

Consciousness and Commissurotomy: V. Concerning an Hypothesis of Normal Dual Consciousness

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Against the commissural-integrative hypothesis, Puccetti argues that all normal people have two streams of consciousness; the cerebral commissures cannot fuse into a single stream any processes proceeding in different hemispheres. Against Puccetti, it is argued that, since the same kind of connecting fibers must be responsible for our having unified cross-modal experiences, they must be able to do the job, as well, of integrating processes across hemispheres. In response to this argument and in a pluralistic effort to instigate further development of Puccetti's hypothesis, I present a "Puccetti-compatible" account of cross-modal integration, which (a) does not assign this function to connecting fibers and (b) proposes two integrative conscious foci, one in each hemisphere of both normal and commissurotomed individuals. Also, I introduce a close alternative to the Puccetti-compatible account, which postulates a functioning integrative conscious focus in the dominant cerebral hemisphere of normal people, but only a potentially functioning integrative conscious focus in their nondominant hemisphere—which is disinhibited upon either full commissurotomy, dominant hemispherectomy, or drugging the dominant hemisphere. Thus, this article is preparation for the next article in this series, which will examine what evidence proposed or possible exists for an actually functioning integrative conscious focus in the fully connected, healthy nondominant hemisphere.

Commissural-Integrative Hypothesis

The particular hypothesis of normal dual consciousness that the present article addresses proposes that there is a separate consciousness in each intact, healthy, normally functioning, fully connected cerebral hemisphere. At this time, no such hypothesis has a large scientific following. According to the much more popular "commissural-integrative hypothesis" (as I have called it [Natsoulas, 1988a, 1992a]), normal people, though they possess two cerebral hemispheres, normally have only a single stream of consciousness.

And this is due to a single, unified, widely distributed, molar process that proceeds at the cerebral cortical level (e.g., Sperry, 1976, 1977, 1984). The commissural-integrative hypothesis holds that, by means of the forebrain commissures, a molar process "straddles" the two cerebral hemispheres and constitutes the normal stream of consciousness. Thus, normal consciousness is an ongoing brain process that, at every point, consists jointly of part-processes taking place in the left cerebral cortex and of corresponding part-processes taking place in the right cerebral cortex (cf. Dimond, 1979, 1980; Doty, 1990; Kinsbourne, 1982, 1988).

On the assumption that the commissural-integrative hypothesis is true, I argued to the following effect in the immediately preceding article of the present series on consciousness and commissurotomy (Natsoulas [1992a]; see also Natsoulas [1988a]). With regard to people with complete forebrain commissurotomy, we should expect to find *that neither the residual consciousness belonging to the right cerebral hemisphere nor the residual consciousness belonging to the left cerebral hemisphere is the same as a normal stream of consciousness*, which is produced, *ex hypothesi*, by the mutually integrated functioning of the two hemispheres. The two distinct streams of consciousness that are proceeding, according to the commissural-integrative hypothesis, one in each cerebral cortex of the fully commissurotomed individual, would be lacking, respectively, the normal, special contribution of the other cerebral cortex.

While I was introducing my main topic (i.e., an examination of three ways in which the consciousness of the disconnected left hemisphere has been hypothesized to differ from normal consciousness [Natsoulas, 1992a]), I mentioned that there are other theoretical views than the commissural-integrative hypothesis concerning the relation of brain and consciousness in the normal individual. And, according to some of these views of normal consciousness, it is expected, contrary to the commissural-integrative hypothesis, *that nothing essential will be discovered about the disconnected left hemisphere's stream of consciousness that cannot also be known through the study of consciousness in intact individuals*.

Hypothesis of Normal Dual Consciousness

I went on to describe a prominent one of these contrary views in the following words:

An example . . . which may come to mind first is Puccetti's hypothesis that the intact, healthy individual already has two streams of consciousness, one proceeding in each cerebral hemisphere (Puccetti, 1973, [1981a, 1981b], 1989; cf. Bogen [1969a, 1969b], 1981, 1986, 1990; Oakley and Eames, 1985; Wigan, 1844/1985; Zaidel, 1987; Zaidel, Clarke, and Suyenobu, 1990). In fact, Puccetti holds that commissurotomed and normal individuals are *each two persons* . . . ["The individual human organism, having two brains, is the biological substrate of *two persons*, each of which has one mind" (Puccetti, 1989, p. 141)].

Thus, according to Puccetti, the two streams continue as they were before commissurotomy except for no longer receiving and being affected by direct information from the other cerebral hemisphere. (Natsoulas, 1992a, pp. 42–43)

And then, after presenting a little more about Puccetti's hypothesis, I proceeded to my main topic, without again mentioning Puccetti's alternative to the commissural-integrative view.

In effect, I had postponed consideration of the mental-duality sort of view to a future article of the present series on consciousness, commissurotomy, and closely related matters. And now, in the present installment of the series, I shall begin to consider the grounds on which Puccetti held that a duality of consciousness characterizes not only fully commissurotomed people, but also the intact, healthy human being. What are this theorist's reasons for claiming that the kind of mental duality that Sperry and others discovered in fully commissurotomed people is also normal and ordinary, and how good are Puccetti's reasons for proposing a normal dual consciousness?

Justification

Pluralistic Approach

In case justification is needed for the attention that I am devoting here to Puccetti's unpopular though intriguing hypothesis, let me first cite the following dimension of my own general psychological approach: "The pluralistic approach assigns low methodological priority to the elimination of alternative conceptions, and high methodological priority to the development of alternative conceptions and to their interanimation" (Natsoulas, 1990, p. 181). It would be a mistake, however, to consider my pluralistic approach as noncritical. From this methodological perspective, criticism can be no less thorough and incisive than it is from the prevalent "eliminative" perspective (Natsoulas, 1990). However, criticism from the present perspective is motivated nearly always (for an exception, see Natsoulas [1991a] and the next main section below) by a strong desire to instigate improvements in the particular conception on which one is focussing, in order that

(a) this particular conception may continue to survive and flourish in the psychological marketplace of ideas, and thus continue to enrich our understanding of the corresponding subject matter; and

(b) the overall quality of our alternative conceptions of the particular subject matter may grow and grow—through comparison and competition among the alternatives, as well as through often-more-subtle psychological processes which take place within the mind of the individual psychologist in contemplating, and working with, more than a single conception of his or her subject matter at a time.

Encouraging Alternative Conceptions

For examples of my pluralistic approach toward alternative conceptions, see the constructive way in which, in the present series of articles, I have discussed and criticized, among others, the following major views of consciousness and commissurotomy with which I am not myself disposed to agree:

(a) Eccles's (e.g., 1987) mind-brain dualism, which has led Eccles to propose that fore-brain commissurotomy succeeds not only in its purpose, which is mutually to disconnect an individual's two cerebral hemispheres at the cortical level, so as to protect the individual against further epileptic attacks, but has also led Eccles to propose *that commissurotomy succeeds in dividing into two independently functioning parts nothing less than the immaterial self-conscious mind itself* (see Natsoulas [1991a]);

(b) Gillett's (e.g., 1986) startling view (which, at this point in the advance of science, is for Gillett only a kind of humanistic faith) *that, without exception, every behavior controlled by the disconnected right (not the left) hemisphere can be scientifically and truly explained without any reference to a stream of consciousness (or any individual conscious process) that belongs to the right hemisphere* (Natsoulas, 1991a); and

(c) Gazzaniga's (e.g., 1985) postulation of a verbal consciousness system ("the interpreter module"), which is claimed to exist only in the left, linguistic hemisphere of the large majority of both normal and commissurotomized people (Natsoulas, 1988a). Thus, according to the latter view, *the right hemisphere commonly lacks consciousness or, at least, it lacks a human consciousness* (LeDoux, 1985).

I expect that the latter conception of consciousness will have large difficulties in accounting for the consciousness evidenced by those rare people who have had their entire left hemisphere removed. These are difficulties that, to my knowledge, the authors of the latter conception have not yet publicly addressed. Those scientists who are concerned with how consciousness is related to the brain would all be better off in their understanding, I believe, were Gazzaniga and LeDoux to publish a systematic attempt to encompass the psychological results of left hemispherectomy from their unique and valuable perspective on how the cerebral hemispheres function in producing consciousness.

Although it too has a linguistic emphasis, Gillett's understanding differs from Gazzaniga and LeDoux's in the following respect, among others. Gillett holds that all behaviors of commissurotomized people (a) that are in fact produced by the right hemisphere and (b) that Gillett cannot interpret as behaviors (including "mistakes") of the one and only person who, according to Gillett, is involved in all such cases, are actually something else, namely, non-behaviors (cf. next main section, i.e., Puccetti on myoclonic fits). Presumably, it is Gillett's view that, even after left hemispherectomy, the identical person would be carrying on, albeit under a major new disabling disadvantage.

Above, I called Puccetti's proposed mental duality "unpopular." I was thinking of the attitude toward such views that I have observed among psychologists, students, and others who assume and value their own unicity (i.e.,

singleness) and unity (i.e., integrity, coherence) of consciousness. Implicitly, however, the dual-consciousness view of normal mentality may not be so alien to those who attempt empirical research on commissurotomed individuals. Thus, Gazzaniga (1988) has stated, "Most prior studies have been carried out in the belief that each half-brain is a functioning, independent system that operates no differently when separated than when connected" (p. 229).

Qualification

A second reason for attending in the present article to the hypothesis that two centers of consciousness (two "integrative conscious foci," as I shall later call them) exist in each normal human being is that this hypothesis has, obviously, very large implications about our very nature. Whatever doubts may attend our reception of the hypothesis of normal dual consciousness, we should welcome some theorists' advocacy and development of this hypothesis because it is the kind of hypothesis that challenges all of us to reexamine our most fundamental assumptions about ourselves.

However, I have previously argued, in effect, *that not all hypotheses fitting the latter description should receive our encouragement or support* (Natsoulas, 1991a). The pluralistic approach must not shirk from making certain important discriminations. Specifically, we should not give any support or encouragement to views we judge to have morally odious consequences; nor should we, generously and understandingly, allow these views to remain unchallenged at any of their vulnerable points, especially at their foundations. My specific example of such a view, in my previous article, was Rey's (1983a) poorly founded case against the very existence of consciousness.

Selective Skepticism (To What End?)

Since before 1983, Rey has been prematurely arguing against the existence of consciousness—while failing to give serious attention to the foundations of the conception of people that he would substitute for those other conceptions, which he disparages, that do make explanatory use of a concept of consciousness. Thus, Rey's conception of people remains in a highly undeveloped condition, even as he cites this conception in order to promote his socially dangerous alternative (Natsoulas, 1991a). As I have previously stated, a general state of scientific ignorance about the matter at hand does not deter Rey from rushing (one has to wonder, *to what end?*) to deny consciousness to everyone in sight—including the weak and the defenseless, that is, to those people who will suffer the most from his contention should he succeed in his long-term effort to get belief in the nonexistence of consciousness to catch on and to spread over the intellectual landscape. (I understand that a book is in the offing.)

Challenging Velmans's (1991a) recent defense of a certain view of consciousness, Rey (1991) once again expressed his selective skepticism, demanding to be shown that consciousness exists, simply insisting on the validity of his faith that "*ideas, beliefs, introspections, [and] phenomenal reports*" can be fully and truly explained without reference to consciousness. In his reply to Rey (1991), Velmans (1991b) stated,

Rey . . . compar[es] my faith in the existence of consciousness to a theologian's faith in the existence of God. . . . In denying the existence of consciousness, Rey is denying the existence of all its contents. Not just love and hate, pleasure and pain, and other inner events such as thoughts, images, and dreams—but even the experienced body and the *entire phenomenal world* (including visual experiences of meter readings, brain events in others, etc.). Given a denial of this order not even a direct line to the Almighty will save his argument. (pp. 714–715)

Note that Rey does not require of himself that he demonstrate his ability actually to explain what he claims to be explainable without any reference to consciousness. In this regard, Rey resembles Gillett (1986) on the actions initiated by the disconnected right hemisphere. Objecting to a claim that the right disconnected hemisphere is behaving unconsciously, Puccetti (1983) stated,

People with cerebellar symptoms will sometimes have myoclonic fits in which they wave their arms as if signalling the engineer of a locomotive, but no one believes this is the case when the [disconnected] right hemisphere uses the left hand to point to the 2 after being asked, "Now point with the left hand to the number you saw." (p. 737)

Soon after this statement appeared, Gillett (1986) expressed himself in such a way as implies that all behavior of the disconnected right hemisphere belongs in the same nonintentional, nonmental category as the bodily movements produced in the myoclonic fits mentioned by Puccetti (unless it can somehow be attributed to the one and only person said by Gillett to be involved in every case of commissurotomy). Gillett has not addressed, with reference to his hypothesis about right-hemispheric behavior, such studies as Sperry, Zaidel, and Zaidel's (1979) on self-awareness in the disconnected right hemisphere.

As well, Rey reminds me of many behaviorists, past and present, who have been, selectively, demanding or permissive, depending on whether whatever is being proposed meets the needs of their "party" (see Natsoulas, 1988c). The pluralistic approach encourages and supports the truly scientific efforts of behaviorists and others. But the pluralistic approach is consistent with the view that forming scientific gangs

(a) amounts to engaging in unscientific behavior, whether or not it takes place under the banner of "good science;" (b) has already proved to be inimical to the progress of psychology, as a large majority of psychologists will readily attest; and (c) is not worthy of a free society, which is the kind of society in which many of us want to live.

Dual Brain

And if it turns out, as it has, that there is double representation for the full subjective visual field in the normal vertebrate brain, then anyone who wants to argue that there is nevertheless only one seeing mind in such animals is going to have to solve the fusing problem, rather than just wave it away. (Puccetti, 1981a, p. 118)

In a recent article, Puccetti (1989) argued again, as he has in other papers (e.g., Puccetti, 1981a, 1981b, 1987, 1988), that the temporally extended brain process which constitutes our stream of consciousness does not span the two cerebral hemispheres. If the process of consciousness did span the hemispheres, "then we should perceive any object of perception *twice* side-by-side: *i.e.* we should have *double vision*" (Puccetti, 1989, p. 141). Since we normally do not have double vision, the following must be the case. The single stream of visual experience of which we are conscious, and which we can readily report on in everyday life, is the stream of visual experience taking place in our left cerebral hemisphere, which controls speech in the large majority of people.

I shall very shortly return to this argument of Puccetti's, which also attributes to the right hemisphere its own stream of consciousness, whether the right hemisphere is disconnected from the left hemisphere or, as is normal, connected to the left hemisphere via the forebrain commissures (see further on, section titled *Nonintegrative Commissures*). I should mention now the fact that there are also subcortical connections between the two cerebral hemispheres, connections whose functioning is presumably not disturbed by forebrain commissurotomy. The information transmitted between the right and left cortex in both directions via subcortical fibers and structures does not have the high specificity and detail of the information that gets transmitted via the forebrain commissures. For example, it has been shown, with fully commissurotomized subjects, that only the connotation, not the identity, of a visually perceived pictured object can be transferred from one disconnected cortex to the other entirely through subcortical pathways (Cronin-Golomb, 1986).

Puccetti (1989, p. 141) wrote the above quoted statement in the course of discussing Wigan's (1844/1985) book, in which Wigan defended the hypothesis that every intact human being has two minds—on the grounds *that every intact human being has two brains*. On our having two brains, Wigan (1844/1985) had stated,

The two hemispheres of the brain are really and in fact two distinct and entire organs, and each respectively as complete (indeed more complete), and as fully perfect in all its parts, for the purposes it is intended to perform, as are the two eyes. The corpus callosum, and the other commissures between them, can with no more justice be said to constitute the two hemispheres into one organ, than the optic commissure can be called an union of the *two eyes* into one organ; and it would be just as reasonable to talk of the two lobes or globes of the eye, as of the two hemispheres of the brain. (p. 19)

That is, to speak of the two cerebral "hemispheres" is to misname them, as though they were two halves of a single organ, as many people and scientific authorities assume.

Puccetti (1989) agreed with Wigan that the cerebral commissures, though they consist of a very large number of fibers that systematically connect many corresponding parts of the two cortexes, do not thereby convert the two brains into a single organ. And Puccetti added to Wigan's anatomical argument the empirical support that is provided by the recent psychological observations conducted on those patients whose cerebral commissures have all been surgically severed, as well as the observations conducted on patients who, due to an intractable brain disease, have had an entire one of their cerebral hemispheres removed (e.g., Smith, 1966). Such observations show, according to Puccetti, that a deconnected or solitary cerebral hemisphere (*in vivo*, of course) functions in such a way as indicates that it has a human mind, including a stream of consciousness. So far as having the necessary brain structures is concerned, therefore, the same can be true in the intact individual.

The cerebral commissures are unnecessary for human consciousness. Note that the latter statement is also agreed to by advocates of the commissural-integrative hypothesis; that is, they acknowledge, of course, consciousness in commissurotomed people and in both right and left hemispherectomized people. However, according to the commissural-integrative hypothesis, it is the case that, in the intact healthy individual, activity in the corpus callosum and other cerebral commissures "becomes part of the conscious event" (Sperry, 1976, p. 171). This does not mean that the cerebral commissures are the seat of consciousness, but that they make possible a single integrated stream of consciousness, as opposed to the two independent streams that take place in those who have been commissurotomed.

Harmony and Unicity

However, Puccetti disagreed with another dimension of Wigan's hypothesis of mental duality. Wigan (1844/1985) had also stated,

I think it may be assumed without risk of contradiction, that the fact of each brain being a perfect and complete instrument of thought is abundantly proved. That each, while in health, corresponds entirely with its fellow, is obvious from the fact that this unison and correspondence give only one result, as in the case of the two eyes producing single vision. (p. 204)

Thus, Wigan was expressing the view that, whereas either one of the two cerebral hemispheres can mentally function independently from the other, the hemispheres normally function together in such a way as to produce, for example, a single visual experience—rather than what is also possible but

abnormal, namely, two simultaneous visual experiences, one in each cerebral hemisphere. The hemispheres, when they are functioning in unison and not discrepantly from each other, result in a single mental life according to Wigan. Puccetti (1989), discussing Wigan's view, disagreed on this point, as I shall explain in the next main section.

Sperry's "Functionalism"

Before I do so, however, let me mention that the idea that the unison and correspondence of processes between the two hemispheres (harmony) gives rise to a single conscious effect (unicity) can be found in some of Sperry's "functionalist" comments about consciousness, those in which Sperry emphasized *that a single and unified consciousness is the product of the two cerebral hemispheres' functioning together harmoniously to produce a joint outcome*. For example, Sperry (1977) stated,

What counts in determining subjective meaning on these terms is the way a given brain process works in the context of cerebral organization. Subjective unity is accordingly conceived in terms of organizational and functional relations which in turn leads to the idea of a functional (thus causal) impact. (p. 116)

I discussed Sperry's "functionalism" about consciousness in the first article of the present series (Natsoulas, 1987a; see also Natsoulas, 1987b).

I argued there that the joint hemispheric outcome to which Sperry was referring must be not simply behavioral, but also a single stream of consciousness proceeding in the brain of the intact human being; otherwise, Sperry's "functionalist" account would have to ascribe to fully commissurotomed people, as well, only a single unified consciousness whenever their behavior is unified—as a result of the mutually harmonious functioning of the individual's disconnected hemispheres, which would seem to be the case nearly always.

Of course, much of Sperry's writing on the topic of consciousness and the two cerebral hemispheres advocates a commissural-integrative account of the normal stream of consciousness and of dual consciousness in commissurotomed people. That is, Sperry does not carry through with his "functionalism" to the point of suggesting either (a) that the stream of consciousness is a behavioral or an immaterial product of the pertinent brain processes, or (b) that consciousness exists only in the eye of the beholder, who observes human behavior bringing it under mentalistic categories.

Nonintegrative Commissures

"Double" (as Distinct from Dual) Consciousness

Now to return to the argument of Puccetti's with which I began the previous main section titled "Dual Brain." In effect, Puccetti was suggesting that there could not be a successful mutual integration of the processes on each side of the brain, that is, the respective processes in the two cerebral hemispheres which are responsible for our visual experiences; *at most, right-hemispheric experience and left-hemispheric experience could be "added" to each other, producing a "double" consciousness analogous to double vision (i.e., as distinct from a dual consciousness).*

Perhaps the two constitutive experiences would not be exactly the same as they would be if they did not adjoin each other (were not "side-by-side"), but the two experiences could not be unified in the sense of their constituting a unitary, undivided, nonredundant single experience. In opposition to Wigan's statement, Puccetti (1989) stated that it does not matter if there is "perfect 'unison and correspondence' between the two percepts: two is not one" (p. 141). That is, if the commissural-integrative theory were true, that is, if there existed in the normal human brain only a single center or process of consciousness involving structures in both hemispheres, we would be conscious of the duplication of our experiences, according to Puccetti's understanding, because the two cerebral hemispheres possess parallel structures and physiology that make this duplication of consciousness not only possible but necessary (unless something further happens to prevent the relevant activation in one of the two hemispheres).

Note that Puccetti's claim that a "double" (as distinct from dual) consciousness would occur that is analogous to the familiar phenomenon of double vision is merely the outcome of an argument which, contrary to Puccetti's own view, assumes that the commissures can give the human being a single consciousness. Puccetti denied that the commissures can do anything at all of an integrative kind. This includes their working in such a way as to produce two streams of consciousness that seem to be proceeding, subjectively, one right adjacent to the other. (In Puccetti's view, the forebrain commissures also cannot provide one cerebral hemisphere with immediate ["introspective"] awareness of mental brain-occurrences that are taking place in the other hemisphere; see just below.) According to Puccetti's own dual consciousness hypothesis, there is a duplicity of consciousness in the normal individual as well, but this individual, too, possesses no firsthand awareness of it, no subjective doubleness of experiences.

"An Inconceivable Expectation"

Whoever "I" am, whether "I" am the left or the right cerebral hemisphere of "my" body, "I" have immediate awareness of only the mental life that proceeds in one of "my" two hemispheres, namely, whichever one of the hemispheres it is that "I" am. Contrary to Churchland (1986, p. 180), Puccetti's hypothesis does not hold that "I" am more than one self, because when "I" speak or think about who "I" am, I do not mean to be making reference at all to the mental life of the other hemisphere that is housed in "my" body, since that mental life is completely outside all that of which "I" can have any immediate ("introspective") awareness.

Evidently, from Puccetti's perspective, such awareness cannot occur at a distance, that is, simply due to a mutual connectivity, by means of commissural fibers, between particular loci of experiences or consciousness in the two hemispheres (cf. Puccetti, 1985, 1989, p. 142). Bradshaw (1989) understood Puccetti to hold that the absence of interhemispheric awareness of conscious contents is due to callosal inhibition. Indeed, Puccetti (1985) stated that there is "an inhibitory mechanism that prevents each half brain from having introspective access to the conscious content of the other" (p. 647).

However, Puccetti might better hold, or might better be understood to hold, that it is dual mindedness that is responsible for this state of affairs; *the reason that you are not aware of the mental life of your other cerebral hemisphere is because its mental life is not your mental life*. Somehow, each hemisphere, by virtue of its structure, internal organization, and how it functions, constitutes a separate mind. Even if experiences occurring in your other hemisphere produce effects in your own mental life, the latter conscious effects, which belong to your mental life, cannot be immediate awarenesses of those other "foreign" experiences which are their causes (cf. subcortically transmitted information in the commissurotomy mentioned earlier). Accordingly, Puccetti (1985) did not merely state that "experiencing two selves" is obstructed by the forebrain commissures' functioning in an inhibitory mode. He stated that "experiencing two selves" is an "inconceivable expectation." It is just as inconceivable as my having immediate ("introspective") awareness of your mental life, since Puccetti is talking about two brains and persons existing in one skull.

Summary

We have no firsthand awareness of a duality of consciousness for the following two reasons according to Puccetti:

1. The cerebral commissures do not perform the integrative function that the commissural-integrative view assigns to them. The commissures do not function to produce just a single center and stream of consciousness—which would mean necessarily, according to Puccetti, a “double” consciousness, analogous to double vision. Rather, the function of the commissures is to relay information from one to the other cerebral hemisphere, that is, to cause the contents of the conscious experiences of one cortex to be duplicated in the form of conscious experiences belonging to other cortex, so that the two hemispheres can work in unison with each other. The cerebral hemispheres perform this function of equalizing information between the hemispheres without giving to any structure of the brain an immediate awareness of the duplication of information or of the duplication of conscious contents.

2. If one cerebral hemisphere were to be immediately (“introspectively”) aware of the opposite stream, in addition to being aware of its own stream, then this would mean, according to Puccetti, a subjective double mindedness, in the same sense as one’s consciously having double vision. The evolutionary process had to eliminate this undesirable result, assuming that this result did emerge to some degree at some point in our evolutionary history. A unicity of consciousness across the cerebral hemispheres, and the immediate (“introspective”) awareness that this unicity would perforce involve of the constituent experiential processes, would mean, subjectively, a constant double vision and other misleading “double” experiences, that is, a moment-to-moment conscious experiential disunity that made action based on experience dangerous.

Intrahemispheric Connecting Fibers

According to Puccetti, the experiential processes that simultaneously, in parallel, proceed in the two cerebral hemispheres, just cannot get themselves, ever, in any way, mutually integrated by means of the cerebral commissures. These interhemispheric connecting fibers can only function to activate, *or to inhibit the activation of*, processes in the other hemisphere. The cerebral commissures cannot do the job of fusing or joining brain processes together, thereby producing, among other things, a unicity of experience across the two brains. And there is no other way, according to Puccetti, by which a unicity of experience can be accomplished in someone who has two intact, healthy cerebral hemispheres—except, of course, by drugging either hemisphere, or removing it, or finding another way of halting the flow of one of the normally two streams of consciousness. There is *no cross-hemispheric fusion mechanism* as advocates of a commissural-integrative hypothesis insist that there must be, though these advocates fail to explain how such a mechanism might work. So Puccetti has argued.

A Useful Response

Against this part of Puccetti’s argument, Anderson and Gonsalves (1981) presented a useful response. They contended that the commissural fibers are capable of doing more than Puccetti claims they can do, and that the commissures must normally do more for the simple reason *that we know firsthand that our experiences are cross-modally integrated*. Anderson and Gonsalves (1981) stated,

The visual, auditory, and tactile modalities overlap in experience and are held in one unity of consciousness. You can see a book and then reach out and touch it; the experiences overlap and correlate with one another in making up a common perceptual space. Choreography is an art form whose essence involves the intimate connection between audition and vision—music and dance. Although these modalities are unified in consciousness, they are located in disparate regions of the brain. Thus the mechanism providing this unity must involve the white fiber cortico-cortico (or subcortical) connections running between these areas. If intermodal unity is accomplished by white-fiber connections, then it is even more likely that intramodal fusion could be accomplished by commissural axonal connections. (p. 100; cf. Sperry [1977]: “The fiber cross connections between the hemispheres are not different [in their unifying function] from fiber systems within each hemisphere” [p. 444])

That is, those activated structures within each hemisphere that, in Puccetti's view, provide our various experiences (e.g., the respective areas 17 and 18 on each side provide visual experiences of the entire field of view to each hemisphere), *must somehow constitute together a unified center of consciousness, though these structures are joined to each other within each hemisphere by no more than the very kind of connecting fibers that comprise the forebrain commissures.* Since these connecting fibers do the required integrative job inside a hemisphere, connecting fibers of the same kind can do this job between hemispheres. So Anderson and Gonsalves have argued.

Against the “Committee” Conception of Mind

But, surely, Puccetti would not countenance the latter consequence of what Anderson and Gonsalves presumed to be the hypothesis of intrahemispheric integration which Puccetti must accept. Nor would Puccetti want to say the following, analogously to his view of the role of the cerebral commissures:

The respective separated mental brain-processes within the left (or right) hemisphere *cannot be mutually integrated or fused* because the connecting fibers between these mental brain-processes merely activate or inhibit these processes but cannot combine them into a single, molar process.

Indeed, Puccetti (1981b) argued persuasively (though not by Rey's [1983b] standard) against the “committee” conception of the mind. That is, Puccetti objected to the view *that there are multiple centers of consciousness in the brain—which send information to, as it were, the “chairperson of the committee” who does not experience anything more than their “messages,” that is, the relayed information in the abstract.* Puccetti (1981b) argued against the committee conception as follows:

Take any three friends and ask them to imagine being, respectively, visual cortex, auditory cortex, and a limbic center connected with a single cerebral hemisphere. Then entertain the picture of all three attending to, say, an attractive member of the oppo-

site sex slowly disrobing to the music of bongo drums. One friend sees the dancer disrobing, but hears and feels nothing. Another friend hears the music, but sees and feels nothing. The third feels sexually aroused but, seeing and hearing nothing, hasn't a clue why. This is absurd, yet it is the committee model of mentality. I for one know it does not model my mind, for in the imaginative exercise I would be seeing, hearing, and feeling aroused. And not as some kind of committee chairman receiving reports from members, but as the original subject of these experiences. (p. 117)

Indeed, Puccetti must be right about who it is who would be seeing, hearing, and feeling; or, at least, Puccetti must be right about the one who is having the conscious experiences involved in these activities. It would not be the members of a "committee," each of whom is performing a different mental function. The one who is consciously experiencing—visually, auditorally, and sexually, all at the same time and in an integrated fashion—and reporting to us about it would be Puccetti himself, that is, a single subject of a single unified experience.

However, the question Anderson and Gonsalves raised still stands. From Puccetti's perspective, how is this unified experiential result possible, given that each of the three kinds of experience occurs in a different structure within a hemisphere?

A Puccetti-Compatible Hypothesis

Two Integrative Conscious Foci

Perhaps it would be consistent for Puccetti to hold, instead, *that there is a single place in each hemisphere where all three kinds of experience are duplicated and mutually integrated*. This place would be a center of consciousness, and it would be that, in my left brain, to which I am actually referring, know it or not, when I speak of *myself* as the one, *the subject*, who takes pleasure in witnessing the dance. To account for the results of commissurotomy and hemispherectomy, Puccetti could postulate two such centers, one in each hemisphere. Thus, there would be a mechanism of fusion within each hemisphere—that is, a duplication of experiences from three different modalities (in the above example) at a single cortical location where, also, the three qualitatively different experiences would be integrated together.

"*Introspective*" awareness. Moreover, according to this proposed "Puccetti-compatible" hypothesis, the integrative focus in each hemisphere would also be an integrative *conscious* focus. That is, an integrative conscious focus functions in such a way as to provide us with those integrated, multimodal experiences with which we are so very familiar directly, on a firsthand basis. This additional, crucial property (i.e., the consciousness) of an integrative conscious focus is consistent with, among other things, one of the points concerning Puccetti's conception of consciousness mentioned in the section

“Nonintegrative Commissures” earlier in the present article. Namely, Puccetti held that *connecting fibers cannot mediate, for either hemisphere, any immediate (“introspective”) awareness of experiences proceeding in the other hemisphere.* This was, he stated, an “inconceivable expectation.”

That is to say, being conscious of an experience occurs at the location of that experience, never at a distance, never mediated by connecting fibers. Any case of, so to speak, being aware-at-a-distance of an experience, which would be due partly to the functioning of connecting fibers, would not be considered by Puccetti as immediate (“introspective”), nor would Puccetti consider awareness-at-a-distance to qualify for the awareness of an experience essential to its being conscious. An awareness-at-a-distance of an experience would be inferential, which is the highly likely case if not the only case.

Sources

The above idea of an integrative conscious focus, which I am proposing as part of a Puccetti-compatible account, owes a great deal to the following comment by Anderson and Gonsalves (1981):

On the unitary hypothesis, we can speculate that visual experience is due to the integration of visual input at higher levels of neural processing. Each area 18, rather than being a projection area corresponding to its contralateral area 17, integrates information from area 17 on both sides of the brain . . . and this bilateral integration is continued at even higher levels. (p. 100)

The following statement by LeDoux and Gazzaniga (1981) also points in the same general direction:

Within each hemisphere, the visual world is multiply represented, and the unified percepts of a single isolated hemisphere thus reflect the integration of processing occurring in many cortical and subcortical cell groups. Similarly, in the intact brain, unified percepts involving both visual fields reflect the fusion of visual processing in the multiple areas representing the visual world within each hemisphere, with the processing occurring in the homologous areas of the other hemisphere. (p. 110)

The Puccetti-compatible hypothesis proposes that, in each cerebral hemisphere, there is a locus where an integration is taking place of inputs from various modalities, and these inputs are determined by processes in both hemispheres. This hypothesis further includes the notions that the integrated process at the locus includes (a) duplicates of experiences belonging to whatever the contributing modalities may be in the particular case and (b) a consciousness of the integration of these duplicates from moment to moment as a unified, single, multimodal experience.

Neurons

This idea of an integrative conscious focus, which I am suggesting as needed by Puccetti's account of consciousness in relation to the brain, reminds me that, a long time ago, when both psychology and neurophysiology were very young, Freud (1895/1964) proposed that there is a consciousness system that consists of unique ("omega") neurons (see Natsoulas [1984]) whose activation yields the various sensory qualities, as well as pleasure and unpleasure. The mental brain-processes of this system were held to possess, as no other processes do, a "subjective side"; that is, they were the only processes taking place (within the psychical apparatus) that Freud postulated to be "intrinsically conscious," as I have called them.

On the basis of Freud's entire body of published works, I have explicated the meaning of "intrinsically conscious" as follows (Natsoulas, 1989b). All mental processes that are conscious (a) possess qualitative and cognitive contents, (b) they individually give to their owner immediate awareness of themselves, and (c) their owner knows at the time of their occurrence that he or she is aware of them. And all of this is possible because of the special neurons that distinctively constitute only those mental processes that are intrinsically conscious.

Compare Freud's view with the present-day neurophysiologist Doty's (1990) following statement. This statement, too, would seem to be a contemplation of special neurons for consciousness, at this much more advanced point in the history and development of brain science. Doty (1990) stated, "A particularly significant clue as to how neurons relate to mind is the fact that only certain types of neuronal activity (or activity in certain classes of neurons?) are associated with conscious perception" (p. 5). Doty went on to mention the possibility of neocortical neurons that are specialized for the purpose of conscious experience. Similarly, Koch and Crick (1991) proposed that consciousness "may be associated with a sufficient number of neurons in layer VI of cortex firing in synchrony" (p. 684).

A Close Alternative to the Puccetti-Compatible Account

Since I have applied the same Puccetti-compatible reasoning to both interhemispheric and intrahemispheric integration, the normal individual still turns out to have two streams of consciousness, one in each hemisphere, because any integrative conscious focus has to be localized in one or the other cerebral hemisphere. If, contrary to such a Puccetti-compatible account, a theorist who has come along nearly to this point wants to insist *that there is, anyway, only one integrative conscious focus in the brain, presumably in the hemisphere that controls speech*, then this theorist would find himself or

herself in the uncomfortable position of having, for consistency's sake, to deny consciousness to the other hemisphere even when it is disconnected or on its own.

This position is an uncomfortable one for a theorist to adopt because the position may not be sustainable in the face of our developing knowledge of consciousness and commissurotomy and hemispherectomy. Such a theorist would have to argue, in addition, *that the neurosurgeon's act of cutting all the fore-brain commissures brings into operation, on the spot, a second integrative conscious focus, which existed structurally but was not functioning as such until after the surgery (as well as in early childhood, before the commissures developed adequately).* That is, this potential center of consciousness, this potential integrative conscious focus, hypothesized to belong to the mute hemisphere, has been continuously inhibited by "stimulations" arriving by means of the commissures and originating from the continuously active integrative conscious focus on the other, speaking side of the dual brain. Indeed, as Puccetti (1988) wrote, "Two minds do not become one upon maturation and myelination of the commissural fibers linking the two brains in our head." But, according to the close alternative to the Puccetti-compatible account, only one of those two minds will end up being a conscious mind unless the individual has, unfortunately, to submit himself or herself to the drastic surgery of commissurotomy.

Comparison with a Commissural-Integrative View

Thus, disagreement would be implied with the following statement of Doty's (1990), notwithstanding a rejection of the Puccetti-compatible account:

Given that the two hemispheres, when isolated by transection of the forebrain commissures, each maintains a wholly human but divided consciousness (Sperry, 1984), the profound conclusion is inescapable: the commissures allow one mind to communicate with another and produce thereby a single conscious entity. (p. 7)

Contrary to Doty, it would not be the functioning of the commissures that would ultimately explain conscious unicity; rather, it would be the integrative conscious focus on one side of the brain.

To this structure (focus) would travel information from within the left hemisphere; but also arriving at the structure (focus) less directly would be information from the right hemisphere that has contributed to those processes of the left hemisphere to be duplicated and integrated. On several good grounds, Doty (1990) rejected a competing view to the effect that the non-dominant hemisphere's contribution to normal consciousness might be negligible. But the above hypothesis of a single, lateralized conscious center (integrative conscious focus) in the intact individual would not treat of the nondominant hemisphere's contribution as though it were negligible. Rather,

the contribution of the nonconscious hemisphere would be indirect in the way that I have indicated.

Doty (1990) concluded his comments on the two cerebral hemispheres with the following statement: "It is only via the privileged intercommunication across the forebrain commissures that the consciousness of the two hemispheres, as distinct from the overt behavior of the individual, can be unequivocally unified" (p. 9). However, in making this statement, Doty did not have in mind the commissures' functioning to inhibit the consciousness that potentially belongs to the nondominant hemisphere. Doty's view was, instead, a commissural-integrative view.

Puccetti-Compatible?

I should pause to mention that what I have been calling a Puccetti-compatible account of intrahemispheric experiential integration may, actually, not be acceptable to Puccetti, although the context of his following remark may explain his making it. Replying to a holographic suggestion from Bradshaw (1983), Puccetti (1983) stated that *each chunk of cerebral cortex "would be either part of a specific and thus distinct projection system, or part of a nonspecific projection system, that is, white matter composed of association fibers that do not themselves subserve conscious functions anyway"* (p. 736; italics added). Puccetti was ruling out the possibility that one and the same chunk of cerebral cortex could subserve experiences of more than a single sensory modality.

It would seem to follow, in that case, that the integration of each hemisphere's experiences is accomplished entirely by connecting fibers. Which means that, as Anderson and Gonsalves argued, Puccetti must explain why the interhemispheric fibers, too, cannot perform the integrative function, resulting in a single stream of consciousness per individual, rather than two streams. Therefore, let me proceed, anyway, on the assumption that two integrative conscious foci, functioning simultaneously in each cerebral cortex, is the desirable Puccetti-compatible account.

Before returning to the main thread of the present discussion, let me also comment on Puccetti's (1981a, p. 95) following rhetorical question:

Now if the arrival in area 17 (primary visual cortex) of neural messages that are decoded as a familiar word is adequate to produce this behavioral readout generated from each of the cerebral hemispheres of the split-brain patient, why should it not be adequate in the callosally intact subject as well?

The answer I have already given to this question, on behalf of what I am calling the Puccetti-compatible account, is that the "behavioral readout" in this instance depends on having conscious visual experience, which occurs at the integrative conscious focus on either side provided the focus on one side is not

being inhibited (via the cerebral commissures) from functioning. The question then becomes *whether, in the callosally intact subject, the potential integrative conscious focus of the one hemisphere is continuously inhibited from functioning.*

Puccetti (cf. 1981a, p. 95) would probably reply that, if it is to be claimed that consciousness is not provided by processes in area 17, then it is incumbent on the one who denies the truth of his statement to propose a reasonable alternative location for conscious visual experiences. I have suggested that Puccetti shares in this problem because he, too, must address the *intra-hemispheric* integration of experiences belonging to different modalities (i.e., Anderson and Gonsalves's problem for Puccetti's position).

Nonconscious Experiences

On the contrary conscious-unicity hypothesis that only a single, lateralized, integrative conscious focus exists, the disagreement with Puccetti would then amount to holding against him *that, in the normal individual only one stream of consciousness flows, notwithstanding the existence and activation in the nonconscious hemisphere, too, of the raw materials, as it were, for consciousness.* These "raw materials" on the nondominant side could be assumed, by the lateralized conscious-unicity view as well, to include actual visual, auditory, and so on, experiences—though these experiences would not be held to be conscious experiences. None of them would be conscious experiences in the sense that integrated conscious duplicates of them would occur at an integrative conscious focus on the same side of the dual brain. Integrated conscious duplications could only occur if the functioning of this structure were disinhibited as a result of a change in the inputs from the dominant side via the commissures.

Part of what I am here suggesting would seem to be compatible with (a) Puccetti's (e.g., 1988) notion that, in area 17 of the occipital cortex on either side, "seeing" takes place. The Puccetti-compatible account would say *that visual experiences take place in area 17, among other locations in the cortex, but that only those visual and other experiences that are duplicated at the integrative conscious focus on either side are conscious experiences.* The above suggestion is compatible as well with (b) Puccetti's (e.g., 1988) own invoking of transcallosal inhibition to explain the fact that the normal individual's nondominant hemisphere does not undertake independent actions. However, Puccetti held that the nondominant hemisphere is conscious nevertheless, and even has conscious awareness (based on inference) that there is a second center of consciousness, in addition to itself, within the one body. Thus, the cross-hemispheric inhibition that Puccetti has proposed is theoretically restrained by Puccetti from operating to prevent consciousness in the nondominant hemisphere.

The theoretical inevitability of dual consciousness, so far as Puccetti is concerned, would seem to have a source in the notion *that consciousness is a*

characteristic of any experience. Support for this understanding of Puccetti can be found in his comments on why he has refused the alternative interpretation (a) that we are each *one person* with two distinct minds (due to our having two distinct brains), in favor of (b) that each intact healthy human being is *two persons*, each of whom possesses one mind. Puccetti (1983) explained that the first of these alternatives would mean that there are experiences taking place in one of a person's two minds of which the person has no consciousness. And this seemed to Puccetti to be impossible: "Every subjective event must occur to a (self-aware, at least) mind as part of a unified whole pattern or stream of conscious experience, on pain of contradiction" (Puccetti, 1983, p. 736). (The claim that there is a necessary contradiction between a process's being mental and the process's being nonconscious needs, of course, to be demonstrated—which Searle [1989, 1990] has attempted to do [see Natsoulas (1992b, 1992c) for critiques of Searle's attempt].)

I am reminded here of Freud's (1900/1953) distinction, which he soon abandoned, between two systems of the psychological apparatus, namely the perception system and the consciousness system. I have elsewhere interpreted these two distinct Freudian systems as both of them involving mental brain-occurrences that have, respectively, different properties of consciousness. I wrote there of (a) the "full" property of consciousness, as possessed by the mental brain-occurrences that take place in Freud's (1900/1953) consciousness system and of (b) the "truncated" property of consciousness, as possessed by the mental brain-occurrences that take place in Freud's (1900/1953) perception system. Rather than identify and discuss here those two properties of consciousness, let me refer the reader to my article that includes comment on them and on Freud's two systems (Natsoulas, 1989a).

Here, let me just draw, from the latter article, the following moral: *consciousness may be a complex property so that one or more of its component properties is capable of being independently instantiated* (cf. Natsoulas, 1988b, pp. 187–190). Along these lines, it may be suggested that, due to the right hemisphere's integrative conscious focus's remaining inoperative, the simultaneous right-hemispheric experiences, belonging to various modalities, would be (a) no less often, in content, qualitative (i.e., "modal" in Michotte's sense; Michotte, Thinès, and Crabbé, 1964/1991) and cognitive; but the experiences occurring in the right cerebral hemisphere would (b) never involve any firsthand, immediate, nonobservational, noninferential awareness of them (and, of course, they would not involve anything else that is built on the latter). In the latter sense of being nonconscious, they would be the kind of proposed mental occurrence that many psychologists consider to be paradoxical; that is, the connected right hemisphere's experiences would be uniformly *nonconscious experiences*.

These nonconscious experiences would have effects that *varied according to what their contents were, but they would not have effects due to immediate aware-*

ness of their contents. Their being nonconscious would include the absence of such awareness. For example, nonconscious visual experiences may have effects on behavior (e.g., Natsoulas, 1982), but, as I have recently argued, visual experiences must be conscious (in the sense mentioned above) if the individual is to control his or her locomotion on a visual basis (Natsoulas, 1991b, 1992d; cf. Gibson, 1979, Ch. XIII). It is indeed, as Doty (1990) stated, a "fact that acts are guided by the contents of consciousness" (p. 9). In the latter statement from Doty, I would replace "by" with "by means of" in order to make my point. Accordingly, it is not the contents themselves that guide the behaviors in which we deliberately engage; rather, these behaviors are guided *by means of* our immediate awareness of here and now having those particular contents.

Conclusion: Normal Dual Consciousness?

Therefore, it does not suffice for Puccetti to draw our attention to the evidence from commissurotomed patients, and the like, and to the ability of the brain to subserve two mental lives simultaneously. The question must be faced as to *whether there are any reasons to prefer the Puccetti-compatible hypothesis of dual integrative conscious foci in normal people, that is, the existence of these foci not only potentially but as actually functioning and producing two streams of consciousness in the intact human being*. Puccetti often writes that our dual consciousness is concealed from us by (a) the sharing of information between the normally connected cerebral hemispheres allowing for their mutually harmonious functioning and by (b) the transcallosal inhibition of the potential independent behavior of the nondominant hemisphere. But is there any way in which the specific normal dual consciousness that he has been proposing can actually reveal itself? The method of putting one hemisphere to sleep (e.g., with sodium amytal injected on the one side) and questioning or testing the other hemisphere cannot answer the present question, because this method may simply work to disinhibit the second integrative conscious focus, which normally remains quite inoperative.

Quite obviously, there is much more that needs to be discussed concerning the Puccetti-compatible account, the competing accounts that I have mentioned, as well as still other accounts and hypotheses that bear on the present issue, which is *the unicity (singleness) of consciousness, and how this unicity is or is not accomplished in the brain*. The present article has prepared the ground for the next stage of my discussion. In the sixth article of the present series on consciousness and commissurotomy, I shall examine whatever evidence has been proposed or that could exist in favor of an actually functioning integrative conscious focus in the normal, healthy, connected nondominant hemisphere. As we have seen, this evidence will have to be such as to count

against the hypothesis that I have characterized in this article as being a close alternative to the Puccetti-compatible account.

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