PhiMiSci
Philosophy and the Mind Sciences | Vol. 6 | 2025

Action unity of consciousness

Elizabeth Schechter[1,*]

Special Issue: *Structuralism in the Science of Consciousness*, edited by Sascha Benjamin Fink & Andrew Lee

Abstract

Two kinds of behavioral dissociation are distinctive of the so-called *split-brain phenomenon* and first motivated the thought that split-brain consciousness might be structurally *dual*, with each cerebral hemisphere associated with a distinct stream or sphere of consciousness. One of these behavioral dissociations, however, tends to diminish in observed frequency and severity over time. What implications does this have for the debate over the structure of split-brain consciousness? Some neuroscientists have recently argued that motoric information remains interhemispherically integrated and that this shows that split-brain consciousness is unitary after all. This paper argues that an account of conscious unity grounded in that sort of integration would look quite different from the most familiar accounts of conscious unity. It proposes a new kind of unity relation that might persist after split-brain surgery and then considers whether this relation is a genuine kind of *conscious* unity.

Keywords: Action • Agency • Motor interaction • Split-brain phenomenon • Unity of consciousness

[1] University of Maryland
[*] Primary contact: eschecht@umd.edu

Schechter, E. (2025). Action unity of consciousness. *Philosophy and the Mind Sciences*, *6*. https://doi.org/10.33735/phimisci.2025.11812

1 Introduction

Philosophical accounts of the structure of consciousness often take on, as a real life "hard case," the so-called *split-brain phenomenon.* According to one account of split-brain consciousness, a split-brain subject has two streams of consciousness, one associated with each cerebral hemisphere (e.g. Schechter, 2018); according to another, a split-brain subject has one stream of consciousness (e.g., Bayne, 2008); according to a third, a split-brain subject has two streams of consciousness under experimental conditions but just one stream of consciousness at other times (Marks, 1981; Tye, 2003); according to a fourth, a split-brain subject has one stream of consciousness that is only partially unified (Lockwood, 1989). All of these accounts concern the *phenomenal* and *access conscious* relations between right hemisphere and left hemisphere experiences.

This paper concerns the possibility of a different conscious unity relation, one holding not between a split-brain subject's experiences, directly, but rather between those experiences and a split-brain subject's *actions.* The paper also notes, however, a sort of conceptual challenge to taking this new form of unity—*action unity*—to be a specifically *conscious* unity relation.

Section 2 will sketch three notions of conscious unity familiar from philosophical work on the unity of consciousness: introspective unity, access unity, and phenomenal unity. Section 2 also introduces the two types of behavioral dissociations distinctive of the split-brain phenomenon: the inability to cross-match and the inability to cross-respond. These dissociations first led to the hypothesis that split-brain consciousness is introspectively, access, and phenomenally *dual,* with experiences unified within but not between the hemispheres.

One of these behavioral dissociations, however, is most reliably evidenced only in the early post-surgical period; eventually, split-brain subjects regain the ability to cross-respond. Section 3 explains why some researchers have sought to explain this regained capacity in terms of the interhemispheric integration of motor (or visuomotor) information.

Could this form of interhemispheric integration unify split-brain consciousness? Section 4 looks at two existing accounts of split-brain consciousness that one might be tempted to use in order to argue that it does. The section explains, however, that neither of these accounts is well suited to explain the kind of unity demonstrated by cross-responding.

Section 5 introduces a new unity relation that could be subserved by interhemispheric visuo/motor integration. I call this *action unity.* Section 6 acknowledges two reasons why one might doubt that action unity is a kind of *conscious* unity, however. While sketching possible responses to those doubts, the section also notes the limits of such responses. Our current ways of thinking about consciousness may be a continued source of resistance to the proposal that action unity is on par, qua form of conscious unity, with introspective, access, or phenomenal unity.

This paper is about the structure of split-brain consciousness, which bears on questions of personal identity—questions about how many *psychological beings* a split-brain subject is. There will be moments, in what follows, when the paper will make explicit reference to the identities of subjects of experience and agents. And it may of course be that claims about the structure of consciousness in split-brain subjects entail (or strongly support) claims about their identities as psychological beings. In particular, some would feel that if each hemisphere is associated with its own *phenomenal perspective* (see Section 2.1), then each hemisphere must also be associated with distinct *subject of experience.* But this point is not argued for here, and for the most part, the paper does not engage directly with questions of personal identity, but only with questions about the structure of split-brain experience itself. Accordingly, my use of the term "split-brain subject" should be read as neutral on all questions of personal identity; in this usage, "subject" just means "experimental subject" or "human animal." This leaves open whether a single subject, in this bare sense, could somehow be associated with multiple subjects of experience.

2 Unity and disunity after split-brain surgery

Current philosophical work on synchronic conscious unity understands it in two related ways. First, two synchronic conscious experiences that bear the right kind of relation to each other can be said to be *unified* or *co-conscious*; second, any animal for whom it's the case that their experiences do bear that relation to each other can be said to enjoy a unified consciousness.

To distinguish between these two related notions of unity—the first a relation (or set of relations) between experiences, the latter a property a subject has in virtue of the former—I will refer to the latter as possession of a *unitary* (rather than a unified) consciousness.

We tend to think of possession of a unitary consciousness as possession of a unitary *subjective perspective*. To have a unitary subjective perspective is to have the entirety of what one is experiencing, at a given moment, brought together for or to oneself somehow: it is to have all the contents of one's consciousness *unified* with each other in some way. But in which way?

Three existing constructs of conscious unity are the most important in this paper: introspective unity (co-introspectability); access unity (co-accessibility), and phenomenal unity (co-phenomenality). Any of these relations could be used to individuate subjective perspectives and thus to define what it is to have a unitary consciousness. The split-brain phenomenon has attracted so much attention in philosophical discussions of conscious unity because it presents suggestive evidence of introspective and access disunity and thus of phenomenal disunity as well.

2.1 Concepts of conscious unity

A first prominent and intuitive notion of conscious unity is that of introspective unity. Two experiences are *introspectively unified,* or co-introspectable, if their subject can be introspectively aware of the conjunction of their contents or of being subject to them both (and not just of being subject to each of them). An introspectively disunified pair of experiences is thus one that cannot be co-introspected. And a human being's consciousness is introspectively unitary if it is the case that for *any two* of the subject's simultaneous experiences, they are co-introspectable.

Introspective unity is partially secured by the mechanisms of *access unity*—the second and most methodologically important concept of conscious unity. An access conscious experience is one that is available to reasoning—including introspection—and to report and to the rational control of action (Block, 1995); this is secured by its contents being accessible to the consumer systems underlying such capacities. For two experiences to be *access unified,* or co-accessible, is for them to be jointly available in this way; that is, it is for the conjunction of their contents to be access conscious. A subject of an *access unitary* consciousness is one of whom it's the case that for any two of their simultaneous access conscious experiences, they are co-accessible. The access unity of two experiences naturally requires that they be made accessible to the very same (token) consumer systems; my visual experiences are available to reasoning, report, and the rational control of action, and so are yours, but mine are not unified with yours, since mine are available to the consumer systems in my brain and yours to a different set.

The third prominent existing notion of conscious unity—and the one that has received the most attention in recent decades—is that of *phenomenal unity.* Two experiences are phenomenally unified, or co-phenomenal, when there is something it is like to have the two of them *together* (not just at the same moment in time, a non-phenomenal notion). It is thus a phenomenal relation between the contents or characters of experience.

Phenomenal unity is the relation structuring phenomenal perspectives: a phenomenal perspective is a set of mutually co-phenomenal contents, giving the entirety of what it is like to be its subject. (Though this assumes subjects stand in a one-to-one relation with phenomenal perspectives. If a subject can have multiple, qualitatively distinct phenomenal perspectives, then none of those perspectives gives the *entirety* of what it is like to be that subject; indeed, there is no single thing that it *is* like to be that subject, at any moment. See Section 4.1.)

Like phenomenal consciousness, phenomenal unity has no broadly accepted, distinctive causal profile. Philosophers have therefore been forced to take access unity as evidence of phenomenal unity, and access disunity as evidence of phenomenal disunity. (Such evidence cannot be decisive, see Bayne & Chalmers, 2003)

Introspective, access, and phenomenal unity are mutually intertwined, so that it does not seem possible to introspect pairs of experiences that are disunified in any of these senses. If you can introspect a pair of experiences in order to scrutinize their unity or disunity, then they are introspectively unified, and if you can jointly access this pair of experiences to introspect them, then they are access unified as well. Phenomenal unity is meanwhile such a thin concept of conscious unity that it would seem that any pair of access and introspectively unified experiences, so long as they are each phenomenally conscious, will also be phenomenally unified. After all, part of what one can access, when an experience is access conscious, is its phenomenal character, and thus when one is access conscious of a *conjunction* of experiences, part of what one can access is the *conjunction* of their phenomenology. Nothing more than this—no distinctive phenomenology—is required for co-phenomenality.

The above taxonomy of concepts of conscious unity is not exhaustive (see Bayne & Chalmers, 2003, for a fuller taxonomy); indeed, another concept, that of *subject unity,* will figure in Section 4.2. But phenomenal unity is often taken to be the concept of conscious unity most fundamental to the intuitive puzzle of the split-brain cases; as Nagel says, it is "difficult to conceive what it is like to *be* one of these people" (Nagel, 1971, 407, original emphasis). Meanwhile, introspective and access unity are plausibly co-extensive with phenomenal unity, as explained above.

2.2 The split-brain phenomenon

The split-brain phenomenon is the consequence of *split-brain surgery*, a colloquial term for surgery sectioning the corpus callosum, which connects the two cerebral hemispheres and is the largest fiber tract in the human brain. A number of these surgeries have been performed on adult human beings as a treatment for cases of epilepsy in which both hemispheres are affected, since severing the corpus callosum reduces the spread of seizure activity from one hemisphere to the other. It also reduces the spread of information: after they are surgically separated from each other in this way, the hemispheres operate with greater mutual independence.

This emerges most clearly under experimental conditions exploiting the fact that the hemispheres are not wholly symmetric with respect to the receipt of sensory/perceptual information or with respect to the control of movement. In the motor realm, movements of each hand are at least predominantly controlled by the contralateral (opposite side) hemisphere, and in at least many split-brain subjects, control of speech resides strictly in the left hemisphere. In the sensory/perceptual realm, fine-grained tactile information is sent directly from each hand to the contralateral hemisphere, and each hemisphere receives visual information at least predominantly from the contralateral visual hemifield—so the left hemisphere (LH) from the right visual field (RVF) and the right hemisphere (RH) from the left visual field (LFV). These asymmetries allow the capacities of the hemispheres to be tested somewhat separately.

Such tests revealed two behavioral dissociations characteristic of the split-brain phenomenon (Zaidel et al., 1990, p. 148). The first is impaired *cross-responding*. In a cross-responding task, a split-brain subject is asked to respond to a single stimulus at a time, presented on one side of space or the other. Strictly speaking, a *crossed response* is a right hand (and thus LH dominant) response to a left side (and thus RH directed) stimulus or a left hand (RH dominant) response to a right sided (LH directed) stimulus, and an *uncrossed* response is a response that is not crossed. From a theoretical standpoint, however, a spoken (LH dominant) response to a left side (RH directed) stimulus is also crossed, since really what is significant about a crossed response is that the hemisphere that is dominant for the production of the type of response required is not the hemisphere that directly received the stimulus. So, if a split-brain subject were shown two stimuli at once, say, a dollar sign in the LVF (RH) and a question mark in the RVF (LH) (as Sperry, 1968, describes), a frank incapacity for cross-responding would be demonstrated if the subject were able to vocally (LH) identify the RVF (LH)

Stimulus directed to ...	Subject responds using ...	Response is ...
RVF (LH)	Left hand (RH dominant)	Crossed
RVF (LH)	Right hand (LH dominant)	Uncrossed
RVF (LH)	Speech (LH dominant)	Uncrossed
LVF (RH)	Left hand (RH dominant)	Uncrossed
LVF (RH)	Right hand (LH dominant)	Crossed
LVF (RH)	Speech (LH dominant)	Crossed

Table 1: Different trial types in a (visual) cross-responding task count as crossed or uncrossed depending on side of stimulus presentation and required response modality.

question mark, and not the LVF (RH) dollar sign, and able to use the left hand (RH) to draw the LVF (RH) dollar sign, and not the RVF (LH) question mark. (See Table 1.)

The second dissociation characteristic of the split-brain phenomenon is impaired *cross-matching*. In a cross-matching task, a split-brain subject is asked to make a same-or-different judgment about two stimuli, either both presented in the LVF (RH) or both in the RVF (LH)—a *within-field* trial—or one presented in each visual hemifield (bivisual field or BVF)—a *cross-field* trial. So, rather than being asked to, say, identify the two stimuli presented in the visual fields as a dollar sign and a question mark, the subject might simply be asked whether they were the same or different. A frank incapacity for cross-matching would be demonstrated if the subject were unable to answer, on cross-field trials, at an above chance level of accuracy, despite being successful on within-field trials.[1]

In the early split-brain experiments, both dissociations were striking. The incapacity for cross-responding made it seem as though the agent who verbally denied having seen anything in the LVF and the agent who drew the LVF dollar sign were not the *very same agent*. The incapacity for cross-matching made it seem as though the visual perspective encompassing the question mark on the right and the visual perspective encompassing the dollar sign on the left were not the *very same perspective*.

It is on the basis of such dissociations that neuropsychologists first suggested that split-brain surgery produces:

> an apparent doubling in the realms of conscious awareness. Instead of the normally unified single stream of consciousness, these patients behave in many ways as if they have two independent streams of conscious awareness, one in each hemisphere, each of which is cut off from and out of contact with the mental experiences of the other. (Sperry, 1968, p. 724)

What Sperry describes here became the classic *duality account* of split-brain consciousness, according to which a split-brain subject has two streams or spheres of conscious awareness, one associated with each hemisphere. But the account faces empirical and conceptual difficulties, and several philosophers have offered, in its stead, accounts according to which split-brain consciousness is unitary, at least for the most part (see especially Bayne, 2008; and Marks, 1981). These accounts are mostly not considered here, since the paper does not argue that split-brain consciousness is unitary or dual, addressing only the prospects for one sort of unity account, rooted in a specific empirical challenge to the duality account.

The challenge is one of which readers only casually familiar with the split-brain studies may be unaware: many split-brain subjects, while remaining unable to match across fields, regain a capacity for crossed responses (Zaidel et al., 1990, p. 154).[2] I will focus on a recent dramatic illustration of this regained capacity in a series of experiments by Pinto, Neville and colleagues (2017), run with the Italian split-brain subject DDC. DDC was unable to cross-match at an above-chance level; his accuracy on cross-responding experiments depended on stimulus type and visual field

[1] More broadly, this second dissociation emerges in experiments in which successful behavioral performance requires information from the two hemispheres to be integrated or combined prior to responding; see, e.g., Kingstone and Gazzaniga (1995).

[2] There are individual differences between split-brain subjects, though, with some able to cross-match and unable to cross-respond; see e.g. Johnson (1984).

but exhibited *no field-response interaction effect*. That is, given a stimulus of a particular type and in a particular visual field, it made *no difference* to DDC's accuracy whether he was asked to respond using the right hand or the left. DDC's verbal responses, too, were no more accurate for RVF (LH) stimuli than for LVF (RH) stimuli.

Indeed, while there is a large and difficult to summarize literature investigating cross-responding after split-brain surgery, it seems safe to say that a total incapacity for cross-responding is most characteristic of the early recovery period and that split-brain subjects generally regain some ability to produce crossed responses—especially crossed manual responses, but sometimes also verbal responses to LVF (RH) stimuli, under certain conditions. Despite the complex empirical literature investigating the extent and basis of this regained capacity, philosophers have not, to my knowledge, specifically addressed what implications it has for the debate about the structure of split-brain consciousness—and yet split-brain subjects' (early) inability to cross-respond was a very substantial part of what evoked the intuition that their consciousness was dual. This paper directly addresses that lacuna.

I will be addressing the consciousness of a split-brain subject like DDC, who is presently capable of cross-responding. Note that if DDC once was, immediately after surgery, *not* so capable, then this may mean that the structure of his consciousness has changed over the course of his post-surgical life. I do not see anything objectionable in the idea that the structure of a subject's consciousness could change gradually over time. Conscious structure supervenes on *something*—whether neural structure or behavioral pattern—that might itself theoretically change in the role it plays in a subject's mental life. I will address the structure of consciousness only in a split-brain subject who can already cross-respond, however.

The clearest evidence of cross-responding is obtained under experimental conditions, and it is possible that outside such conditions, cross-responding is less common or more common or carried out differently. It would be difficult to work out what very short-term changes in the nature of interhemispheric interaction signified, concerning the structure of consciousness; some philosophers have argued that it is in fact different inside versus outside of experimental conditions (see Marks, 1981; and Tye, 2003). For the purposes of this paper, however, I make the simplifying assumption that the interhemispheric mechanisms operative during cross-responding experiments are equally operative in the subjects' daily lives.

Beyond cross-matching and cross-responding experiments, there is a great deal of further evidence relevant to determining the structure of split-brain consciousness. Investigations of bimanual coordination after split-brain surgery, for instance, and of interhemispheric and intrahemispheric competition for attentional resources, bear on the question of whether split-brain consciousness is unitary. Whether split-brain subjects' behavior is "normal" outside of experimental conditions, and in what sense, is also relevant (see Ferguson et al., 1985; see discussion in Schechter, 2018). This paper neglects such evidence since it does not attempt to argue that split-brain consciousness is unitary or dual but rather investigates whether there is a particular *kind* of conscious unity, subserved by a particular interhemispheric mechanism, that may persist in split-brain subjects, whether or not other interhemispheric mechanisms subserving other forms of conscious unity are also operative.

3 Direct interhemispheric visuo/motor integration

The empirical basis of cross-responding after split-brain surgery is subject to debate. The issue plausibly depends, in part, upon the type of stimuli and responses used in a particular trial; to take one example, researchers have implicated visual transfer via the superior colliculus in the production of some crossed responses (Clarke & Zaidel, 1989), but this presumably cannot be the explanation for crossed responses to purple stimuli (Savazzi et al., 2007), since the superior colliculus is believed to be insensitive to purple light (Tamietto et al., 2010). Even focusing only on the stimuli and responses used across Pinto, Neville and colleagues' (2017) various experiments, however, Schechter and Bayne (2021) point out that three different mechanisms could have enabled DDC's crossed responses.

First, it is possible that the hemisphere to which the stimulus was directed always produced the response, whether crossed or uncrossed. Many split-brain researchers believe that each hemisphere develops a fair ability to control movements even of the ipsilateral (same side) hand (see e.g. Clarke & Zaidel, 1989; Johnson, 1984). Several researchers also claim to have found evidence of a limited capacity for RH speech in some subjects (Baynes et al., 1995; Gazzaniga et al., 1996), at least under conditions in which the range of possible verbal responses is known to both hemispheres in advance (as it would have been in Pinto, Neville and colleagues' 2017, experiments).

If this sort of redundancy of motor capacity were the mechanism of crossed responses, then such responses might not provide evidence that split-brain consciousness is unitary. Rather, in this picture, RH experiences remain localized to and thus presumably apt to be unified only with other RH experiences, and mutatis mutandis for LH experiences—and experiences in each hemisphere are available to a distinct set of systems for the production of movements—it is just that the two sets can produce most of the same kinds of movement.

A second possibility is that the hemisphere to which a stimulus was directed, on a crossed response trial, initiated some sort of overt movement that was then used by the other hemisphere to guide the appropriate response. For instance, since Pinto and colleagues presented answer choices in free vision, the hemisphere that had seen the stimulus on a trial could have directed the subject's *gaze* to the matching answer choice, and then, finding its eyes fixed on that answer choice, the other hemisphere could have selected it.

If this were the mechanism of crossed responses, then such responses might again not provide evidence that split-brain consciousness is unitary. In this picture, too, RH experiences remain localized to the RH and LH experiences to the LH. It is true that the information carried by one hemisphere's experiences is, in a way, made available to the other hemisphere. But, first of all, what is directly communicated may be something about the proper *response,* from which the nature of the stimulus can at best be reliably *inferred.* Second of all, *movement* is the means by which the information is made available. But I can make information available to *you* by moving—for instance, I can look at the correct answer choice, and you can follow my gaze—without you being subject to the experience of mine that prompted my looking.

The third possibility is that the hemisphere to which the stimulus was directed, on a given trial, sent a *direct neural signal* to the other hemisphere, allowing it to make the correct response. This is the hypothesis that Pinto and colleagues believe their results support. And the version of this third hypothesis that I will work with, is one according to which what transferred between hemispheres was motor or perhaps visuomotor information about the proper response, rather than semantic or strictly perceptual information about the stimulus. This is the version most deserving of our attention, for four reasons.

First, as Pinto and colleagues point out, on some experiments they obtained a main effect of visual field, suggesting that strictly visual information was processed only *within* each hemisphere. Second, it is the transfer of *response* information that would enable cross-responding but not cross-matching. On any trial of a cross-responding experiment, the hemisphere that received the stimulus is in a position to calculate the correct response—information about which could in principle enable the other hemisphere to act. But in a (cross-field trial of a) cross-matching experiment, neither hemisphere is in a position to calculate the correct response without first knowing what the other hemisphere's stimulus was; an ability to transfer *response* information would therefore not enable cross-matching. Whereas it it were the interhemispheric transfer of stimulus information that enabled cross-responding, one might expect such transfer to enable cross-matching as well.

A third reason to work with the assumption that any interhemispheric integration was of specifically motor or perhaps visuomotor information, is that there are other studies that seem to implicate a such a capacity. Consider a go/no-go experiment by Reuter-Lorenz et al. (1995, Experiment 6), which found that the split-brain subject JW was able to produce or inhibit actions to whose success information from both visual hemifields was relevant: even when the (motor dominant) LH received a stimulus meaning *go* in

its visual hemifield (the RVF), the presence of a stimulus meaning *stop* in the RH's visual hemifield (the LVF) could be successfully used to inhibit a response. This was despite the fact that JW verbally indicated (LH) a lack of awareness of LVF (RH) stimuli, suggesting that successful performance was not achieved on the basis of interhemispheric transfer of a representation of the stimulus, but rather an actual stopping signal of some kind.

Consider also a pair of studies with split-brain primates (Savaki et al., 1993, 1996), which suggested that the RH could control a unimanual (left hand) response to a visual stimulus even when that hemisphere was blind (via unilateral optic tract section). The functional neuroanatomy of these (surgical) primates makes it unclear how strictly visual (or semantic) information about the stimulus could have transferred from the seeing to the blind hemisphere, and the studies' authors propose, instead, that the RH generated preliminary intentions to reach, and that the cerebellum (comparing the RH's corollary discharges with, among other things, LH visual information about the target) sent corrective signals back to the RH that were used to generate updated and accurate motor intentions.

The cerebellum has indeed been identified as at least one plausible substrate for the interhemispheric integration of visuo/motor information, as argued in a number of papers by Michael Glickstein (see Glickstein, 1990, 2000, 2009; Glickstein & Berlucchi, 2008; Glickstein & May, 1995; Glickstein et al., 1998; see also Prevosto et al., 2010), a researcher who performed some of the earliest split-brain experiments on non-human animals (see e.g. Glickstein & Sperry, 1960). The cerebellum is reciprocally connected to a host of cortical regions involved in motor and visuomotor tasks. The descending (cortico-ponto-cerebellar) pathway from the cerebrum to the cerebellum and the ascending (cerebello-thalamo-cortical) pathway from the cerebellum to the cerebrum are each usually thought to be lateralized and crossed, coupling each cerebellar hemisphere with the opposite side cerebral hemisphere. But there appears to be an ipsilateral (same side) descending (ponto-cerebellar) projection as well (Brodal, 1982; Rosina & Provini, 1984). This would put each cerebellar hemisphere in a position to receive visual information from both cerebral hemispheres. And the information in question would be from the dorsal stream (Goodale & Milner, 1992; Ungerleider & Mishkin, 1982): Glickstein and May (1995) reported that while several dorsal visual areas send substantial downstream projections to the cerebellum (via motor pons), no ventral visual area did. This circuitry may thus enable *interhemispheric visually guided reaching* after split-brain surgery.[3]

A fourth and final reason to consider a motor or perhaps visuomotor version of the interhemispheric integration hypothesis, is that this is the version that Pinto and colleagues themselves endorse. And the truth of this hypothesis would show, they claim, that split-brain consciousness is in fact unitary.

4 Experience and action

Going forward, I will assume the hypothesis that split-brain subjects' successful crossed responses are the product of the interhemispheric integration of some sort of motor or visuomotor information; I will refer to visuo/motor integration for short. If crossed responses after split-brain surgery are the product of such integration, then they arguably pose some difficulty for a duality account of split-brain consciousness. Perhaps the interhemispheric availability of conscious visual or semantic information would more clearly show that conscious experiences in one hemisphere are apt to be unified with conscious experiences in the other. But even the interhemispheric integration of visuo/motor information offers some

[3] Some split-brain subjects, including DDC, are also able to make crossed *verbal* responses, of a primitive sort, at least under the right experimental conditions, while the cerebellum is more clearly involved in visuomotor control of *reaching* (and eye movements). But it is possible that a simple capacity for interhemispheric go/no-go signaling, of the sort Reuter-Lorenz and colleagues (1995) discovered, could enable such responses. Perhaps if the LH formed intentions to speak all of the possible answer choices, the RH could selectively disinhibit the answer choice it knew was correct. Or perhaps verbal responses to LVF (RH) stimuli are produced by the RH; perhaps the LH normally inhibits RH speech, but disinhibits all possible correct answer choices under experimental conditions. These mechanistic explanations seem as likely as any other.

prima facie challenge to the conscious duality account. Certainly, there is no such (direct) integration possible between you and me, or between your consciousness and mine. And crossed responses are intentional actions, undertaken in response to consciously perceived stimuli; any interhemispheric integration in the production of these responses might therefore be thought to subserve a kind of *conscious* integration.

It is not immediately clear, however, how to use interhemispheric visuo/motor integration in an argument that split-brain consciousness is unitary.

4.1 Partial unity

One initially tempting thought might be that a capacity for visuo/motor integration shows that split-brain consciousness is at least partially unified (as Schechter & Bayne, 2021, suggest). Now one thing one could mean by this is just that split-brain consciousness is unified in some respects while disunified in others; then the question just becomes in which respects. But the actual existing partial unity account of Michael Lockwood (Lockwood, 1989, 1994; see also defenses by Godfrey-Smith, 2021; and Schechter, 2014) is arguably not usefully employed to explain cross-responding.

In Lockwood's account of split-brain consciousness, there are RH experiences phenomenally unified with each other but not with (some of) those of the LH, LH experiences phenomenally unified with each other but not with (some of) those of the RH, and then a third set of experiences that are phenomenally unified with all others. The key and striking feature of this account is its relinquishment of the idea that phenomenal unity is a necessarily transitive relation.

This feature of the account is controversial. In part that is because, in both functional and phenomenological respects, a partially unified consciousness, in Lockwood's sense, is rather like a dual consciousness with some overlap in contents between the two streams (Hurley, 1998). (Although the partial unity account and the duality account may have different implications concerning personal identity, a point to which I will return at the very end of the paper.) Functionally, the two accounts agree about which hemisphere's consumer systems will have access, at any moment, to which contents. Phenomenologically, the two accounts both imply that a split-brain subject will have two *phenomenal perspectives*. A phenomenal perspective seems to include all and only *transitively* unified experiences, as Lockwood himself notes (see 1989, p. 92), and for reasons Nagel (1971, 1974) and Schechter (2018) have tried to articulate: basically, if two experiences are not phenomenally unified, then there is nothing it is like to have them *together*, and if there is nothing it is like to have them together, then they aren't *together* in anyone's—or any *one*—perspective. This is why Lockwood, defending the partial unity account, wrote that what is "… required to imagine a given state of awareness of a commissurotomy patient is to imagine *each* of his current, overlapping *phenomenal perspectives* in turn" (1989, 92, emphasis added).

Perhaps split-brain consciousness is partially unified in Lockwood's sense. But non-transitive phenomenal unity does not seem to be a relation in terms of which one can model a consciousness that makes possible cross-responding and not cross-matching. In a crossed response trial, a split-brain subject is responding to only a single hemisphere's stimulus and thus to a single experience at a time. Lockwood's account concerns relations between three or more experiences—rather than between individual experiences and *actions*.

In this respect, Lockwood's account is in fact traditional and like other important accounts of split-brain consciousness not considered here, including the (similar) accounts of Marks (1981) and Tye (2003) and including Bayne's interesting "switch" model (Bayne, 2008, 2010; see also Hurley, 1998). These accounts all concern *access and phenomenal unity relations* between RH and LH experiences—relations that determine whether a split-brain subject has one perspective or two.

The inability of a split-brain subject like DDC to match stimuli across fields suggests that his experience of a left field stimulus and his experience of right field stimulus are not incorporated into a single perspective. Meanwhile, since cross-responding tasks require a subject to make use of only a single RH *or* LH experience at a time, such responding does not seem to provide countervailing evidence that RH and LH experiences *are* so

incorporated. It is cross-*matching* that requires a perspective incorporating a bihemispheric *pair* of experiences, and DDC cannot cross match.

4.2 Agent unity

Pinto and colleagues themselves proposed that DDC's capacity for cross-responding provides compelling grounds for thinking that split-brain consciousness is unitary (they say "unified") (Pinto, de Haan, & Lamme, 2017; Pinto, Neville, et al., 2017). Their reasoning seems to crucially involve the notion of *subject unity*. In their account, interhemispheric motor integration demonstrates that a split-brain subject is a unitary conscious *agent* (Pinto, Neville, et al., 2017); the subject's experiences are thus unified in virtue of being the experiences of a *single conscious being*. Reconstructed, the argument is something like:

> **P1.** In a split-brain subject, while there is not interhemispheric perceptual or cognitive integration, there is *interhemispheric motor integration*, enabling the subject to *act*, via any response modality, in response to a conscious experience of a stimulus received by either hemisphere. (Empirical hypothesis explaining DDC's ability to cross-respond but not cross-match.)
>
> **P2.** A split-brain subject is *one conscious agent*, who acts in response to both RH and LH experiences. (Inference from P1.)
>
> **P3.** A split-brain subject is one *conscious subject*. (Inference from P2.)
>
> **C.** A split-brain subject has a *unitary (unified) consciousness*, albeit one in which perception and cognition are not integrated. (Inference from P1 and P3.)

P3 is not explicit in the relevant papers (Pinto, de Haan, & Lamme, 2017; Pinto, Neville, et al., 2017) but allows the argument to employ an existing construct of conscious unity: two experiences are *subject unified* if they are the experiences of one conscious subject (see Bayne & Chalmers, 2003, p. 26); P3 thus permits the inference that RH experiences are unified, in just this sense, with LH experiences. Depending upon how P3's "conscious subject" is interpreted, however, this premise could be considered redundant, as we shall see.[4]

It is not totally clear how to interpret the final notion of a *unitary consciousness* appealed to in the argument's conclusion. The proposal may simply be that a split-brain subject's consciousness is unitary *not* in the sense that RH experiences are, say, access or phenomenally unified with LH experiences, but unified just in the sense of being the experiences of a single subject qua agent; this deflationary (but, as we shall see, still interesting) reading is supported by the first paper's describing a split-brain subject's situation as that of " '*split phenomenality*' combined with 'unity of consciousness' " (Pinto, Neville, et al., 2017, 1236, emphasis added). Alternatively, the proposal may be that the subject unity of a split-brain subject's RH and LH experiences demonstrates that they are also unified *in some further, familiar way*—say, access or phenomenally unified; this bold reading is supported by the other paper's analogizing a split-brain subject's

[4] While it is easy to formulate what it is for experiences to be *subject unified*, it is on the face of it difficult to formulate, in a non-tautological way, what it is for a *subject* to have a *subject unitary consciousness*. By structural parallel with the formulations of what it is for a subject to have an introspectively or access or phenomenally unitary consciousness, we should say that a subject has a subject unitary consciousness if all the experiences of that subject are subject unified—that is, if they are all the experiences of a common subject! But whether this is in fact tautological depends on whether the term "subject" has a consistent meaning in all three instances in which it occurs in that formulation, or whether it in the first two instances refers to an animal and in the third instance to an entity whose identity conditions are psychological. This ambiguity is addressed, in other terms, in this section, but in brief, if "subject" has a consistent meaning throughout, then subject unity turns out to be "trivial" (Bayne & Chalmers, 2003, p. 26); if it does not have a consistent meaning throughout, then we need an independent specification of the identity conditions of the subject referred to in the third instance, and that specification will itself presumably appeal to some other unity relation *such as* phenomenal unity. Most philosophers at present seem to think there is no route to individuating subjects of experience without *first* determining what unity relations hold between conscious experiences, which is why subject unity receives less philosophical attention than introspective, access, or phenomenal unity.

conscious perspective to that of a non-split subject watching a film whose audio was out-of-sync with its visuals (Pinto, de Haan, & Lamme, 2017, pp. 845–846).

We are by this point assuming that P1 of the argument is true, so the issue becomes whether the kind of unitary agency supported by P1 and referred to in P2 can ultimately provide support for C, interpreted in either the bold or the deflationary way.

The next section of this paper could be viewed as laying the grounds for defending a deflationary version of the argument's conclusion, so I will postpone its discussion here. The ultimate difficulty however will be that it is consistent with the proposition that RH and LH experiences are not introspectively, access, or phenomenally unified, and most philosophers would then probably not immediately recognize the conclusion as concerning a real or robust form of conscious unity.

Here I will explain two difficulties for the argument when C is given the bold reading, according to which split-brain consciousness, in virtue of being subject unitary, is also introspectively, access, and/or phenomenally unitary.

The core problem is that P3's appeal to a unitary conscious subject is itself ambiguous. Normally, we assume that a single conscious subject is the subject of a single phenomenal perspective. This assumption strikes me as strongly held. Suppose for example that someone said that since conscious subjects are necessarily animals, a split-brain subject necessarily enjoys a unitary consciousness, albeit one in which the two hemispheres were associated with distinct phenomenal perspectives. But this would likely strike most philosophers as an account according to which split-brain consciousness was *dual*. It is the strongly held nature of the assumption that makes puzzling the authors' reference to "split phenomenality" together with "unity of consciousness" (Pinto, Neville, et al., 2017, p. 1236). The inference from P3 to the bold reading of C thus seems secure only if P3's "one conscious subject" is read as "subject of one phenomenal perspective." In that case, the subject unity of RH with LH experiences would mean that they were also phenomenally unified.

But it is not clear that the version of P2 supported by P1 provides reason to think that a split-brain subject *is* one conscious subject in this phenomenal sense. For it is not clear how interhemispheric integration of *motor* (or even visuomotor) information could provide the basis for the phenomenal unity of, say, perceptual experiences. Meanwhile, the inability to cross-match provides at least *some* reason to think that perceptual experiences are *not* interhemispherically unified. Indeed, given how much of experience is perceptual in nature, it is unclear how to make sense of the proposal that a consciousness in which "perception" was "divided" (Pinto, Neville, et al., 2017), could still be phenomenally unified—as the second paper (Pinto, de Haan, & Lamme, 2017) implies that it is, by analogizing a split-brain subject to a non-split subject watching an out-of-sync film (Pinto, de Haan, & Lamme, 2017, pp. 845–846).

That analogy risks misleading. A non-split subject would demonstrate co-accessibility, and thus, one assumes, co-phenomenality, of an out-of-sync film's audio and visuals, in judging that they were out-of-sync (Schechter & Bayne, 2021). But this is what split-brain subjects cannot do, when they cannot cross-match. Their inability to report the conjunction of or to cognitively relate to each other a bihemispheric pair of conscious contents provides at least some reason to think that these are not introspectively or access unified and thus, one assumes, not phenomenally unified either. And if they are not so unified—not incorporated into a single perspective—then C, on the *bold* reading, is false.

Alternatively, P3 might be taken to say that a split-brain subject is one conscious subject in the mere sense that any experience—whether of the RH or the LH—is one that the agent referred to in P2 can use somehow in action. In this case, P2 clearly supports P3, since P3 now more or less restates P2. But now it is not clear that P3 supports the bold reading of C. For, once again, it is unclear how a split-brain subject's being a single subject *of the sort whose unity is grounded in strictly visuo/motor integration*, could provide the basis for, say, the phenomenal unity of perceptual experience.

Granted, we do normally assume that a unitary conscious agent has a unitary conscious perspective. But this is assuming a normal conscious agent. This brings us to a caution about P2: the truth of P1 might show

that a split-brain subject is a unitary agent in some respects, but not in every respect in which a non-split subject is. Pinto, de Haan, and Lamme themselves acknowledge (2017) that *perception and cognition* are dual or divided in a split-brain subject, explaining the inability to cross-match. But in that case—assuming that integration at the level of perception and cognition are not epiphenomenal with respect to agency—a split-brain subject could not be entirely normal qua unitary agent. And in addition to carrying perceptual and cognitive (Sidtis et al., 1981) information about stimuli, the corpus callosum also appears to be a site of exchange of information about *action* (Oliveira & Ivry, 2008; Wahl et al., 2007; Zapparoli et al., 2018). (Savazzi and colleagues have indeed proposed that the (anterior) corpus callosum carries an *intention,* "rather than a sensory or a motor signal" (Savazzi et al., 2007, p. 2424; see also Iacoboni, 2006; and Geffen et al., 1994).) If that is correct, then a split-brain subject might be dual qua agent even with respect to highest levels of the control of action, even if unitary qua agent with respect to lower levels of the motor hierarchy. (See Schechter, 2018 for a discussion of this point and for consideration of evidence offered by Franz et al., 1996; see also Franz et al., 2001 and Franz et al., 2000.)

Consider a pair of figures Pinto, de Haan, and Lamme published to illustrate their proposal (see Figure 1, reproduced from Pinto, de Haan, & Lamme, 2017). The top figure (Figure 1a) is meant to illustrate the picture of split-brain psychology suggested by the inability to cross-match *and* cross-respond. In this picture, stimuli are perceptually and cognitively processed only within each hemisphere, and then the motor outcomes of such processing are made available to only that single hemisphere's motor control systems. The picture supported by their findings, the authors note, is different, and illustrated by the lower figure (1b). In this picture, stimuli are still perceptually and cognitively processed only within each hemisphere, but the final output of such processing is made available to the full set of motor production systems within the organism. And it is the possession of this kind of unified system for the production of movement that Pinto and colleagues suggest is or grounds the existence of a unitary conscious agent.

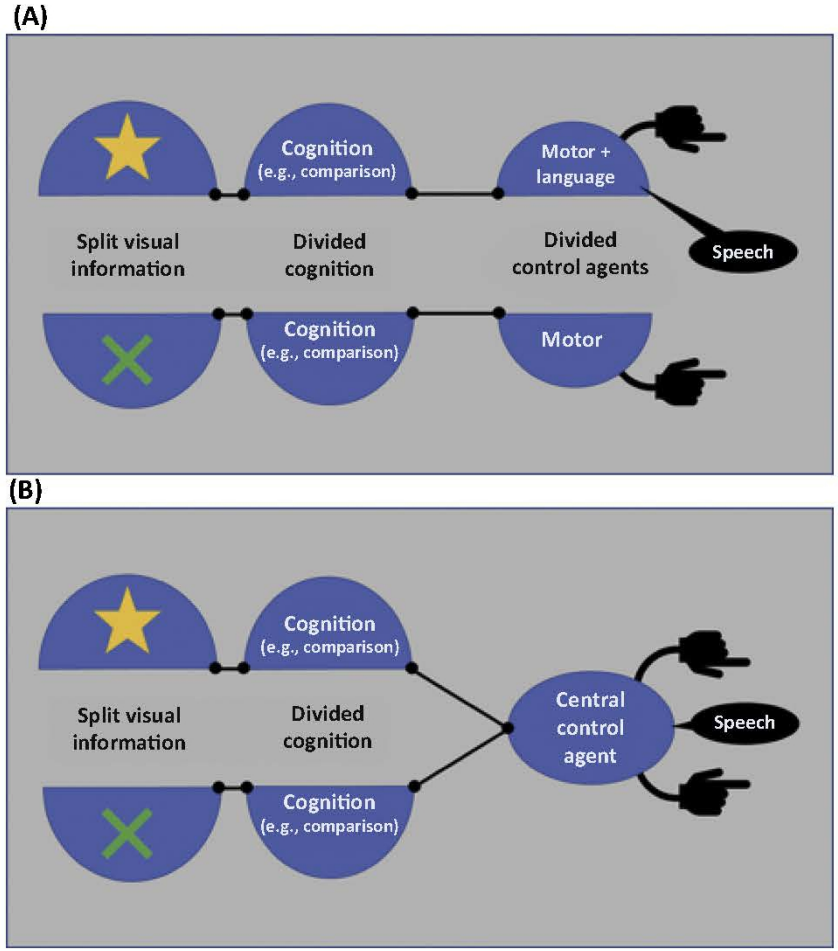

Figure 1: This figure appears in Pinto, de Haan, and Lamme (2017) and is meant to illustrate the picture of split-brain psychology supposedly implied by the inability to cross-respond or cross-match on the one hand (Figure 1a) and the picture of split-brain psychology supposedly implied by the ability to cross-respond but not cross-match (Figure 1b).

In evaluating the proposal, however, it is tempting to make the following mistake. Seeing a little semi-circle labeled "central control agent"—which appears to have two hands and be speaking—it is tempting to imaginatively project one's own agential capacities into it and to think something like, "If my perception and cognition were divided, I would be able to do nifty things such as, say, calculate, separately and simultaneously, the costs of two different home renovation projects, and then bring the results of the two calculations together to compare their costs." (The thought has a Parfitian flavor, see Parfit, 1971, p. 6.) Having imagined this, it might then seem to you that you would still be an agent of the sort you are now—perhaps with enhanced abilities.

But your imagining would have led you astray, for comparing the results of the two calculations is itself cognition, and for the agent in Figure 1b, cognition is *dual*: this agent can engage in calculating costs only in each of two different "streams," and the outputs of the two streams' cognitive processing are not directly disposed to become joint objects of cognition in either stream—even if each disposes the agent to, say, dial a contractor's number, using either hand. This is a respect in which a split-brain subject is not a unitary agent. And once it is acknowledged that a split-brain subject, while one agent in some respects, is also two agents in other respects (for instance, with respect to *thinking*), the question would become which sort of agency had a stronger connection to prominent notions of conscious unity. Given the connections between cognition and access consciousness, and between access unity and phenomenal unity, it seems unlikely that the kind of agent whose unitariness was entailed by P1 is more closely connected to phenomenal unity than is the kind of agent whose unitariness was *not* so entailed.

It would thus be a mistake to think that, if a split-brain subject is a unitary agent, they are necessarily a unitary agent in *every* respect in which we assume a non-split subject is. And once we recognize this, we have further reason to doubt that C, on the bold reading, is adequately supported by the argument's premises.[5]

[5] One might wonder whether results a more recent experiment by Pinto and colleagues (Pinto et al., 2023) with the split-brain subject DDC support the strong reading of C. In a novel *cross-field query task*, a stimulus was presented in one visual field, then a task-specifying signal in one visual field, then answer choices in free vision (both visual fields). The answer choices on each trial were an image matching the stimulus, a foil, and an "X". When the task-specifying signal was an "X", the subject was to select the X; when it was a "?", the subject was to select the answer choice matching the stimulus. In the trials of interest, the stimulus was presented in one visual field while a "?" was presented in the other. Though still unable to cross-match in other experiments, DDC was able to perform this novel task. The authors believe that determining the correct answer in a cross-field query task involves a kind of deliberate or "conscious" effort, while in a cross-matching task, one judges literally at a glance what the answer is; they therefore propose that "conscious processes" in the split-brain are unified even if "unconscious" (in the sense of swift or automatic) processes are not.

Like those of the older (2017) paper, the results of the more recent (2023) paper could be the product of several different mechanisms. Some of these do involve interhemispheric motor integration, so the paper may provide additional support for P1 of the argument above. And one might read the author's recent (2023) proposal as in line with the argument reconstructed at the beginning of this subsection (4.2), if one thinks that the processing the authors call "conscious" requires a greater exercise of DDC's *agency*. But it is in fact unclear whether the paper provides further support for the bold reading of C.

First, it is uncertain whether the proposal is one according to which conscious experience itself is unified or whether it is meant as it is phrased—as the claim that effortful *processing* is somehow unified (or perhaps that conscious experience is somehow unified during effortful processing). Second, it is unclear how it *could* show that conscious experience itself is generally unified; indeed, the proposal seems to be that DDC cannot determine the correct answer via a quick glance *visually presenting to him* two (cross-field) stimuli in relation to each other, which provides some reason to think that he *has* no (single) *visual* perspective incorporating representations of both stimuli. In any event, in at least some cases, split-brain subjects cannot cross-match even when there is a delay between the two stimuli (Gazzaniga et al., 1996; see also Funnell et al., 2000), making such cross-matching "conscious" or effortful (and *pace* Pinto and colleagues' prediction in the 2023 paper). Finally, it's not clear how the distinction between effortful versus automatic processing would explain the dissociation between ordinary cross-responding versus cross-matching; neither seems more effortful, since both involve perceptual recognition, perceptual comparison, and memory. This last dissociation remains the focus of this paper, since it has been obtained by multiple researchers.

The considerations marshalled here and in the previous subsection on Lockwood point towards a common conclusion. If we want to develop an account of conscious unity grounded in interhemispheric visuo/motor integration, it will likely employ an unfamiliar unity relation, one consistent with at least the *apparent* breakdown of interhemispheric access unity and thus, one assumes, of phenomenal unity as well.

5 Action unity of consciousness

Familiar accounts of what it is to possess a unitary consciousness reduce it to a relation between one conscious experience and another. We can think of this as a kind of "horizontal unity," linking homologous things, say, visual experiences. The inability to cross-match provides one piece of evidence suggesting the absence of such horizontal unity between the two hemispheres' conscious experiences. The ability to cross-respond using interhemispheric visuo/motor integration, meanwhile, does not seem to provide countervailing evidence, since this capacity does not on its face concern horizontal relations between experiences at all, but rather "vertical" relations between experiences and actions. DDC seems like one agent not with respect to his experiences co-belonging to any perceptual or cognitive perspective, but rather with respect to his ability to use (motor representations downstream of) any experience in the production of any token *action*.

But we can of course recast this vertical relationship between experiences and actions as a relationship between experiences. The relation between experiences that would explain DDC's ability to cross-respond is that of their mutual availability to contribute to the very same (token) actions or to the same (token) motor consumer systems producing action. (Note that there are two possible formulations of this mutual availability. On the stronger reading, it is the case that, for any pair of experiences, *both* members can contribute to any token action; on a weaker reading, *either* can contribute. I believe there is support for the stronger reading and will tend to assume it going forward, but evaluating the relative support received by the stronger versus the weaker formulation would require more work, and one might view the weaker notion as less plausibly representing a kind of conscious unity.)

This relation is similar to a kind of conscious unity relation recently proposed by Wu (2020), who has suggested that ventral and dorsal stream contents might be mutually unified in virtue of both being available to contribute to the same intentional actions, even if only ventral stream contents can be conceptualized, introspected, or reported.

Call this form of unity *action unity*. It could turn out that all bihemispheric pairs of conscious experiences in a split-brain subject are action unified—in which case we could say that split-brain consciousness was *action unitary*. Perhaps we could also say that a split-brain subject was a unitary agent of some kind, in virtue of the action unity of their experiences. Of course, depending upon the sort of task such a "vertically unified agent" was trying to perform, they might or might not be able to perform it, since some tasks (e.g. cross-matching tasks) require horizonal unity. But when tasks don't require such horizontal unity, the agent might perform well.

This unity construct is, however, fairly different from familiar constructs. Most saliently, action unity is not phenomenal unity (perhaps *pace* Wu, 2020, p. 433). Of course, access unity isn't phenomenal unity either, but it is plausible to many people that the two should be co-extensive: whenever one attends to a pair of co-phenomenal experiences, one employs introspection, and co-introspectability requires co-accessibility; to co-introspect two experiences as phenomenally unified therefore requires that they be access unified as well. But given their inability to cross-match, split-brain subjects seem unable to bring together, in introspection or cognition, bihemispheric pairs of experiences—*even if* such experiences are *action unified*. Thus, action unity is also not *access unity*. The version of the proposal best supported by the data considered here is one according to which RH and LH experiences can be action unified without needing to be access or, presumably, phenomenally unified. (Though of course they *could,* for all that, be unified in all these senses.)

It might be questioned whether split-brain subjects cannot co-introspect bihemispheric pairs of experiences. That would mean that

split-brain consciousness was not introspectively unitary, and split-brain subjects certainly do not report anything unusual about their consciousness, even when asked (including in Pinto, Neville, et al., 2017, p. 1235). But for two experiences to be introspectively disunified is not for their subject to be capable of introspecting that they are disunified; this shouldn't be possible, since any act of introspection is itself a conscious event occurring *within* some perspective or other, rather than outside any such perspective and yet somehow capable of surveying how many perspectives there are. This is why the introspective sense that there is just one conscious perspective "in one's brain" does not provide evidence that there is. The only way to detect the introspective disunity of bihemispheric pairs of experiences is to obtain third-personal evidence that such pairs cannot be co-introspected—via, for instance, a cross-matching test.

It might also be questioned whether it is true that successful cross-responding—*if* it is explained by interhemispheric visuo/motor integration—does not demonstrate access unity. True, DDC was asked to respond to just one hemisphere's conscious experience on each individual cross-responding trial, but across trials, DDC acted on experiences of both RH and LH experiences. Doesn't this demonstrate interhemispheric access unity of those experiences, at least across trials?

But access unity is a relation between two (or more) experiences that holds when they are available to the same token consumer systems, where many of these are understood to be cognitive. In the proposal under consideration, RH and LH experiences are both available to *different* cognitive consumer systems and only to the same *motor* consumer systems. Access unity, like access consciousness, involves availability to more than just the latter. It involves availability to working memory, for instance, and to systems for the long-term encoding of semantic information. It involves availability to various conceptualizing systems and to verbalizing systems.

Indeed, describing action unity in terms of the availability of all of a split-brain subject's *experiences* to the same token motor systems itself risks misleading on an important point. According to the hypothesis of the direct exchange of *visuo/motor* information, what is available to either hemispheres' motor control systems is *visuo/motor information* from either hemisphere. Given DDC's inability to cross-match, it looks as though visual experiences of the sort used to identify stimuli are not interhemispherically available. Conscious thoughts, too—like the thought, "The stimulus on the left was a tank"—also seem to remain intrahemispheric. In the proposal under consideration, things like conscious percepts are interhemispherically available only very indirectly, in virtue of the *direct* interhemispheric availability of the downstream, *visuo/motor* representations formed on their basis. Indeed, the "unitariness" of the agent we are considering lies purely in the visuo/motor realm, rather than in the realm of perception-for-identification or of thought.

This point does not undermine the construct of action unity, which speaks only of experiences' availability to *contribute* to actions. These contributions might indeed be very indirect, mediated through their downstream effects on, say, motor plans. Phenomenal unity, however, does seem to be a direct relation between experiences.

The action unity of a pair of, say, bihemispheric visual experiences in a split-brain subject, might turn out to be a very indirect, dispositional, causal relationship. Note that the action unity of a given pair of bihemispheric visual experiences in a *non-split* subject might be equally indirect. It is just that, in a non-split subject, those experiences would also be more directly causally connected to each other and thus consciously unified in other senses as well.

6 Is action unity a kind of conscious unity?

I've proposed a construct of conscious unity—action unity—that might hold between a bihemispheric pair of experiences in a split-brain subject. This unity relation seems interesting and worth further investigation in the split-brain case. One might, however, doubt that action unity is a kind of *conscious* unity, for two reasons.

6.1 Zombie unity?

The empirical aspect of the proposal is one according to which what remains unified is something like dorsal stream visuomotor processing or else strictly motoric processing (beneath the level of high-level action concepts and intentions, again, see Schechter's (2018) discussion of split-brain agency). But the representations that are trafficked by the systems responsible for such processing are typically said to be *non-conscious*. It might then seem puzzling that the unity of a non-conscious system and its non-conscious representations should serve as the basis for any kind of *conscious* unity. Why not just think that a split-brain subject has two streams or centers of consciousness that influence action in part via their mutual connectedness to a single "zombie" system (Clark, 2007) for the control of movement?

In response to this concern, a defense of action unity as a genuine kind of conscious unity might proceed along either of two lines. First, it might argue that the visuo/motor information available interhemispherically is at least partially conscious. Some philosophers have recently tried to show that at least some dorsal visual stream representations are in fact phenomenally conscious (Phillips, 2021; Wu, 2020; though see also Michel & Lau, 2021)—or perhaps some of the strictly motoric signals that transfer between the hemispheres are themselves conscious.

It is unclear though what putative consciousness of dorsal stream contents would be contributing to an explanation of crossed responses. Consider again a trial in which a stimulus was presented in DDC's LVF (RH) and now two answer choices appear in free vision (both RH and LH), and his task is to point to the answer choice matching the stimulus, using the right hand (predominantly LH). The stimulus (the LVF image) presumably received conscious ventral stream representation in the RH, the hemisphere that (according to Pinto et al.'s hypothesis) is sending a motor signal to the LH about the proper response; no further conscious representation of the *stimulus*—whether RH or LH or both—would seem to be necessary. Meanwhile, the *answer choices* are receiving conscious ventral stream representation in *both* hemispheres.

What putative consciousness of interhemispheric *motor* signals would contribute to an explanation of cross-responding is also unclear. It might seem that the LH would have to have been conscious of something or other in order for it to (decide to?) point to any answer choice at all—at least if such a response were to be rational. But first of all, it is arguable that the LH would have an intention to point to *something*—that's what the subject is required to do, and the LH is prepared to do it—and the LH could be conscious of *that* (LH) intention. Second of all, even on the basis of receiving a non-conscious motor signal indicating to select a particular answer choice (which would presently be receiving conscious representation in the LH ventral stream), the LH could perhaps form its own conscious intention to select it. And, in any event, whatever the connection between consciousness and rational action in normal contexts, we are discussing actions undertaken in experimental contexts. The LH is aware of the experimental request to point to one of two things, and aware that, whatever is pointed to, that response has a good statistical chance (given the limited response options) of being correct; under those conditions, perhaps it is rational for the LH to select an option even without any consciousness of either the original stimulus or of the RH motor signal to select that option.

It is, then, at best unclear what interhemispheric visuo/motor consciousness would contribute to an adequate explanation of successful cross-responding, and it is therefore arguable that the best model of action unity would not be one that appeals to it. And this is so even if some dorsal visual stream contents *are* conscious, as Wu (2020) and Phillips (2021) believe. Dorsal visual stream consciousness might explain certain findings in the split-brain literature—such as a preserved ability to verbally describe (LH) certain features of especially moving LVF (RH) stimuli (e.g. Trevarthen & Sperry, 1973)—and could perhaps be accommodated by Lockwood's (1989) partial unity account. But, again, it is unclear whether the consciousness of specifically visuo/motor information that is interhemispherically integrated, contributes anything to an explanation of cross-responding.

A more radical defense of action unity as a kind of conscious unity would argue that the visuo/motor information integrated between the hemispheres does not itself need to be conscious in order for its integration

to secure a kind of conscious unity. One might reason along the following lines. Any type of motor response can be used to execute either LH or RH conscious intentions, formed on the basis of *any* LH or RH conscious experience—in other words, a split-brain subject is action unitary. Action unity inherits its status as a kind of *conscious* unity either (or both) from the fact that what are ultimately, indirectly unified, on the basis of the direct interhemispheric integration of their downstream, visuo/motor consequences, are *conscious experiences,* or from the mere fact that action unity is the (or a) relation undergirding the identity of a *conscious* agent. That agent is *unitary* in virtue of its action unity and *conscious* because its experiences and the intentions formed on their basis are themselves conscious.

6.2 A conscious subject without a (single) conscious perspective

A second reason to doubt whether action unity is a genuine kind of *conscious* unity is simply that it dissociates from the three more familiar constructs of conscious unity first introduced in Section 2, *while they do not seem so dissociable from each other.*

Although introspective unity, access unity, and phenomenal unity are distinct constructs, it is plausible that they are necessarily co-extensive (see Section 2.1). For reasons we have seen, however, action unity seems not just conceptually distinct but empirically dissociable from these other three. Of course, it may be that there is no such dissociation in the split-brain case: as stated early in, the paper is not concerned to argue that split-brain consciousness *is* introspectively, access, or phenomenally dual; perhaps it isn't. But given the plausible mechanisms of action unity on the one hand and of introspective and access unity on the other, it should be empirically *possible* for them to dissociate.

A defender of action unity as a genuine form of conscious unity might respond that, even if introspective and access and phenomenal unity are not empirically dissociable from each other, though action unity is dissociable from the others—well, so what? So there are just a plurality of kinds of conscious unity, some of which overlap with each other with respect to their mechanisms and some of which stand alone.

The difficulty for this response, I think, is the strength of our tendency to identify having a unitary consciousness with the possession of a single phenomenal perspective, of the sort that any act of introspection will necessarily reveal. To say that a split-brain subject's consciousness is *action unitary* is *not* to say that their brain is associated with only a single such perspective. Indeed, again, it seems possible to have an action unitary but phenomenally multiple consciousness: action unity most directly relates experiential contents to actions, while to have a unitary *perspective* is to have the contents of one's experiences directly related to *each other* somehow.

The apparent empirical dissociability of having an action unitary consciousness and having a unitary phenomenal perspective is perhaps especially perplexing if one is inclined to think that where there is an action unitary consciousness there should thereby be a unitary conscious *subject.* The thought is somewhat intuitive; if nothing else, one might think that the unitariness of the conscious subject is secured by the preservation of *any* kind of conscious unity. But since action unity appears not just conceptually but also empirically consistent with phenomenal disunity, we would then be forced either to drop the idea that a single conscious subject necessarily has a single phenomenal perspective or else to somehow find a way of delineating phenomenal perspectives other than in terms of phenomenal unity.

I myself regard this choice as something of a dilemma, but of the two horns, the second is least attractive: it is difficult for me to think of what it is to have a single phenomenal perspective except in terms of a phenomenal relation between conscious phenomenal characters! Indeed, my basic notion of a *subjective perspective* is a phenomenal one, and in this I imagine I'm typical.

It might indeed be easier to recognize action unity as just another kind of conscious unity if we moved away from thinking about conscious unity in phenomenal terms altogether. The recent movement towards *illusionism* (see e.g. Frankish, 2016; Shabasson, 2022) suggests that this could happen.

Issues of phenomenal consciousness and phenomenal unity are, admittedly, what has always made the split-brain cases so gripping (Nagel, 1971, p. 410); perhaps the greatest challenge facing existing unity accounts is that we find it difficult to imagine what it would be *like* to see two (bi-visual field) stimuli—clearly enough to identify each of them—and yet somehow unable to see whether they were the same or different. But if we came to accept that "there is nothing it is like to be *anyone*", as one recent illusionist has put it (Kammerer, 2022, 2846, emphasis added), then it would make no sense to wonder whether there are one or two things it is like to be a split-brain subject.[6]

Why would ceasing to think of conscious unity in phenomenal terms help? After all, introspective and access unity relations could readily be used (in practice *are* used) to individuate subjective perspectives, and a split-brain subject's inability to cross-match could still suggest that their consciousness was introspectively and access dual. But if we ceased taking it to be an indicator of or proxy for *phenomenal* unity, access unity might just look like one kind of functional integration in a conscious being, and action unity might just look like another. And action unity might then not *feel,* in some deep way, less fundamental.[7]

A proponent of action unity as a kind of conscious unity, and one who believed that the relation can be used to individuate conscious subjects, might finally note that theirs is not even the first account of split-brain consciousness to distinguish between being a single conscious subject and having a single phenomenal perspective.

Recall that where the classic conscious duality account posits two streams or sets of conscious experience, each comprising distinct token experiences but with some duplication of contents, Lockwood's (1989) partial unity account posits one stream or set of conscious experiences that is only partially (non-transitively) unified. And some philosophers who think that two streams of experience implicate *two* subjects of experience, find it more natural to think of a single stream of experience as implicating just one subject of experience—even if that stream is only partially unified and thus the source of multiple phenomenal perspectives.

They may think this for two reasons. First, the partial unity account posits token experiences that are shared between the hemispheres and therefore common to both phenomenal perspectives, and there are prima facie reasons to deny that multiple *subjects* can share token experiences.

Second, where the partial unity account posits token experiences that are shared between the hemispheres, the duality account instead attributes phenomenally identical yet token distinct experiences to each hemisphere. And it might seem puzzling or even incoherent that a single subject of experience could have, at any moment in time, two experiences with one phenomenal character—experiences that were somehow distinct despite the second making no phenomenal difference to their subject's perspective (see Bayne, 2008, pp. 289–291). This might then push someone to assign *phenomenal duplicates* to different subjects—and only the duality account appeals to such duplicates.

One way of interpreting Lockwood's account, then, is that a split-brain subject is a unitary conscious being who is subject to multiple phenomenal perspectives. In this way, the proponent of action unity might consider it a salutary precedent for distinguishing between the individuation of phenomenal perspectives and the individuation of the conscious beings whose perspectives they are. Perhaps a split-brain subject is a *single action unified agent*—whether that agent turns out to have two phenomenal perspectives or one.

Lockwood's partial unity account has itself never garnered widespread enthusiasm, however (as Schechter, 2014, explains). And if we cannot think our way to a radically different notion of conscious unity—one *not* involving familiar and introspectable horizontal relations between experiential contents—then we may be forced to that old fallback: we could simply insist—*pace* Pinto and colleagues, as well as many philosophers, and in

[6] The right way to characterize illusionism's commitments is obviously controversial, as is my characterization of it as the thesis that there is nothing it is like to be anyone. Nothing important hinges upon this here, however.

[7] The fundamentality I mean to point to is of the conceptual sort—assuming Nagel (1974), is right, again, that our most fundamental concept of the conscious is that of the phenomenal. It could of course still be that some kinds of functional integration remain, say, *ethically* fundamental.

apparent tension with portions of the behavioral evidence—that split-brain consciousness is *dual*.

Acknowledgments

I am grateful to Tim Bayne, Andrew Lee, and Yair Pinto for helpful feedback on drafts of this paper.

References

Bayne, T. (2008). The unity of consciousness and the split-brain syndrome. *The Journal of Philosophy*, *105*, 277–300. https://doi.org/10.5840/jphil2008105638

Bayne, T. (2010). *The unity of consciousness*. Oxford University Press.

Bayne, T., & Chalmers, D. (2003). What is the unity of consciousness? In Cleeremans (Ed.), *The unity of consciousness: Binding, integration, and dissociation* (pp. 23–58). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198508571.003.0002

Baynes, K., Wessinger, C., Fendrich, R., & Gazzaniga, M. (1995). The emergence of the capacity to name left visual field stimuli in a callosotomy patient: Implications for functional plasticity. *Neuropsychologia*, *33*, 1225–1242. https://doi.org/10.1016/0028-3932(95)00039-6

Block, N. (1995). On a confusion about a function of consciousness. *Behavioral and Brain Sciences*, *18*, 227–287. https://doi.org/10.1017/S0140525X00038188

Brodal, P. (1982). Further observations on the cerebellar projections from the pontine nuclei and the nucleus reticularis tegmenti pontis in the rhesus monkey. *The Journal of Comparative Neurology*, *204*, 44–55. https://doi.org/10.1002/cne.902040106

Clark, A. (2007). What reaching teaches: Consciousness, control, and the inner zombie. *British Journal for the Philosophy of Science*, *58*, 563–594. https://www.jstor.org/stable/30115188

Clarke, J., & Zaidel, E. (1989). Simple reaction times to lateralized light flashes. *Brain*, *112*, 849–870. https://doi.org/10.1093/brain/112.4.849

Ferguson, S., Rayport, M., & Corrie, W. (1985). Neuropsychiatric observations on behavioural consequences of corpus callosum section for seizure control. In A. Reeves (Ed.), *Epilepsy and the corpus callosum* (pp. 501–514). Plenum Press.

Frankish, F. (2016). Illusionism as a theory of consciousness. *Journal of Consciousness Studies*, *23*, 11–39. https://www.ingentaconnect.com/contentone/imp/jcs/2016/00000023/f0020011/art00002;jsessionid=93prm9h3a66hl.x-ic-live-03

Franz, E., Eliassen, J., Ivry, R., & Gazzaniga, M. (1996). Dissociation of spatial and temporal coupling in the bimanual movements of callosotomy patients. *Psychological Science*, *7*, 306–310. https://doi.org/10.1111/j.1467-9280.1996.tb00379.x

Franz, E., Waldie, K., & Smith, M. (2000). The effect of callosotomy on novel vs. familiar actions: A neural dissociation between controlled and automatic processes? *Psychological Science*, *11*, 82–85. https://doi.org/10.1111/1467-9280.00220

Franz, E., Zelaznik, H., Swinnen, S., & Walter, C. (2001). Spatial conceptual influences on the coordination of bimanual actions: When a dual task becomes a single task. *Journal of Motor Behavior*, *33*, 103–112. https://doi.org/10.1080/00222890109601906

Funnell, M., Corballis, M., & Gazzaniga, M. (2000). Insights into the functional specificity of the human corpus callosum. *Brain*, *123*, 920–926. https://doi.org/10.1093/brain/123.5.920

Gazzaniga, M., Eliassen, J., Nisenson, L., Wessinger, C., Fendrich, R., & Baynes, K. (1996). Collaboration between the hemispheres of a callosotomy patient: Emerging right hemisphere speech and the left hemisphere interpreter. *Brain*, *199*, 1255–1262. https://doi.org/10.1093/brain/119.4.1255

Geffen, G., Jones, D., & Geffen, L. (1994). Interhemispheric control of manual motor activity. *Behavioural Brain Research*, *64*, 131–140. https://doi.org/10.1016/0166-4328(94)90125-2

Glickstein, M. (1990). Brain pathways in the visual guidance of movement and the behavioral functions of the cerebellum. In C. Trevarthen (Ed.), *Brain circuits and functions of the mind: Essays in honor of Roger W. Sperry* (pp. 157–167). Cambridge University Press.

Glickstein, M. (2000). How are visual areas of the brain connected to motor areas for the sensory guidance of movement? *Trends in Neuroscience*, *23*, 613–617. https://doi.org/10.1016/S0166-2236(00)01681-7

Glickstein, M. (2009). Paradoxical inter-hemispheric transfer after section of the cerebral commissures. *Experimental Brain Research*, *192*, 425–429. https://doi.org/10.1007/s00221-008-1524-4

Glickstein, M., & Berlucchi, G. (2008). Classical disconnection studies of the corpus callosum. *Cortex*, *44*, 914–927. https://doi.org/10.1016/j.cortex.2008.04.001

Glickstein, M., Buchbinder, S., & May, J. (1998). Visual control of the arm, the wrist and the fingers: Pathways through the brain. *Neuropsychologia*, *36*, 981–1001. https://doi.org/10.1016/s0028-3932(98)00053-0

Glickstein, M., & May, J. (1995). Visual control of movement: The circuits which link visual to motor areas of the brain with special reference to the visual input to

the pons and cerebellum. In C. Neff (Ed.), *Contributions to sensory physiology* (pp. 103–145). Academic Press.

Glickstein, M., & Sperry, R. (1960). Intermanual somesthetic transfer in split-brain Rhesus monkeys. *Journal of Comparative and Physiological Psychology*, *53*, 322–327. https://doi.org/10.1037/h0046386

Godfrey-Smith. (2021). Integration, lateralization, and animal experience. *Mind & Language*, *36*, 285–296. https://doi.org/10.1111/mila.12323

Goodale, M., & Milner, D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, *15*, 20–25. https://doi.org/10.1016/0166-2236(92)90344-8

Hurley, S. (1998). *Consciousness in action*. Harvard University Press.

Iacoboni, M. (2006). Visuo-motor integration and control in the human posterior parietal cortex: Evidence from TMS and fMRI. *Neuropsychologia*, *44*, 2691–2699. https://doi.org/10.1016/j.neuropsychologia.2006.04.029

Johnson, L. (1984). Bilateral visual cross-integration by human forebrain commissurotomy patients. *Neuropsychologia*, *22*, 167–175. https://doi.org/10.1016/0028-3932(84)90059-9

Kammerer, F. (2022). How can you be so sure? Illusionism and the obviousness of phenomenal consciousness. *Philosophical Studies*, *179*, 2845–2867. https://doi.org/10.1007/s11098-022-01804-7

Kingstone, A., & Gazzaniga, M. (1995). Subcortical transfer of higher order information: More illusory than real? *Neuropsychology*, *9*, 321–328. https://doi.org/10.1037/0894-4105.9.3.321

Lockwood, M. (1989). *Mind, brain and the quantum*. Blackwell Publishers.

Lockwood, M. (1994). Issues of unity and objectivity. In C. Peacocke (Ed.), *Objectivity, simulation, and the unity of consciousness* (pp. 89–95). Oxford University Press.

Marks, C. (1981). *Commissurotomy, consciousness and unity of mind*. MIT Press.

Michel, M., & Lau, H. (2021). Is blindsight possible under signal detection theory? Comment on Phillips. *Psychological Review*, *128*, 585–591. https://doi.org/10.1037/rev0000266

Nagel, T. (1971). Brain bisection and the unity of consciousness. *Synthese*, *22*, 396–413. http://www.jstor.org/stable/20114764

Nagel, T. (1974). What is it like to be a bat? *Philosophical Review*, *83*, 435–450. https://doi.org/10.2307/2183914

Oliveira, F., & Ivry, R. (2008). The representation of action: Insights from bimanual coordination. *Current Directions in Psychological Science*, *17*, 130–135. https://doi.org/10.1111/j.1467-8721.2008.00562.x

Parfit, D. (1971). Personal identity. *The Philosophical Review*, *80*, 3–27. https://doi.org/10.2307/2184309

Phillips, I. (2021). Blindsight is qualitatively degraded conscious vision. *Psychological Review*, *128*, 558–584. https://doi.org/10.1037/rev0000254

Pinto, Y., de Haan, E., & Lamme, V. (2017). The split-brain phenomenon revisited: A single conscious agent with split perception. *Trends in Cognitive Sciences*, *21*(11), 835–851. https://doi.org/10.1016/j.tics.2017.09.003

Pinto, Y., Neville, D., Otten, M., Corballis, Lamme, V., & De Haan, E. (2017). Split brain: Divided perception but undivided consciousness. *Brain*, *140*, 1231–1237. https://doi.org/10.1093/brain/aww358

Pinto, Y., Villa, M., Siliquini, S., Polonara, G., Passamonti, C., Lattanzi, S., Foschi, N., Fabri, M., & De Haan, E. (2023). Visual integration across fixation: Automatic processes are split but conscious processes remain unified in the split-brain. *Frontiers in Human Neuroscience*, *17*, 1278025. https://doi.org/10.3389/fnhum.2023.1278025

Prevosto, V., Graf, W., & Ugolini, G. (2010). Cerebellar inputs to intraparietal cortex areas LIP and MIP: Functional frameworks for adaptive control of eye movements, reaching, and arm/eye/head movement coordination. *Cerebral Cortex*, *20*, 214–228. https://doi.org/10.1093/cercor/bhp091

Reuter-Lorenz, Nozawa, G., Gazzaniga, M., & Hughes, H. (1995). Fate of neglected targets: A chronometric analysis of redundant target effects in the bisected brain. *Journal of Experimental Psychology: Human Perception and Performance*, *21*, 211–230. https://doi.org/10.1037/0096-1523.21.2.211

Rosina, A., & Provini, L. (1984). Pontocerebellar system linking the two hemispheres by intracerebellar branching. *Brain Research*, *296*, 365–369. https://doi.org/10.1016/0006-8993(84)90075-1

Savaki, H., Kennedy, C., Sokoloff, L., & Mishkin, M. (1993). Visually guided reaching with the forelimb contralateral to a "blind" hemisphere: A metabolic mapping study in monkeys. *The Journal in Neuroscience*, *13*, 2772–2789. https://doi.org/10.1523/jneurosci.13-07-02772.1993

Savaki, H., Kennedy, L., Sokoloff, L., & Mishkin, M. (1996). Visually guided reaching with the forelimb contralateral to a "blind" hemisphere: Contribution of the cerebellum. *Neuroscience*, *75*, 143–159. https://doi.org/10.1016/0306-4522(96)00258-8

Savazzi, S., Fabri, M., Rubboli, G., Paggi, A., Tassinari, C., & Marzi, C. (2007). Interhemispheric transfer following callosotomy in humans: Role of the superior colliculus. *Neuropsychologia*, *45*, 2417–2427. https://doi.org/10.1016/j.neuropsychologia.2007.04.002

Schechter, E. (2014). Partial unity of consciousness: Evidence and implications. In D. Bennett & C. Hill (Eds.), *The unity of consciousness and sensory integration* (pp. 347–373). MIT Press.

Schechter, E. (2018). *Self-consciousness and split-brains: The minds' "I"*. Oxford University Press.

Schechter, E., & Bayne, T. (2021). Consciousness after split-brain surgery: The recent challenge to the classical picture. *Neuropsychologia*, *160*, 107987. https://doi.org/10.1016/j.neuropsychologia.2021.107987

Shabasson, D. (2022). Illusionism about phenomenal consciousness: Explaining the illusion. *Review of Philosophy and Psychology*, *13*, 427–453. https://doi.org/10.1007/s13164-021-00537-6

Sidtis, J., Volpe, B., Holtzman, J., Wilson, D., & Gazzaniga, M. S. (1981). Cognitive interaction after staged callosal section: Evidence for transfer of semantic activation. *Science*, *212*, 344–346. https://doi.org/10.1126/science.6782673

Sperry, R. (1968). Hemisphere deconnection and unity in conscious awareness. *American Psychologist*, *23*, 723–733. https://doi.org/10.1037/h0026839

Tamietto, M., Cauda, F., Corazzini, L., Savazzi, S., Marzi, C., Goebel, R., Weiskrantz, L., & de Gelder, B. (2010). Collicular vision guides nonconscious behavior. *Journal of Cognitive Neuroscience*, *22*, 888–902. https://doi.org/10.1162/jocn.2009.21225

Trevarthen, C., & Sperry, R. (1973). Perceptual unity of the ambient visual field in human commissurotomy patients. *Brain*, *96*, 547–570. https://doi.org/10.1093/brain/96.3.547

Tye, M. (2003). *Consciousness and persons: Unity and identity*. MIT Press.

Ungerleider, L., & Mishkin, M. (1982). Two cortical visual systems. In D. Ingle, M. Goodale, & R. Mansfield (Eds.), *Analysis of visual behavior* (pp. 549–586). MIT Press.

Wahl, M., Lauterbach-Soon, B., Hattingen, E., Jung, Singer, O., Volz, S., Klein, J., Steinmetz, H., & Ziemann, U. (2007). Human motor corpus callosum: Topography, somatopy, and link between microstructure and function. *Journal of Neuroscience*, *27*, 12132–12138. https://doi.org/10.1523/JNEUROSCI.2320-07.2007

Wu, W. (2020). Is vision for action unconscious? *The Journal of Philosophy*, *117*, 413–433. https://doi.org/10.5840/jphil2020117826

Zaidel, E., Zaidel, D., & Bogen, J. (1990). Testing the commissurotomy patient. *Neuropsychology Neuromethods*, *17*, 147–201. https://doi.org/10.1385/0-89603-133-0:147

Zapparoli, L., Seghezzi, S., Scifo, P., Zerbi, A., Banfi, G., Tettamanti, M., & Paulescu, E. (2018). Dissecting the neurofunctional bases of intentional action. *Proceedings of the National Academy of Science*, *115*, 7440–7445. https://doi.org/10.1073/pnas.1718891115