Mindmelding
Consciousness, Neuroscience, and the Mind's Privacy

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Great Clarendon Street, Oxford OX2 6DP

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
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Oxford New York

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Kuala Lumpur Madrid Melbourne Mexico City Nairobi
New Delhi Shanghai Taipei Toronto

With offices in
Argentina Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan Poland Portugal Singapore
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Published in the United States
by Oxford University Press Inc., New York

First published 2012

British Library Cataloguing in Publication Data
Data available

Library of Congress Cataloging in Publication Data
Data available

Typeset in Minion by Cenveo publishers services
Printed in Great Britain
on acid-free paper by
CPI Group (UK) Ltd, Croydon, CR0 4YY

ISBN 978–0–19–923190–4

10 9 8 7 6 5 4 3 2 1

Chapter 9

Sharing conscious states

Introduction

The separation between those brain processes that embody our conscious representations and those that manipulate them and produce a sense of self appears to open up the possibility of one person experiencing the conscious representations of another. If conscious perceptual representations are located in the back of the brain, specifically, in the temporal and parietal lobes, and sense of self is generated by processes located toward the front, in the prefrontal lobes, what if we imagine connecting person A's temporal lobes to person B's prefrontal lobes? Could this produce a case where B has direct awareness of A's perceptual representations? Could this be done in a way that would produce a coherent conscious state for B? I think that this is a real possibility. Possible in what sense, however, since there are several ways that something can be possible. In the first section below, I will examine some of these ways and clarify exactly which of them I believe apply to mindmelding. But the heart of this chapter is a hypothesis about how exactly to achieve mindmelding. I have spoken vaguely about "connecting" one person's temporal lobes to another's prefrontal lobes, but connecting what to what, and how? The temporal lobes causally interact with the prefrontal lobes by way of fiber bundles that run underneath the cortical surface. This provides the perfect first experiment in mindmelding: "branch" those fiber bundles and run the other end into the brain of another person. No doubt many other connections and accommodations will need to be made, but I believe we are in the right neighborhood. I will offer evidence below that these bundles have close connections to consciousness, in that whatever affects them has immediate effects on consciousness. Then, before responding to several objections, I will look at another issue brought up by these experiments, the question of the relation between mindmelding and mindreading. Is mindmelding similar to mindreading? Does the existence of a mindreading system help us achieve mindmelding?

What sort of possibility?

The thesis I am defending in this book is that conscious states are not private. This means that it is possible for more than one person to experience the same conscious state. Mindmelding occurs when a person is aware of, or directly experiences, the conscious states of another person. There are several different meanings of the term "possible," and its opposite, "impossible," however. I need to clear about what I mean by claiming that mindmelding is possible, and what the pro-privacy theorists mean by claiming that it is impossible. We will see below that the current defenders of privacy are using "impossible" in at least two ways, so these need to be addressed. In the end though, we won't need to make distinctions here that are too fine, since my claim is that mindmelding is possible in all of the relevant senses.

Here are some senses in which the terms "possible" and "impossible can be meant:

1 It is **logically** impossible for A to experience B's conscious state. This is the sense of "impossible" in which square circles are impossible. Something is logically possible of it does not involve a contradiction

2 It is **unimaginable** (or inconceivable) that A could experience B's conscious state. Armstrong uses conceivability to argue against the idea that mindmelding is logically impossible, saying that:

> We can conceive of being directly hooked-up, say by a transmission of waves in some medium, to the body of another. In such a case we might become aware e.g. of the movement of another's limbs, in much the same sort of way that we become aware of the motion of our own limbs. In the same way, it seems an intelligible hypothesis (a logical possibility) that we should enjoy the same sort of awareness of what is going on in the mind of another as the awareness we have of what is going on in our own mind. A might be 'introspectively' aware of B's pain, although A does not observe B's behavior".
>
> (Armstrong, 1984, p.113)

This seems conceivable to me. The question is, though, how good is our sense of what is conceivable at tracking what is really possible? Could something be conceivable to us even though it involves a hidden contradiction? Mindmelding seems quite imaginable, and has been depicted several times in movies and fiction. The problem is that we also seem to be able to imagine perpetual motion, something declared by physicists to be impossible

3 It is **metaphysically** impossible for A to experience B's conscious state. Given the metaphysical nature of conscious states, mindmelding is simply ruled out, in this sense. It is impossible for one person to experience the conscious states of another in the same way that it is impossible for two objects to occupy the same place at the same time, or for there to be water that is not H2O (Kripke, 1971). Those philosophers, such as Searle and Nagel, who believe that we cannot separate our awareness of our conscious states from the conscious states themselves believe that mindmelding is metaphysically impossible. For them, conscious states must be tied to one and only one subject. Some dualists might endorse the idea of the metaphysical impossibility of mindmelding because they see conscious states as having a metaphysical nature that ties them necessarily to their owner. Most religious dualists, I suspect, would not endorse this though, since they believe that God has direct access to our thoughts

4 It is **analytically false** to say that A is experiencing B's conscious state. "Shared qualia" and "mindmelding" are analogous to "married bachelor" on this account. Wittgenstein might argue that the privacy of conscious states is a "grammatical"

principle, a claim governing the proper use of a concept, i.e., a logical-conventional claim. He says, for instance, that to say, "Only you can know if you are in pain" is not a truth of metaphysics, but an instruction for how to use the word "pain," comparable to "One plays solitaire by oneself" (Wittgenstein, 1955). Our concept of pain does not allow interpersonal experience of pain. But why should we take our word meanings as capturing the ultimate metaphysical nature of reality? We are fallible and there have been countless examples where our concepts needed correcting once we gained more information. If the internalist account of color described in Chapter 5 is correct, for instance, we were wrong in making it part of our concept of colors that they are on the surfaces of objects, or in light

5 It is **physically** impossible for A to experience B's conscious state. This sense of "possible" is indexed to our current theories in science. These theories tell us, for instance, that it is impossible for something to travel faster than the speed of light. If we could know for certain that one of our theories in physics were absolutely true, we could elevate it to a metaphysical principle. The laws of physics, if true, are metaphysical necessities (Kripke, 1971, 1977). What physics rules out, assuming it is correct in doing so, is metaphysically impossible

6 It is **extremely improbable** that we could allow A to experience B's conscious state. Sometimes when we say that something is impossible, this is what we mean. If I say that it is impossible for you to do 100 pull-ups, this seems to be the operative sense. Scientists are interested in what is physically possible, but they are typically much more interested in what is physically probable. Some of them who deny mindmelding may be thinking of this sort of possibility

7 It is **technologically** impossible for A to experience B's conscious state. As with physical impossibility, this type of possibility is indexed to the current state of our technology. We cannot build a car that can go 2000 miles per hour, or a drill that can bore to the center of the earth, for instance. One type of technological impossibility is based on the materials involved. Wood, for example, has very definite limitations, and simply is not a feasible material for some applications.

I am denying all of these claims. The only sense of "possible" that might not apply to mindmelding means something like "can be accomplished right here and now." The two meanings of "impossible" most frequently employed by those who claim privacy are metaphysical impossibility and physical impossibility, by philosophers and scientists, respectively. The consensus among philosophers seems to be that mindmelding is logically possible. In addition to Armstrong, Ayer (1963) argued decades ago that there is no logical contradiction in one person experiencing the mind of another. But I also think it is metaphysically possible. Even more than that, I believe it is possible given our current technology. The consensus position on the possibility of mindmelding or any breach of privacy is not that it is improbable, or impossible with our current technology, but that it is metaphysically impossible or physically impossible, in the same way that perpetual motion, or exceeding the speed of light is impossible.

How do we tell what is possible? We need to be clear about what exactly we are doing when we attempt to discern whether something is possible by attempting to conceive of it. We need to better understand how conceivability relates to metaphysical possibility. In general, conceivability is not a good guide to possibility.

*x is metaphysically possible if and only if x is conceivable.

There are counterexamples to both of the constituent conditionals. The first conditional, If x is possible, x is conceivable is subject to the following counterexamples: Conceivability is context-sensitive. Our current computers were not conceivable to people in the 1300s, but they are possible. The second conditional, that conceivability implies possibility is again subject to the counterexample of perpetual motion. Our abilities to conceive pull in two directions when it comes to accessing to the conscious states of others. Anyone who has ever introduced the idea of privacy to an introductory philosophy class knows that it invariably brings universal agreement. At least initially. One has only to remind them of the depictions of mind access in various films, such as the Vulcan mindmeld on *Star Trek*; the film *Futureworld*—in which a person's dream contents appear on a screen; or the film *Strange Days*, which depicts a device that can record and play sequences of conscious states, producing a black market in recordings of extreme experiences. More recently, the film *Inception* shows people mindmelding with dreamers to extract clues from their dream contents. I refer to these as mind access, because not all of them depict mindmelding. And depending on what exactly happens with the Vulcan mindmeld, perhaps none of them depict it. The device shown in *Strange Days* does not produce mindmelding, since two sets of conscious experiences are involved, one from the producer of the recording, and one in the mind of the person who re-experiences it.

Cleaving representations and executive processes

One way the alternative views presented here could fail would be if there simply was no clean break where two minds could be separated and reconnected, while still producing coherent inner mental lives for the subjects. In attempting mindmelding, one must break into brain circuits or processing streams and divert that processing into another brain. What one is breaking into is a perception–action cycle. Suppose we take a straightforward perceptual–motor response involving executive activity, say a subject responding during the Stroop test, quickly inhibiting the tendency to read the word and attending instead to the color and responding based on that. At some point between the instant that word is displayed on the monitor and the instant the subject's keypress registers, visual perceptual representations first come into contact with prefrontal executive processes. What we need to do then is find this point, and see whether there is a way to cleanly separate the perceptual representations and the executive processes.

Perhaps brain states are so thoroughly holistic and impossible to modularize, though, that what I'm suggesting here simply could not be done. Even if there is a flow from perception to higher cognitive areas, this flow might occur along so many diverse types of routes and at different rates that it is meaningless to speak of *the* place where perception can be cleaved from cognition. Contrary to this, there is one primary high-level stream of visual processing where a coherent separation can be made between the conscious visual percept, and prefrontal executive processes, I will argue. Crick and Koch affirm a fundamental distinctness between the two, based on the impression of a homunculus:

> The illusion of a homunculus inside the head looking at the sensory activities of the brain suggests that the coalition(s) at the back of the brain are in some way distinct from the coalition(s) at the front. The two types of coalitions interact extensively, but not exactly reciprocally.
>
> (2003, p.124)

The existence of two-phase theories of neurological phenomena such as confabulation (Hirstein, 2005) and delusion (Langdon and Coltheart, 2000) also supports the idea of a fundamental separability of executive processes from conscious representations. When a neurological patient confabulates about what he did yesterday, there are two separate stages of error. The first stage happens when one of the brain's knowledge domains, either perception or memory, produces an ill-grounded representation. Then a second error occurs: The patient fails to realize that the representation is ill-grounded and correct it. The first error is typically traceable to damage in the posterior portions of the cortex, while the second error can be traced to damage in a prefrontal executive area. Notice also how crucial the separation between the initial production of representations and their use by executive processes is to our conception of ourselves. We acknowledge, for instance, that people might consider doing all sorts of unethical and illegal things, while preventing themselves from doing them, thanks to our inhibitory executive processes. We tend to hold people legally responsible for executive failures, unless we have reason to believe that their executive processes are damaged (Hirstein and Sifferd, 2011).

White matter fiber tracts

We saw in Chapter 4 that the temporal lobes meet most if not all of the criteria for housing conscious states. If they really do house qualia, they would make a good target for thought experiments about mindmelding. We would first need to understand both their input and their output. We might imagine grasping the temporal lobes and slowly pulling them out away from the rest of the brain. Imagine that all of the connections between the temporal lobes and the rest of brain are able to stretch, so that as we pull the temporal lobes away, we begin to see them all. We would see connections to perceptual areas in the lateral and inferior temporal lobe, and mnemonic connections of all sorts originating in the medial temporal lobe. We are interested more in the sensory than the mnemonic functions of the temporal lobes, so our attention will be directed more at the lateral and inferior temporal lobes than at their mesial aspects. Those former connections there would include callosal connections via the corpus callosum and the anterior commissure. We would see specific thalamic input as well as non-specific thalamic input that would include inputs from the intralaminar nuclei, which we saw in Chapter 4 plays important roles in consciousness. Specific inputs to the thalamus run from the superior temporal gyrus, as well as the superior temporal sulcus via the lateral thalamic peduncle (a type of fiber tract) (Schmamann and Pandya, 2006). Another connection between the temporal and frontal lobes is in the form of a circuit involving the amygdala, the thalamic mediodorsal nucleus, and the orbitofrontal cortex. There are also neurochemical influences directed at the temporal lobes, affecting the different neurotransmitter systems. The temporal lobes also of course have a blood supply, something that would be very difficult to duplicate in mindmelding. Since A and B do not share their blood supply, this will eliminate any blood-borne influences, such as hormones.

Most importantly, we would see large bundles of fibers connecting the temporal lobes to the prefrontal lobes. Nature has provided the perfect structure to allow us to perform mindmelding thought experiments. The temporal and parietal lobes are extensively interconnected with the executive processes in the prefrontal lobes by several different white matter fiber tracts, called long association fibers (Schmahmann and Pandya, 2006). Filley (2001, p.23) observes that these fibers "share the interesting feature that they all have one terminus in the frontal lobe. No other lobe of the brain enjoys such rich connectivity. The white matter is therefore structurally organized to facilitate frontal lobe interaction with all other regions of the cerebrum." The recent development of a new type of magnetic resonance imaging called diffusion tensor imaging has made it possible to obtain clear and detailed images of white matter fiber bundles in both normal and abnormal brains (Basser et al. 1994). These bundles, also known as *fasciculi* are made up of millions of connecting fibers, which are axons protected by a sheath of myelin that serves as an electrical insulator. The myelin that insulates the fibers is white in color, and made up of 70% lipid (primarily cholesterol) and 30% protein (McLaurin and Young, 1995). The diameter of the axons themselves is from 0.2–20 micrometers, not including the myelin sheath that makes them substantially wider (Kandel et al., 2000). These fasciculi make up the major portion of what is known as the brain's white matter. Somewhere between 40–50% of the volume of the cerebral hemispheres is actually white matter (Miller et al., 1980).

The cortical areas linked by these fibers are composed of gray matter. As we have seen, cortical areas typically operate in networks linking areas that may be spatially widely distributed (see Mesulam 1981, 2000). The fasciculi thus form crucial parts of several of the brain networks described in Chapter 3. The white matter bundles are the "connecting tissues that link these areas into coherent neural assemblies" (Filley, 2001, p.14). They provide the connecting links, in both directions. The fiber pathways are also proving valuable guides, in that the anatomists can follow them to determine the constituent brain areas for a given network. Petrides and Pandya (2002), for instance, demarcate posterior cortical areas according to their targets in the prefrontal cortex. The causal flow within white matter tracts is unlike the orderly movement of electrical impulses along computer data transmission lines, those ribbons of gray wires that connect the different parts of the typical desktop computer. For one thing, there is causal flow in both directions (Filley, 2001). The axons that are bundled together to form these fasciculi (including commissural fibers) come primarily from layer III of the areas they originate from (Schmahmann and Pandya 2006, p.81). The pathways use the neurotransmitter glutamine primarily (White and Keller, 1989), and they are excitatory (rather than inhibitory) in both directions.

According to Barbas and Zikopoulos the excitatory pathways leading from perceptual areas to the prefrontal cortex "may underlie the selection of relevant information, such as focusing on the traffic lights at an intersection and taking appropriate action" (2007, p.533). The sensory information involved may be unimodal or multimodal (Petrides and Pandya, 2002, p.45). What about the excitatory connections running from prefrontal executive areas back to perceptual areas in the temporal and parietal lobes? The anatomists report two different types of connections, indicating perhaps two different functions: "At the synaptic level, the prefrontal to temporal pathways target, for the most part, dendritic spines of pyramidal neurons, which are excitatory" (Barbas and Zikopoulos, 2007, p.537). Recall from Chapter 4 that pyramidal neurons are mentioned frequently in the current research on the neural basis of consciousness. "In addition, a smaller but significant number of prefrontal axonal boutons synapse with dendritic shafts of inhibitory neurons in superior temporal cortices, both in the upper layers as well as the middle layers" (Barbas and Zikopoulos, 2007, p.537). Again, this part of the cortex is one of the most frequently-mentioned candidates for housing conscious states.

One clue to the function of these prefrontal-to-temporal connections is contained in the statement by Crick and Koch that "attention probably acts by biasing the competition among rival coalitions, especially during their formation" (2003, p.123). Both the prefrontal lobes (especially area 46) and the sensory cortices (such as most of the temporal lobes) project to the thalamic reticular nucleus. Barbas and Zikopoulos (2007, p.539) suggest that the widespread connections from area 46 to the thalamic reticular nucleus "may allow selection of sensory and other signals and suppress distractors at an early stage of processing." "The widespread prefrontoreticular projections," they say elsewhere, "may thus contribute to the supervisory and modulatory effects that specific prefrontal areas exert over other cortices" (Zikopoulos and Barbas, 2006, p.7359). Thus it is important to include these reticular projections of the temporal lobes among the causal routes that must be preserved to achieve mindmelding. They might, for instance, allow me to focus on another part of your conscious state from you.

As I noted, certain fasciculi terminate in multimodal areas thought to house conscious percepts.

We are especially interested in tracts emanating from multimodal areas that showed up in our survey of good candidate areas for housing conscious states in Chapter 4. Some of these fasciculi function to complete the ventral visual processing stream (see Chapter 3) which is a good candidate for housing our conscious focal vision. Most of interest to us, since they connect the temporal lobes with the prefrontal lobes, would be the cortical association bundles, specifically the temporofrontal association bundles. These include the superior longitudinal fasciculus, the inferior fronto-occipital fasciculus (also known as the inferior occipitofrontal fasciculus), and the uncinate fasciculus (Ungerleider et al., 1989). The inferior longitudinal fasciculus would be of less interest for mindmelding, since it runs the length of temporal lobe, rather than contacting the prefrontal lobes, and contains shorter association fibers. The occipital and inferotemporal cortex are connected via the inferior longitudinal fasciculus and the occipitotemporal fasciculus (see Figure 9.1).

Posterior parietal areas are connected to the prefrontal cortex by the superior longitudinal fasciculus. Petrides and Pandya divide it into three different branches they call

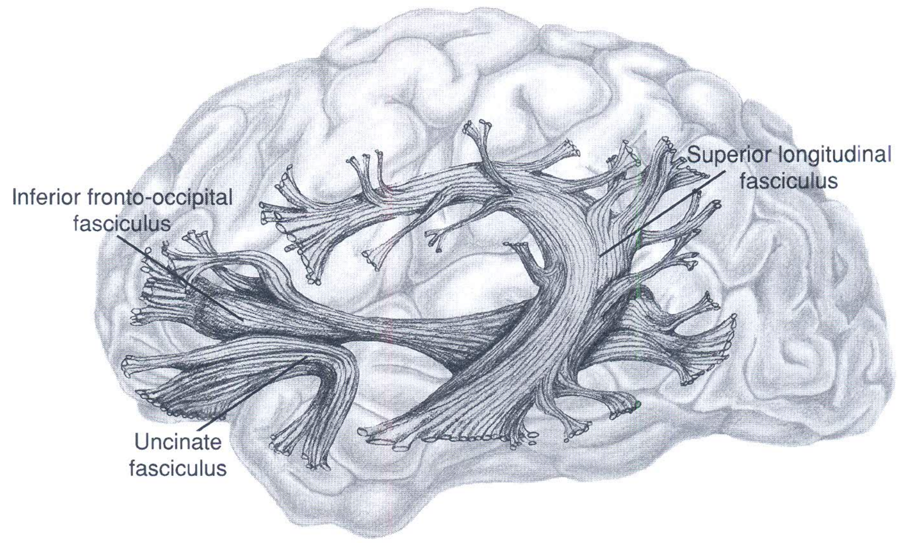

Fig. 9.1 Three fasciuli of interest for mindmelding experiments. These tracts connect the temporal and parietal lobes with the prefrontal cortex. Diagram by Katie Reinecke, after Kier et al., 2004.

SLF I, II, and III. Interestingly, what Schmahmann and Pandya call SLF III can be seen to be connecting PF with ventral area 6, two core parts of the mirror system. The inferior occipitofrontal fasciculus "appears to include fibers connecting the auditory (area 22), and visual (areas 20 and 21) association cortex in the temporal lobe with the prefrontal cortex" (Kier et al., 2004, p.688). We are also beginning to learn more about the exact functions of these connections: "Both the uncinate fasciculus and the inferior occipitofrontal fasciculus have a role in extratemporal lesions triggering temporal-lobe syndromes, such as visual hallucinations" (Kier et al. 2004, p.689). Feinberg (1994) reported three patients with inferior longitudinal (occipitofrontal) fasciculus damage who had difficulty recognizing objects and words but were able to recognize faces. The extreme capsule contains fibers that "connect the temporal and frontal lobes in addition to those of the arcuate fasciculus" (Damasio and Damasio, 1980). According to Schmahmann and Pandya (2006) the extreme capsule links Wernicke's area with Broca's area, not the arcuate fasciculus, as had classically been thought. Their diagram shows the extreme capsule connecting at its posterior end to the superior temporal sulcus.

The uncinate fasciculus is part of a larger trend of fasciculi that connect highly developed and multimodal sensory representations with the prefrontal cortex. It is "a monosynaptic corticocortical route of interaction between the temporal and frontal lobes" (Kier et al. 2004, p.688). It contains two-way, or what anatomists call afferent and efferent connections between the two areas (Kier et al. 2004). One of its specific connections runs between area 13 (as well as area 47/12o and 47/12l) to the rostral part of the superior temporal gyrus (Petrides, 2002, fig. 3-10). Anatomists have a good fix on exactly which cortical areas the uncinate connects:

> The ventro-medial fiber bundles [of the uncinate fasciculus] connect the uncus, cortical nuclei of the amygdala and the tip of the third temporal convolution with the gyrus rectus and subcallosal area. The dorso-lateral bundle connects the tip of the first and second temporal convolutions with the retro-orbital cortex lateral to the gyrus rectus.
>
> (Ebeling and Cramon 1992, pp.144–5)

Staining studies allow the anatomists to trace the fibers to determine exactly where they enter the recipient areas:

> Retrograde labeling after fluorescent dye injections of prefrontal cortex in these cases demonstrated that the inferior convexity and lateral orbital surface receive direct projections not only from inferior temporal cortex, but also from the anterior portion of the superior temporal cortex, the inferior parietal cortex, the cingulate cortex, and the insula. . .but only those fibers arising from the inferior temporal and anterior superior temporal cortex pass through the uncinate fascicle.
>
> (Ungerleider et al. 1989, p.483)

What do we know about the sort of signals traveling along the white matter tracts? "Highly processed sensory information in post-[central] areas is provided to the orbitofrontal cortical region via the uncinate fasciculus" (Petrides and Pandya, 2002, p.45). Surgical cutting of the uncinate fasciculus "effectively disconnects the prefrontal cortex from the inferior temporal cortex" (Eacott and Gaffan, 1992). "Transection of the uncinate fascicle deprives the prefrontal cortex of virtually all input from [temporal area] TE, but leaves intact inputs from prestriate and parietal visual areas as well as the amygdala" (Ungerlieder et al. 1989, p.473). The operation known as anterior temporal lobectomy, sometimes performed to reduce the severity of epilepsy, also severs the uncinate fasciculus. After undergoing this operation, patients can show "severe disturbances of memory and learning functions" (Ebeling and Cramon 1992, p.143). Kier et al. (2004, p.688) cite memory problems caused by uncinate disconnection: "Patients who undergo anterior temporal lobectomy have object and action naming deficits resulting from the disruption of frontotemporal connections mediated by the uncinate fasciculus" (Kier et al. 2004, p.688). My prediction is that such deficits involve consciousness. For instance in this case it might mean that the conscious representation of an object failed to connect in the right way with other processes capable of producing the object's name. "It appears that the impairment produced by section of the uncinate fascicle is in using visual information as a cue in conditional learning" (Eacott and Gaffan 1992, p.1332). Again, this should be conscious visual information.

One piece of evidence that these fiber bundles have important connections to consciousness is that damage to them has immediate effects on the patient's consciousness. The fasciculi are abnormal in schizophrenics who experience auditory hallucinations (Friston, 1998). According to Kier et al. (2004), the uncinate fasciculus and the inferior occipitofrontal fasciculus play a role in producing hallucinations when their connected areas are damaged. In their 2004 article entitled, "Pathways that make voices," Hubl and her colleagues found that schizophrenics who experienced auditory hallucinations had marked differences in their association fibers (in the arcuate fasciculus, connecting the temporal and prefrontal lobes), which led to "disrupted frontotemporal processing" (2004, p.666). Friston (1998, p.122) similarly notes that the schizophrenic brain shows an absence of positive correlations between prefrontal and superior temporal regions that he traces to abnormal glutamate transmission, which "is the mainstay for the excitatory cortico-cortical interactions that integrate different brain areas."

Recall that Crick and Koch used the analogy that the front of the brain is looking at the back of the brain. Apparently the fasciculi are the means by which they do this, as well as the means through which they influence processing in the temporal and parietal lobes. Crick and Koch speculate that what they call the neural correlate of consciousness is "expressed by only a small set of neurons, in particular those that project from the back of the cortex to those parts of the front of the cortex that are not purely motor and that receive feedback from there" (2003, p.124). More specifically, Koch (2004) says that some projection neurons from inferior temporal areas to the principal sulcus in the dorsolateral prefrontal cortex may form part of neural correlate of (subject) consciousness.

Mindmelding experiments

The best odds for making mindmelding work would involve clear sensory qualia. If the bearer closes her eyes and is simply thinking, mindmelding becomes more subtle. Sometimes we think explicitly in language, using qualia derived from the auditory modality. We say sentences to ourselves, then our executive processes or other parts of the brain, such as the emotional systems, react to them. Other times we think more quickly and automatically with little or no experience of qualia. Also, since A and B retain their conceptual systems, if they associate different concepts with the same word they will not be thinking about the same thing. We can attempt to connect the fiber bundles topographically, matching each fiber to its nearest topographic equivalent in the other bundle. A tuning period may be needed in order for the two brains to work effectively, but one thing we know about the central nervous system is that it is very good at this sort of tuning and adjustment. It possesses tremendous plasticity to adapt and repair itself (Buonoman and Merzenich, 1998). The experiment in which people wore glasses that inverted their vision, so that up was down, showed that the visual system can adjust over a period of several days, enough so that the people were disoriented when they finally took the glasses off, and had to readjust to normal vision (Stratton, 1896).

Perhaps we can first achieve certain background conditions to make mindmelding more likely. We can make A and B identical twins, or even molecular duplicates, to help with the splicing problems. In initial mindmelding experimentation, it may be necessary to simply block the causal influences coming from either A's or B's frontal regions. This would be a strange experience for the person whose frontal processes were blocked; it might appear to them as an inability to control and manipulate qualia (Figure 9.2). It might be frightening, and make the person feel as if he is "going crazy," in the way that many schizophrenics claim that their minds have been invaded by outside parties.

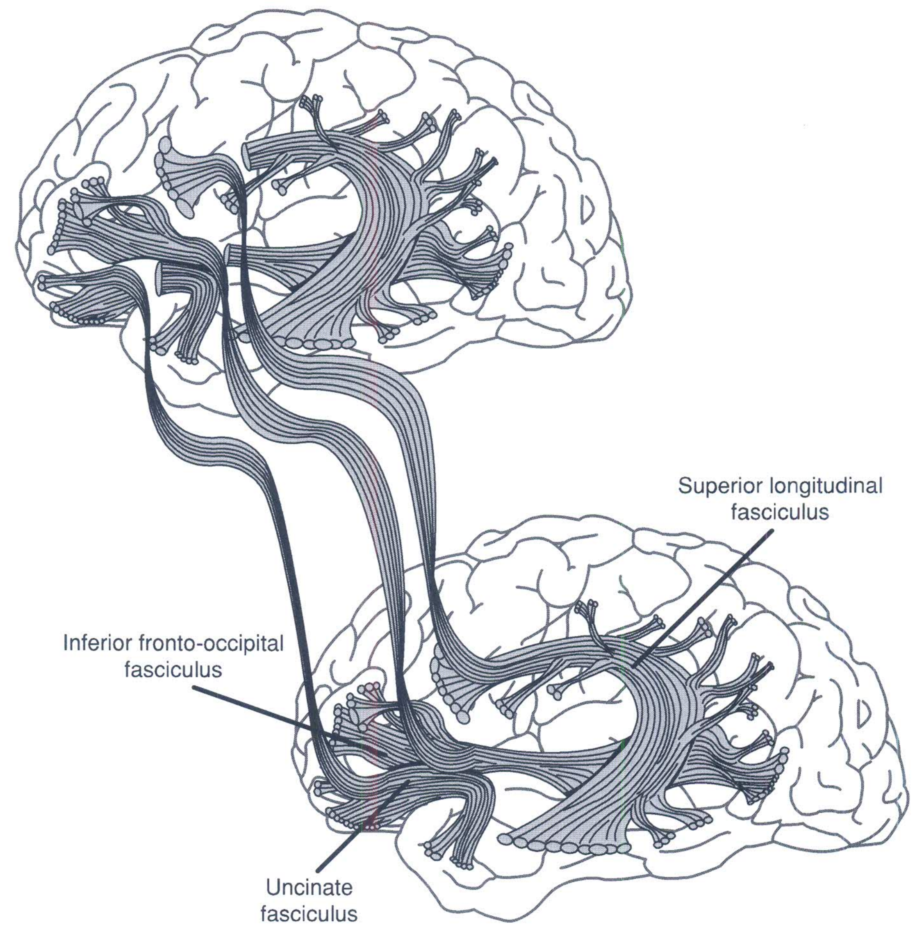

Fig. 9.2 Mindmelding experiment. There are certain patterns of activity moving along the fiber bundles. We attach the fiber bundle from the brain of the bearer of the qualia (below) to the right places in the brain of the sharer (above). The owner of the brain on top can experience the conscious representations of the owner of the brain on the bottom. What the person on top experiences cannot be his own conscious perceptual representations, which reside in his temporal and parietal lobes, since the connections to those are broken. Diagram by Katie Reinecke.

The idea of mindmelding yields many interesting and productive questions, such as the following:

Could we pair my perceptual qualia with your emotions? Can we draw a line between our qualia and our emotional reactions to them? There are two ways to do this. First, it might be that the perceptual qualia are completely formed before we emotionally react to them. Second, it might be that the emotional reaction proceeds along different routes, once a basic stimulus representation has been created, so that the prepared qualia reach consciousness at roughly the same time the emotions do.

Can each type of qualia be removed from a person's conscious states, while the others remain? One problem here is that if there are causal interactions among the different qualia-bearing processes, this would argue against selective removal of qualia types. It is hard to imagine color without shape, but it may be possible, perhaps in cases in which the entire visual field is colored.

There are also interesting questions about what it would be like to experience different or abnormal qualia. What if we mindmeld and I detect visual qualia, but you detect auditory qualia? What if you are a synesthete but I am not? Can I experience your synesthesia? Can I mindmeld with a shark and sense electrical fields? Can I mindmeld with a bat and experience his radar? What if a very "visual" person mindmelding with a very "auditory" person, or in an extreme case, a blind person with a normal person?

Questions about how mindmelding interacts with the process of attention also come up. What if you and I mindmeld, but I attend to a different part of your conscious field? If you are looking at an ambiguous figure, such as the duck/rabbit, and we mindmeld, can I see the duck while you see the rabbit? If A and B are mindmelding, can there be a conscious state in A's mind that A is not aware of, but B is?

There are also questions involving the relations between consciousness, mindmelding, and the concept of representation. Can the same conscious state be a representation for A but not for B? Can the same set of qualia represent one thing for one person and another thing for someone mindmelding with her? One difference here will be that while the incoming chain is the same for A and B, the two will direct actions toward different objects. Suppose A and B are mindmelding, so that A is experiencing B's conscious representations. When a possible representation pops into A's mind, this is not automatically a belief or a desire. A, or his executive processes, must "accept" it as a belief.

There are also questions about how mindmelding would interact with the processes of memory. If a memory representation pops into A's mind, even if A accepts it, it is not *his* memory. If A reports it as his memory, that would presumably be a new species of confabulation. Can the same representation be a desire for B, but a fear for A? If A and B mindmeld as A experiences the recall of one of B's memories, B's memories might be corrected by A's executive memory correction mechanisms. There could be a case where A received B's perceptual qualia, then issued motor commands to B's body. A would feel like he had taken over B's body, and B would feel this way too.

The type of mindmelding I am mainly speaking about is partitioned mindmelding. Partitioned mindmelding occurs when each A and B experience the conscious state of B as if it were their own state. But A and B maintain their senses of self, by maintaining more or less normal operation of their prefrontal lobes. A much more radical type of experiment (that we may or may not want to call mindmelding) would involve also attempting (somehow) to merge A's and B's sense of self, i.e., attempting to merge their entire minds. As it is described on the television show *Star Trek*, the Vulcan mindmeld sounds like a variety of this sort of complete mindmelding. Open, unpartitioned, mindmelding would be a new experience for both participants. It would somehow involve two selves operating at the same time. It is not at all clear what this would be like. No wonder Mr Spock finds it so draining. In this case, there is perhaps a type of normal state that provides a clue as to what such a mindmelding experience might be like. One possibility would be that this type of experiment would produce something like mutual knowledge, or common knowledge, which occurs when one is knowingly experiencing something together with someone. A first question here is, how does mindmelding compare to joint attention to an external object? Mindmelding where the bearer is looking at a tree might be similar to joint attention where two people are standing together looking at a tree.

A can never experience B's entire mind, the perceptual qualia in addition to the indirect awareness of executive activity, as B experiences it, because A would have different executive activity. There is a way in which one person can never experience the entire mind of another as that person does, but this has to do with identity of the observer. The problem with A having direct knowledge of the entire mind of B is not an epistemic problem but an identity problem—not a problem of privacy, but a problem of identity. There are some limited cases where person A can have direct knowledge of the entire conscious state of person B, if B's conscious state consists only of, for example, perceptual qualia. For example, if B is mesmerized by a waterfall and has no executive activity going on at all, then A can experience this entire state. But it is not possible for A and B to both experience the entire conscious state of B, if there is (different) executive activity in both of their minds.

What would lateral mindmelding—we connect your left hemisphere to my right hemisphere—be like? We could start by connecting our brains via their commissural bundles, including the primary one, the corpus callosum, as well as the two secondary ones, the anterior commissure (which connects areas of the temporal lobes), and the hippocampal commissure. This would shed light on an old debate about the nature of consciousness in the right hemisphere (Sperry et al., 1979; Gazzaniga, 1983). Minimally, our conscious awareness of the far left side of our visual field is coming from the right hemisphere. Doty says that the corpus callosum is the means by which "the normal unity of experience is synthesized from the potentially independent processes in the two hemispheres" (Doty, 1989, p.2). If conscious states are bound across the corpus callosum, this shows large-scale binding can be achieved using white matter fibers. Perhaps states of this sort are achievable.

Mindmelding versus mindreading

In our review of some of the major brain systems in Chapter 3, I described the mindreading system. Imaging studies show it becoming active when subjects must attribute mental states to people they are observing. What is the relation between mindmelding, and mindreading? A question to start with is whether the existence of mindreading capacities is of any help in making mindmelding more imaginable. We use our mindreading capacities to achieve the nearest natural equivalent of mindmelding: a simulation of the mind of the other rather than actual contact with it. The existence of mirror systems shows that our brains are built to understand one another. My primary tool for understanding your mind is my own mind. I fuse an internal simulation of you with discerning observation of your every sensible feature, your sights, sounds and motions, to form a richly detailed representation of you (Hirstein, 2010). Full of detail and designed for optimal function, guiding my thought about you and my interactions with you, these *person concepts* allow us to negotiate life in a society.

Interestingly, the etymology of the word "consciousness" itself contains an interpersonal feature. Its root words are "*con*," meaning with, and "*scire*" meaning to know, so that it originally meant to share knowledge with someone (*Oxford English Dictionary*; see also Natsoulas, 1983). Some have argued that the achievement of mutual social knowledge is the primary function of consciousness (e.g., Humphrey, 1984). One obvious difference between mindmelding and simulation is the vividness and clarity of the qualia. (This difference might be important, see Chapter 12.) Could A tell the difference between his simulation of B's mind and B's mind itself? If we somehow muted or suppressed the vividness of B's actual mind, could A tell it from his normal simulation of B's mind? What would it be like if we hooked my executive processes up to your egocentric representation system? This would be a different, and much more vivid experience from my simply using my egocentric representation in simulation mode to represent your mind. If I am using my egocentric representation system to represent you, and then we also mindmeld to allow me to experience your perceptual qualia, this might be a happy combination, in allowing me a particularly accurate and effective simulation of you.

So there is an obvious way in which the answer is yes, mindreading makes mindmelding seem more plausible. In the case of pain for instance, if I understand your pain in part by an activation of some of the same processes involved when I am in pain (Jackson et al., 2006), then this paves the way for mindmelding to be coherent. It might appear like a very vivid sort of empathy. Ramachandran (2010) tested an amputee who felt actual pain in his phantom right arm when he saw someone else's right arm (apparently) being hurt. Ramachandran's working hypothesis is that the presence of an actual arm in normal people which is not feeling that pain works to inhibit the empathic pain from becoming actual pain. Would this amputee notice the difference between the actual pain he feels, and the actual pain of someone he is looking at, conveyed to him via mindmelding? If there are such cases—where the line between strong empathy and actual experience can be crossed—I think this makes mindmelding seem more conceivable. It allows the sharer in mindmelding to believe with conviction that she really is experiencing the pain of the other.

Mindmelding technology

Cochlear implants are an early type of brain–computer connection. They allow deaf people to hear by using a microphone to pick up sounds and then directly stimulating the auditory nerve. Cognitive neural prosthetics are implantable electronic devices that record signals coming from cortical areas (Anderson et al., 2010). They are used to assist patients with paralysis or amputations and they work by sending the cortical signals to all sorts of different devices such as robotic limbs or motorized wheelchairs. They can also be used to bypass a severed nerve and relay signals to muscles to create movement (Iwata, et al. 2006). They are based on the idea that patients with amputations or severed nerves still possess the cortical areas that plan and organize motor movements but merely lack the ability to execute those movements. What is of interest to us in this is that these devices could be used to transmit neural signals from one brain to another in an organized and meaningful way. So rather than employing the crude notion depicted in our diagrams, of running artificial fasciculi between brains, these devices could record activity in the fasciculi as well as their areas of origin, then transmit that information to another brain. Achieving mindmelding might involve capturing the signals emanating from executive areas back to sensory areas in the parietal and temporal lobes, and this is precisely what Anderson and his lab group are doing. Early in their research, they realized that the monkeys they were studying did not need to actually move a limb, or send the signals to do so, to move a computer cursor. Rather, brain signals in higher cortical areas also worked to accomplish the task. "This control can be derived from motor imagery, planning, attention, decision-making, or executive control, to name just a few of the cognitive signals that are potentially useful for neuroprosthetics" (Anderson et al., 2010, p.171; Carmena et al., 2003). People are now able to move prosthetic arms by activating electrodes planted in their brains, a step that it is hoped will lead to the ability to bypass damaged nerves and allow the brain to communicate directly with prosthetic arms and legs.

Another early research effort involves the use of a television camera mounted on a pair of eyeglass frames that sends signals to a computer. The computer then transforms those signals into a code that is fed into the visual cortex of a person who has lost sight due to damage in the early visual system, e.g., to the eyes or optic nerves, to read text and navigate around a room (Dobelle, 2000). Another device allows stroke patients who are unable to speak to activate a speech synthesizer, slowly forming vowel and speech sounds. Another project that involves the attempt to create an artificial hippocampus aims at repairing damaged memories or improving normal ones. They have been able to connect an artificial hippocampus to the brain of a white rat (Song et al., 2007). In another promising research program, a patient with a spinal cord injury was able to "traverse" a virtual environment using his mind alone (Pfurtscheller and Neuper, 2001; Wolpaw et al., 2002).

This progress in understanding how to connect the brain to artificial devices also relates to our question of connecting brains to other brains. The work with artificial prostheses will allow us to begin to identify where the important points of connection are. Research in this area will also allow us to gain knowledge about the neural codes used by the brain to transmit information. There are three types of neural code: Rate codes use the average number of firings in a given time interval. Temporal codes contain information in the amount of time that passes between firings. Population codes use patterns of activity of large groups of neurons. Again, anyone attempting mindmelding has the brain's natural flexibility to work with different types of input working in his favor. We are, according to Clark, "creatures whose minds are special precisely because they are tailor-made for multiple mergers and coalitions" (2003, p.7).

Objections and replies

One potentially threatening objection to mindmelding comes from the presence of top-down effects in perception. Mindmelding is more straightforward when perception only works in a bottom-up manner, assembling conscious representations of objects out there. But when causal flow is also moving in the other direction, from the top down, things get more complicated. When a basketball player looks at a basketball, he sees it as something to dribble, pass, catch, and shoot with (Gibson, 1977). If we placed the basketball next to a vase, different things would happen in the motor areas of the basketball player as he alternately looked at the two. Certain top-down effects, e.g., I am looking for x, or mnemonic effects, e.g., using a current perception as a memory cue, appear to involve executive activity. This may produce effects such as the case I mentioned earlier where two people are mindmelding as one of them looks at an ambiguous figure such as the duck/rabbit, and one of them sees the duck while the other sees the rabbit. Depending on whose executive processes are allowed to exercise causal influence over the temporal cortical areas housing the qualia, either the duck or the rabbit might become accentuated, sharpened, and clarified, perhaps at the cost of the other interpretation.

Given that perception happens on different levels, as the case of blindsight shows for instance, why am I so sure that we can make a clean break between two phases, between perceptual processes and executive processes? Even though perception can follow many routes, we are really only interested in one of them, the top level where consciousness exists. It also seems that there is one powerful fact arguing for the possibility of separating the two phases: the presence of all those fasciculi, which appear to be allowing for causal interaction between prefrontal executive processes and temporoparietal conscious states.

If the perceptual and mnemonic systems are modifying and correcting their products for the executive processes, as I noted in Chapter 5, how individual does this adapting get? Aren't I assuming vast similarities in the ways that our brains process and produce conscious representations? Conscious states that contain representations have contents that are already conceptualized. But, the problem is that the other components of the concept are in the other person's brain, what if the two people have radically different conceptual systems, as in the case of a modern urban dweller and a person from a stone-age culture? There could be a case of mindmelding where one person simply wasn't able to make out representations in the qualia of another. The person in whose brain they resided might regard them as representations, while the other person sharing her qualia regarded them merely as an abstract pattern of colors and shapes. One person would have a kind of perceptual agnosia with the qualia of another.

Another objection is that, in allowing myself tuning—in that individual differences, say in the topography of fibers in the uncinate fasciculus, can be corrected for by the brain's ability to retune and recalibrate feedback loops after damage—I am losing the very thing I wanted, genuine mindmelding, since the two brains are changing in response to each other. This would be difficult to get around, given our current set up. This may indicate that the experience of the two people engaged in mindmelding would show an interesting time course. There might be an initial period in which representations appeared a bit fragmented to the person experiencing the other's qualia, due to the inexact mapping of fibers in the fasciculi onto one another. Then as this problem was slowly adapted for, the conscious states would become clear to both parties.

I seem to have the prefrontal processes "perceiving" conscious representations in, for example, the temporal lobes. But there are no sense organs in the prefrontal lobes, so how are we to understand this? Dennett (1998) argues that something like this appears to involve a case of "double transduction," in that there would have to be another level of transduction of energy from one form to another when the executive processes "perceive" the conscious representations. Recall from Chapter 3 that the sense organs transduce energy of different forms into electrical causal flow, a process requiring some rather specialized and highly evolved equipment, such as the human eyes and ears. We would then need an equally fancy system in the prefrontal lobes, the objection goes. Not at all. Consider the example of computers. They have hard lives in that they are forced to work with a lot of very inexact, approximate, messy creatures: us. They have all sorts of specialized input devices, though, keyboards, mice, video cameras, and so on, each of which is tailored toward converting our inexactness into exact digital signals. Once the computer has done that, however, no more of this sort of transduction is needed. The processes in the CPU that perform operations on the computers data are devised so that they can work with that data in exactly the form it is in.

Conclusion

A scientist might take advantage of mindmelding to set up a method for studying correlations between states of the brain viewed externally, via fMRI for instance, and brain states experienced internally, via mindmelding. He could alternate between the two techniques. Before doing this, he could have performed the simpler experiment of externally observing his own brain while noting his conscious experiences, so he could have developed a detailed qualia map of his own brain. Without mindmelding, we are left guessing. I can stimulate a part of your brain and ask you to report to me what you experience, but then language is getting between us. Are you using words in exactly the same way I am? There is also significant variation in how good people are at introspecting and reporting their conscious states. With mindmelding, our scientist can methodically compare one small brain area to another, by first stimulating it in his own brain, then stimulating it in the brain of his subject, as he mindmelds with him.

If mindmelding is possible, that means that sentences of the form "Jo is experiencing Nat's conscious state" can genuinely be true. Sentences that report mental states such as this have been intensively studied by philosophers and linguists, and have been found to possess several interesting features. In the next chapter, I will examine these features and enlist them to further my case for the plausibility and coherence of mindmelding.