Two Conscious Minds in the Same Brain?
Split Brains and the Alien-Hand Syndrome

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Abstract—It is not uncommon, even for distinguished investigators in neuroscience, to believe that two independent consciousness, two minds, may exist side by side in split-brain patients. A split-brain patient is a severe epileptic whose corpus callosum the structure that connects the right and left hemispheres of the cerebral cortex has been severed. This belief arose in great part because some split-brain patients have been afflicted by the alien-hand syndrome, in which the patient, say, would reach for an object with his right hand, only to have the left hand block or undo the action. This fascinating possibility of two minds in the same brain is undermined, however, by more recent understanding of how a cerebral structure called the supplementary motor area selects and inhibits plans for action (developed in the premotor cortex). Nevertheless, explaining the true cause of alien-hand syndrome can be fascinating in its own right.

Index Terms—Epilepsy, split brain, consciousness.

In the second half of the 20th Century, neurosurgeons decided to treat severe epilepsy by cutting the corpus callosum of some of the worst sufferers of that disease. The corpus callosum is the very large group of axons that connect the right and left hemispheres of the cerebral cortex. Since communication between the two hemispheres was thus severed, the patients were said to have split brains. A curious and unfortunate result in some of the split-brain patients was that the left hand seemed to interfere with the actions of the right hand, as if the right hemisphere that controlled the left hand were at odds, indeed in a struggle, with the left hemisphere that controlled the right hand. The patient, say, would reach for an object with his right hand, only to have the left hand block or undo the attempt. This affliction, termed alien hand syndrome, has led many observers to conclude that, in the split brain, each hemisphere has its own consciousness.

For example, the psychologist Rhawn Joseph said the following after observing the bizarre behavior of one splitbrain patient. [Patient] 2-C’s left arm and leg not only engaged in controlled, directed, and purposeful behavior, but at times performed activities which his left hemisphere found objectionable and annoying. In some instances, physical struggles involving the right and left extremities of this patient were observed [1].

After several months, the alien-hand syndrome subsided and eventually disappeared in those few patients, presumably because the two hemispheres found new ways to communicate with each other by establishing sub-cortical connections. Nevertheless, the feeling persisted amongst many investigators that those split-brain patients still had two minds in one brain, albeit collaborating ones. This feeling has important consequences for our scientific attempt to understand consciousness, which is, in Nobel Laureate Eric R. Kandells words, the most challenging task confronting science [2].

Consider the famous psychological experiments on split-brain patients carried out first by John Sperry and Michael Gazzaniga [3], and later by Gazzaniga and Joseph LeDoux [4] (on the basis of this research, Sperry was awarded the Nobel Prize for Medicine or Physiology in 1981 [5]). Typically, in these experiments, a split-brain patient fixes his gaze on the center of a screen. Images appearing on his right visual field will be projected by his brain to his left cortical hemisphere, while images appearing on his left visual field will be projected to his right hemisphere.

In a famous version, conducted by Gazzaniga and LeDoux, an image of a chicken claw was projected to the patients left hemisphere. He was then asked to choose one image from a set of four with his right hand (controlled by his left hemisphere). He chose the image of the chicken head. And of course we know why: Its the image most related to the image of a chicken claw that was projected to his left hemisphere.

An image of a wintry scene (a snow-covered cabin with smoke coming out of the chimney and a snow man in front) was then projected to his right hemisphere. He was then asked to choose one from the same set of images with his left hand (controlled by his right hemisphere). He chose a snow shovel. Again that seems to make sense, for we know that a wintry scene was projected to his right hemisphere.

The surprise came when he was asked why he chose as he did. He explained that since he had chickens, he would need the shovel to clean the chicken shed!

It seems that the patient was conscious only of what his left hemisphere processed: A chicken claw. It also seems that he had unconsciously grasped the snowy scene in his right hemisphere, and thus he chose the snow shovel, but he was not consciously aware of it. Thus he resorted to confabulation, to making up a connection between chickens and the shovel. Why would this be so? In most of us the left hemisphere is dominant for several conscious functions, language in particular. So it may be that for the kinds of tasks involved in the Gazzaniga-LeDou experiment, and others like it, the left hemisphere is needed for us to be conscious of the performance of the task. The right does its own job too (it detects a wintry scene and then chooses a drawing that relates to that scene) but unconsciously.

It is worth emphasizing that the patient did not feel confused and had no difficulties verbalizing his conscious perceptual experiences. For in these experiments the patients can be quite confident, indeed adamant, that they have not seen the images projected to the right hemisphere.
Nevertheless, many notable investigators would insist that the patient did have a conscious experience of the wintry scene. Christopher Koch [6] seems to think that since the brain mechanisms in the two hemispheres are similar, and since they are able to produce successful behavior (e.g., making the right associations: chicken head snow shovel), then we are entitled to conclude that the right hemisphere is conscious too, just as we are entitled to conclude that the cat is conscious because of the way it jumps and screams when we step on its tail. So structure plus behavior justify the conclusion of consciousness. This analogy fails, however, because, when it comes to consciousness, first-person reports are crucially relevant behavior (not beyond doubt, but surely no less significant than the cat's screaming). And the subject is adamant that he does not experience the wintry scene. It thus seems reasonable to accept his testimony that he has seen nothing, just as in the well-known phenomenon of blindsight we accept the subject's testimony that she does not see the wooden blocks she successfully places into the slanted slots (blindsight patients cannot provide details of objects in front of them, but seem to have a sense for the location of those objects and how to manipulate them; this is explained by pointing out that the brain has two anatomically separate visual systems: the What system and the Where system. A patient with damage to the What system may still have an intact Where system).

It may seem that stronger evidence in favor of consciousness in the right hemisphere might be provided by patients under general anesthesia. Such patients sometimes carry on a conversation using hand signals, but postoperatively deny ever being awake. This retrospective oblivion, presumably, is not proof of unconsciousness [7]. But are these anesthesia examples really like the case we have been discussing? The disruption by anesthesia of thalamic and cortical areas is substantial and may well interfere with the formation of memories. Nothing of the sort happens in the case of the Gazzaniga-LeDoux experiment. And nothing really suggests that the right hemisphere had a conscious experience of the wintry scene but could not remember it.

No matter what replies one may offer, however, the suspicion remains, among many investigators, that the right hemisphere did have a conscious experience. One reason that makes such suspicion seem reasonable is the widespread belief that the alien-hand syndrome has already established the existence of two minds in split-brain patients. Nevertheless, exciting possibilities do not always amount to exciting scientific discoveries. Science sometimes provides a simpler explanation. I believe this is one of those times.

Suppose you decide to pick up a tea cup within your reach. Several areas of the brain will then be activated. Your premotor cortex (PMC) in each hemisphere will entertain one or more potential movements that might fulfill the intended goal, e.g., grabbing it with the right or left hand, in a quick or slow motion, etc. These plans for potential action (motor plans) are driven strongly by your perceptions of the objects around you and your typical interactions with them. For example, the handle of a tea cup near you will influence both your left and your right PMC to draw up a plan to pick it up. At this point another brain region, your supplementary motor area (SMA), which is influenced mostly by internal sources, such as your craving for tea, will decide between the competing motor plans, e.g. it will determine that your right hand is better positioned or more skilled, and will thus pass on the motor plan of your left hemisphere to your motor cortex, which will then send signals to the muscles to make the appropriate motions to pick up the tea cup (remember that your left hemisphere controls your right hand). At the same time your SMA will inhibit all other competing motor plans. The tea is available. You decide to have some. You reach over with your right hand and pick up the cup. Simple story [8].

What happens, however, if your SMA is damaged by a stroke or a tumor? In that unfortunate case, all the several competing motor plans will be passed on to your motor cortex. If so, both your right and your left hand will compete for the handle of the tea cup. To an outside observer, it may look as if your two hands are fighting for it. You will then be diagnosed as suffering from alien-hand syndrome!

Yes, people who do not have split brains can, and do, suffer from alien-hand syndrome, but it would occur to no one to suggest that they have two competing minds in the same brain. Neurosciences simple explanation of the syndrome has no room for such fancy. Moreover, the relevant processes in the right and left PMCs, as are those in the SMAs need not be conscious; indeed, like most brain processes they are likely to be unconscious (e.g., you dont say to yourself, I want some tea, so I think I will pick up the cup with my right hand). And that is for the best, for otherwise our actions would become dangerously slow.

What about split-brain patients, though? Severing the corpus callosum destroys the communication between right and left SMAs. It destroys, that is, the necessary coordination and selection of only one action to be passed on to the motor cortex. The inability to inhibit potential actions may thus result in behavioral conflicts between the two sides of the body. It may result, that is, in alien-hand syndrome.

Advances in neuroscience allow us to dispel the mystery created at an earlier stage of the discipline. But its seemingly simple explanation conjures up possibilities that are not less fascinating. In developing it, I am clearing the way to investigate consciousness by comparing the sensory processes in the two hemispheres of split-brain patients. Apart from that, knowledge of the actual manner in which alien-hand syndrome comes about may also offer some clues for ways to alleviate the distress of those so bizarrely afflicted.

REFERENCES


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