

All three divisions can work both in close cooperation and in relative independence. When you touch an object whose texture gives you pleasure, signals from all three divisions have been brought to maps in the central nervous system which describe the ongoing interaction along its many dimensions, e.g., the movements with which you investigate the object; the properties which activate tactile sensors; and the humoral and visceral reactions which constitute the pleasurable response to the object. But the divisions may operate independently, e.g., the first with little help from the second, or the first and second with no help from the third. The important point to note is that the first division—the one concerned with the organism's interior—is permanently active, permanently signaling the state of the most internal aspects of the body proper to the brain. Under no normal condition is the brain ever excused from receiving continuous reports on the internal milieu and visceral states, and under most conditions, even when no active movement is being performed, the brain is also being informed of the state of its musculoskeletal apparatus. The brain is truly the body's captive audience as I noted.

The internal milieu and visceral division is in charge of sensing changes in the chemical environment of cells throughout the body. The term *interoceptive* describes those sensing operations generically. One aspect of these signals dispenses with nerve fibers and pathways altogether. Chemicals flowing in the bloodstream are sensed by nuclei of neurons in some regions of the brain stem, hypothalamus, and telencephalon. If the concentration of the chemical is within the permissible range, nothing happens. If the concentration is too high or too low, the neurons respond—they initiate a variety of actions aimed at achieving a correction of the imbalance. For instance, they can make you calm or make you jittery, they can make you feel hungry or wish to have sex, which is all fascinating, of course, but the point is that the signals create, moment by moment, multiple maps of the internal milieu, as many as the dimensions of our interior that can be measured with this peculiar method, and there are *many* such dimensions.

The brain's exposure to the chemicals that circulate in the bloodstream is remarkable. The brain is protected from the penetration of certain molecules by the so-called blood-brain barrier, a biological filter that envelops virtually all the blood vessels that carry nutrients to the brain tissue and is quite selective about what is or is not allowed to trespass from the blood into the brain tissue. A few brain regions, however, are devoid of blood-brain barrier and easily admit large molecules that, elsewhere in the brain, are kept from influencing the neural tissue directly. Molecules that cross the blood-brain barrier act on the brain directly, at sites like the hypothalamus; large molecules that cannot penetrate the blood-brain barrier get to act on the brain at special sites in which the barrier is missing, the so-called circumventricular organs. Examples of such sites are the area postrema (located in the brain stem) and the subfornical organs (located at cerebral hemisphere level). The chemically excited neurons in these areas pass their messages on to other neurons. The action of substances such as oxytocin, which is critical for a variety of behaviors, from sex and bonding to childbirth, depends on this arrangement. The brain's immersion in the chemical milieu is serious business.

The internal milieu and visceral division uses nerve pathways to carry the signals which we eventually perceive as pain, which can originate almost anywhere in the body, e.g., in viscera of the abdomen or in a joint or muscle. That division also carries neural signals related to aspects of the internal milieu so that the organism's chemical profile gets to be mapped not just via the bloodstream but also via neural pathways—for instance, pH levels and the concentration of oxygen and carbon dioxide are both dually mapped.

Finally, this division also signals the state of the smooth muscles, which are so abundant throughout the viscera and which are under autonomic control. The designation *autonomic* means that a particular process is controlled in its virtual entirety by devices independent of our will which are located in the brain stem, hypothalamus, and limbic nuclei, rather than in the cerebral cortex. There are smooth muscles everywhere, for example, in any blood vessel anywhere in

the body. Those smooth muscles can contract or dilate to regulate blood circulation and its attendant functions. One result of such contraction or dilation of smooth muscle becomes well known to us when it increases or decreases systemic blood pressure or when it causes skin to blanch or to flush. Incidentally, the largest of all viscera in the body is the skin itself. I am not referring to the surface of the skin, which has a critical role in the sense of touch, but to the "thick of the skin," which is vital to the regulation of temperature. Extensive burns can kill you not because you lose tactile functions but because your homeostatic regulation is severely disturbed. This critical part of the skin's function derives from the ability to change the caliber of the many blood vessels that crisscross its thickness. "I've got you under my skin" unwittingly captures this important physiological idea and the lyric would have been even more accurate if Cole Porter had written, "I've got you in the thick of my skin," and it would be just as naughty. Predictably, the French have got it right on when they say "*Je t'ai dans la peau,*" which means, "I have you *in* my skin."

The signals I have been considering travel via a particular sector of the spinal cord (the lamina I and II of the posterior horn) and of the trigeminal nerve nucleus (the pars caudalis). I should add, however, that the convenient grouping of all these signals in one large division hides much in terms of channel subdivision. For instance, we know from the work of A. Craig that the neurons that carry signals related to nociception (pain) are different from those which mediate other aspects of body sense, although all of them draw on C-fibers and A- δ fibers.⁹ On the other hand, we also know that many body-related signals are not only conveyed separately to high levels of the nervous system but also mixed and pooled together shortly after entering the central nervous system. This is what happens, for example, in the deeper zones of each spinal-cord segment.¹⁰ Additional information for this division of the somatosensory system comes from viscera and is carried by visceral afferents to the spinal cord and by nerves such as the vagus nerve (which bypasses the cord altogether and aims directly at the brain stem).

The second division, the musculoskeletal one, conveys to the central nervous system the state of the muscles which join moving parts of the skeleton, that is, bones. When muscle fibers contract, the length of a muscle is reduced and the appropriately connected bones are pulled into motion. When muscle fibers relax, the opposite occurs. All the muscles that perform skeletal movement can be controlled by our will and are striated muscles (there is an exception to this rule and it has to do with the heart, whose muscle fibers are striated rather than smooth and yet are neither under volitional control nor in charge of moving any bony parts). The function of this division of the somatosensory system is generically known by the terms *proprioceptive* or *kinesthetic*. Just as is the case with the interoceptive signals from the internal milieu and viscera, proprioceptive/kinesthetic signals form many maps of the body aspects which they survey. These maps are placed at multiple levels of the central nervous system, all the way from the spinal cord to the cerebral cortex. The vestibular system, which maps the coordinates of the body in space, completes the somatosensory information under this division.

A third division of the somatosensory system conveys *fine touch*. Its signals describe the alterations which specialized sensors in the skin go through when we make contact with another object and investigate its texture, form, weight, temperature, and so on. While the internal milieu and visceral division is largely preoccupied with the description of internal states, the fine-touch division is mostly preoccupied with the description of external objects based on the signals generated in the body surface. The musculoskeletal division, somewhat in between, can be used both to express internal states as well as to help describe the outside world.

THE NEURAL SELF

The sense of self, in either core or autobiographical versions, is unlikely to have been the original variety of the phenomenon. I propose that the sense of self has a preconscious biological precedent, the *proto-self*,



and that the earliest and simplest manifestations of self emerge when the mechanism which generates core consciousness operates on that nonconscious precursor.

*The proto-self is a coherent collection of neural patterns which map, moment by moment, the state of the physical structure of the organism in its many dimensions. This ceaselessly maintained first-order collection of neural patterns occurs not in one brain place but in many, at a multiplicity of levels, from the brain stem to the cerebral cortex, in structures that are interconnected by neural pathways. These structures are intimately involved in the process of regulating the state of the organism. The operations of acting on the organism and of sensing the state of the organism are closely tied. The proto-self is not to be confused with the rich sense of self on which our current knowing is centered this very moment. We are not conscious of the proto-self. Language is not part of the structure of the proto-self. The proto-self has no powers of perception and holds no knowledge.*¹¹

Nor is the proto-self to be confused with the rigid homunculus of old neurology. The proto-self does not occur in one place only, and it emerges dynamically and continuously out of multifarious interacting signals that span varied orders of the nervous system. Besides, the proto-self is not an interpreter of anything. It is a reference point at each point in which it is.

This hypothesis should be considered in the perspective of an important qualification regarding the relation between brain regions and functions, such as proto-self. Such functions are not "located" in one brain region or set of regions, but are, rather, a product of the interaction of neural and chemical signals among a set of regions. This is true of the nonconscious proto-self in relation to the set of regions I outline below, and it is also true of functions such as core self or autobiographical self, to be discussed later. Phrenological thinking must be resisted at all costs.

The structures required to implement the proto-self are listed below, along with those which are not required to implement it. Drawing on the two lists, it is possible to test the hypothesis in a vari-

ety of ways. The most direct way consists of formulating predictions regarding the effects of damage to some of the key structures presented in both lists. Some lesions ought to disrupt the proto-self and consequently disrupt consciousness, more or less severely, while others ought to leave consciousness unscathed. A preliminary assessment of the validity of those predictions is possible on the basis of current evidence from neuropathology and neurophysiology but further prospective studies are needed to firm up any conclusions.

Brain Structures Required to Implement the Proto-Self

1. Several *brain-stem nuclei* which regulate body states and map body signals. Along the chains of signaling that begin in the body and terminate in the highest and most distal structures of the

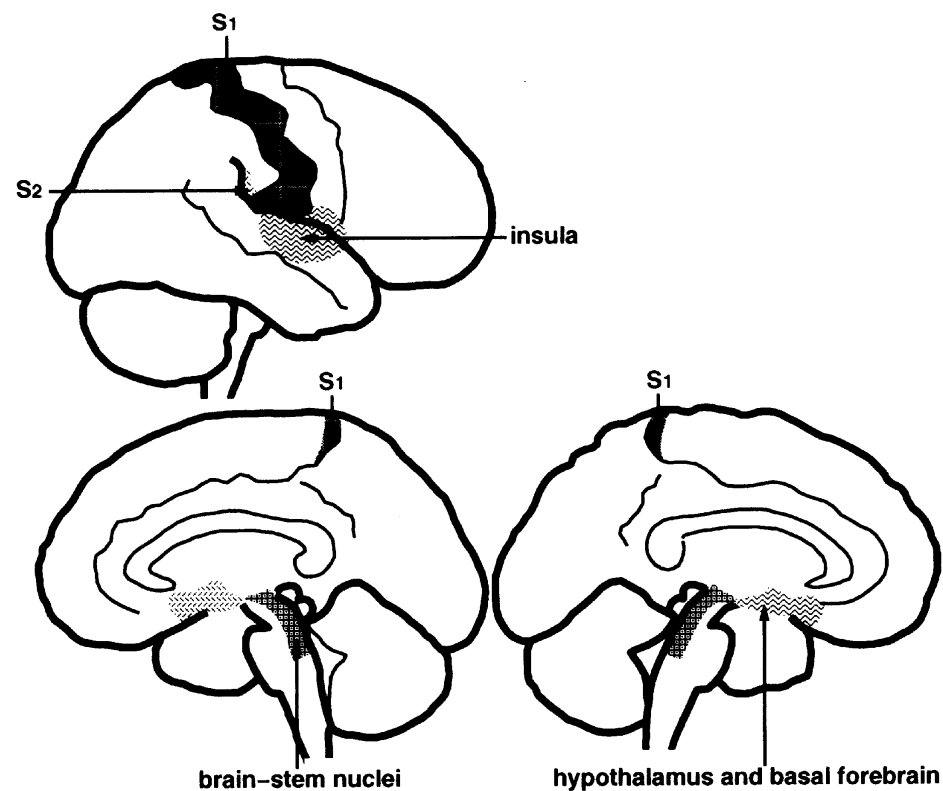


Figure 5.1. Location of some proto-self structures. Note that the region known as the insula is buried inside the sylvian fissure and not visible on the cortical surface.

brain, this region is the first in which an aggregate of nuclei signal the overall current body state, as mediated by the spinal cord pathways, the trigeminal nerve, the vagus complex, and the area postrema. Included in this region are classical reticular nuclei as well as monoamine and acetylcholine nuclei.¹²

2. The *hypothalamus*, which is located near the structures named in 1 and closely interconnected with them, and the *basal forebrain*, which is located in the vicinity of the hypothalamus, is interconnected with both hypothalamus and brain stem, and constitutes an extension of those lower structures into the forebrain. The hypothalamus contributes to the current representation of the body by maintaining a current register of the state of the internal milieu along several dimensions, e.g., level of circulating nutrients such as glucose, concentration of varied ions, relative concentration of water, pH, concentration of varied circulating hormones, and so on. The hypothalamus helps regulate the internal milieu by acting on the basis of such maps.
3. The *insular cortex*, the *cortices known as S2*, and the *medial parietal cortices* located behind the splenium of the corpus callosum, all of which are part of the somatosensory cortices. In humans the function of these cortices is asymmetric. Based on my own observations in patients, I have suggested that the ensemble of these cortices in the right hemisphere holds the most integrated representation of the current internal state of the organism at the level of the cerebral hemispheres, along with representations of the invariant design of the musculoskeletal frame. In a recently published article, Jaak Panksepp also links body and self, by means of an innate representation of the body in brain stem. His idea comes close to my notion of proto-self, in several respects, although his view of how such a representation contributes to consciousness is entirely different from mine.¹³

Brain Structures Which Are Not Required to Implement the Proto-Self

The structures listed below are not required to implement the proto-self. This non-exhaustive list covers most of the central nervous system. It includes all the early sensory cortices for external sensory modalities—which means that it includes visual and auditory cortices as well as the sectors of somatosensory cortices concerned with fine touch; all the temporal and most of the frontal higher-order cortices (higher-order cortices are those that are not exclusively dedicated to one sensory modality but rather to supramodal integration of signals related to early sensory cortices), and the hippocampal formation and its interconnected cortices, e.g., entorhinal cortex (area 28) and the perirhinal cortices (area 35). The specific roster is as follows:

1. Several early sensory cortices, namely those of areas 17, 18, 19, which are dedicated to vision; 41/42, 22, dedicated to hearing; area 37, which is partly dedicated to vision but is also a higher-order cortex (see 2, below), and the part of S1 concerned with fine touch. These cortices are involved in the making of modality-specific sensory patterns, which support the mental images of diverse sensory modalities available in our mind. They play a role in consciousness, both core and extended, inasmuch as the object to be known is assembled from these regions, but they play no role in the proto-self.
2. All the inferotemporal cortices, namely areas 20, 21, part of 37, 36, and 38. These cortices are the basis for the dispositional (implicit) memories that can be reconstructed in recall in the form of explicit sensory patterns and mental images. These cortices support many of the autobiographical records on the basis of which the autobiographical self can be assembled and extended consciousness realized.
3. The hippocampus, a vital structure in the “on-line” mapping of multiple, concurrent stimuli. The hippocampus receives signals related to activity in all sensory cortices, which arrive

indirectly at the end of several projection chains with multiple synapses, and reciprocates signals via backward projections along the same chains. It is essential to create new memories of facts but not new memories of perceptuomotor skills. It appears to hold memories within itself temporarily but not permanently. Most importantly, it appears to contribute to the establishment of memories elsewhere, in circuitry connected to it.

4. The hippocampal-related cortices, namely areas 28 and 35. These cortices may hold dispositional memories of even higher complexity than those in 2, above.
5. The prefrontal cortices. A vast array of higher-order cortices. Some of them hold high-complexity dispositions for personal memories involving unique temporal and spatial contexts; for memories of the relation between certain categories of events or entities and somatic states; and for memories for abstract concepts. Some of these cortices participate in high-level working memory for spatial, temporal, and linguistic functions. Because of their role in working memory, prefrontal cortices are critical for high levels of extended consciousness. Because of their role in autobiographical memory, they are relevant to autobiographical self and extended consciousness.
6. The cerebellum. One of the most transparent but also elusive sectors of the brain. It is obviously involved in the construction of fine movement—you cannot shoot straight without it, never mind sing, play an instrument, or play tennis. Yet it is also involved in affective and cognitive processes, and I suspect all the more so during development. It may be involved in the processes of emotion and of mental search, e.g., searching for a specific word or nonverbal item in memory. The lack of severe dysfunction following its ablation or inactivation suggests that the role it plays in cognition is subtle. But recent studies suggest this could be an artifact of inadequate observation, made

all the more likely by the cerebellum's blatant anatomical and functional redundancy.

SOMETHING-TO-BE-KNOWN

We have seen how a specific set of neural structures can support the first-order representation of current body states that I call the proto-self, and in so doing, provide the roots for the self, the “something-to-which-knowing-is-attributed.” It is time to say something about the roots for the other key player in the process: the “something-to-be-known.”

The background for our understanding of how the brain represents the something-to-be-known is extensive. We have a considerable, though incomplete, understanding of how sensory representations in the main sensory modalities (e.g., vision, hearing, touch) are related to signals arising in peripheral sensory organs, such as the eye or the inner ear, and how those signals are relayed to the respective primary sensory regions of the cerebral cortex by means of subcortical nuclei such as those in the thalamus. Beyond the primary sensory cortices we understand a little about how explicit mental representations—those which have a manifest structure—are related to varied neural maps and about how some memory for those representations can be recorded in implicit manner. We know, for instance, that varied aspects of an object—for instance, its form, its color and motion, or the sounds it produces—are handled in a relatively segregated way by cortical regions located downstream from the respective primary visual or auditory cortices. We suspect that some kind of neural integrative process helps generate, within the overall region related to each modality—the so-called early sensory cortices—the composite of neural activities which support the integrated image we experience.¹⁴ However, we do not know all the intermediate steps between neural patterns and mental patterns. We do know that the same overall region supports image making for both perception (which we construct from

the actual scene external to the brain, from the outside in) and for recall (which we reconstruct in the mind internally, inside out, as it were). We have reasons to believe that the integration of sensory representations across modalities—say, vision *and* auditory, or vision *and* touch—may well depend on timing mechanisms that coordinate activity across large regions of the brain and probably will not need yet another single integrative space per se—a single Cartesian theater. And we know for certain that basic sensory integration does not require higher-order cortices in anterior temporal and prefrontal cortices.¹⁵ (See the appendix, section 3, for a more extensive discussion of these issues.)

Let us now consider first the situation of an actual something-to-be-known, an actual object. Such an object is implemented in early sensory cortices, those collections of cortices in which signals from the varied sensory channels, such as vision, hearing, and touch, are processed along the many dimensions of an object, such as color, shape, motion, auditory frequencies, and so on.

The presence of such signals from an actual object provokes in the organism the sort of response I discussed earlier in this chapter, namely, a collection of motor adjustments required to continue gathering signals about the object as well as emotional responses to several aspects of the object. In other words, the implementation of the something-to-be-known is inevitably accompanied by a complex effect on the proto-self, that is, an effect on the very neural basis of the something-to-which-knowing-is-attributed. Let me repeat that this is enough for *being* but not enough for *knowing*, that is, not enough to be conscious. Consciousness, as we shall see, only arises when the object, the organism, and their relation, can be re-represented.

Now let us turn to the case of an object that is not actually present but has, rather, been committed to memory. According to my framework, the memory of that object has been stored in dispositional form. Dispositions are records which are dormant and implicit rather than active and explicit, as images are. Those dispositional memories

of an object that was once actually perceived include not only records of the sensory aspects of the object, such as the color, shape, or sound, but also records of the motor adjustments that necessarily accompanied the gathering of the sensory signals; moreover the memories also contain records of the obligate emotional reaction to the object. As a consequence, when we recall an object, when we allow dispositions to make their implicit information explicit, we retrieve not just sensory data but also accompanying motor and emotional data. When we recall an object, we recall not just sensory characteristics of an actual object but the past reactions of the organism to that object.

The significance of the distinction between actual object and memorized object will become clear in the next chapter. I will preview that significance by saying that this distinction permits memorized objects to engender core consciousness in the same way that actually perceived objects do. This is why we can be conscious of what we remember as much as we are conscious of what we actually see, hear, or touch now. Were it not for this magnificent arrangement, we could never have developed an autobiographical self.

A NOTE ON THE DISORDERS OF THE SOMETHING-TO-BE-KNOWN

The disorders of the something-to-be-known fall into two broad categories: perceptual disorders and agnosias. In perceptual disorders, a lack of signals from a sensory modality such as vision or hearing or the somatosensory division of touch prevents the sensory representation of an object from being formed—acquired blindness or deafness are examples. Under those circumstances, an object X, which was to be represented by a particular sensory channel, can no longer be represented, fails to engage the organism in the usual manner, and does not modify the proto-self. The result is that no core consciousness ensues.

Now for the second category, the agnosias. *Agnosia* is an obscure but well-formed word that denotes an inability to conjure up from memory the sort of knowledge that is pertinent to a given object as the

object is being perceived. The percept is stripped of its meaning, as an old and lapidary definition stated so well. The exemplary form of agnosia is the condition known as *associative agnosia*, to use technical neurological terms. Associative agnosia occurs with respect to the main sensory modalities, e.g., there are cases of visual agnosia, auditory agnosia, and tactile agnosia. Because of their exquisite specificity, these are some of the most intriguing cases encountered in neurology. As you will discover in the illustration below, a perfectly sane and intelligent human being can be deprived of the ability to recognize familiar persons by sight but not by sound (or vice versa).

It Must Be Me because I'm Here

That is what Emily said cautiously as she contemplated the face in the mirror before her. It had to be her; she had placed herself in front of the mirror, of her own free will, so it had to be her; who else could it be? And yet she could not recognize her face in the looking glass; it was a woman's face, all right, but whose? She did not think it was hers and she could not confirm it was hers since she could not bring her face back into her mind's eye. The face she was looking at did not conjure up anything specific in her mind. She could believe it was hers because of the circumstances: She had been brought by me into this room and asked to walk to the mirror and see who was there. The situation told her unequivocally that it could not be anyone else and she accepted my statement that, of course, it was her.

Yet, when I pressed "play" on the tape deck and let her hear an audiotape of her own voice, she immediately recognized it as hers. She had no difficulty recognizing her unique voice even if she could no longer recognize her unique face. This same disparity applied to everyone else's faces and voices. She could not recognize her husband's face, her children's faces, or the faces of other relatives, friends, and acquaintances. However, she could easily recognize their characteristic voices.

Emily was not unlike David in the sense that "nothing came to mind" when certain specific items were shown to her. But she was

vastly different in the sense that her problem pertained exclusively to the visual world. Nothing came to mind *only* when she was shown the visual aspect of a unique stimulus with whom or with which she was perfectly familiar—a person's face, a particular house, a particular vehicle. The nonvisual aspects of the same stimulus—say, sound or touch—brought to mind everything they were supposed to bring.¹⁶

Emily did better with the less than unique. Remarkably, she could easily tell that a face whose identity she could no longer access expressed an emotion. The same was true of the age and gender of the person who owned a certain face.¹⁷ Her problem was confined to unique items in the visual medium.

How does Emily fare on my core consciousness checklist? The answer is, perfectly. I do not need to tell you that she is awake and attentive in every way. Her attention focuses easily and is sustained for all sorts of tasks. Her emotions and the feelings she reports are entirely normal, too. Her behavior is purposeful and appropriate for all contexts, immediate as well as long term, limited only by her visual difficulties. In fact, even in spite of those difficulties, she can do remarkable intellectual feats. She sits for hours observing people's gaits and tries to guess who they are, often successfully; she can hold perfect conversations with guests at the receiving line of her parties, provided her husband whispers the name of the visually unknown person; and she can find her visually unrecognizable car in the supermarket parking lot by checking systematically all the license plates.

I do want to call your attention to something quite revealing, however. Not only is she conscious of what she knows perfectly well, but she is also conscious of what she does not know. She generates core consciousness for every stimulus that comes her way regardless of the amount of knowledge she can conjure up about the stimulus. Emily, as well as the many other patients like her that I have studied over the years, is perfectly conscious of the things she does *not* know and she examines those things, in reference to her knowing self, in the same way she examines the things she does know. Consider the following experiment we customized for Emily.

We had noted, purely by chance, as we used a long sequence of photographs to test her recognition of varied people, that upon looking at the photo of an unknown woman who had one upper tooth slightly darker than the rest, Emily ventured that she was looking at her daughter.

“Why do you think it is your daughter?” I remember asking her.

“Because I know Julie has a dark upper tooth,” she said. “I bet it is her.”

It wasn't Julie, of course, but the mistake was revealing of the strategy our intelligent Emily now had to rely on. Unable to recognize identity from global features and from sets of local features of the face, Emily seized upon any simple feature that could remind her of anything potentially related to any person she might be reasonably asked to recognize. The dark tooth evoked her daughter and on that basis she made an informed guess that it was indeed her daughter.

To check on the validity of this interpretation, we designed a simple experiment. We modified a few photos of smiling men and women so that they would show a slightly darker upper incisor and interspersed them randomly in a stack of many other photos. Whenever Emily came to a modified photo of any young woman—never the men or older women—she proclaimed it to be her daughter. She had a keen awareness for the whole and for the parts of the photos she was shown, or she would have had no possibility of reasoning as intelligently as she did, item after item, and would have had no chance of spotting the target stimuli. In the very least, Emily and those like her demonstrate that one does not require specific knowledge of an item at a unique level in order to have core consciousness of the item.

When a patient with face agnosia fails to recognize the familiar face in front of her and affirms that she has never seen that person, that she has no recollection of anything related to that person, the pertinent knowledge is not being deployed for conscious survey, but core consciousness remains intact. In fact, once you confront the patient with the fact that the face before her is that of a close friend, the patient is not only conscious in general but conscious also of her failure,

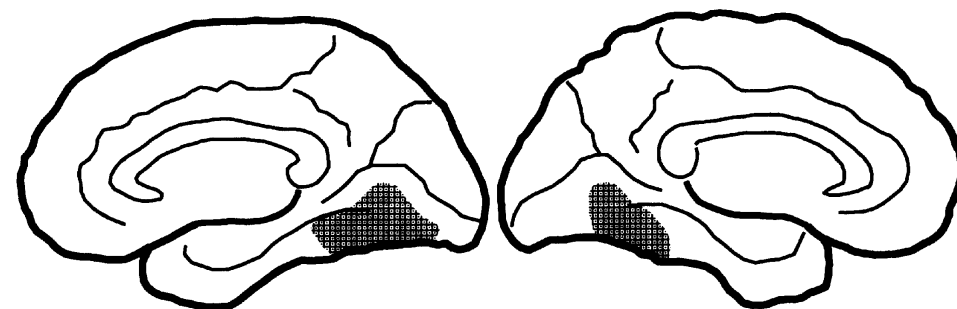


Figure 5.2. The lesions that caused prosopagnosia in patient Emily were located at the junction of the occipital and temporal lobes of both hemispheres. This is the typical location of lesions in patients with associative prosopagnosia.

conscious of her inability to conjure up any knowledge useful to recognize the close friend. Her problem is not one of consciousness but of memory. The specific something-to-be-known is missing—she cannot represent the knowledge of who it is she is looking at, she cannot be conscious of something now present. But core consciousness is present as generated by other layers of something-to-be-known—for instance, the face as face, as opposed to the face of a unique person. It is precisely because normal core consciousness is present that the recognition void comes to be acknowledged.

Emily's problem was caused by bilateral damage in the early visual cortices, specifically in the visual association cortices located at the transition of occipital and temporal lobes in the ventral aspect of the brain. Brodmann's areas 19 and 37, in a region known as the fusiform gyrus, bore the brunt of the damage.

On the basis of our early neuroimaging correlations regarding face agnosia, almost two decades ago, we suggested that these cortices were normally involved in the processing of faces and of other visually ambiguous stimuli that made similar demands on the brain.¹⁸ Current functional neuroimaging experiments support this idea: normal individuals consistently activate the region damaged in Emily's brain when they are aware of processing a face.¹⁹ It is important to note that activation of this area in a functional neuroimaging experiment should not

be interpreted as meaning that “consciousness for faces” occurs in the so-called face area. The image of the face of which the subject is conscious cannot occur without a neural pattern becoming organized in the face area, *but the remainder of the process that generates the sense of knowing that face and that drives attention to the pattern is occurring elsewhere, in other components of the system.*

The significance of the above qualification is nowhere more clear than when we consider the following fact: when an unconscious patient in persistent vegetative state was shown familiar faces, the so-called “face area” (at the occipito-temporal junction, within the fusiform gyrus) lit up in a functional imaging scan, much as it does in normal and sentient persons.²⁰ The moral of this story is simple: the power to make neural patterns for the something-to-be-known is preserved even when consciousness is no longer being made.

BILATERAL DAMAGE TO auditory cortices yields the same results as damage to visual cortices as far as core consciousness goes. In the same way that Emily does not conjure up specific knowledge pertinent to unique items, such as the previously familiar person or object, patients with damage within selected regions of the auditory sector of the cerebral cortex lose the ability to conjure up specific knowledge pertinent to, say, a previously familiar melody or the previously familiar voice of a unique person. The patient known in my laboratory as patient X. illustrates the situation. He is a highly accomplished and successful opera singer who, as a result of a stroke, lost the ability to recognize the singing voices of the colleagues with whom he had performed around the world. As for his own singing voice, he could no longer recognize it, either. He also lost the ability to identify familiar melodies including those of arias he had sung hundreds of times in his long career. Just as was the case with Emily, he had no problem outside the auditory realm and, just as was the case with Emily, he properly generated core consciousness for the stimuli that he was no longer able to know in the proper sense of the term. He scrutinized each unrecognized piece with keen awareness, searching within every

tone, within its color and mode of production, for a possible clue to the identity of the singer producing it. The only voice he was ever able to recognize unfailingly was that of Maria Callas, perhaps one more bit of evidence that Callas was indeed a breed apart.

Both Emily and X. have damage within the association cortices, respectively visual and auditory association cortices. It is apparent, then, from the study of numerous cases like theirs, that extensive damage in those sensory cortices does not compromise core consciousness. When it comes to extensive damage of early sensory cortices, only damage to the somatosensory regions causes a disruption of consciousness, for the reasons adduced earlier: the somatosensory regions are part of the basis of the proto-self, and their damage can easily alter the basic mechanisms of core consciousness.

NOW THAT WE know how the brain can put together the neural patterns that represent an object, and the neural patterns that represent an individual organism, we are ready to consider the mechanisms that the brain may use to represent the relationship between the object and the organism — the causal action of the object on the organism and the resulting possession of the object by the organism.