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A Case of Shared Consciousness

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Abstract

If we were to connect two individuals' brains together, how would this affect the individuals' conscious experiences? In particular, it is possible for two people to *share* any of their conscious experiences; to simultaneously enjoy some token experiences while remaining distinct subjects? The case of the Hogan twins—craniopagus conjoined twins whose brains are connected at the thalamus—seems to show that this can happen. I argue that while practical empirical methods cannot tell us directly whether or not the twins share conscious experiences, considerations about the locality of content processing in the brain entails that they most likely do so.

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1. Introduction

It is sometimes supposed that were we to connect two brains together we could fuse the individual minds associated with those brains. Derek Parfit (1971: 18-19) famously outlines a thought experiment in which brain halves are removed from the bodies of two individuals and then joined within a new body. Parfit wonders whether there would be struggle between the two brain halves—for instance whether one pre-fusion individual's opinions would come to dominate the other—or whether they would reach some sort of compromise. Yet the basic idea that a singular mind would result is assumed. Similar assumptions abound in the personal identity literature (e.g. Lewis 1976; Unger 1990; Van Inwagen 1995; Dainton 2008; Hershenov 2013, see also Churchland 1981: 88).

Although Parfit's thought experiment is simplistic, neurologically speaking, it is by no means crazy to suppose that a sufficient degree of connection between brains would result in a unified set of conscious experiences. After all, if single brains are sufficient for consciousness, they manage to achieve unity by means of what is basically a large network of neural connections. Whatever allows this network to achieve a unified consciousness should in principle be achievable with a larger network made up of two brain masses.

One possibility that is rarely explored, however, is whether neural connection can result in *shared consciousness*. By shared consciousness, a mean a case where neural connection falls short of bringing about either a singular subject of experience or a wholly unified consciousness. Rather, the conscious experiences of two subjects overlap or fuse such that there are some single token experiences that both simultaneously possess. If this is indeed possible, the identity of an experience would be disassociated from the identity of the subject bearing that experience. Instead, experiences could be possessed by multiple people and still count as individual experiences. One interesting consequence of this may be to undermine experiential scepticism—the question of how I know that my experience of something has the same character as your experience of something—since it would allow that some of our experiences are one and the same. Besides this, the possibility of shared consciousness would force us to consider just how much neural connection is required to bring about a unified consciousness—an issue of relevance to the split-brain debate. The degree of connection that allows some experiential contents to be co-present for a subject does not automatically entail a wholly unified consciousness (more on this later).

As it happens, there may be a real case of shared consciousness in the world right now. Tatiana and Krista Hogan are craniopagus conjoined twins- that is, they are joined at the head. What makes Tatiana and Krista unique is that their brains are connected by a thin band of neural tissue. This tissue connects to each girl's thalamus, and so has been labelled a 'thalamic bridge'. Observation of the twins indicates that information passes across this bridge.

The twins are becoming quite celebrated in the philosophical literature. Major references to them include Hershenov (2013) who uses their example to indict theories of personal identity, Langland-Hassan (2015) who uses them to challenge the immunity to error through misidentification (and accordingly the essential privacy of experience, cf. Roelofs 2019: 112 fn.21), and Montero (2017) who uses them to respond to the combination problem for panpsychism.

These philosophers generally infer from the example of the twins that it is possible for people to share some of their experiences without becoming a single subject, even if they could not share *all* of their experiences without becoming a single subject. Yet none of these philosophers is able to establish whether or not the twins really do share experiences. So we

can continue to doubt that it is really possible to share experience in the ways these philosophers suppose. What we need, and what this article aims to provide, is a more thorough examination of the twins' case that pays closer attention to the neurological details and the possibilities they afford.

The problem is that the twins' case displays all the usual messiness of real life. It may be the case that the twins enjoy, to a limited extent, genuinely shared experiences. But it is also compatible with virtually all possible behavioural observations and self-reports that, despite neural connection, the twins retain strictly distinct streams of conscious experience. As a result, to judge this case, it is necessary to appeal to a general principle concerning the neural correlates of consciousness: that conscious content is localised in the brain. Having argued for this principle, I will conclude that some of the twins' conscious experiences are most likely shared.

2. Observational details

Tatiana and Krista Hogan were born in October 2006. To someone facing the twins, Tatiana would be on the left, and Krista on the right. The twins are developmentally delayed but otherwise seem to achieve a reasonably normal level of mental and physical functioning in their everyday lives.[1] There has yet to be a thorough first-hand scientific report of their case published in the academic literature. Our primary sources remain several television documentaries and newspaper articles, the most detailed of which remains Susan Dominus' write up for the *New York Times* (2011). The lack of a peer-reviewed scientific report is regrettable, since television documentaries tend to cherry pick incidents for the sake of entertainment value. Nevertheless, the video recordings are highly valuable for capturing the nuances of the twins' behaviour. In the most recent Canadian Broadcasting Company documentary (Pyke 2017), the twins are also able to provide some experiential self-reports.

The most startling fact about the Hogan twins is that each is capable of reporting on inputs presented to the other twin's body. For example, while her own eyes are covered, Tatiana is able to report on visual inputs to both of Krista's eyes. Meanwhile, Krista can report on inputs to one of Tatiana's eyes. Krista is able to report and experience distaste towards food

[1] A clip of the children reading in the *Inseparable* documentary (Pyke 2017: 31.00-32.00) suggests a roughly 1st grade level of reading at the age of 10

that Tatiana is eating (the reverse has not been reported, but may also be true). An oft-repeated anecdote is that while Tatiana enjoys ketchup on her food, Krista will try to prevent her eating it (e.g. Pyke 2014: 15.15-16.00). Both twins can also detect when and where the other twin's body is being touched, and their mother reports that they find this easier than visual stimuli (Pyke 2017: 6.15-6.30). Transmission of auditory information is not reported, though this may be because it is harder to informally test.

With regards to motor control, the *Twin Life* documentary (Pyke 2014: 20.10-21.02) reports that fMRI imaging revealed that Tatiana's brain 'processes signals'[2] from her own right leg, both her arms, and Krista's right arm (the arm on the side where they connect). Meanwhile Krista's brain processes signals from her own left arm, both her own legs and Tatiana's left leg (again on the side where they connect). Each twin is able to voluntarily move each of the limbs corresponding to these signals (cf. Pyke 2017: 15.00-15.10). Of course, I use 'Krista's leg' or 'Tatiana's arm' in reference to ordinary human body plans for mere ease of expression; it is an open question to whom ownership of the limbs should be properly attributed. Yet the documentaries suggest that the twins are also capable of voluntary bodily control for all the limbs within their ordinary body plans. As their mother Felicia puts it, "they can choose when they want to do it, and when they don't want to do it" (Pyke 2017: 15.51-15.58). As such, control over some limbs (Krista's right arm, and Tatiana's left leg) seems to be bilateral.

The twins also demonstrate a common receptivity to pain. When one twin's body is harmed, both twins cry (e.g. Ryan 2014). Here, two incidents in the *Inseparable* documentary are particularly worthy of close scrutiny. At one point the twins experience a headache (Pyke 2017: 12.00-12.48). Though it is hard to tell from the clip, it appears to hit Tatiana first because Krista reports "my sister has a headache" but immediately afterwards the clip shows both twins expressing distress, including a precisely synchronized howl of pain. Later, when asked by an interviewer "who gets the headache- you or Krista?" Tatiana replies, "both of us, it's like… big" (while gesturing widely) (Pyke 2017: 12.35-12.40). A contrasting incident is where the twins fall while sledging, with Tatiana landing on her buttock. Krista later reports that it didn't hurt her, although she felt it, indicating a non-shared affective response.

[2] It is not specified in the documentary whether these are sensory signals, or motor signals, or both. However, given the observational evidence, it seems to be at least motor signals.

However, the mother also notes that both twins cried and Krista agrees that she was crying because her sister hurt her buttock (Pyke 2017: 28.45-29.15).

As indicated by the sledging incident, emotional responses are also reported to be synchronized. Indeed, there are no reports of *desynchronized* emotional responses. Their mother Felicia reports, "the emotions definitely are connected. When one feels angry, the other one automatically feels angry. And I've never seen one happy without the other being happy" (Pyke 2014: 28.17-28.27). It is noteworthy that their mother supposes that the emotion of one twin contagiously arouses the other (*Inseparable* 12.50-13.06). Perhaps she has observed delays in synchronization, but this cannot be discerned from the various reports or videos.

Finally, in the *Inseparable* documentary, the twins report that they talk to each other in their heads (Pyke 2017: 7.15-7.24). This had previously been suspected by family members (Pyke 2014: 8.40-8.58; Ryan 2014) due to signs of apparent collusion without verbalisation. Again it is regrettable that this report has not been scientifically confirmed. It could be tested by asking the twins to use inner speech to agree on any number between one and a thousand and then say the number out loud at the same time.[3] Even if the twins are able to use subtle bodily movements to communicate intentions, it would become increasingly improbable as a method to agree on numbers given a wide-enough range of numbers and strictly simultaneous report.

Overall it is clear that the twins can transmit or communicate a considerable range of cognitive information. Indeed, given that the twins connect at their thalami, this may not be surprising. We are not told at exactly what point the thalamic bridge connects to each twin's thalamus, yet the thalamus is generally known to serve as a hub for signals from all sensory modalities apart from olfaction (e.g. Usrey & Alitto 2015; Courtiol & Wilson 2015). Here it does not simply relay information, it also contributes some low level processing. The thalamus is also understood to play a key role in the sensation of pain (e.g. Ohara & Lenz 2003; Ab Aziz & Ahmad 2006; see Koelsch et al. 2015 for a meta-review). Note that researchers tend to distinguish sensory aspects of pain from its affective aspects (that is, the specifically unpleasant character of pain) which is sometimes associated with the posterior

[3] This particular observation is relevant for theories of self-knowledge such as Carruthers (2009), since it indicates that inner speech is being transmitted through the sensory hub of the thalamus. Thus it could support the claim that we listen to ourselves producing inner speech.

insula (e.g. Ibañez et al. 2010; Klein 2015). This could potentially explain why, when Tatiana hurt her buttock, Krista reported that although she felt it, it didn't hurt. However, if emotions are regularly being synchronized it seems likely that affective information is being transmitted as well.

3. Three Possibilities

While the twins' neural connection is sufficient to allow information initially processed in one brain to be passed to the other, this does not tell us how the girls' conscious experiences are related. Here we can recognize three broad possibilities: i) that the girls have one unified set of conscious experiences overall; ii) that the girls' sets of experiences are partially shared or; iii) that the girls enjoy two entirely distinct sets of experiences.

3.1 A single unified consciousness

The first, most radical, possibility of unity is unlikely, though surprisingly hard to decisively refute. Everyone around the twins takes it for granted that the twins are distinct individuals. They point to their different personalities and preferences; the twins even fight at times (though physical attacks hurt both). The twins show fluent use of individual pronouns contrasting with joint pronouns (though with some interesting occasional slips). It is also possible for one twin to sleep while the other is awake (Pyke 2017: 16.34-16.41).[4] Yet a sceptic could remark that none of these facts are sufficient to prove that the twins do not in fact possess a wholly unified consciousness. We cannot automatically infer from apparent distinctions in personhood to non-unified consciousnesses or vice-versa (this is one of the key arguments of Roelofs 2019). For instance, cases of dissociative identity disorder arguably involve distinct personalities (even capable of dispute), preferences, and pronoun usage, while maintaining a unified stream of conscious experience (e.g. Radden 2011; Langland-Hassan 2015). As for the sleep distinction, some animals are capable of sleeping in one brain half while the other remains awake.

The best evidence that the twins have distinct sets of conscious experience is cases where one twin takes herself to be capable of something that the other twin is not. For instance, if only the individual identifying herself as Krista can move her own legs, this indicates a distinction in the sense of agency. A distinct conscious experience most probably accompanies this

[4] This raises the fascinating question of whether the twins can access each other's dreams.

distinct sense of agency; that is, the feeling 'I am doing this' (e.g. Gallagher 2012). Could this be sceptically challenged? I suppose we might question what it is the twins understand when we ask "Tatiana, can you move these limbs?" It is conceivable that they understand it to mean something like, "is your Tatiana personality capable of moving this limb?" Yet this would be a rather far-fetched way to make sense of the twins' mental life. It's not impossible, but it's certainly not the default interpretation to take. Accordingly, I'm going to rule out the possibility that the girls possess a single wholly unified consciousness in the below discussion.

3.2 Partially shared consciousness

The second possibility—partially shared consciousnesses—is rather more plausible. On this model, there is a single token experience of say, Krista's cheek being stroked, yet Krista and Tatiana possess distinct sets of experiences overall. This model can be clarified by appeal to Bayne's (2010) notion of 'phenomenal unity'. Phenomenal unity is basically the kind of unity we enjoy when there is something it is like to experience one thing at the same time as experiencing another thing.[5] For instance, suppose Krista experiences the sensation in her cheek, while also experiencing a feeling of control over her left arm. Simultaneously, Tatiana enjoys the exact same token sensation in Krista's cheek, while also experiencing a feeling of control over her own right arm. On the sharing model, it is possible that neither twin experiences control over the other twin's 'outer' arm. Thus the twins have distinct phenomenal unities.[6]

According to the sharing model, whatever it is in cases of sharing that realises the conscious experience of some content for one twin does so for both twins. However, the sharing model allows that the shared experiential token could occupy quite different roles within the twins' overall mental economy, depending on what else they are experiencing at the same time. For instance, the tactile sensation could be at the centre of one twin's attention, while only pre-reflectively present for the other twin. Similarly, they could share the experiential part while taking different attitudes towards it, e.g. one twin could like the sensation while the other twin dislikes it (Hirstein 2012: 29 also raises this possibility when describing a hypothetical

[5] Bayne distinguishes phenomenal unity from representational unity (where experiential aspects are bound under a common representational content, such as the redness and roundness of a ball) and subject unity (where experiences are subject-unified just in case they occur to the same person).

[6] Montero (2017) appears to be defending a similar position on the twins' case, although she does not analyse this in depth.

case of neural connection). It may even be possible for one twin to recognize or understand the sensation while the other does not.

Here it may be objected that the sharing model ignores the way that contextual factors can impact the qualities of experience. For instance, we are familiar with experiences such as White's Illusion where areas of identical hue appear significantly lighter or darker due to the influence of surrounding colours (White 1979). At another level of mental organisation there are cross-modal effects where the same flash of light may be experienced as either a double flash or a single flash depending on whether the individual simultaneously feels a double or single tap (Violentyev et al. 2005). And at yet another level it is plausible that pleasant or unpleasant affect can deeply permeate sensory qualities (e.g. Bramble 2013) such that the same food may be experienced as possessing significantly different properties by the person who finds it disgusting and the person who finds it delicious. The lesson of these examples seems to be that experiential quality relies too much on the overall gestalt for isolated bits of experiential content to be truly sharable in the ways the sharing model demands.

While we can agree that contextual factors contribute deeply to overall experiential quality, this need not contradict the sharing model. What grounds the possibility of sharing is that an individual's overall conscious experience is made up of parts where these parts have intrinsic qualities of their own.[7] These intrinsic qualities make it the conscious part that it is. Consider the sound of a musical chord. We can imagine a case where the twins share their experience of the D note, where one twin hears it combined with an F# (thus a major third) and the other twin hears it combined with an F natural (thus a minor third). Although the resultant experiences differ overall, their experience of the D note has intrinsic qualities that contributes to the overall experiences. We can tell this because when we experience a chord, we can introspectively identify at least some aspect of the experience contributed by *that* note, which would be different if replaced by a different note. The sound of the note is experientially discriminable.

At the same time, it is fair to say that one conscious part cannot present in two conflicting ways and still count as one bit of conscious experience. So the sharing model is committed to

[7] Even Bayne, who thinks that conscious experience is necessarily phenomenally unified, agrees that conscious experience is made up of phenomenal parts (2010: Chapter Two). Here he argues against a more radically holistic view proposed by Tye (2003).

saying that the intrinsic qualities of a shared conscious part are not altered by contextual factors that are not also shared. Out of the above three examples, the latter two at least can be understood as retaining intrinsic qualities independently of context effects. That is, whether a light flashes once or twice can be mere misinterpretation or superimposed division of an experience that has some temporal duration. And whether a taste is disgusting or delightful can depend on the kinds of associations one makes, or the details that are foregrounded in attention, rather than its intrinsic flavour. What we should say about White's Illusion is less clear, but given the twins' access to each other's visual fields, their susceptibility to the illusion may be shared anyway.

Overall, sharing seems coherent and potentially able to make sense of our behavioural observations of the twins. Sharing may even describe the majority of cases in which the girls access stimuli to each other's bodies. It is also important to note that sharing bears a striking similarity to one of the positions in the split-brain debate. Typically, philosophers claim either that splitting the corpus callosum results in two streams of consciousness (e.g. Davis 1997; Tye 2003) or that the remaining sub-cortical connections are sufficient to retain a single stream of consciousness after all (e.g. Bayne 2010). But a third intermediate position is that consciousness can be partially unified (e.g. Lockwood 1989; Schechter 2014). The crucial feature of the partial unity model is that, like shared consciousness, it denies the transitivity of conscious unity. That is, even though an experience A is unified with experience B, and experience B is unified with experience C, experiences A and C need not be unified with each other.

There are definite attractions to the partial unity model. It can simultaneously explain apparent failures in inter-hemispheric conscious unity (e.g. in recognizing objects) while allowing for apparent conscious unity in other respects (e.g. in emotional content). Another attraction is that partial unity straightforwardly correlates the degree of conscious unity with the degree of neurophysiological unity. Yet the partial unity model is not popular (even Lockwood expresses doubts 1994: 95 and Schechter does not ultimately defend the position in her 2018 book).[8] It seems the evidence for maintained unity (e.g. in emotion) is not so

[8] A common charge against the partial unity model is that it is inconceivable—we cannot imagine what it would be like to have a partially unified consciousness (e.g. Bayne 2010: section 2.4). However, as Schechter (2014) points out, we similarly cannot imagine what it would be like to have two separate streams of consciousness. The whole point of both views is to give up the claim that there is a single subjective perspective. Another objection concerns indeterminacy: what could make it true that a subject had a partially unified consciousness as

clear that two-streams defenders cannot say that content has been duplicated instead. Meanwhile, defenders of unity (such as Bayne 2010) have found ways to accommodate apparent disunities anyway. Perhaps the Hogan twins can offer some support for the partial unity model. That is, if we accept sharing in their case, we may be more willing to consider partial unity in the analogous split-brain case. A crucial difference between partial unity and shared consciousness is that shared consciousness involves two persons rather than one. However if our focus is really on subjective perspectives and not subjects, the cases may be sufficiently analogous to support the possibility of partial unity.

3.3 Divergent consciousness

The main barrier to endorsing sharing is the plausibility of the third possibility, in which the twins enjoy entirely separate sets of conscious experiences.[9] I shall call this 'divergence'. Since the twins are reporting matching experiences (e.g. of seeing the toy), with the same physiological origin (e.g. originating in one token pattern of retinal activity), it is helpful to envisage two ways in which this could be realised.

The first way is that information is passed between the brains but conscious experience relating to that information only occurs after the point at which it is transmitted between brains. So for example, tactile information relating to being stroked passes through the early stages of Krista's tactile processing to her thalamus. At this point the path then branches. One processing stream projects through Krista's somatosensory cortex and then becomes conscious for Krista, while another processing stream crosses the thalamic bridge, projects through Tatiana's thalamus and somatosensory cortex and becomes conscious for Tatiana.

The second way may be understood as a kind of experiential contagion. Here Krista has a conscious tactile experience of being stroked, and then information correlated with this tactile experience is passed across the thalamic bridge, generating a replica of that conscious experience for Tatiana. Thus conscious experience of some content occurs for one twin prior to it occurring for the other twin. It may even be the case that the first girl's conscious experience causally influences the character of the second girl's experience. Nevertheless neither twin's experience, in whole or in part, is token-identical with the other. Thus strictly

opposed to two separate streams. This is directly parallel to the problem of distinguishing sharing from divergence that I develop in section 4.

[9] Langland-Hassan (2015) also contrasts these possibilities when discussing the twins' case.

speaking, in both sub-types of divergence, either twin could have the experience without the other twin having it at all.

4. The Problem

The key question we have regarding the twins can now be sharpened. When we think about cases such as Tatiana reporting on what is being shown to Krista's eyes, or when both girls report a headache happening for both of them, is it *ever* the case that sharing occurs, or should we always suppose that their experiences diverge?

Readers may well take one or other version of divergence to be the default interpretation. Sharing is quite a radical possibility after all. It flatly denies that experiences are individuated by the subject who possesses them. Like the partial unity model of split-brains, sharing also denies the transitivity of conscious unity (though sharing does not deny transitivity within subjects). Another interesting neurological issue concerns *where* exactly we suppose a shared experience to occur. I should note here that nothing about the models I have presented demands a materialist theory of consciousness. If property dualism is true, it is still possible that a token immaterial property is shared by both twins. Nevertheless, we will need to suppose some correlation between conscious experience and neural activity (which property dualists generally accept). So if sharing occurs, the correlated neural area must be located either in the thalamic bridge, or spread out across both twins' brains, or just in one twin's brain. In all of these cases, the shared bit of content must make use of neural areas extending beyond the individual brain, for at least one of the twins.

Of course the immediate vehicle of a person's experiences is normally the activity in their brain alone. Yet I see no principled reason to deny that functional neural connections capable of supporting the generation of conscious experience can be extended. Moreover, we must never forget that the twins are physiologically unique. Regardless of what brains are commonly adapted for, the twins' brains have, since gestation, adapted for their peculiar connection. Indeed the way that the twins have adapted to the thalamic bridge is an exemplary case of neural plasticity.

Another factor that may push our intuitions towards the sharing model is that some conscious content for the twins may be 'double-bodied' in the sense that either or both twins experience content as present to, or happening within *both bodies*. This may be case for their shared

headache, for instance; it feels to either twin that it is happening in both heads. Such experiences would display a radical extension of the way that an ordinary individual's experience presents in relation to that individual's body. This experiential extension may well correlate with neural extension. Whether content is ever double-bodied in this sense is not explicitly confirmed in any of the reports. However, where a twin experiences the other twin's foot being stroked (Pyke 2014: 18.27-18.40), or tastes food in the other twin's mouth (Pyke 2014: 15.30-15.52), it strongly indicates that their overall phenomenal set extends beyond the ordinary human body-plan.

So far we have isolated two main possibilities, sharing or divergence, but neither is obviously a default position. Indeed, here we must confront a deep problem: There seems to be no practical observation, test, or self-report from the twins that—independently of already knowing how consciousness is realized—could definitively establish that sharing rather than divergence ever occurs.

Let us suppose that both girls report similar content, for instance the sensation of pain in Krista's arm. To both girls, the sensation is immediate and vivid. This is enough to make sharing a definite possibility. But beyond this, no degree of similarity between the girls' self-reports will definitively establish sharing. It could simply be the case that more detailed features of the girls' experiences are being replicated. Suppose that the girls even report a matching sense of agency regarding an experience. For instance, each girl reports feeling that she personally directed attention towards the content, or recalled it, or imagined it. Again, it might be the case that the girls' mental agency is shared, or it might be the case that certain efferent cues that allow a person to identify a mental event as their own have been replicated between brains.

If self-reports cannot establish sharing or divergence, how about behavioural observations or tests? Recall that sharing is compatible with differences in attention, understanding and attitude. So both sharing and divergence are compatible with either the similarity of their behavioural responses, or their divergence. A better indicator of merging is if the girls act as a singular unit, by say attending as a unit, or spontaneously producing speech as a unit. This would suggest that any conscious mental acts driving that behaviour are shared. However we would need to show that the singular behaviour wasn't in fact one girl acting for both bodies, and the other girl passively replicating the experience of acting.

Finally, could neural observations tell us anything? If similar self-reports of some bit of content could be correlated with neural activity in the two brains that is definitely *desynchronized*, then assuming that experiences are generally temporally coincident with neural activity, divergence seems likely (probably the contagion sub-type). But if neural activity is even roughly synchronized, this could allow that either sharing or divergence is occurring. That is, synchronized activity could be interpreted either as simultaneous processing of two type-identical contents, or else as one broad circuit of neural activity that correlates with a single token experience.

What if we could establish that while both girls are able to report on some sensory input, only one girl's brain shows activity in areas correlated with perceptual sensation? For instance, suppose that both girls report the experience of visual motion, while only one brain's V5 area in the visual cortex is active. This would certainly be highly suggestive of sharing. However, a sceptic may reply that one brain area simultaneously serving both girls' experiences may yet branch into two distinct interactions with distinct areas of each girl's brain. Perhaps the conscious experience is only realised with the addition of these distinct interactions, and thus divergence is supported. Indeed, to establish any conscious experience requires both girls' self-report. So there must be at least some activity happening in both girls' brains that allows them to make these reports. The sceptic could thus appeal to this distinct activity as the basis of divergent conscious experiences. Indeed, this picture of divergence resembles certain models of consciousness in which executive areas in the prefrontal cortex need to 'access' content in perceptual processing zones.[10] I will return to this idea later.

Now if neither observation nor self-report is able to differentiate sharing from divergence, we may start to doubt whether the two models are in fact meaningfully distinct. However, our problem here is largely due to practical limitations rather than any metaphysical indistinguishability between the two models. In principle, for any piece of purported shared content, we could try to alter the intrinsic qualities of one girl's experience of that content without altering the intrinsic qualities of the other girl's experience. If this can be done then

[10] Access consciousness is often linked with activity in the prefrontal cortex. See e.g. Lamme (2004), who argues for a neural distinction between access and phenomenal consciousness).

divergence is true, and if it cannot be done, then sharing is true.[11] Yet for this to be a fair test, we would have to be sure that it is only the intrinsic character of the experience that is being manipulated and not some contextual feature, or the more general capacity for self-report. Thus to even attempt such a test would require a fineness of control over the neural correlates of experience that is unavailable to current neuroscience (and overly invasive besides).

At any rate, we lack empirical ways to directly establish whether or not the girls' experiences are shared or diverge. Accordingly, it may seem pointless for us to discuss this case. However, I believe we can make definite progress on this issue by considering more general principles about the relationship between neural activity and conscious content. In the following section I will argue that a principle regarding the locality of conscious content entails that the twins' consciousnesses are very likely to be shared, at least in some cases.

5. Locality of Content

The initial argument in favour of locality is the quite familiar denial of a specific convergence zone in the brain at which all consciousness occurs (e.g. Dennett 1991; Damasio 1992; Hardcastle 2017). Neuroscientists have never found such a site, and have no expectation of ever finding one. Thus it does not seem to be the case that the brain unconsciously processes content and then shuttles all that information to some special area where it is then made conscious. Instead it appears that the neural correlates of consciousness are widely distributed across the brain.

A natural way to develop this claim is that conscious content occurs at the location at which content is processed. Of course, this processing typically involves several stages. For instance, visual content has stages, localised at different points in the brain, at which various details are discriminated or organised (colour, edges, depth, motion etc.). But we may say that consciousness of each of those details occurs at the location at which the detail is processed. For instance, consciousness of the raw sensory features of colour should occur at the location where raw colour is discriminated. It is not the case that raw colour content is replicated again and again as the image goes through its various processing stages, and only at one of the higher processing locations, when all the details are present, does conscious

[11] The same argument seems to refute the indeterminacy objection to the partial unity model of split brains. The possibility of differentially manipulating common experiences is a clear way to distinguish partial unity from two-stream views.

colour occur. There is no location where the entire picture is put together. That would be a convergence zone. The final conscious picture, in so far as there is one, is distributed across the relevant parts of the visual system.

I should emphasise here that we are focused on the *spatial location* of consciousness (or its most immediate neural correlates), not its time or causal profile.[12] So we are not committed to saying that at the moment content reaches an initial stage of processing it is already conscious. That would be incompatible with the various evidence we have for unconscious perception (see e.g. Prinz 2012: 80-84 for a review). Instead, there seems to be some process or operation that makes content conscious. What we are saying is that the consciousness-making process does something to the different stages of content processing to make that processing conscious. Thus the neural correlates of a bit of conscious content are spatially local.

There is an issue of just how far into the early stages of sensory processing the consciousness of content is supposed to extend. For instance, would visual consciousness extend as far as the initial activity in the retinal ganglion cells? Since we have not yet identified how consciousness occurs, I do not think we are in a position to answer this question. We are certainly not obliged to say that it extends all the way to the retina, though I am not implacably opposed to this idea.

Before dealing with further criticisms of this model, let us first outline how it suggests that the Hogan twins' consciousnesses are shared. To make the strongest case, I want to appeal to stages of neural processing that are both shared by the twins and which process significant aspects of content. Thus instead of focusing on visual consciousness, where most stages of discrimination occur in the cortical areas of V1-V5 following the thalamus (see e.g. Koch et al. 2016), I will focus on pain, which is widely agreed to have key processing stages both prior to, and including the thalamus, in addition to the somatosensory cortex after the thalamus.[13] I do not believe this to be a necessary condition on sharing. We generally understand neural processing to be realised by recurrent circuits rather than linear paths.

[12] Though note that Dennett would deny even this spatially distributed model, since he believes that the consciousness of content has no 'finish line' in the brain, either or spatially or temporally.

[13] See sources cited at the end of section 2. There is also a case reported by Ploner et al 1999 in which a patient, following damage to his somatosensory cortex was unable to locate the sensation of pain in his arm, while still able to report an unpleasant sensation 'somewhere between his shoulder and hand'.

Hence post-thalamic processing should be in reciprocal communication with thalamic stages and thus available to both twins. Nevertheless, it supports the plausibility of sharing when the pathway from one twin to other already includes stages responsible for processing significant aspects of content. It is moreover notable that the twins automatically experience pains simultaneously, while visual content seems to require definite effort to 'tune in' (Dominus 2011, cf. Ryan 2014).

Consider the case where Tatiana senses damage in Krista's right arm. Processing of this content up to and including the thalamic level already occurs in Krista's brain prior to it being passed to Tatiana's brain. Indeed, Tatiana must access that processing if she is to receive the input at all.[14] Then since conscious content occurs at this location of processing, there is one conscious content that is accessed by both twins. Thus the aspects of conscious content up to, and including, the thalamic level of processing should be identical for the twins. Meanwhile, locality allows that conscious aspects requiring post-thalamic processing may be divergent for the twins (including aspects like pinpointing the location on the body, conceptual recognition, and the reflective planning of responses). Still, locality entails that the girls' pain consciousnesses are significantly shared.

This is a remarkable claim. Yet before we get too excited, we must first consider a significant worry. There is an ongoing debate regarding the locality of the consciousness-making process, and several different positions can be discerned, all of which are compatible with the denial of a specific convergence zone. On one side we have philosophers like Jon Opie and Gerard O'Brien (1998; 2000, cf. the neurologist Samir Zeki 2007), who argue that consciousness-making processes are widely distributed across the brain, and individual areas in the brain can make content conscious independently of consciousness-making processes operating elsewhere in the brain. On the other side we have philosophers like Tim Bayne (2010), who argue that consciousness is a thoroughly holistic process. That is, while we may be able to analyse conscious experience in terms of various experiential parts, these parts only become conscious as a group. There are also positions intermediate between these 'atomistic' and 'holistic' alternatives. A representative example is Jesse Prinz (2012), who argues that consciousness occurs once perceptual content is integrated at a fairly high level of

[14] The pre-thalamic stages of Tatiana's pain processing system may also be active but they need not be (this should be possible to confirm with current neural imaging).

organisation and then made available to the working memory (commonly associated with the dorsolateral prefrontal cortex). Prinz allows that there are several circuits of such processing, so there can be independent consciousness-making processes occurring simultaneously at different areas in the brain.

Opie and O'Brien's theory of consciousness appears to be conducive to the claims about the locality of content made earlier, but the other two theories appear not to be. The challenge that Bayne's and Prinz's models present is that processing up to and including the thalamic stage may be incapable of sustaining the consciousness of any content at all. Indeed, Prinz specifically claims that the consciousness-making process depends upon interactions with stages of perceptual processing that are further along than the thalamus. Accordingly, Bayne's and Prinz's models both seem to resemble the picture of divergence that I outlined earlier. They may argue that, although the twins share their non-conscious processing of content, the consciousness of this content cannot be shared because consciousness depends upon wider interactions in the brain, and these wider interactions are not shared by the twins.

If determining whether or not the twins share experiences requires that we firmly adjudicate this debate between competing theories of consciousness, each of which has been meticulously defended, it will simply not be possible to achieve this here. Fortunately it does not. What we need to do is distinguish between the spatial location of conscious content (or its neural correlates) and the processes responsible for making a bit of content become conscious. Even if it were the case that the consciousness-making process depended constitutively on processes happening at a late stage of cognitive processing, or on operations occurring across the whole brain, this would not entail that the *conscious content* is located at the late stage, or across the whole brain.

To be clear, the foregoing distinction does not entail that conscious content must occur locally either. The point is that it's a separate argument to establish the location of content. To establish the locality of content, what we need to argue is that making content conscious does not, in general, require replicating content in areas not shared by the twins. For instance, pain content does not need to be copied over to the late somatosensory areas or to the working-memory from the early stages. Rather, for each aspect of the content that is made conscious, there is typically one location responsible for that aspect.

Why should we think this? One general theoretical consideration is that replication of content would entail massive redundancy in the processing of content. Any content that is replicated would entail that one or more areas can potentially be bypassed to achieve awareness of that content. Redundancy is not impossible, and is sometimes desirable as an engineering principle, but it is in tension with our understanding of evolutionary development. Nature is a tinkerer rather than a designer. It is more apt to make re-use existing processes (i.e. initial stages of content) than replicate them. This principle is defended in depth with supporting neural evidence by Anderson (2010).

Another general consideration is just the reiteration that there is no specific convergence zone in the brain. If content needs to be replicated, it is unclear where this would end. Perhaps each stage of processing needs a new copy of the content. But the more that later stages function as complete pictures of content, the more these later stages would correspond to a convergence zone.

Besides these points, the fact that our awareness of different aspects of content can be both disrupted by damage to specific sites, and generated by the micro-stimulation of specific sites in the brain (including thalamic and pre-thalamic areas) suggests that these specific sites are where the conscious content occurs. Indeed, the whole thrust of neuroscientific research depends on associating specific sites with the sensitivity to specific aspects of content. Even if those specific sites are only necessary rather than sufficient for the consciousness of that content, it is still the most plausible interpretation of these observations that the distinct content is directly correlated with the distinct location.

Of course, damage to earlier stages can have downstream effects on processing at later stages. We do not have to deny that the consciousness of a certain aspect may depend upon receiving the outputs of earlier stages processing. But the nature of this ‘output’ is unlikely to be replicated content. It is more likely to be signals about what has been done at earlier stages.

So my argument is that if content tends not to be replicated, there is typically a singular site where each aspect of conscious content occurs, regardless of the location of the consciousness-making process. Any specific site can therefore be the immediate basis for some bit of conscious content for both Hogan twins simultaneously. In particular, there are sites on their shared neural pathways that realise conscious content.

Yet here another worry may arise. Suppose (as Bayne, Prinz, and many others claim) that consciousness depends upon a kind of communicative interaction between a content processing area and other areas in the brain (i.e. the possibility that I raised in section 4). For instance, let's assume that consciousness depends on some kind of synchronization between the temporal pattern of neural activity in the content processing area and activity in executive areas. Wouldn't this mean that one twin could become conscious of some bit of content—because it synchronizes with some other area in her brain—while the other twin is not conscious of that bit of content, because it is not synchronizing with the respective executive area in her brain? But if so, wouldn't this contradict the claim of the sharing model that there is one vehicle for the conscious bit of content for both twins?[15]

Actually, I think the sharing model can allow this possibility. The claim of sharing is that when one twin is conscious of stimuli that the other twin is also conscious of, then the conscious content is shared. It does not demand that the twins are always mutually accessing stimuli. Indeed, as I mentioned above, there are hints in the observational data that the twins need to deliberately 'tune-in' when they access each other's sensory inputs, at least for visual stimuli. Perhaps this extends to nociceptive sensations as well. Pains tend to intrude upon our consciousness. Yet it is conceivable that one twin could neglect a mild pain that the other twin focuses upon. This need not contradict the claim that when both twins focus on the pain content, it is a genuinely shared experience.

Now the sceptic may retort that if consciousness depends on interaction patterns between the shared area and other areas that are distinct for the twins, then the conscious experience itself is not shared (the same objection could arise within Baar's 1988 global workspace view, since the twins do not share the same global workspace). But even if integration with other activity is a feature of consciousness that the twins do not share, the essential part of the

[15] There is another version of this objection according to which a content area accessed by both twins is somehow communicating with each twin in a distinct way simultaneously. For instance, Prinz appeals to synchronized rhythmic activity across neural populations. Perhaps one subset of the neural population is communicating with one twin, while another subset communicates with the other twin. We lack the fineness of resolution to tell that this is not occurring. Effectively, the objection here is that the twins are not really accessing the very same processing stages. I think all we can say in response is that we have no reason to believe it is even possible for a neural population to consciously process a single aspect of content while simultaneously adopting two distinct synchronisation patterns. The suggestion is merely an ad hoc way to defend divergence, in contrast to a simpler picture in which one pattern of neural activity in the content-processing site is able to contribute to both girls' consciousnesses.

experience—its phenomenal character—is shared. If not, such theories of consciousness are once again asserting of replication of content—now occurring 'in' the interaction somehow. Again, there are reasons to deny that this occurs. First, note that this interaction model relies on the claim that a certain area of the brain processes some specific bit of content unconsciously, and then the right kind of interaction is required for that content to become conscious. As such, to say that the conscious content is 'in' the interaction is to suggest that content must be redundantly in both the original content area and in the interaction. Second, we have absolutely no support for a model of neural signalling that treats it like a television transmission of data between a transmitter and receiver. All indications are that the extent of the interaction is one of synchronization or simple reciprocal stimulation. Thus the interaction itself does not have the distinct qualities that could plausibly make it the carrier of distinct content.[16]

Another way to put my argument is that I am making a distinction between conscious content and the 'consciousness of' (or 'awareness of') relation, and then claiming that conscious content can be shared even if the conscious-of relation is not. This broadly corresponds to Block's well-known distinction between access-consciousness and phenomenal consciousness (1995). To be conscious-of p, or for p to be access-conscious may involve a level of wider integration or higher-order activity, the vehicle of which may or may not be distinct for the twins.[17] But even if it is, this is not the whole of a conscious experience. On the contrary, the conscious content is the more crucial part. For without this there is no phenomenal character, no what it's likeness at all. Meanwhile, theories that make use of higher-order functions often define consciousness as the *availability* or preparedness for the integration or higher order reference (e.g. Prinz 2012, Carruthers 2019), allowing that something is conscious even if it is not right this moment being consumed by the wider

[16] On the basis of the neural evidence, the same conclusion that content is not replicated in the frontal executive areas is drawn by Hirstein (2012: 88-89; cf. 29; cf. Prinz 2012: 101-102), though Hirstein believes that the frontal areas are the basis of the self which reflects on conscious content (e.g. 2012: 22-24). Note that if the executive area with which content processing sites are supposed to interact is supposed to replicate that content, then this would simply be another version of a specific convergence zone, and is contradicted by the neural observations.

[17] It may be the case that the twins share consciousness in this sense in addition to sharing conscious content though it would require a very careful articulation of just what the relevant function involves. For now I merely point out that the twins seem to collaboratively manage their shared conscious content, as when they use it to fluently move around, or jointly attend to their pain. Depending on how exactly the function is articulated, perhaps even listening to each other's inner speech counts as shared integration of conscious content, or higher-order reference to it.

system. Such approaches put the emphasis on the conscious content itself as the essential feature of consciousness.

Admittedly, if you think consciousness is *entirely* the function of globally integrating contents (an extreme version of the global workspace theory) then this would automatically rule out the possibility of shared consciousness. Similarly, if you think consciousness is entirely the function of the whole person or subject enjoying the contents, then again sharing is automatically ruled out, because the twins are two distinct subjects. However, the principle of locality I have articulated here would put considerable pressure on such approaches; why hold on to them if intrinsic phenomenal content is localised? It is plausible that we should give a role, if not a decisive role, to intrinsic phenomenal content when offering a model of the essential features of consciousness. That is, when I want to explain consciousness, I'm *not* first and foremost trying to explain how we can report on a conscious experience, or fit it with other conscious experiences, I am first and foremost trying to explain phenomenal character.

6. Conclusion

Given the above arguments, I believe we can conclude that the twins probably share consciousness. At the very least, the empirical possibility of shared consciousness is now far more plausible. First, we know that each twin accesses processing stages in the other twin's brain, at least up to the thalamic level (otherwise they would not be able to report on inputs to the other body at all). Second, the neural evidence combined with the principle of locality establishes that some conscious content occurs in these processing stages. Thus both twins are accessing the same processing that (by whatever process) has been made conscious. And thus one bit of conscious content is contributing to two persons' conscious experiences.

Now all this is provisional upon scientific confirmation of the twins' capacities. However it is a very striking conclusion. Given the generality of the arguments presented in section 5, it is plausible that any time both twins can access an area of processing that realises conscious content, the twins' consciousnesses of that content should be shared.

It is not clear how wide-ranging are the contents shared by the twins. I focused on the case of pain because the girls' experience of pain is clearly synchronized and because pre-thalamic and thalamic areas play a major role in pain content. Thus a common path for pain processing

is an excellent candidate for the realising basis of a shared conscious experience. I suspect that the same applies to emotional consciousness, since a lot of this content also seems to be sub-cortically processed (see Koelsch 2015 for a meta-review). Still, it is also possible that all kinds of contents processed in their separate cortices may be shared by the twins, given that these areas generally have reciprocal connections with the thalamus and may thus be accessible to both twins. After all, the relatively minor structure of the corpus callosum is apparently sufficient to unify content processed in different halves of the individual cortex. In each case, what we would need to show is that, for *both* girls, a *single* (i.e. not replicated) neural area is necessary for discriminating a bit of conscious content.

The twins provide an important 'proof of concept' that connecting up two separate brains could result in the sharing of consciousness. Of course, the facts that the twins' brains have developed in tandem, and that they must coordinate virtually all of their activities must also have made a significant difference. Yet given the plasticity of the brain, it is feasible that, given a period of mutual adjustment and coordination, ordinary separate individuals could come to share consciousness in a similar way.

The twins show us that sharing is possible, but what would it take to fully merge two distinct consciousnesses? Again, the argument of section 5 implies that consciously accessing the content discriminating processes occuring in another brain is sufficient for literal sharing. We might thus extrapolate that consciously accessing all the content processing occurring in another brain would generate a singular consciousness. It does not even matter if two (or more) consciousness-making processes are in operation. What matters is the mutual accessibility of the content that is made conscious.

Finally, the twins offer us a unique opportunity to investigate the mechanics of consciousness sharing and conscious unity, should they be willing to engage with scientists as they grow older. I have argued that brain scans and self-reports cannot independently establish whether or not the twins share consciousness. But if the theoretical arguments presented here hold water, then the potential of these observations to reveal the mechanics of shared consciousness are unlocked.[18]

[18] Thanks to Philip Gerrans, Jon Opie and the two anonymous referees of this journal for their comments on earlier versions of this paper.

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