain interpretations, allowing us to
 generate a set of specific, testable brain hypotheses
 about consciousness and its many roles in the
 brain. Some of these ideas have now received
 considerable empirical support (Baars, 2002; Baars
 et al., 2003).

13 The theory has been implemented in computa-
 15 tional and neural net models and bears a family
 17 resemblance to Neural Darwinist models (Edel-
 19 man, 2003). Franklin and colleagues have imple-
 21 mented GW theory in large-scale computer agents,
 23 to test its functionality in complex practical tasks
 25 (Franklin, 2001). IDA (for “intelligent distributed
 27 agent”), the current implementation of the ex-
 29 tended GW architecture directed by Franklin, is
 31 designed to handle a very complex artificial
 33 intelligence task normally handled by trained
 35 human beings (also see Aleksander on machine
 37 consciousness in this volume). The particular
 39 domain in this case is interaction between U.S.
 41 Navy personnel experts and sailors who move
 43 from job to job. IDA negotiates with sailors via e-
 45 mail, and is able to combine numerous regulations,
 47 sailors’ preferences, time, location and travel
 considerations into human-level performance.
 While it has components roughly corresponding
 to human perception, memory, and action control,
 the heart of the system is a GW architecture that
 allows the content or meanings of the messages to
 be widely distributed, so that specialized programs
 called “codelets” can respond with solutions to
 centrally posed problems. Franklin writes that
 “The fleshed out global workspace theory is
 yielding hopefully testable hypotheses about hu-
 man cognition. The architectures and mechanisms
 that underlie consciousness and intelligence in
 humans can be expected to yield information
 agents that learn continuously, adapt readily to
 dynamic environments, and behave flexibly and
 intelligently when faced with novel and unexpected
 situations.” (<http://csrcg.cs.memphis.edu/>). Similar
 architectures have been applied to difficult pro-
 blems like speech recognition. While such auton-

1 omous agent simulations do not prove that GW
 3 architectures exist in the brain, they give an
 5 existence proof of their functionality. It is worth
 7 noting that few integrative theories of mind or
 9 brain show functional utility in applied settings.

11 **Sensory consciousness as a test case**

13 Visual consciousness has been studied in depth, and
 15 there is accepted evidence that visual features that
 17 become conscious are identified by the brain in the
 19 ventral stream of visual cortex. There, feature-
 sensitive cells support visual experiences of light,
 color, contrast, motion, retinal size, location, and
 object identity; small lesions can selectively abolish
 those conscious properties without affecting other
 aspects of conscious vision (Zeki, 2001; Naccache,
 in this volume).

21 However, to recollect the experience of a human
 23 face, we need the hippocampal system. To respond
 25 to it emotionally, neurons in amygdala may be
 27 activated. But hippocampus and amygdala do not
 29 seem to support conscious contents directly
 31 (Moscovitch, 2001). Thus, the ventral visual
 33 stream, which is needed for specific conscious
 35 contents, seems to influence regions that are not.

37 Dehaene and colleagues have shown that back-
 39 ward-masked visual words evoked brain activity
 41 confined to the well-known visual word recogni-
 43 tion areas of cortex (Dehaene et al., 2001).
 45 Identical conscious words triggered higher levels
 47 of activity in these areas, but more importantly,
 they also evoked far more widely distributed
 activity in parietal and prefrontal cortex. That
 result has now been replicated more than a dozen
 times, using different brain imaging techniques
 and different methods for comparing conscious
 and unconscious input. Such methods have
 included binocular rivalry (Sheinberg and Lo-
 gothetis, 1997), inattention blindness (Rees et al.,
 1999), neglect and its extinction (Rees et al., 2002),
 and different sense modalities, such as audition
 (Portas et al., 2000), pain perception (Rosen et al.,
 1996), and sensorimotor tasks (Haier et al., 1992;
 Raichle et al., 1994). In all cases, conscious sensory
 input evoked wider and more intense brain activity
 than identical unconscious input.

1 Complementary findings come from studies of
 3 unconscious states. In deep sleep, auditory stimu-
 5 lation activates only primary auditory cortex
 7 (Portas et al., 2000). In vegetative states following
 9 brain injury, stimuli that are ordinarily loud or
 11 painful activate only the primary sensory cortices
 13 (Laureys et al., 2000, 2002). Waking consciousness
 is apparently needed for widespread of input-
 driven activation to occur. These findings support
 the general notion that conscious stimuli mobilize
 large areas of cortex, presumably to distribute
 information about the input.

15 ***Inner speech, imagery, and working memory***

17 Both auditory and visual consciousness can be activated
 19 endogenously. Inner speech is a particularly important
 21 source of conscious auditory-phonemic events, and
 23 visual imagery is useful for spatial memory and
 25 problem-solving. The areas of the left hemisphere
 27 involved in outer speech are now known to be involved
 29 in inner speech as well (Paulesu et al., 1993). Likewise,
 mental imagery is known to involve visual cortex
 (Kosslyn et al., 2001). Internally generated somatosen-
 sory imagery may reflect emotional and motivational
 processes, including feelings of psychological pain,
 pleasure, hope, fear, sadness, etc. (Damasio, 2003). Such
 internal sensations may communicate to other parts of
 the brain via global distribution or activation.

31 Prefrontal executive systems may sometimes
 33 control motor activities by evoking motivational
 35 imagery, broadcast from the visual cortex, to
 37 activate relevant parts of motor cortex. Parts of
 39 the brain that play a role in emotion may also be
 41 triggered by global distribution of conscious
 contents from sensory cortices and insular cortex.
 For example, the amygdala appears necessary to
 recognize visual facial expressions of fear and
 anger. Thus, many cortical regions work together
 to transform goals and emotions into actions
 (Baars, 1988).

43 ***The attentional spotlight***

45 The sensory “bright spot” of consciousness
 47 involves a selective attention system, the ability
 of the theater spotlight to shine on different actors

on the stage. Like other behaviors like breathing
 and smiling, attention operates under dual control,
 voluntary, and involuntary. Voluntary attentional
 selection requires frontal executive cortex, while
 automatic selection is influenced by many areas,
 including the brain stem, pain systems, insular
 cortex, and emotional centers like the amygdala
 and peri-aqueductal grey (Panksepp, 1998). Pres-
 9 sumably, these automatic attentional systems that
 11 allow significant stimuli to “break through” into
 13 consciousness, as when a subject’s name is
 15 sounded in an otherwise unconscious auditory
 17 source.

19 ***Context and the first-person perspective***

21 When we step from a tossing sailboat onto solid
 23 ground, the horizon can be seen to wobble. On an
 25 airplane flight at night passengers can see the cabin
 27 tilting on approach to landing, although they are
 29 receiving no optical cues about the direction of the
 31 plane. In those cases unconscious vestibular
 33 signals shape conscious vision. There are numer-
 35 ous examples in which unconscious brain activities
 37 can shape conscious ones, and vice versa. These
 39 unconscious influences on conscious events are
 41 called “contexts” in GW theory (Fig. 1). Any
 43 conscious sensory event requires the interaction of
 45 sensory analyzers and contextual systems. In
 47 vision, sensory contents seem to be produced by
 the ventral visual pathway, while contextual
 systems in the dorsal pathway define a spatial
 domain within which the sensory event is defined.
 Parietal cortex is known to include allocentric and
 egocentric spatial maps, which are not themselves
 objects of consciousness, but which are required to
 shape every conscious visual event. There is a
 difference between the disorders of content sys-
 tems like the visual ventral stream, compared to
 damaged context systems. In the case of ventral
 stream lesions, the subject can generally notice a
 missing part of normal experience; but for damage
 to context, the brain basis of expectations is itself
 damaged, so that one no longer knows what to
 expect, and hence what is missing. This may be
 why parietal neglect is so often accompanied by a
 striking loss of knowledge about one’s body space

QA :3

1 (Bisiach and Geminiani, 1991). Patients suffering
 3 from right parietal neglect can have disturbing
 5 alien experiences of their own bodies, especially of
 7 the left arm and leg. Such patients sometimes
 9 believe that their left leg belongs to someone else,
 11 often a relative, and can desperately try to throw it
 13 out of bed. Thus, parietal regions seem to shape
 15 contextually both the experience of the visual
 17 world and of one's own body. Notice that neglect
 19 patients still experience their alien limbs as
 21 conscious visual objects (a ventral stream func-
 23 tion); they are just disowned. Such specific loss of
 25 contextual body information is not accompanied
 27 by a loss of general intelligence or knowledge.

15 Vogeley and Fink (2003) suggest that parietal
 17 cortex is involved in the first-person perspective,
 19 the viewpoint of the observing self. When subjects
 21 are asked to adopt the visual perspective of
 23 another person, parietal cortex became differen-
 25 tially active.

23 **Self-systems**

25 Activation by of visual object regions by the sight
 27 of a coffee cup may not be enough to generate
 29 subjective consciousness of the cup. The activated
 31 visual information may need to be conveyed to
 33 executive or self-systems, which serve to maintain
 35 constancy of an inner framework across percep-
 37 tual situations. When we walk from room to room
 39 in a building, we must maintain a complex and
 41 multileveled organization that can be viewed in
 43 GW theory as a higher-level context. Major goals,
 45 for example, do not change when we walk from
 47 room to room, but conscious perceptual experi-
 49 ences do. Gazzaniga (1996) has found a number of
 51 conditions under which split-brain patients en-
 53 counter conflict between right and left hemisphere
 55 executive and perceptual functions. He has pro-
 57 posed the existence of a "narrative self" in the left
 59 frontal cortex, based on split-brain patients who
 61 are clearly using speech output in the left hemi-
 63 sphere to talk to themselves, sometimes trying to
 65 force the right hemisphere to obey its commands.
 67 When that proves impossible, the left hemisphere
 69 will often rationalize the sequence of events so as
 71 to repair its understanding of the interhemispheric

QA :4

1 conflict. Analogous repairs of reality are observed 1
 3 in other forms of brain damage, such as neglect. 3
 5 They also commonly occur whenever humans are 5
 7 confronted with major, unexpected life changes. 7
 9 The left-hemisphere narrative interpreter may be 9
 11 considered as a higher-level context system that 11
 13 maintains expectations and intentions across many 13
 15 specific situations. Although the inner narrative 15
 17 itself is conscious, it is shaped by unconscious 17
 19 contextual influences. 19

11 If we consider Gazzaniga's narrative interpreter 11
 13 of the dominant hemisphere to be one kind of self- 13
 15 system in the brain, it must receive its own flow of 15
 17 sensory input. Visual input from one-half of the 17
 19 field may be integrated in one visual hemicortex, as 19
 21 described above, under retinotopic control from 21
 23 area V1. But once it comes together in late visual 23
 25 cortex (presumably in inferotemporal object re- 25
 27 gions), it needs to be conveyed to frontal areas on 27
 29 the dominant hemisphere, in order to inform the 29
 31 narrative interpreter of the current state of 31
 33 perceptual affairs. The left prefrontal self system 33
 35 then applies a host of criteria to the input, such as 35
 37 "did I intend this result? Is it consistent with my 37
 39 current and long-term goals? If not, can I 39
 41 reinterpret it to make sense in my running account 41
 43 of reality?" It is possible that the right hemisphere 43
 45 has a parallel system that does not speak but that 45
 47 may be better able to deal with anomalies via 47
 49 irony, jokes, and other emotionally useful strate-
 51 gies. The evidence appears to be good that the
 53 isolated right prefrontal cortex can understand
 55 such figurative uses of language, while the left does
 57 not. Full consciousness may not exist without the
 59 participation of such prefrontal self systems.

37 **Relevance to waking, sleeping, coma, and general**
 39 **anesthesia**

41 Metabolic activity in the conscious resting state is 41
 43 not uniformly distributed. Raichle et al. (2001) 43
 45 reported that mesiofrontal and medial parietal 45
 47 areas, encompassing precuneus and adjacent 47
 49 posterior cingulate cortex, can be posited as a 49
 51 tonically active region of the brain that may 51
 53 continuously gather information about the world 53
 55 around, and possibly within, us. It would appear 55

1 to be a default activity of the brain. Mazoyer et al.
 QA:5 (2001) also found high prefrontal metabolism
 3 during rest. We will see that these regions show
 5 markedly lower metabolism in unconscious states.

7 Laureys (1999a, b, 2000) and Baars et al. (2003)
 9 list the following features of four unconscious
 11 states, that are causally very different from each
 13 other: deep sleep, coma/vegetative states, epileptic
 15 loss of consciousness, and general anesthesia under
 17 various agents. Surprisingly, despite their very
 19 different mechanisms they share major common
 21 features. These include: (i) widely synchronized
 23 slow waveforms that take the place of the fast
 25 and flexible interactions needed for conscious
 functions; (ii) frontoparietal hypometabolism;
 (iii) widely blocked functional connectivity, both
 corticocortical and thalamocortical; and (iv) be-
 havioral unconsciousness, including unresponsiveness
 to normally conscious stimuli. Fig. 2 shows
 marked hypofunction in the four unconscious
 states compared with conscious controls, precisely
 where we might expect it: in frontoparietal regions.

27 In a related study, John and co-workers showed
 29 marked quantitative electroencephalogram
 31 (EEG)² changes between conscious, anesthetic,
 33 and post-anesthetic (conscious) states (John et al.,
 35 2000). At loss of consciousness, gamma power
 37 decreased while lower frequency bands increased
 in power, especially in frontal leads. Loss of
 consciousness was accompanied by a significant
 drop in coherence between homologous areas of
 the two hemispheres, and between posterior and
 anterior regions of each hemisphere. However,
 there was hypersynchronous activity within ante-
 rior regions. The same basic changes occurred
 across all six anesthetics,³ and reversed when

39 ²Although the spike-wave EEG of epileptic seizures appears
 41 different from the delta waves of deep sleep and general
 43 anesthesia, it is also synchronized, slow, and high in amplitude.
 The source and distribution of spike-wave activity varies in
 45 different seizure types. However, the more widespread the
 47 spike-wave pattern, the more consciousness is likely to be
 impaired (Blumenfeldt and Taylor, 2003). This is again marked
 in frontoparietal regions.

³There is a debate whether ketamine at relatively low doses
 should be considered an anesthetic. All anesthetic agents in this
 study were used at dosages sufficient to provide surgical-level
 loss of consciousness.

patients regained consciousness (see John, in this
 volume).

From the viewpoint of globalist theories, the
 most readily interpretable finding is the coherence
 drop in the gamma range after anesthetic loss of
 consciousness. It suggests a loss of coordination
 between frontal and posterior cortex, and between
 homologous regions of the two hemispheres. The
 authors also suggest that the anteriorization of low
 frequencies “must exert a profound inhibitory
 influence on cooperative processes within (frontal)
 neuronal populations. This functional system then
 becomes dedifferentiated and disorganized” (p.
 180). Finally, the decoupling of the posterior
 cortex with anterior regions suggests “a blockade
 of perception” (p. 180). These phenomena appear
 to be consistent with the GW notion that wide-
 spread activation of nonsensory regions is required
 for sensory consciousness.

*The role of frontoparietal regions in conscious
 contents and states*

25 Could it be that brain regions that underlie the
 27 contextual functions of Fig. 1 involve frontal and
 29 parietal regions? In everyday language, the “ob-
 31 serving self” may be disabled when those regions
 33 are dysfunctional and long-range functional con-
 35 nectivity is impaired. Frontoparietal association
 37 areas have many functions, but several lines of
 39 evidence suggest that they could have a special
 41 relationship with consciousness, even though they
 43 do not support the sensory contents of conscious
 45 experience directly. (i) Conscious stimulation in
 47 the waking state leads to frontoparietal activation,
 but unconscious input does not; (ii) in unconscious
 states, sensory stimulation activates only sensory
 cortex, but not frontoparietal regions; (iii) the
 conscious resting state shows high frontoparietal
 metabolism compared with outward-directed cog-
 nitive tasks; and (iv) four causally very different
 unconscious states show marked functional decre-
 ments in the same areas. Although alternative
 hypotheses must be considered, it seems reason-
 able to suggest that “self” systems supported by
 these regions could be disabled in unconscious
 states. From the viewpoint of the narrative

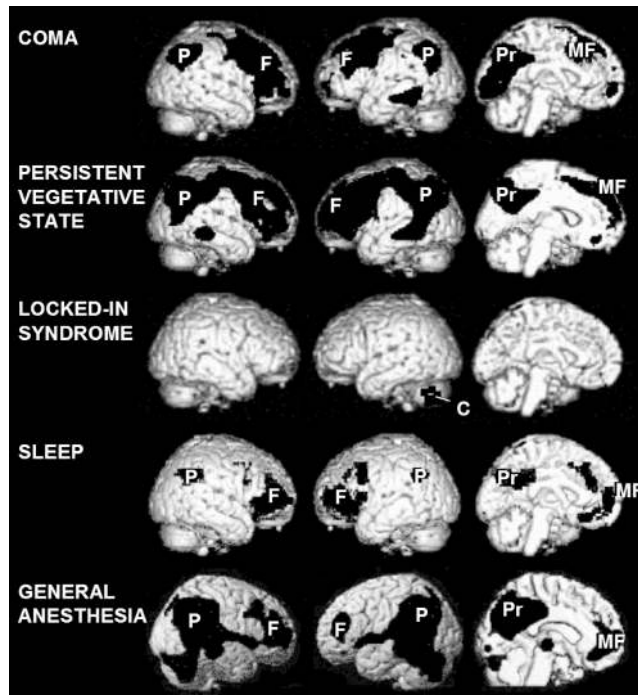


Fig. 2. Neural activity in four types of unconscious states, subtracted from conscious controls. Positron emission tomography scans showing regional decreases in metabolism or blood flow when unconscious states are compared with resting consciousness. Coma, persistent vegetative state, sleep, and general anesthesia all show regional decreases in frontoparietal association cortices. Column 1: the right lateral aspect of the brain; column 2: the left lateral aspect; column 3: a medial view of the left hemisphere. Abbreviations: F, prefrontal; MF, mesiofrontal; P, posterior parietal cortex; Pr, posterior cingulate/precuneus (from Baars et al., 2003).

observer, this would be experienced as subjective loss of access to the conscious world. Unconscious states might not necessarily block the objects of consciousness; rather, the observing subject might not be at home.

Conclusion

GW theory suggests that consciousness enables multiple networks to cooperate and compete in solving problems, such as retrieval of specific items from immediate memory. Conscious contents may correspond to brain processes that work much like brief memories whose contents activate widespread regions in the brain. Physiologically such interactions seem to involve multiple high-frequency oscillatory rhythms. The overall function of consciousness is to provide widespread access,

which in turn may serve coordination and control. Consciousness is the gateway to the brain.

Uncited References

Fiset et al. (1999); Frackowiak et al. (2004); Franklin (2000); Freeman (2003); Tononi and Edelman (1998).

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