THE JOURNAL OF PHILOSOPHY
VOLUME CV, NO. 6, JUNE 2008

THE UNITY OF CONSCIOUSNESS AND THE SPLIT-BRAIN SYNDROME*

According to conventional wisdom, the split-brain syndrome puts paid to the thesis that consciousness is necessarily unified. The aim of this paper is to challenge that view. I argue both that disunity models of the split-brain are highly problematic, and that there is much to recommend a model of the split-brain—the switch model—according to which split-brain patients retain a fully unified consciousness at all times. Although the task of examining the unity of consciousness through the lens of the split-brain syndrome is not a new one—such projects date back to Thomas Nagel's seminal paper[1] on the topic—the time is ripe for a re-evaluation of the issues.

I. THE SPLIT-BRAIN SYNDROME

First performed on humans in the late 1930s, the split-brain procedure involves severing the corpus callosum in order to prevent epileptic seizures spreading from one hemisphere to another. The original version of the procedure, known as a commissurotomy, involved severing a number of interhemispheric tracts (such as the anterior commissure, the hippocampal commissure, and the massa intermedia of the thalamus) in addition to the corpus callosum. In later versions of the procedure, known as a callosotomy, only the corpus callosum is sectioned. The differences between these two patient groups are not pronounced, and I will refer to both commissurotomy and callosotomy patients as "split-brain patients."[2]

* In writing this paper I have benefited greatly from comments by Andrew Brook, Michael Corballis, David Chalmers, Barry Dainton, Rami Gabriel, Uriah Kriegel, David Milner, Nishat Nishat, David Rosenthal, Colwyn Trevarthen, Eran Zaidel, and especially Jerre Levy.

[1] Nagel, "Brain Bisection and the Unity of Consciousness," *Synthese*, XXII (1971): 396–413.

[2] The main division appears to be between patients who have had the anterior portion of their corpus callosum sectioned and those in whom only the posterior portion of

0022-362X/08/0506/277–300

The split-brain procedure has surprisingly little impact on cognitive function in everyday life.[3] Split-brain patients can drive, hold down jobs, and carry out routine day to day tasks. Early researchers remarked on their "social ordinariness," and were baffled by their inability to detect any cognitive impairments arising from the operation.[4] However, subsequent research has revealed a complex array of deficits—and the occasional benefit—in the split-brain.[5] It is this research that gives rise to the view that split-brain patients have a disunified consciousness.

In a typical split-brain experiment, two stimuli are presented to the patient in such a way that one will be processed by the left hemisphere and the other by the right hemisphere. For example, the word 'key-ring' might be projected such that 'key' is restricted to the patient's left visual field (LVF) and 'ring' is restricted to the patient's right visual field (RVF). The contralateral structure of the visual system ensures that stimuli projected to the LVF are processed in the right hemisphere and vice-versa. Other perceptual systems can be studied in a similar manner. For example, tactile perception is examined by asking the patient to compare an object presented to the right hand with one presented to the left.

Such studies have revealed two kinds of disunities in the split-brain: *behavioral disunities* and *representational disunities*. Behavioral disunities

---

the corpus callosum has been cut. The former tend to exhibit the classic split-brain syndrome, while the latter show only minimal dissociations.

[3] See Dahlia W. Zaidel, "A View of the World from a Split-Brain Perspective," in E.M.R. Critchley, ed., *The Neurological Boundaries of Reality* (Northvale, NJ: Aronson, 1995), pp. 161–74; S.M. Fergusen et al., "Neuropsychiatric Observation on Behavioral Consequences of Corpus Callosum Section for Seizure Control," in A.G. Reeves, ed., *Epilepsy and the Corpus Callosum* (New York: Plenum, 1985), pp. 501–14. But see also Victor Mark, "Conflicting Communicative Behavior in a Split-Brain Patient: Support for Dual Consciousness," in S.R. Hameroff et al., eds., *Towards a Science of Consciousness* (Cambridge: MIT, 1996), pp. 189–96.

[4] Andrew J. Akelaitis, "A Study of Gnosis, Praxis and Language following Section of the Corpus Callosum and Anterior Commissure," *Journal of Neurosurgery*, I (1944): 94–102. For discussion, see Joseph E. Bogen, "The Callosal Syndromes," in Kenneth M. Heilman and Edward Valenstein, eds., *Clinical Neuropsychology* (New York: Oxford, 1993), pp. 337–407.

[5] Useful reviews of the split-brain literature can be found in Michael S. Gazzaniga, "Cerebral Specialization and Interhemispheric Communication: Does the Corpus Callosum Enable the Human Condition?" *Brain*, CXXIII (2000): 1293–336; Sally P. Springer and Georg Deutsch, *Left Brain Right Brain* (New York: W.H. Freeman, 1998, 5th ed.); S.E. Seymour et al., "The Disconnection Syndrome: Basic Findings Reaffirmed," *Brain*, CXVII (1994): 105–15; J.J. Sidtis, "Can Neurological Disconnection Account for Psychiatric Dissociation?" in Jacques M. Quen, ed., *Split Minds/Split Brains: Historical and Current Perspectives* (New York: University Press, 1986), pp. 127–48; George Wolford et al., "Split Decisions," in Gazzaniga, ed., *The Cognitive Neurosciences III* (Cambridge: MIT, 2004), pp. 1189–200; E. Zaidel et al., "The Callosal Syndromes," in Heilman and Valenstein, eds., *Clinical Neuropsychology*, pp. 347–403.

are most striking. When asked to report what she sees the patient in the key-ring experiment will typically say that she sees only the word 'ring'; yet, with her left hand, the patient may select a picture of a key and ignore pictures of both a ring and a key-ring. Generally speaking, visual information projected to the RVF cannot be verbally reported, and visual information projected to the LVF is unavailable for behavior involving the right hand. In the tactile modality, the patient cannot describe, or use her right hand to respond to, objects palpitated by her left hand, and objects palpitated by the right hand cannot be reported via left-handed actions.

Representational disunities involve a lack of integration between the contents of the patient's conscious states. These states do not enjoy the inferential promiscuity that conscious states typically enjoy. The patient in the key-ring experiment appears to have representations of the words 'key' and 'ring' without having a representation of the word 'key-ring'. Similarly, a patient might appear to be conscious of the identity of the objects palpitated by each hand but have no conjoint awareness of both objects. As we shall see, the precise nature of behavioral and representational disunities differs from patient to patient, but the foregoing description captures the core features of the split-brain syndrome.

II. THE UNITY OF CONSCIOUSNESS

Whether or not the split-brain syndrome is at odds with the unity of consciousness clearly depends on what it is for consciousness to be unified. There are a number of things that might be meant by "the unity of consciousness," only some of which are called into question by the split-brain syndrome. This section provides a brief overview of the conception of the unity of consciousness with which I will work.[6]

The kind of consciousness in which I am interested is *phenomenal* consciousness. States of phenomenal consciousness are characterized by the fact that there is something it is like to be in them. Typically, we enjoy multiple phenomenal states at a time. I currently have visual experiences associated with seeing these words on a computer screen,

[6] I draw here on Tim Bayne and David J. Chalmers, "What Is the Unity of Consciousness?" in Axel Cleeremans, ed., *The Unity of Consciousness: Binding, Integration and Dissociation* (New York: Oxford, 2003), pp. 23–58; see also Bayne, *The Unity of Consciousness* (New York: Oxford, forthcoming). For other perspectives on the unity of consciousness, see Barry Dainton, *Stream of Consciousness: Unity and Continuity in Conscious Experience* (New York: Routledge, 2000); John R. Searle, "Consciousness," *Annual Review of Neuroscience*, XIII (2000): 557–78; and Michael Tye, *Consciousness and Persons* (Cambridge: MIT, 2003).

auditory experiences of the sounds associated with the café in which I am sitting, a range of bodily sensations, emotional and mood experiences, experiences of agency, and conscious cognitive states of various kinds. Perhaps there is no point in time at which my overall phenomenal perspective includes experiences drawn from each of these categories, but there are certainly times at which I enjoy a number of these phenomenal states at once.

Experiences, when they occur simultaneously, do not occur as phenomenal atoms but have a conjoint phenomenology—there is something it is like to have them together, and they are so had. There is something it is like to taste a well-made macchiato, there is something it is like to have a word on the tip of one's tongue, and there is something distinctive that it is like to enjoy these two phenomenal states *together*. One can think of phenomenal unity as a relation that phenomenal states have when they are experienced together in this way. When one experiences the taste of coffee together with having a word on the tip of one's tongue, one is in a phenomenal state that in some way subsumes both the sensory and cognitive states.

We are now in position to say what it is for consciousness to be unified. A subject's consciousness is unified exactly when they enjoy a single phenomenal state that subsumes each of their fine-grained phenomenal states. This total phenomenal state—what is sometimes referred to as a "phenomenal field"—fully captures what it is like to be the subject of experience. Subjects that are not in such a total state do not have a unified consciousness; there is no single thing that it is like to be such a subject.

The split-brain data suggests that split-brain patients do not enjoy a unified consciousness, for it appears as though there are times at which the split-brain patient has no total phenomenal state. Of course, this pressure can be relieved by individuating subjects of experience in phenomenal terms; one might say that where an organism has two total phenomenal states, it also has (or supports) two subjects of experience. Those tempted by this move will claim that any evidence for thinking that split-brain patient have a disunified consciousness is evidence not that such patients are subjects with a disunified consciousness, but that split-brain patients are not themselves conscious subjects.

There is much to be said on behalf of this response but it can be set to one side here, for I will argue that there is no time at which the split-brain *patient* has a disunified consciousness. We need not individuate subjects of experience in phenomenal terms in order to "save" the unity of consciousness from the split-brain syndrome. At least, so I will argue.

III. THE CASE FOR PHENOMENAL DISUNITY

Disunity models of the split-brain regard the split-brain patient as having simultaneous, but phenomenally disunified, experiences. I will examine two lines of argument for this view of the split-brain, each of which proceeds on the assumption that in the key-ring experiment (and others like it) the patient has representations of the stimuli that are both *simultaneous* and *conscious*. I will revisit the assumption of simultaneity in section IV, but for now let us proceed by accepting it. What about the assumption that the split-brain patient's mental states are *conscious*?

Early treatments of the split-brain sometimes presented the minor (typically right) hemisphere as a zombie, conscious neither of its environment nor of its own behavior. This view was sometimes defended on the grounds that consciousness in the split-brain (and perhaps more generally) is restricted to the language-generating left hemisphere.[7] This defense cannot be supported. For one thing, a number of split-brain patients have some capacity for both LH and RH speech production.[8] More importantly, we should not make language production—or, for that matter, language comprehension—a precondition on the possession of consciousness; such a principle would, implausibly, remove pre-linguistic children and aphasics from the realm of the conscious. Even the claim that creatures capable of producing verbal reports must be able to report the contents of each of their conscious states is unacceptably demanding.

One might attempt to defend the zombie model by assimilating right-hemisphere guided behavior to other instances of nonconscious behavior, such as on-line dorsal stream motor control in the visual system, or the high-level automaticity effects as studied in social psychology.[9] This line of argument is more potent but it too fails to convince, for the right-hemisphere is capable of carrying out tasks that

[7] See John C. Eccles, *The Understanding of the Brain* (New York: McGraw-Hill, 1973); D.M. MacKay, "Cerebral Organization and the Conscious Control of Action," in Eccles, ed., *Brain and Conscious Experience* (New York: Springer, 1966), pp. 422–45.

[8] See K. Baynes et al., "The Emergence of the Capacity of a Disconnected Right Hemisphere to Name LVF Stimuli: Implications for Functional Plasticity," *Neuropsychologia*, XXXI (1995): 1225–42; Gazzaniga et al., "Collaboration between the Hemispheres of a Callosotomy Patient: Emerging Right Hemisphere Speech and the Left Hemisphere Interpreter," *Brain*, LXXXVIII (1996): 1255–62; Zaidel et al., "The Callosal Syndromes."

[9] For discussion of unconscious behavioral control as revealed by cognitive neuropsychology, see A.D. Milner and M.A. Goodale, *The Visual Brain in Action* (New York: Oxford, 1995/2006), and Andy Clark, "Visual Experience and Motor Action: Are the Bonds Too Tight?" *Philosophical Review*, CX (2001): 495–519; for social psychology, see John A. Bargh and Melissa Ferguson, "Beyond Behaviorism: On the Automaticity of Higher Mental Processes," *Psychological Bulletin*, CXXVI, 6 (2000): 925–45.

far surpass in cognitive complexity those that are elsewhere attributed to "zombie systems." Summarizing an experiment testing the right-hemisphere based abilities of split-brain patients (with left hemisphere language), R.W. Sperry and others write,[10] "The overall level of the right hemisphere's ability to identity test items and also the quality of the accompanying emotional and evaluative responses were of the same order approximately as those obtained from the right visual field and left hemisphere" (*ibid.*, p. 163). In short, there is good reason to think that each hemisphere in the split-brain can support consciousness—the question is whether the conscious states that they support are unified.

The first argument for phenomenal disunity appeals to the connection between phenomenal unity and representational content. Consider a split-brain patient (*S*) in the key-ring experiment. *S* has two experiences, one of which represents the word 'key' and one of which represents the word 'ring', but it seems clear that *S* does not have an experience of the word 'key-ring'. But—so the argument goes—any subject with phenomenally unified experiences of the words 'key' and 'ring' must also have an experience of the word 'key-ring'. Since *S* has no such experience, we should conclude that *S*'s experiences of 'key' and 'ring' are not phenomenally unified. Call this the closure argument.

As stated, the closure argument is unconvincing. We must distinguish experiences with the content <'key-ring'> from experiences with the content <'key' & 'ring'>. To see a stimulus as the word 'key-ring' goes beyond seeing it as containing the words 'key' and 'ring'. But this objection is far from fatal, for there is no more reason to suppose that *S* has an experience with the content <'key' & 'ring'> than there is to suppose that *S* has an experience with the content <'key-ring'>. After all, *S* shows no indication—either by verbal report or manual behavior—of having seen the words 'key' and 'ring'.

Of course, absence of evidence is not always evidence of absence. Perhaps, as David Chalmers and I have suggested, *S* has a <'key' & 'ring'> experience whose content is not available for high-level cognitive consumption due to the presence of processing bottlenecks.[11] In support of this proposal we invoked George Sperling's experiments on the reportability of information in brief visual displays. Although the interpretation of Sperling's data is contested, arguably it provides

[10] Sperry et al., "Self-Recognition and Social Awareness in the Deconnected Minor Hemisphere," *Neuropsychologia*, XVII (1979): 153–66.

[11] Bayne and Chalmers, "What Is the Unity of Consciousness?"

some reason to think that subjects can be conscious of more than they can report.[12]

But there are problems with this proposal. First, subjects in the Sperling case have a kind of meta-access to their putatively "unreportable" contents, for they report *that* they were aware of more than they could directly report. Split-brain patients produce no such reports; unlike Sperling's subjects, they do not say that they had fleeting "unreportable" experiences. Furthermore, one cannot appeal to processing bottlenecks to explain why the patient cannot use the contents of her representation of 'key' in ways in which she can use her representation of 'ring' and vice-versa, for it seems unlikely that saying 'key' or picking out a ring with one's left hand presents more of a challenge to consuming systems than does saying 'ring' or picking out a key.

Let us return to the closure argument. The argument can be presented as follows:

(1) *S* has experiences with contents <*A*> and <*B*>.
(2) *S* does not have an experience with content <*A*&*B*>.
(C) Therefore, *S*'s experiences with contents <*A*> and <*B*> are not phenomenally unified.

There is clearly a missing premise here. We can tighten the argument up by appealing to the following principle:

> *Closure*: Necessarily, if a subject (*S*) has an experience with content <*A*> and an experience with content <*B*>, and these experiences are phenomenally unified with each other, then *S* has an experience with content <*A*&*B*>.

Closure is not incontrovertible. One could treat phenomenal unity as a primitive relation that has no implications for the representational relations between the contents of those states that it unifies.[13] Nonetheless, *closure* is appealing. I am inclined to think that experiences are phenomenally unified only when they stand in a certain relation—subsumption—to a single phenomenal state. And if this is right, then there is a plausible line of argument for the closure principle. Suppose that phenomenal states *A* and *B* are unified. In that case, there will be a phenomenal state (*M*) that subsumes *A* and *B*. Now, it seems

[12] Sperling, "The Information Available in Brief Visual Presentations," *Psychological Monographs*, LXXIV, 11 (1960): 1–29. See also Ned Block, "Consciousness, Accessibility, and the Mesh between Psychology and Neuroscience," *Behavioral and Brain Sciences*, XXX (2007): 481–548.

[13] See Dainton, *Stream of Consciousness*.

plausible to suppose that if *M* subsumes *A* and *B* then the content of *M* must entail the contents of *A* and *B*. In the case of states with contents <*A*> and <*B*>, the best candidate for a subsuming state will be a state with content <*A*&*B*>. In short, *closure*, and with it the closure argument, is highly plausible.

A second argument for phenomenal disunity in the split-brain involves an appeal to behavioral unity, or rather, the lack thereof.

(1) *S*'s representations of 'key' and 'ring' are not behaviorally unified: although the contents of both states are available for high-level consumption, they are not available to *the same* consuming systems.
(2) Phenomenal unity entails behavioral unity: two experiences cannot be phenomenally unified without being behaviorally unified.
(C) So, *S* has simultaneous but phenomenally disunified experiences.

The crucial premise would appear to be (2). Does behavioral disunity entail phenomenal disunity?

There is some reason to think that the contents of consciousness need not be globally available for high-level control. And if that is right, then it is possible that the contents of phenomenally unified conscious states might be available for different forms of high-level control—that is, they might not be behaviorally unified. Let us examine two syndromes in which behavioral unity seems to break down.

Children participating in the Dimensional Change Card Sort task are asked to sort a series of cards (for example, red rabbits and blue dogs) into piles according to a certain dimension (for example, color).[14] Having sorted several cards, the children are then told to switch the sorting rule, say, from colors to animals. Three year-olds typically fail to switch dimensions when instructed to do so, but they usually respond correctly to questions about what they ought to be doing. Their verbal behavior suggests that they are conscious of the post-switch rules, yet the content of this state does not seem to be available to drive their sorting behavior.

The Dimensional Change Card Sort task involves cognitive states. Of more direct relevance to the interpretation of the split-brain data is evidence that perceptual states are not always globally available for cognitive consumption. Subjects in metacontrast experiments are presented with a series of letters in a format designed to "mask" some of the stimuli. In one such experiment, subjects were instructed to press one key if they saw the letter 'J' (for example) and another key if they

[14] See Phillip D. Zelazo, "An Age-Related Dissociation between Knowing Rules and Using Them," *Cognitive Development*, XI (1996): 37–63.

failed to see a 'J'.[15] When urged to respond as quickly as possible subjects tended to respond to the occurrence of a target letter in the "blanked" (masked) positions with a fast (and *correct*) press of the "target present" key, only to apologize immediately for having made an error.[16] Arguably, these subjects had experiences whose contents were available to some forms of behavioral control (manual button-pressing) but not others (verbal report).[17]

Nonetheless, even if behavioral disunity does not *entail* phenomenal disunity, it does seem reasonable to regard it as a *good guide* to phenomenal disunity. In general, the best explanation of the fact that the contents of (simultaneously) conscious states are not available to the same consuming systems is likely to be that they are not phenomenally unified. And, in light of this, the behavioral disunity argument surely has some weight.

I have examined two arguments for the claim that split-brain patients are phenomenally disunified: the closure argument and the behavioral disunity argument. Each argument has considerable merit, and their combined force does much to justify disunity accounts of the split-brain. So let us temporarily proceed on that assumption that the split-brain patient is phenomenally disunified. The question we must now address is whether the split-brain subject has two separate streams of consciousness or a single, partially unified, stream of consciousness.

IV. THE TWO-STREAMS MODEL

It is frequently said that split-brain patients have two streams of consciousness.[18] However, the two-streams moniker has been applied to

[15] Reported in Alan Allport, "What Concept of Consciousness?" in Anthony J. Marcel and E. Bisiach, eds., Cons*ciousness in Contemporary Science* (New York: Oxford, 1988), pp. 159–82.

[16] See also Joel Lachter and Frank H. Durgin, "Metacontrast Masking Functions: A Question of Speed?" *Journal of Experimental Psychology: Human Perception and Performance*, xxv (1999): 936–47; Lachter et al., "Disappearing Percepts: Evidence for Retention Failure in Metacontrast Masking," *Visual Cognition*, vii (2000): 269–79; Anthony J. Marcel, "Slippage in the Unity of Consciousness," in Gregory R. Bock and Joan Marsh, eds., *Experimental and Theoretical Studies of Consciousness* (New York: Wiley, 1993), pp. 168–79.

[17] These cases do not falsify the claim that conscious content is always globally available for cognitive control. One could attempt to rescue the claim that conscious content is always globally available for cognitive control by invoking local performance failures. For example, one could say that perceptual content in the metacontrast experiment was report*able* even though not report*ed*. I doubt that this line of response can be sustained, but must leave this issue to one side here.

[18] Lawrence H. Davis, "Cerebral Hemispheres," *Philosophical Studies*, lxxvii (1997): 207–22; Michael S. Gazzaniga and Joseph E. LeDoux, *The Integrated Mind* (New York: Plenum, 1978); James Moor, "Split-Brains and Atomic Persons," *Philosophy of Science*, xlix (1982): 91–106; Charles E. Marks, *Commissurotomy, Consciousness and Unity of Mind* (Cambridge: MIT, 1981); Roland Puccetti, "The Case for Mental Duality: Evidence from Split-Brain Data and Other Considerations," *Behavioral and Brain Sciences*, iv

a variety of views. Here, I take the two-streams model to hold that at any one time phenomenal states in the split-brain patient can be divided into two sets, *A* and *B*, where states within each set are mutually phenomenally unified but no state within either set is phenomenally unified with any state in the other set.

The two streams model draws support from standard presentations of the split-brain data of the kind I gave in section I. Such presentations encourage one to conceive of the split-brain operation as bisecting a single global workspace into two (less global) workspaces, one per hemisphere. Unfortunately for the two-streams model, there is rather more integration in the split-brain than this picture would predict. Although the details of inter-hemispheric integration vary from patient to patient, almost all split-brain patients show some degree of inter-hemispheric integration.

Some (partial) split-brain patients are split for visual information but not tactile information.[19] They can integrate tactile information presented to each hand, but cannot integrate visual information presented across the visual mid-line. However, such patients can integrate tactile information presented to each hand with visual information presented in the ipsilateral visual hemi-field. A similar fractionation of integrative abilities can be observed in patients with complete commissurotomies. Although patient N.G. was unable to match patterns presented to her right hand against those presented in her LVF, she could match patterns presented to her left hand against those presented in her RVF.[20] Given that N.G. can (presumably) match patterns presented to her right (left) hand against those presented in the RVF (LVF), she too seems to possess the kind of behavioral integration that is ruled out by the two-streams model. Even within vision standard split-brain subjects are not fully split. Information concerning shape, color, and category typically cannot be integrated between hemifields, but most split-brain patients are to integrate information about the relative motion and size of visual stimuli.[21]

(1981): 93–123; Sperry, "Mental Unity following Surgical Disconnection of the Cerebral Hemispheres," *Harvey Lectures*, LXII (1966–67): 293–323; Tye, *Consciousness and Persons*.

[19] Gazzaniga and Howard Freedman, "Observations on Visual Processes after Posterior Callosal Section," *Neurology*, XXIII (1973): 1126–30.

[20] Eran Zaidel, "Stereognosis in the Chronic Split-Brain: Hemispheric Differences, Ipsilateral Control and Sensory Integration across the Midline," *Neuropsychologia*, XXXVI, 11 (1998): 1033–47.

[21] Colwyn Trevarthen, "Experimental Evidence for a Brainstem Contribution to Visual Perception in Man," *Brain Behavior and Evolution*, III (1970): 338–52; Trevarthen and Sperry, "Perceptual Unity of the Ambient Visual Field in Human Commissurotomy Patients," *Brain*, XCVI (1973): 547–70; see also Michael C. Corballis, "Visual Integration

These data problematize the two-streams model, for they suggest that the split-brain patient has experiences that "straddle" both hemispheres. Such bilateral experiences would be phenomenally unified with both right hemisphere and left hemisphere experiences, in opposition to the thought that the patient's two streams of consciousness are sealed off from each other.

In response, the two-streams theorist might be tempted to argue that apparently bilateral experience are really confined to one or other of the patient's two hemispheres. The *content* of so-called bilateral experiences might involve information drawn from both hemispheres, but—so the proposal goes—the experiences themselves do not bridge the two hemispheres. But this proposal faces the following problem. Suppose that the two-streamer assigns a supposedly bilateral experience with the content <*A*&*B*> to the patient's right hemisphere (which includes an experience with content <*A*>). Now, does this stream also include an experience with the content <*B*>? If not, it is difficult to see how the experience <*A*&*B*> could have formed. But if we allow that *S*'s right hemisphere stream contains an experience with exactly the same content as her left hemisphere stream, then we must endorse the duplication assumption, according to which it is possible for a conscious subject to have, simultaneously, two experiences with exactly the same content. I shall argue below that the duplication assumption is problematic.

Behavioral integration in experimental contexts also poses challenges for the two-streams view. In the typical split-brain experiment, the patient's right-handed behavior accords with her verbal reports and differs from her left-handed behavior. However, in some experiments the patient's right-handed behavior accords with her *left-handed* behavior, both of which are at odds with her verbal reports.[22]

---

in the Split-Brain," *Neuropsychologia*, XXXIII, 8 (1995): 937–59; Johnson, "Bilateral Visual Cross-integration by Human Forebrain Commissurotomy Subjects"; E. Zaidel, "Interhemispheric Transfer in the Split-Brain: Long-Term Status following Complete Cerebral Commissurotomy," in Richard J. Davidson and Kenneth Hugdahl, eds., *Brain Asymmetry* (Cambridge: MIT, 1995), pp. 491–32. Partial representational integration is made possible by the representational specialization of the corpus callosum—the anterior midbody transfers motor information, the posterior midbody transfers somatosensory information, the isthmus transfers auditory information, and the splenium transfers visual information (De Lacoste et al., "Topography of the Corpus Callosum," *Journal of Neuropathology and Experimental Neurology*, XCIV (1985): 578–91; Margaret G. Funnell et al., "Insights into the Functional Specificity of the Human Corpus Callosum," *Brain*, CXXIII (2000): 920–26).

[22] See J. Levy et al., "Perception of Bilateral Chimeric Figures following Hemispheric Deconnexion," *Brain*, XCV (1972): 61–78. It is unclear to me why the data reported in

Furthermore, some patients (for example, L.B.) can name LVF stimuli without being able to integrate stimuli between the two visual hemi-fields, whereas others (for example, N.G.) can integrate stimuli between the two visual hemi-fields but cannot name LVF stimuli.[23] Again, these findings suggest that the availability of content to systems of cognitive consumption in the split-brain is a messy and somewhat fragmented affair, rather than one in which there is a clean division between two clearly demarcated workspaces.

Of course, there are various ways in which one might attempt to account for inter-hemispheric behavioral integration within the two-streams framework. Each hemisphere has some degree of bilateral motor control, and many split-brain patients have at least some right-hemisphere capacity to comprehend and produce language. In the light of this, the two-streamer could argue that (say) left-handed responses involve a consuming system that has access to both left and right hemisphere streams of consciousness. More perspicuously, perhaps, the two-streamer might regard left-handed responses as involving different consuming systems depending on whether or not they are guided by the right hemisphere or the left hemisphere. There are certainly questions to be asked here about just how consuming systems—and cognitive workspaces more generally—ought to be individuated, but I doubt that the two-streams model can be saved by going down this path. In fact, the model is likely to look increasingly implausible as the two-streamer is forced to individuate consuming systems in an ad hoc fashion rather than on any principled (or even intuitive) basis.

A further objection to the two-streams model concerns everyday integration in the split-brain. How could someone with two streams of consciousness exhibit the kind of behavioral unity that split-brain patients demonstrate in their day-to-day lives? Some two-streamers meet this objection by suggesting that split-brain patients have two streams of consciousness only in experimental conditions.[24] The main challenge for this contextualist position is to explain how the structure of the patient's consciousness might be altered by the transition between everyday and experimental environments given that phenomenal structure supervenes only on neural structure and neural structure

---

this study depart from those normally reported, but it may have had something to do with the kinds of stimuli Levy's group used.

[23] L.E. Johnson, "Vocal Responses to Left Visual Field Stimuli following Forebrain Commissurotomy," *Neuropsychologia*, XXII (1984): 153–66; Johnson, "Bilateral Visual Cross-Integration by Human Forebrain Commissurotomy Subjects," *Neuropsychologia*, XXII (1984): 167–75.

[24] Marks, *Commissurotomy, Consciousness and Unity of Mind*; Tye, *Consciousness and Persons*.

seems not to be fundamentally altered by moving between everyday and experimental contexts.

Of course, the contextualist could deny that phenomenal structure does supervene on neural structure. She might follow Susan Hurley in identifying the unity of consciousness with a "dynamic singularity in the field of causal flows that is centered on but not bounded by a biological organism."[25] But even those attracted to Hurley's vehicle externalism need to explain *how* the transition between everyday and experimental contexts has an impact on the structure of consciousness. The contextualist might argue that the cognitive demands (uniquely) imposed by experimental conditions alter the patient's neural dynamics in such a way that the patient's single stream of consciousness bifurcates into two streams, whereas removing those demands reunites these two streams. Although we do not know enough about the neural basis of consciousness to rule this proposal out, it does not seem to me to be a promising one. After all, high cognitive load does not normally bifurcate the stream of consciousness, so why should it do so in the context of the split-brain syndrome?

Rather than going contextualist, most two-streamers attempt to account for everyday behavioral unity in the split-brain by deploying the *duplication gambit*.[26] They hold that the ability of patients to orient at will to salient stimuli allows them to enjoy duplicate experiences—that is, distinct phenomenal states with the same content, one in each conscious stream.

The duplication gambit faces three challenges. The first concerns its very coherence: Can a conscious subject have, at a single time, multiple experiences with the same phenomenal content? Given that many perceptual properties are bilaterally represented, it might seem obvious that the answer to this question must be 'yes'. But matters are not so straightforward. Phenomenal states are usually individuated in terms of their content (or phenomenal character), subject, and time. This tripartite account rules out phenomenal duplicates, for by definition duplicate states have the same content, are had by the same subject of experience, and occur simultaneously. So, on the face of things, endorsing the duplication gambit requires rejecting

[25] Hurley, *Consciousness in Action* (Cambridge: Harvard, 1998), p. 207. See also Hurley, "Action, the Unity of Consciousness, and Vehicle Externalism," in Axel Cleeremans, ed., *The Unity of Consciousness: Binding, Integration and Dissociation* (New York: Oxford, 2003), pp. 78–91.

[26] See Davis, "Cerebral Hemispheres"; Moor, "Split-Brains and Atomic Persons"; and Puccetti, "The Case for Mental Duality."

the standard account of experiences.[27] This is not an inconsiderable cost.

Some proponents of the duplication gambit might be tempted to deny that apparent duplicates would belong to the same subject of experience. Perhaps in sectioning the corpus callosum we have also created two subjects of experience. I have some sympathy with this response, but I am assuming here that the split-brain patient is but one conscious subject, whether or not he or she lacks a unified consciousness. Note, moreover, that few two-streamers will want to save the duplication gambit in this way, for most are committed to the claim that both streams of consciousness belong to a single subject of experience.

But why insist on the tripartite account of experience? Why should the proponent of the duplication gambit not individuate experiences in (say) neural terms? Perhaps a subject can have multiple tokens of the same experiential type at the same time as long as the two states occur in (supervene on, are grounded in) different neural areas.

Perhaps the most potent motivation for retaining the tripartite account is phenomenological. As representationalists have argued in recent years, it is plausible to hold that we have introspective access only to the content (phenomenal character) of our conscious states.[28] Suppose that you have exactly three experiences, A_1, V_1, and V_2, where A_1 is an auditory experience and V_1 and V_2 are visual experiences with identical content. Further, suppose that A_1 is phenomenally unified with exactly one of your visual experiences (say, V_1). Would you be able to tell, on the basis of introspection alone, that it is V_1 rather than V_2 that is unified with A_1? I think not. You might have introspective access to the fact that you have a *V*-type experience that is unified with an *A*-type experience, but you would lack introspective access to the fact that it is V_1 rather than V_2 that is unified with A_1. Indeed, you would have no introspective access to the fact that you have two *V*-type experiences. Phenomenal unity is an experiential relation. There must be a phenomenal or "what it's like" difference between a state of affairs in which the members of a set of states are phenomenally unified and one in which they are not, and this phenomenal dif-

[27] Someone might argue that we should think of so-called duplicates as parts (or components) of a single token experience rather than distinct tokens of the same experiential type. The problem with this proposal is that it is not clear why distributed neural activity ought to count as the vehicle of a single token experience given that the mental events it gives rise to are neither functionally nor phenomenologically unified.

[28] See, for example, Tye, *Consciousness and Persons*.

ference must be introspectively accessible, at least in principle. But the possibility of phenomenal duplication would be at odds with this constraint, for it would allow that a state of affairs in which phenomenal unity holds might be introspectively indistinguishable from a state of affairs in which it fails. In short, any account of phenomenal states that allows for phenomenal duplicates jeopardizes our grip on the very notion of phenomenal unity.[29]

Finally, the duplication gambit would be deeply problematic even if we were to recognize the coherence of phenomenal duplication. For one thing, there is no reason to suppose that the *total* content of each of the patient's two streams would be identical. There might be *overlap* in perceptual content between the two streams, but other components of the streams—cognitive, emotional, intentional, and agentive content—would presumably differ, and these differences ought to lead to behavioral disunity. Furthermore, it is not clear that even complete duplication of content between streams would lead to behavioral integration. States with the same content can trigger different behaviors if they are located in different deliberative contexts, and such differences are likely if, as a number of theorists have suggested, the two hemispheres have unique cognitive styles.[30] Stimuli that the left hemisphere regards as salient might not be regarded as salient by the right hemisphere, and vice-versa.

In summary, neither of the strategies deployed by two-streamers to account for everyday behavioral integration in the split-brain is promising. The two-streams model may represent the conventional wisdom on the split-brain, but it does not deserve that status.

V. PARTIAL UNITY

Grappling with the difficulties posed by the data, Nagel suggested that perhaps there is no whole number of minds that split-brain patients enjoy (*op. cit.*, p. 410). One way to develop Nagel's proposal is in the direction of Michael Lockwood's partial unity model, according to which split-brain subjects have simultaneous experiences (E_1, E_2 and E_3) such that E_1 and E_2 are each phenomenally unified with E_3 but

[29] In effect, I have turned an argument suggested by Hurley on its head (see *Consciousness in Action*, p. 165; see also Hurley, "Action, the Unity of Consciousness, and Vehicle Externalism," p. 74 and 82). Whereas Hurley uses the possibility of phenomenal duplicates to reject the "what it's like" analysis of phenomenal unity ("co-consciousness," in her terminology), I use the "what it's like" analysis of phenomenal unity to reject phenomenal duplicates. See also note 34.

[30] See, for example, Matthew Roser and Michael S. Gazzaniga, "Automatic Brains—Interpretive Minds," *Current Directions in Psychological Science*, XIII, 2 (2004): 56–59.

not with each other.[31] The partial unity model attempts to capture the fact that split-brain subjects show too much unity to be thought of as having two completely separate streams of consciousness, yet too little unity to be ascribed a single fully unified consciousness.

As we saw in the previous section, the "raw" split-brain data seem to favor the partial unity model over its two-stream rival. Far from clustering into two autonomous systems, perception and cognition in the split-brain is inter-hemispherically integrated in various ways (see also section VI). But if the data themselves point to the partial unity model why has it had so few proponents?

I suspect that neglect of the partial unity models is almost entirely due to concerns about its intelligibility: consciousness, so the thought goes, *cannot* be partially unified. Even Lockwood, to whom we owe the model, admits to having doubts about its coherence.[32] I share Lockwood's doubts, but care must be taken in how they are put. It is sometimes suggested that the problem with the partial unity model is that we cannot imagine what it would be like to have a partially unified consciousness.[33] This, it seems to me, is not the real issue here. The phenomenal perspective of a partial unified subject may not be imaginatively accessible (to us, at least), but it would be the height of hubris to suppose that the limits of what we can imagine are the limits of phenomenal possibility.[34]

[31] To the best of my knowledge, the first explicit presentation of the partial unity model can be found in Lockwood (*Mind, Brain and Quantum*), but the earlier neuropsychological literature contains frequents hints of it. See, for example, Sperry, "Mental Phenomena as Causal Determinants in Brain Function," in Gordon Globus et al., eds., *Consciousness and the Brain* (New York: Plenum, 1976), pp. 163–77; Sperry, "Consciousness, Personal Identity, and the Divided Brain," *Neuropsychologia*, XXII, 6 (1984): 661–73; C. Trevarthen, "Analysis of Cerebral Activities That Generate and Regulate Consciousness in Commissurotomy Patients," in S.J. Diamond and J. Graham, eds., *Hemisphere Function in the Human Brain* (New York: Wiley, 1974), pp. 235–63; Trevarthen, "Functional Relations of Disconnected Hemispheres with the Brain Stem, and with Each Other: Monkey and Man," in Marcel Kinsbourne and W.L. Smith, eds., *Hemispheric Disconnection and Cerebral Function* (Springfield, IL: C.C. Thomas, 1974), pp. 187–207.

[32] Lockwood, "Issues of Unity and Objectivity," in Christopher Peacocke, ed., *Objectivity, Simulation and the Unity of Consciousness: Proceedings of the British Academy*, Volume LXXXIII (New York: Oxford, 1994), pp. 89–95.

[33] Dainton, *Stream of Consciousness*, p. 98; Lockwood, *Mind, Brain and the Quantum*, p. 92; Peacocke, "Introduction: The Issues and Their Further Development," in Peacocke, ed., *Objectivity, Simulation and the Unity of Consciousness*, p. xx.

[34] Hurley also argues that the (un)imaginability objection to the partial unity model fails, but her argument depends on the rejection of "what it's like" accounts of phenomenal unity ("co-consciousness" in her terminology). This is problematic, for phenomenal unity is defined in what it's like terms. Indeed, Hurley herself appears to invoke "what it's likeness" in introducing the notion of co-consciousness *(Consciousness in Action*, p. 88*)*.

The real objection to the partial unity model concerns not its unimaginability but its *inconceivability*. Contrast the perspective of a partially unified subject with that of a bat. Although the phenomenal perspective of a bat is not imaginatively accessible to us, we have no difficulty conceiving that there is something it is like to be a bat. By contrast, we have difficulty—arguably *great* difficulty—in conceiving that there is something it is like to be partially unified. Arguably, first-person acquaintance with consciousness reveals that simultaneous phenomenal states that are unified with a third (simultaneous) experience *must* be unified with each other.

This line of argument will not convince everyone. Some theorists will not share the intuition that partial unity is impossible, others will put little stock in inconceivability intuitions (at least when they involve consciousness), and even those who both share the intuition that partial unity is impossible and who are prepared to grant it some epistemic weight might regard its force as being outweighed by the empirical considerations in favor of the model. Nonetheless, it seems to me that the apparent inconceivability of partial unity goes *some* way towards undermining its appeal. We ought to be reluctant to accept a model of the split-brain that is of dubious coherence.

It is time to recap. Not only does the two-streams model receive only equivocal support from the experimental data, it has trouble accounting for the everyday behavioral integration of split-brain patients. The partial unity models fares better with respect to the experimental data, and arguably has less difficulty accounting for everyday integration in the split-brain, but its very coherence is questionable. Perhaps we should reconsider the possibility that split-brain patients retain a unified consciousness.

VI. THE SWITCH MODEL

In an important series of split-brain experiments, Levy and collaborators presented chimeric stimuli—that is, stimuli created by conjoining two similar half-stimuli at the vertical midline—to a series of split-brain patients.[35] On some trials patients were instructed to point to the figure that matched the stimulus, whilst on other trials patients were required to name the stimulus.

> For all patients examined, and for tasks including the perception of faces, nonsense shapes, picture of common objects, patterns of Xs and squares, words, word meaning, phonetic images of rhyming pictures, and outline drawings to be matched to colors, patients gave one response on the vast majority of competitive trials. Further, the nonre-

[35] Levy, "Perception of Bilateral Chimeric Figures following Hemispheric Deconnexion."

> sponding hemisphere gave no evidence that it had any perception at all. Thus, if the right hemisphere responded there was no indication, by words or facial expression, that the left hemisphere had any argument with the choice made, and, similarly, if the left hemisphere responded, no behavior on the part of the patient suggested a disagreement by the right hemisphere.[36]

In their original report, Levy and co-authors presented a two-streams interpretation of these findings, according to which each hemisphere had a conscious perception of the stimulus presented in the contralateral visual field. But, as Levy subsequently pointed out, this model fails to explain the absence of inter-hemispheric conflict. If the two hemispheres had separate perceptions, why did they not take issue with each other's responses?

In light of this, Levy proposed an alternative—and, I think, superior—account of these experiments and the split-brain in general.[37] I call it the "switch model." As the name suggests, the switch model holds that consciousness in the split-brain switches between the patient's two hemispheres. The hemispheres contribute in succession to the contents of the patient's consciousness, but, for the most part at least, consciousness does not occur in both hemispheres simultaneously. The switch model paints the split-brain patient as suffering from a kind of fluctuating perceptual extinction: when the left hemisphere is activated stimuli in the RVF win the competition for entry into consciousness at the expense of LVF stimuli, and the converse happens when the right hemisphere is activated. In general, inter-hemispheric activation will march in step with changes in the subject's attentional focus. Rapid inter-hemispheric switches will generate the impression that the patient is conscious of much more than she is in fact conscious of—in much the same way, perhaps, that our fluid interaction with the environment generates the impression that we are conscious of more than we are.

From the perspective of the switch model, we can now see that the closure and behavioral disunity arguments go wrong in assuming that the patient is *simultaneously* conscious of 'key' and 'ring'. The patient might be conscious of the word 'key' (due to right hemisphere activation), and she might be conscious of the word 'ring' (due to left hemisphere activation), but she will not be conscious of both 'key' and 'ring'

[36] Levy, "Regulation and Generation of Perception in the Asymmetric Brain," p. 235.

[37] Levy, "Manifestations and Implications of Shifting Hemi-Inattention in Commissurotomy Patients," *Advances in Neurology*, XVIII (1977): 83–92, and Levy, "Regulation and Generation of Perception in the Asymmetric Brain," in Trevarthen, ed., *Brain Circuits and Functions of the Mind: Essays in Honour of Roger W. Sperry* (New York: Cambridge, 1990), pp. 231–48.

at the same time, even when the two words are presented simultaneously. The patient's behavior might suggest that she is simultaneously conscious of both stimuli, but this would be an illusion generated by the rapidity with which her attention switches between hemispheres.[38]

In their original report of the chimeric studies, Levy and co-authors ascribed a nonexpressed conscious state to the nonresponding hemisphere on the grounds that the patient could be encouraged to report (or express) its percept simply by changing the response required of the subject.[39] However, they came to regard this modulation in responses as facilitating the entry into consciousness of previously unconscious content, rather than merely allowing the patient to access hitherto inaccessible experiences.

> ... lateralization of seeing of human commissurotomy patients to one half of the visual field was influenced by requiring response with one or the other hand, and the side of perception could be switched by interchanging hands. In the case of human subjects, the lateralization of perception was, on most occasions, further and more profoundly effected by asking the subject to speak about his experiences, causing him to use the left hemisphere and to shift his vision to favour the right field.[40]

In other examples of response-dependent processing, Levy and Trevarthen found that requiring patients to match chimeric stimuli based on their visual appearance favored the LVF (that is, RH processing) whereas instructions to match chimeric stimuli based on their function favored the RVF (that is, LH processing).[41] Arguably, however, consciousness is not shuttled between hemispheres by changes to the patient's responses per se but by the redistribution of attention that such changes bring about.[42]

[38] E.L. Teng and Sperry found further evidence of perceptual extinction in the split-brain (Teng and Sperry, "Interhemispheric Interaction during Simultaneous Bilateral Presentation of Letters or Digits in Commissurotomized Patients," *Neuropsychologia*, XI (1973): 131–40). They presented six split-brain patients with a mixture of dot and numeral counting exercises, in which the stimuli were presented either in the LVF or RVF alone, or in the two visual fields simultaneously. Patients were able to report stimuli presented to either field on trials involving only one visual hemi-field, but showed massive amounts of extinction on bilateral trials.

[39] It is this interpretation that has entered this philosophical literature. In an odd irony, Marks (*op. cit.*, p. 47, n. 26) rejects the switch model on the grounds that it is at odds with Levy's chimeric experiments.

[40] Trevarthen, "Functional Relations of Disconnected Hemispheres with the Brain Stem," p. 195.

[41] Levy and Trevarthen, "Metacontrol of Hemispheric Function in Human Split-Brain Patients," *Journal of Experimental Psychology: Human Perception and Performance*, II (1976): 299–312.

[42] Something akin to inter-hemispheric switching can be elicited in normal subjects, see A.D. Milner and J.J. Dunne, "Lateralized Perception of Bilateral Chimaeric Faces by

Levy's chimeric experiments provide reasonably direct evidence in favor of the switch model, but there are additional considerations that lend a degree of background plausibility to it. One such consideration concerns the structure of attention in the split-brain. In a 1987 review paper Michael Gazzaniga described the attentional system in the split-brain as "largely integrated."[43] Gazzaniga's assessment was perhaps an over-simplification, but there is evidence that many attentional systems remain unified in the split-brain.[44] An early study by C. Krueter and others[45] concluded that "a maximum effort by one hemisphere does withdraw capacity from the other, an effect which in the absence of the corpus callosum is presumably mediated by a 'capacity distributing system' located in the brain stem" (*ibid.*, p. 460). More recently, J.D. Holtzman and Gazzaniga showed that cognitive load in one split-brain hemisphere can interfere with performance in the other hemisphere.[46] A.J. Lambert has argued that there is a single system of selective attention in the split-brain,[47] while

---

Normal Subjects," *Nature*, CCLXVIII, 5616 (1977): 175–56. Milner and Dunne used chimeric stimuli in which the vertical join was hidden by a white strip, the purpose of which was to hinder detection of the incongruity between the two sides of the stimulus. At 100 ms exposure normal subjects had great difficulty detecting that the stimuli were chimeric. On trials in which no awareness of asymmetry was present, the subjects indicated (either manually or verbally) only one face, which was always perceived as complete. Furthermore, Milner and Dunne's subjects manifested response-dependent processing akin to that seen in Levy's experiment, with verbal responses favoring RVF stimuli and left-handed responses favoring LVF stimuli. One *could* take this study to show that normal subjects have two streams of consciousness under these experimental conditions, but it seems to me more reasonable to conclude that even in the normal brain visual experience can switch between hemispheres.

[43] Gazzaniga, "Perceptual and Attentional Processes following Callosal Section in Humans," *Neuropsychologia*, XXV, 1A (1987): 119–33.

[44] See M. Arguin et al., "Divided Visuo-Spatial Attention Systems with Total and Anterior Callosotomy," *Neuropsychologia*, XXXVIII (2000): 283–91; J.D. Holtzman et al., "Spatial Orientation following Commissural Section," in R. Parasuraman and D.R. Davies, eds., *Varieties of Attention* (Orlando: Academic, 1984), pp. 375–94; S.J. Luck et al., "Independent Hemispheric Attentional Systems Mediate Visual Search in Split-Brain Patients," *Nature*, CCCXLII, 6249 (1989): 543–45; Luck et al., "Independent Attentional Scanning in the Separated Hemispheres of Split-Brain Patients," *Journal of Cognitive Neuroscience*, VI (1994): 84–91; G.R. Mangun et al., "Monitoring the Visual World: Hemispheric Asymmetries and Subcortical Processes in Attention," *Journal of Cognitive Neuroscience*, VI (1994): 267–75.

[45] Kreuter et al., "Are Deconnected Cerebral Hemispheres Independent Channels? A Preliminary Study of the Effect of Unilateral Loading on Bilateral Finger Tapping," *Neuropsychologia*, X (1972): 453–61.

[46] Holtzman and Gazzaniga, "Dual Task Interactions Due Exclusively to Limits in Processing Resources," *Science*, CCXVIII (1982): 1325–27.

[47] Lambert, "Interhemispheric Interaction in the Split-Brain," *Neuropsychologia*, XXIX, 10 (1991): 941–48; Lambert, "Attentional Interaction in the Split-Brain: Evidence from Negative Priming," *Neuropsychologia*, XXXI, 4 (1993): 313–24.

H. Pashler and co-authors[48] concluded that "even after commissurotomy the left and right hemispheres appear to be incapable of selecting motor actions independently and simultaneously" (*ibid.*, p. 2383). The degree of attentional integration seen in these studies is not what the two-streams and partial-unity models would lead one to expect, but it is very much in keeping with the switch account.

The switch model also acquires indirect support from a wide range of evidence—drawn from studies of coma, the minimally conscious state, anaesthesia and hydranencephelic children—that identifies sub-cortical systems, centered on the thalamus, as playing a crucial role in consciousness.[49] These systems are not divided in the split-brain patient, which might explain not only how consciousness could switch between hemispheres but also why split-brain patients, unlike cetaceans, have a single sleep-wake cycle.[50]

I conclude by considering two objections to the switch model. If, as the switch model asserts, split-brain patients often undergo sudden and radical changes in the contents of their experience, why are they not aware of this? After all, subjects who experience alterations in the contents of consciousness (as in binocular rivalry) are normally aware of those alterations. Split-brain patients occasionally report sudden changes in the contents of consciousness, but such comments are rare. Why might this be?

One possibility is that inter-hemispheric switches in consciousness might themselves be unusual outside of experimental contexts. Perhaps split-brain patients generally get by on one (presumably the left) conscious hemisphere. Experimenters often remark that it can be difficult to elicit right-hemisphere controlled behavior in the split-brain. Even when the right hemisphere initiates a task the left frequently takes over and attempts to complete it, sometimes to the detriment of the patient's performance.[51]

[48] Pashler et al., "Sequential Operation of Disconnected Cerebral Hemispheres in Split-Brain Patients," *Neuroreport*, v (1994): 2381–84.

[49] Michael T. Alkire and Jason Miller, "General Anesthesia and the Neural Correlates of Consciousness," in Steven Laureys, ed., *Progress in Brain Research, Volume 150: The Boundaries of Consciousness* (2005), pp. 445–55; Laureys, "The Neural Correlate of (Un)awareness: Lessons from the Vegetative State," *Trends in Cognitive Sciences*, ix, 12 (2005): 556–59; Nicholas D. Schiff and Fred Plum, "The Role of Arousal and Gating Mechanisms in the Neurology of Impaired Consciousness," *Journal of Clinical Neurophysiology*, xvii (2000): 438–52; B. Merker, "Consciousness without a Cerebral Cortex: A Challenge for Neuroscience and Medicine," *Behavioral and Brain Sciences*, xxx, 1 (2007): 63–81.

[50] L.M. Mukhametov, "Interhemispheric Asymmetry of the Electroencephalographic Sleep Patterns in Dolphins," *Brain Research*, cxxxiv (1977): 581–84.

[51] Sperry, "Lateral Specialization in the Surgically Separated Hemispheres," in Francis O. Schmitt and Fredrick G. Worden, eds., *Neuroscience, 3rd Study Prog.* (Cambridge: MIT,

But why don't split-brain patients experience phenomenal discontinuity in those contexts in which they *do* undergo an inter-hemispheric switch in consciousness? I lack a full response to this question, but there is some comfort to be had in the fact that disorders of consciousness are often accompanied by "introspective blindness." In their famous study of unilateral neglect, E. Bisiach and C. Luzzati asked patients to imagine themselves standing in Milan's Piazza del Duomo with their back to the cathedral.[52] As predicted, they failed to describe the buildings on the left. But when asked immediately afterwards to describe when they would see if looking at the cathedral from the opposite end of the square, the same patients named the previously neglected buildings and neglected those that they had just mentioned. At no point did the patients attempt to integrate their successive reports, nor did they express any concern about the obvious inconsistency between them. Just as the ability to track perceptual continuity may be impaired by the very damage that causes unilateral neglect, so too the ability to detect changes in the contents of consciousness may be undermined by the very procedure that prevents consciousness from being bilaterally distributed. It is one thing for the contents of one's consciousness to switch, it is another to be conscious *of* switches in conscious content.

A second objection concerns not the truth of the switch model per se but rather the claim that it is consistent with the unity of consciousness. I have presented the switch model in terms of a single stream of consciousness switching between hemispheres, but a critic might claim that the switch model is better described in terms of the possession of two streams of consciousness that are activated only sequentially. Thus, the critic might continue, far from vindicating the claim that consciousness remains unified in the split-brain, the switch model actually undermines it.

This objection returns us to the question of what it is for consciousness to be unified. According to the account formulated in section II, all it takes for a subject to have a unified consciousness at a time is the existence of a single phenomenal state (or phenomenal field) that subsumes each of the subject's experiences at that time. As far as I

1974), pp. 5–19; E. Zaidel and Sperry, "Performance on the Raven's Colored Progressive Matrices Test by Subjects with Cerebral Commisurotomy," *Cortex*, IX (1973): 34–39; R.D. Nebes and Sperry, "Hemispheric Deconnection Syndrome with Cerebral Birth Injury in the Dominant Arm Area," *Neuropsychologia*, IX (1971): 247–59.

[52] Bisiach and Luzzatti, "Unilateral Neglect of Representational Space," *Cortex*, XIV (1978): 129–33.

can see, there is nothing in the critic's redescription of the switch scenario that is at odds with this account.

Of course, the critic might reply that even if the switch model is consistent with the unity of consciousness, there is a sense in which it is at odds with the *continuity* of consciousness: in order for a subject to have a single stream of consciousness during a particular interval, that subject's experiences must be grounded in a single set of consciousness-generating mechanisms. And, so the critic continues, this condition is not met if consciousness alternates between left and right hemispheres.

There is something to the claim that the continuity of consciousness requires physical continuity of some kind, although spelling out just what kind of continuity is required is not easy. No matter, for there is good reason to think that the switch model is consistent with any plausible continuity requirement. I presented the switch model as holding that consciousness in the split-brain switches between hemispheres, but this is true only to a first approximation. Two important qualifications must be made. First, some forms of conscious content, such as affective content, involve sub-cortical systems that are not separated by the split-brain procedure. The mechanisms responsible for such states constitute a form of physical continuity that underlies inter-hemispheric switches. Second, we should not think of the cortical mechanisms responsible for the content of consciousness as the mechanisms of consciousness per se. Arguably, cortical activity does not generate consciousness under its own steam, but contributes to the contents of consciousness only when integrated with sub-cortical processing. Again, these sub-cortical networks can provide any physical continuity that might be required for the continuity of consciousness.

VII. CONCLUSION

Although few contemporary theories would follow the seventeenth-century anatomist Giovanni Lancisi in identifying the corpus callosum as the seat of the soul, it is widely assumed that splitting the corpus callosum also splits consciousness. The burden of this paper has been to undermine this dogma. I have attempted to loosen the grip that disunity models of the split-brain have on us, and to present the switch model as a live alternative to them. Not only does it do better in accounting for the behavior of split-brain patients in both experimental and everyday contexts, it also avoids the philosophical baggage that accompanies the two-streams and partial unity models.

I leave open the question of whether consciousness is necessarily unified. Even if consciousness in the split-brain syndrome remains

unified, it is possible that the unity of consciousness breaks down in the context of other pathologies of consciousness; and, of course, it is possible that the unity of consciousness might fail in nonhuman animals. All that can be said at this stage is that the case against the unity of consciousness remains unproven.

TIM BAYNE

St. Catherine's College, The University of Oxford