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Consciousness and Commissurotomy: VI. Evidence for Normal Dual Consciousness?

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This article addresses the problem of evidence for Puccetti's hypothesis of normal dual consciousness, i.e., the hypothesis that a stream of consciousness flows in each cerebral hemisphere when both are functioning normally in intact, healthy people. Evidence counts as supportive only if it is not explainable by a certain close alternative hypothesis that holds consciousness to proceed in the nondominant hemisphere only when the dominant hemisphere is unable to inhibit it (e.g., complete commissurotomy, dominant hemispherectomy, dominant anesthesia). From this perspective, I discuss (a) two experiments involving anesthesia of the dominant hemisphere that were proposed, respectively, by Wilson and Puccetti, (b) an actual experiment on normal, unanesthetized subjects reported by Landis, Graves, and Goodglass, as well as (c) a further kind of experiment which, I suggest, may discriminate between the hypotheses. Assuming Puccetti is right, this experiment should yield a distinct pattern of reports from the dominant hemisphere about its experiences of acting as the individual deals with different kinds of tasks ("nondominant" vs. "dominant"). Also considered is the common (negative) introspective evidence to the effect that we have only a single stream, never two distinct experiences at the same time. I argue, in support of Puccetti, that this is as it should be because introspection-at-a-distance is impossible; privileged access is internal to a stream, never occurs between streams.

The present article develops directly out of the immediately preceding installment in a series of articles that have for their main title "Consciousness and Commissurotomy" (Natsoulas, 1987, 1988, 1991, 1992, 1993). This series is largely devoted to that which is currently known or knowledgeably held regarding the consciousness of people who, because of intractable, life-threatening epilepsy, have submitted themselves to complete forebrain commissurotomy. That is, these people's entire corpus callosum has been surgically severed, as well as all the other commissures that connect the right

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and left cerebral hemispheres at the cortical level. Also, I address in this series of articles pertinencies of the research on the commissurotomized to our understanding of the consciousness of neurologically intact, normally functioning, healthy human beings. I view the various inquiries into commissurotomized consciousness as contributions to a joint effort to account for consciousness in general. In the last installment, I discussed an hypothesis about normal consciousness that has repeatedly appeared in the literature on commissurotomy and its implications (Puccetti, e.g., 1989b). Here, I discuss evidence which advocates of the hypothesis and others believe is or would be pertinent to it.

According to this hypothesis, not only the commissurotomized but normal people too have, each of them, two streams of consciousness. Do not confuse this normal-dual-consciousness hypothesis with those hypotheses, such as Freud's, according to which all of us have two kinds of mental processes, conscious and nonconscious, that occur simultaneously and interact with each other. Rather, "dual consciousness" means a stream of consciousness in James's full sense, as described in *The Principles* (1890), proceeds in each of our two cerebral hemispheres — or, alternatively, a distinct stream of consciousness is somehow associated with the functioning of each hemisphere. I mean by "James's full sense" that the stream's basic durational components are "states of consciousness" (Natsoulas, in press), which Freud's nonconscious mental-occurrence instances are not. That is, each state of consciousness (a) gives awareness of something, or as though of something (i.e., when the object of a state does not, has not, and will not exist) *and* (b) is itself, actually or potentially, an object of noninferential, nonperceptual awareness. I must mention that James (1890) did not consider, as I do, the stream of consciousness *to be* a brain process. At the time, James was a dualist interactionist, he conceived of the mental as causally related to the physical (in both directions), and he held that the total brain process brings consciousness into existence state by successive state (Natsoulas, 1992–1993).

Before proceeding, let me say that throughout the present article, I take the liberty of treating all authors and researchers whose work I discuss as though they subscribed to the identical mind–body position, as though they all believed, as I do, that a stream of consciousness literally is a protracted brain process. For many years, beginning before the mid-sixties, this has been the (physical monist) position, as well, of the Nobel-prize winning psychobiologist who has been our most prominent researcher on commissurotomy (Sperry, 1969, 1976, 1982, 1992). However, the phrase I inserted right after the only dash in the immediately preceding paragraph was intended to acknowledge that there exist, among the pertinent authors, various positions on the mind–body problem. For example, Puccetti (1985, 1987a, 1989a), who figures importantly here and in the preceding article, stated that the distinctness of

mind and brain is guaranteed by the fact that no brain process possesses intentionality, whereas mental acts do. Puccetti explained his point by adding that brain processes cannot be about anything, do not take objects, or have semantic content. Thus, Puccetti is frequently careful to speak merely of the mind's biological substrate, or of the neurophysiological basis of mental events and activities (cf. Puccetti and Dykes [1978]). However, for present purposes, differences in mind–brain view need not be brought up again (cf. Bogen, 1986). I proceed as though all authors whom I mention locate consciousness literally in the brain.

I closed the fifth article of the present series with the following paragraph, in which I announced my next task:

> 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. (Natsoulas, 1993, pp. 199–200)

I had formulated two hypotheses having very different implications for ordinary consciousness. (a) H_1 holds that two "integrative conscious foci" are active in any neurologically intact, normally functioning, healthy human being. Both foci, or brain centers, one in each cerebral hemisphere, are normally activated; and so, in normal people, two streams of consciousness normally flow at the same time. (b) A close alternative, H_2, holds that the "integrative conscious focus" in the nondominant hemisphere is normally inhibited by the activity of the "integrative conscious focus" on the other side. Which means a stream of consciousness flows on the nondominant side only when the "integrative conscious focus" there cannot perform its relevant inhibitory function (e.g., after complete forebrain commissurotomy or dominant hemispherectomy, or when the dominant side is drugged).

A Puccetti-Compatible Hypothesis

H_1 is the hypothesis that I previously described as a "Puccetti-compatible hypothesis" (Natsoulas, 1993). H_1 holds, as Puccetti (1973, 1976, 1977, 1981a, 1981b, 1983, 1985, 1987b, 1988, 1989b) has for a long time, that there exists no cross-hemispheric fusion mechanism. Such a mechanism would operate via the corpus callosum and other commissures, as has been proposed by several theorists (e.g., Dimond, 1979, 1980; Doty, 1990; Kinsbourne, 1982, 1988; Sperry, 1984). According to Puccetti, no such mechanism exists even in a human being all of whose commissures are intact and functioning quite normally. No way exists for a single unified stream of consciousness to be consti-

tuted from part-processes going on in each of the two cerebral hemispheres. Thus, the Puccetti-compatible hypothesis contradicts the prominent account which I have been calling the "commissural-integrative hypothesis" — and which is not equivalent to H_2. H_2 is like H_1 in locating any stream of consciousness in a cerebral hemisphere, specifically at its constituent active "integrative conscious focus." The commissural-integrative hypothesis holds that normal people have one consciousness stream, produced over extended durations by a unified bihemispheric molar process at the cortical level (e.g., Sperry, 1976, 1977, 1984). After commissurotomy, two streams of consciousness somehow flow, one in each hemisphere; though one stream alone flowed before surgery, involved both hemispheres, and was a different stream from either of the two new ones.[1]

Objecting to the commissural-integrative hypothesis, Bogen (1981) stated, "Adding the commissures, with their potential for inhibition, may complicate hemispheric interaction more than it synchronizes" (p. 101). That is, in the commissurotomized as compared to the normal, there may be greater "integration" across hemispheres; there may be relatively less reason to speak of commissurotomized people as having two minds, because certain potential similarities in functioning between their hemispheres are not prevented by connecting fibers, as occurs in normal people. However, Bogen hesitated to speak, as Puccetti does, of commissurotomized and normals' possessing two minds (and, presumably, two streams of consciousness) though Bogen did state that "two minds" characterizes both groups better than "one mind" does. To this, Puccetti (1981a) responded that the occurrence of parallel experiences in the two hemispheres cannot convert doubleness into singleness. In this connection, Puccetti could have mentioned parallel streams of consciousness, one in each hemisphere. There is a difference between qualitative and numerical identity, Puccetti explained; the qualitative identity of two things should not be confused with their being one rather than two. To have only one stream of consciousness would not require a similarity of functioning across hemispheres; indeed, there could be large differences in the relevant processes on the two sides. It would require that the two sets of processes somehow get fused into a single process.

In the immediately preceding article of the present series, I introduced the concept of an "integrative conscious focus" located in a cerebral hemisphere and producing a stream of consciousness. Although Puccetti's own account

[1]Sperry (1977) called attention to how his view of consciousness and the brain differs from Puccetti's (1973, 1976) view, and stated that this clear difference is empirically decidable. Sperry added that, in his view, "the fiber systems of the brain mediate the stuff of conscious awareness" (p. 116). Of course, he did not mean that the stream of consciousness is localized entirely in the corpus callosum. However, the suggestion seems present that the stream is a brain process that takes place partly in the interhemispheric connecting fibers themselves.

does not include the concept of an "integrative conscious focus," this concept is central to the Puccetti-compatible account of consciousness and the brain that I have elsewhere spelled out in a preliminary way (Natsoulas, 1993). The need for a Puccetti-compatible account arises from (a) a fundamental problem which would seem to trouble Puccetti's normal-dual-consciousness hypothesis (see next paragraph), and (b) a desire to see this evident difficulty overcome without abandonment of the main thrust of Puccetti's thought on the topic. That is, I did not want to advance arguments to the effect that, given the problem, Puccetti must abandon one or more of his main theses. This sympathetic way of treating of someone else's theory, insofar as one practices it as well with respect to theories with which one does not agree, is an aspect of my general pluralistic approach to psychological science. I have elsewhere described and argued in favor of psychologists' adopting the pluralistic approach (Natsoulas, 1990, in press). There, I contrasted this approach with the eliminativist approach, which is a broad scientific philosophy that enjoys wide acceptance in psychology, and emphasizes, in contrast, the elimination of alternative accounts, rather than their improvement and increase in number.

All along, Puccetti has rejected any integrative capability of the multitudinous cortical connecting fibers between the cerebral hemispheres. That is, a process on one side may cause, by means of these fibers, a process on the other side to take place (or inhibit it from taking place); but the connecting fibers cannot integrate processes occurring in different hemispheres into a single unified molar process, such as the stream of consciousness is. However, Anderson and Gonsalves (1981) argued, against Puccetti (1981b), that experiences belonging to different modalities must be integrated by means of the same kind of connecting fibers as make up the corpus callosum and other forebrain commissures; therefore, such connecting fibers should be able to do the job across hemispheres as well (cf. Sperry, 1977, p. 116).[2] These authors did not say how integration by means of connecting fibers takes place; and, so, I devised an account, on Puccetti's behalf, that allows for integration of experiences within a hemisphere yet denies any unitary cortical processes that span the two hemispheres (as according to the commissural-integrative hypothesis; Natsoulas, 1993). Thus, I introduced an "integrative conscious focus" in each hemisphere, as would seem to be consistent with Puccetti's main thesis. Although the Puccetti-compatible account holds that these two brain centers are the loci of cross-modally integrated experiences, the account grants no powers to connecting fibers beyond their causing brain processes to occur or not to occur.

[2]I have the impression that Puccetti (1981a, p. 118) considers intrahemispheric experiential unity, which he certainly acknowledges (p. 117), to constitute a different kind of explanatory problem from interhemispheric experiential unity, which he denies. But Puccetti (1981a) gave no reply to the objection (Anderson and Gonsalves, 1981) which I just called attention to in the text.

An integrative conscious focus is postulated to be a unique structure, within a cerebral hemisphere, where experiences belonging to different modalities are duplicated and therein fused together into a unified cross-modal experience. The latter results from the integrative conscious focus's being active in certain ways; that is, certain specific processes occur there due to the intrahemispheric connecting fibers that arrive at the integrative conscious focus from a number of locations in the same cerebral hemisphere. At the source locations, experiences occur belonging to a single modality (visual, auditory, etc.). Both (a) the unknown process by which experiences are integrated across modalities and (b) the respective integrated experiences themselves, are postulated to take place only at an integrative conscious focus. The intrahemispheric connecting fibers are limited in their function to causing experiential duplication, rather than somehow fusing experiences together. Somewhat similarly, the interhemispheric connecting fibers are held to run between corresponding centers for single-modality experiences, and so such experiences can be duplicated across the hemispheres (Puccetti, 1988, p. 13). Note again that "duplication" is a matter of producing the same experience on the other side, rather than the integration of experiences taking place at different locations that are connected by the respective connecting fibers. Compatibility with Puccetti's account is thereby maintained, as is my purpose.[3]

A Close Alternative Hypothesis

I also formulated a close alternative (H_2) to the Puccetti-compatible account (H_1), in order to contrast the two hypotheses' expectations regarding neurologically intact, normally functioning, healthy human beings (Natsoulas, 1993). Both H_1 and H_2 postulate two integrative conscious foci, one in each hemisphere, but H_2 holds that the connecting fibers between the two foci continuously inhibit the functioning of the focus on the nondominant side. This integrative conscious focus is, normally, only potentially such a focus or brain center. Thus, two simultaneous streams of consciousness do not take place in a single individual unless the nondominant focus gets disinhibited. H_2 holds that in commissurotomized people this disinhibition has indeed occurred; H_2, like H_1, expects that commissurotomized people will be

[3]However, Puccetti (e.g., 1983) would reject the idea, which is part of H_1, that single-modality experiences taking place elsewhere than in an integrated conscious focus are nonconscious in principle (Natsoulas, 1993). According to H_1, a mental-occurrence instance (which may be an experience) that occurs outside any integrative conscious focus cannot be an object of direct awareness, cannot be a "consciousness" or "state of consciousness" (Natsoulas, in press). Puccetti (1983) would insist, instead, that any mental-occurrence instance must be an actual or potential object of direct awareness.

found consistently to have dual consciousness, two simultaneous streams of consciousness. Also, H_2 expects people who, because of life-threatening brain disease, have their entire dominant cerebral hemisphere surgically removed (dominant hemispherectomy) to maintain their consciousness. There should be no lapse in their consciousness due to the loss. In their case, the stream produced at the integrative conscious focus on the one side will be succeeded immediately, according to H_2, by a new stream of consciousness proceeding on the other side, a stream which has not flowed before (or for a long time; see below). To get this second stream of consciousness started only requires removal of the interference.

H_1 and H_2 differ regarding what should occur if normal individuals submit to a test in which (a) their dominant cerebral hemisphere is drugged so that, temporarily, it cannot control behavior nor inhibit the integrative conscious focus on the other side and (b) their nondominant cerebral hemisphere is interrogated to determine what it knows concerning its own past functioning under normal conditions. In this way, I introduce a certain claim of Puccetti's (1981a, 1981b, 1985) about the nondominant hemisphere in the normal human being. Owing to the nondominant hemisphere's possessing, all along, its own distinct stream of consciousness, and owing to certain observations that it has inevitably made, the nondominant hemisphere, unlike the dominant one, grasps the fact that there are two agents simultaneously functioning in its body ("the truth"). Puccetti (1985) stated, "Our mute cerebral companion is probably aware of the truth, even if nonverbally, since from an early age he must have known he was not doing the talking or writing performed by that body" (p. 647). The nondominant hemisphere knows the truth, not simply because it can tell the difference between actions it initiates and does not initiate (Puccetti, 1981a, p. 120), but because it does not fully understand much of the complex speech and writing that the other hemisphere has been producing for some time. Studies of commissurotomized people have not uncovered the nondominant hemisphere's knowledge of the truth, though H_1 holds it exists in both the commissurotomized and the normal.

Puccetti (1981a) argues that the dominant hemisphere of a normal individual does not likewise know the truth. That is, it does not know the truth as a result of its inability to execute complex spatial tasks on its own. Puccetti gives as the main reason for the dominant hemisphere's ignorance (a) that "spatial performances are notoriously difficult to explicate verbally" (p. 120), and as a further reason (b) that the dominant hemisphere "will not [even] admit the obvious" (to itself?) when it witnesses, when deconnected, good performances by the left hand on spatial tasks. But all that Puccetti needs to account for the dominant hemisphere's not knowing the truth would seem to be that, under normal conditions, only the dominant hemisphere can issue behavior; its dominance is comprised of successfully inhibiting the potential

behavior of the other hemisphere. That is, the dominant hemisphere, when normally connected, is the hemisphere that performs even those tasks which it can no longer perform when deconnected, when the nondominant hemisphere's contribution is unavailable (H_2). As Puccetti (1981a) states: "The left half brain execut[es] a spatial task with the preferred hand on the basis of right-hemispheric cognitive input" (p. 120). However, as will be seen, if the nondominant hemisphere of normal individuals could be induced, experimentally, to issue behavior in the face of present cross-hemispheric inhibition, this would be extraordinarily useful in the effort to secure evidence for normal dual consciousness (H_1).

Of course, H_2 would predict no such knowledge of the truth, since the nondominant hemisphere's stream of consciousness does not begin to flow, if at all, until the dominant hemisphere is no longer inhibiting it. H_2 would also differ from H_1 in not expecting to find any evidence for a second stream of consciousness in normal people — except under special conditions, when something like the test mentioned in the preceding paragraph is performed, or when other circumstances somehow develop in which, very unusually, the nondominant integrative conscious focus does get unleashed. However, the main arena for competition between H_1 and H_2 would seem to be the behavior of neurologically intact, normally functioning, healthy human beings. The Puccetti-compatible hypothesis holds that the cortical activity that takes place during the normal functioning of such human beings includes the flow of two streams of consciousness, not only one in the dominant hemisphere but, contrary to H_2, one in the nondominant hemisphere as well. Therefore, in the present article, I am occupied with the prospect for evidence (a) to support an hypothesis like H_1, that is, an hypothesis of normal dual consciousness, a stream of consciousness proceeding in each cerebral hemisphere, evidence (b) that cannot be accounted for equally well by an hypothesis like H_2, that is, in terms of, at most, a single stream of consciousness on the dominant side, except under conditions disinhibiting a second integrated conscious focus.

An Argument for Duality

The following is an argument of Puccetti's (1973) in favor of normal dual consciousness. Two streams cannot be brought into existence by destroying part of the brain. The two streams must already exist, though commissurotomy makes it easier to demonstrate their presence. This amounts to an argument against the commissural-integrative view, and a challenge to the latter view to explain how rendering impossible a molar process that purportedly was the individual's stream of consciousness does not result in unconsciousness, but in the miracle of two streams, one in each cerebral hemisphere

(cf. Puccetti, 1981a, p. 119). Puccetti (1973) similarly comments on complete hemispherectomy:

> Over and over again clinical reports [e.g., Bogen, 1969] suggest that essentially the same personality, character traits and long term memory traces persist postoperatively. The only way I can see to explain this is to say the same "person" did not survive hemispherectomy at all. Because this former "person" was never a unitary person to begin with. He or she was a compound of two persons who functioned in concert by transcommissural exchange. What has survived is one of two *very similar* persons with roughly parallel memory traces, nearly synchronous emotional states, perceptual experiences, and so on, but differential processing functions. (p. 352)

Surely, if the commissures normally integrate part-processes across hemispheres, their ceasing to function should mean a larger number of fundamental changes than evidently do occur.

The close alternative to the Puccetti-compatible account (H_2) is not vulnerable to Puccetti's argument, because the only functions H_2 assigns to the cerebral commissures are causal and not integrative. Therefore, to section the commissures is not to intervene in the very process which is supposed to be the stream of consciousness. And there is developmental reason to countenance a potential integrative conscious focus on the nondominant side. Recently, reviewing the new evidence for brain growth after birth, Trevarthen (1990) concludes that, due to the slowness of myelin deposition on the axons, "brain circuits undergo developmental transformation for decades, even though the brain changes little in size and surface appearance" (p. 351). These brain circuits involve the axons making up the connecting fibers between loci in the same or different cerebral hemispheres. The effect of myelination is probably to improve not only the elicitation of processes on one side by processes on the other side, but also the ability of one hemisphere to inhibit certain processes that would otherwise proceed in the other hemisphere. Therefore, it seems reasonable for H_2 to hold that in the early life of normal human beings two integrative conscious foci, one in each hemisphere, may have been functioning. Whereas activity in the dominant hemisphere later inhibits the second integrative conscious focus, this focus produced at one time a second stream of consciousness and can do so again when given a chance to function (disinhibition). A relevant study of normal children was conducted by Galin, Johnstone, Nakell, and Herron (1979), based on the thesis that

> the corpus callosum and other commissures are not completely formed at birth and mature very slowly. In very young children, therefore, there may be little communication between the hemispheres; they may each function relatively independently as in adult "split-brain" patients who have had the connections surgically severed. (p. 1330)

Since it had been already established that tactile matches cannot be performed across deconnected hemispheres, these researchers compared how well normal three- and five-year-olds match fabrics with the same hand and different hands. Thus, the three-year-olds might well perform relatively poorly when matching between hands, assuming their hemispheres functioned more independently of each other. Indeed, (a) five-year-old girls showed no difference in their performance (error rates in matching fabrics) whether an experimenter rubbed one or both of their hands (the fingers) with two pieces of cloth, whereas (b) three-year-old girls made more matching errors when they compared fabrics rubbed on the fingers of each hand. The researchers cautioned against the inference that the hemispheres of the older children have already become well connected; these older children might show the same kind of differences (between vs. within hands) if tested using different materials or sense modalities, or if they were tested with regard to certain nonsensory functions.[4]

Two Proposed Tests

Wilson (1983) suggested an empirical test of Puccetti's (1981a, 1981b) hypothesis. He proposed that the left hemisphere of normal right-handed human subjects be anesthetized by means of an injection of sodium amytal in their carotid artery on the left side. While their left hemisphere is anesthetized, the subjects would be shown pictures of the personal or affect-laden kind that, using a special contact lens, no drugs, and to excellent effect, Sperry, Zaidel, and Zaidel (1979) presented independently to each of the hemispheres of fully commissurotomized subjects for immediate response. Another difference from the Sperry, Zaidel, and Zaidel study would be the following. Wilson's subjects would be questioned, regarding what they had seen, only after they recovered from the anesthesia, not while looking at the pictures as were the commissurotomized people. Wilson might have proposed that right-hemispheric consciousness be assessed during the lateralized anesthesia; however, the latter would not be as good a test from the perspective of the present article (see next paragraph). If Puccetti is right, and if the right

[4]A further study (Galin, Diamond, and Herron, 1977) showed that touch localization of the fingers develops with age particularly across hands. With all hands out of a child's sight, an experimenter touches one of the child's fingers and, in response, the child must touch either the same finger with the thumb of the same hand, on some trials, or the homologous finger with the thumb of the other hand, on other trials. From five through ten years of age, performance improved greatly in the crossed task, and to a much smaller degree in the uncrossed task. This large difference was due to the many errors on the crossed task until approximately eight or nine years of age. Again, the experimenters suggested that the explanation of these results might be found in "progressive myelination or other aspects of maturation of the forebrain commissures" (p. 589; cf. O'Leary, 1980).

hemisphere of normal subjects is indeed able to produce behavior on its own, after recovery from anesthesia the right hemisphere, using signs or choosing among answers by pointing with the left hand, should show some knowledge of the pictures. At the same time, the subject (left hemisphere) should claim to know nothing about the pictures' being presented during his or her participation in the study (cf. Risse and Gazzaniga, 1978).

Note that correct or meaningful responses by the right hemisphere during left-hemisphere anesthesia would not favor H_1 over H_2; H_2 expects that anesthetizing the left hemisphere, and thus stopping temporarily the functioning of the integrative conscious focus on that side, will disinhibit the focus on the nondominant side, including the production of a stream of consciousness therein. However, a positive outcome after recovery from the anesthesia would indicate that a stream is flowing now in each hemisphere; that is, the right hemisphere too is able to follow instructions, by controlling the left hand, and is able to answer questions correctly by making choices. This result would contradict H_2 and support H_1, which is an hypothesis of normal dual consciousness. Underlying this reasoning is the assumption, based on Risse and Gazzaniga's findings (1978; however, see Milner, Taylor, and Jones–Gotman, 1990), that between recovery and questioning, the right hemisphere's information is not duplicated in the left hemisphere. Perhaps this is because mnemic traces of experiences taking place in the right hemisphere during left-hemisphere anesthesia do not, between recovery and questioning, determine the contents of the right stream of consciousness, though this stream continues to flow according to H_1. That is, after recovery from left anesthesia, perhaps these mnemic traces on the right, acquired during anesthesia, must "become-conscious" (Natsoulas, 1985) there in order for the left also to acquire them (cf. Puccetti, 1981a, p. 117).

In replying to Wilson, Puccetti (1983) stated that the proposed lateralized anesthesia could not be safely induced in subjects for more than two to three minutes, since it is dangerous to inject any larger quantity of sodium amytal. And, in such a brief time, "the repertoire of (nonverbal) responses to questions would be extremely limited" (p. 738). Tasks must be carefully chosen if the duality of consciousness is to be revealed. After all, Wilson was proposing a test of Puccetti's radical hypothesis, and Puccetti wanted to make sure such a test was a fair one, not biased against his hypothesis. Puccetti failed to grasp that Wilson's proposal did not include questioning the subjects during lateralized anesthesia, but only after the sodium amytal wore off. Puccetti (1983) stated it was the limitations of brief nonverbal responding that led him to propose in an earlier article (Puccetti, 1977) an adaptation of Efron's (1963a, 1963b) flashing-lights procedure as a test of normal dual consciousness. Accordingly, Puccetti's prediction would be as follows. Light-flashes presented prior to lateralized anesthesia and verbally reported (by the left

hemisphere) at the time as simultaneous would be signaled (by the right hemisphere) during anesthesia to have occurred successively prior to anesthesia. This would show that two distinct consciousnesses were flowing before the injection of sodium amytal, that is, in the absence of any conditions causing the brain to function abnormally.

Of course, this result would depend on properly timing the light-flashes, and where, in which parts of the visual field, the light-flashes were presented. If the first light is flashed in the left visual half-field and the second a certain number of milliseconds later in the right visual half-field, the left hemisphere should experience them as simultaneous. It takes more time for a light in the left half-field to be seen by the left hemisphere, since the neural path from the right half of each retina to the left hemisphere is longer than the neural path from the left half of each retina. This is indeed what Efron (1963a) found. Therefore, Puccetti predicted that, during left anesthesia, evidence will be secured that the right hemisphere had seen the light-flashes occur successively. Owing to the lengths of the two paths which, as it were, the inputs travel, the right hemisphere should have seen the light-flash in the left half-field sooner than the left hemisphere did, and the light-flash in the right half-field later than the left hemisphere did. Puccetti (1983) added that many subjects might be needed to secure from the right hemisphere a few negative responses (i.e., reports of successiveness) since "the mute brain of the normal subject is so used to executive subordination to the dominant hemisphere that it [might] be unresponsive under these conditions" (p. 454). In Wilson's experiment, responses from the right hemisphere are even less likely because the right hemisphere must perform in the face of present inhibition from the left hemisphere.

Again, as in Wilson's proposed experiment, Puccetti's experiment would not be simply a test to determine whether a stream of consciousness flows in the right hemisphere during the brief period when the left hemisphere is anesthetized. One might have expected Puccetti to want to show that something like what takes place after dominant hemispherectomy can be shown to take place in normal subjects when sodium amytal is directed into only the left hemisphere. However, in such a test as the latter, both H_1 and H_2 would expect a positive result — though I should mention that neither Puccetti nor Wilson addressed an hypothesis like H_2. In both proposed experiments, the crucial questioning would occur after the fact. Either the questioning would be about something that took place while the anesthetic was working (Wilson's proposed experiment), or before the anesthetic was injected (Puccetti's proposed experiment). Thus, either (a) the questioning would occur while, according to Puccetti's theory, two streams of consciousness are flowing and may reveal that they are (Wilson's experiment) or (b) the questioning would be about what took place when, according to Puccetti's theory,

two streams of consciousness were flowing and may reveal that they were (Puccetti's experiment). But neither author argued that a positive result would not be understandable from a perspective according to which the second stream of consciousness flows only during (and owing to) lateral anesthetization (H_2).

At one point, Puccetti (1981a) stated that mental duality in normal people is "powerfully concealed" (p. 118). Indeed, nowhere in Puccetti's articles of two decades does he cite, as evidence in favor of normal dual consciousness, any test or observation that has already been performed on a normal individual. Instead, Puccetti stressed (early on; e.g., Puccetti, 1976, p. 59) the difficulty of testing the nondominant hemisphere of fully commissurotomized people in a satisfactory way, owing to this hemisphere's (a) becoming upset by independent actions issuing from its body (i.e., actions it knows it has not initiated), and (b) frequently intervening in performances of the left hand (Levy, Nebes, and Sperry, 1970; Levy, Trevarthen, and Sperry, 1972). In this context as well, Puccetti proposed that the (deconnected) left hemisphere might be drugged immediately after certain well-known experiments conducted on commissurotomized people, in order to learn whether the verbal behavior during the experiments corresponded to how the right hemisphere would have responded at the time (cf. Puccetti, 1974). Since then, the problem Puccetti called attention to — testing commissurotomized people's nondominant hemisphere adequately for Puccetti's purposes (including demonstrating selfhood) — has been solved by Zaidel's (1977) devising a contact lens that occludes stimulation in one or the other half-field. This permits lengthy interrogations of either hemisphere with materials visible (throughout) only to it (Sperry, Zaidel, and Zaidel, 1979).

Of course, such a device cannot work to the same effect in the neurologically intact, normally functioning, healthy individual. Occluding all visual stimulation to the left (or right) hemisphere does not render that hemisphere blind, or in the dark, during the occlusion. Rather, intact interhemispheric connecting fibers quickly transmit to either cerebral hemisphere the visual (and other sensory) information that is projected to the other hemisphere. Thus, Puccetti (1988) states, "Blocking a verbal report of what was seen by the left hemisphere leads, in the normal subject, to his or her left hand under control of the right hemisphere nevertheless pointing to the same word, TAXABLE" (p. 16). That is, thanks to the forebrain commissures that link the cortical visual areas on the two sides, both hemispheres have, according to Puccetti, visual perceptual consciousness of the entire word TAXABLE — though, in the example, (a) TAX was projected only to the right half of both retinas and, therefore, directly only to the right hemisphere, and (b) ABLE was projected only to the left half of both retinas and, therefore, directly only to the left hemisphere. What would seem to be required for a test of

Puccetti's hypothesis of normal dual consciousness is some method by which to distinguish how the hemispheres function and behave notwithstanding that, in a particular situation, both have available to them the same stimulus information that is picked up by the individual's perceptual systems.

Negative Evidence?

Actually, there is some real evidence from intact, healthy, normal people which Puccetti (1977) and others consider relevant to his hypothesis. However, this evidence seems to many to count crucially against Puccetti's hypothesis. And, certainly, Puccetti is obliged to provide, as he does attempt, an adequate explanation of this negative evidence. Puccetti (1977) called it "the strongest argument" against normal dual consciousness; and he gave credit to S. Harnad for having formulated this argument in a personal communication of 1974: "After all, [Harnad] asks, do we not have what the philosophers call 'privileged access' to the conscious content of *both* hemispheres" (p. 455)? What exactly is the argument? I take it to be something along the following lines. If we each have two distinct streams of consciousness as Puccetti has proposed that we have, we should know that we have them. In fact, however, Puccetti's hypothesis is typically greeted with disbelief. The reason is that we do not introspect a second stream. Our "privileged access" to our mental life does not reveal to us that we have, at any point, two simultaneous and distinct experiences. And it makes no sense to speak of two streams of consciousness and, then, to suggest one of the streams is *nonconscious*, that we do not have privileged access to its components. After all, a stream of consciousness consists of a succession of "consciousnesses," or "states of consciousness" (James, 1890; Natsoulas, in press); this means the basic durational components of a stream of consciousness are all actual or potential objects of privileged access.

However, Puccetti *has not* proposed, either for the commissurotomized or for the normal individual, that either of their two streams of consciousness is nonconscious. Yet it is certainly a part of Puccetti's account that neither hemisphere has the ability to introspect what is going on in the stream of consciousness of the other hemisphere — or, for that matter, to introspect any stream of consciousness that is proceeding in any other hemisphere, belonging to anyone, however the two hemispheres may be artificially connected. A stream of consciousness gives direct awareness only of its own components; and it never gives such awareness to another cerebral hemisphere. Thus, the kind of self-awareness which is an essential feature of a stream of consciousness's being conscious cannot be provided by the connecting fibers between hemispheres. Such fibers do not constitute a mechanism by which one stream of consciousness can apprehend what is taking

place in the other stream.[5] Puccetti (1977) pointed out that, if it could be arranged (using a futuristic procedure) that a certain tactual feeling in your right hemisphere resulted in the same feeling in Puccetti's left hemisphere, this would not mean Puccetti had privileged access to your tactual feeling. Rather, Puccetti would be conscious of his own tactual feeling, which in the example is produced futuristically by your tactual feeling. Experiential duplication across hemispheres by means of connecting fibers, or otherwise, is not privileged access to the original, duplicated experience.

For the same reason, a notion of telepathy is faulty if it entails that one can have privileged access by causality to thoughts, perceptual experiences, or other mental-occurrence instances. Since mental-occurrence instances are brain occurrences, a time will doubtlessly come when we will be able to "read" another person's mind. But this will require special instrumentation, and we may well refuse to designate what takes place as perception of another's mental life, notwithstanding the sensory dimension involved in our reading the instrument. In contrast, telepathy is supposed to work without instruments, and without a sensory basis; instead, one simply has direct, unmediated awareness, not by noticing anything else, of something taking place in another person's mind — just as though his or her mental-occurrence instance were one's own state of consciousness. Notions of telepathy are fundamentally mistaken whenever they hold that one can have privileged access to another's mental-occurrence instances, as this person has to some of his or her own mental-occurrence instances. That is, if telepathy exists, it must be based on the duplication or similarity of mental-occurrence instances across brains, because the "receiver" cannot have privileged access to the "sender's" brain, only to some of his or her own mental-occurrence instances, in his or her own brain. Privileged access is entirely internal to streams of consciousness. At most, causal links between two streams can make the streams' contents more similar.

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[5]I do not discuss here the contrast to Sperry (1976), who wrote:

> The only way an observer brain would be able to interact with and thereby experience the subjective qualities of another brain would be through an intimate *communication* into the interior of the observed brain that would enable [the observer brain] *to react* to the internal operational effects and internal relations of the observed brain. An observer relation is not enough; the second brain must be in an intimately involved relation with the internal operations of the first brain. Reasoning from our split-brain findings in animals and human patients, I have used the example of a corpus-callosum-type of *intercommunication system* in this connection (Sperry, 1969) to illustrate the kind of interaction that is required. (p. 174; emphases added)

Against Distant Introspection

Puccetti (1977) proffered the following evidence that the interhemispheric connecting fibers do not constitute a mechanism for introspecting-at-a-distance:

> Suppose I am walking barefooted on a rug in a darkened room and I step on a marble with my left foot. Due to the cross-recross arrangement of the afferent fibers, I believe that a feeling of having stepped on a marble would occur in the right hemisphere a few milliseconds before a very similar feeling occurred in the left brain. Yet I do not feel two such sensations in rapid succession. I feel just one. (p. 455)

If each stream of consciousness included immediate awareness of what was taking place in the stream proceeding in the other hemisphere, then Puccetti should not only (a) have two experiences of stepping on the marble; he should also (b) be aware of having these two successive experiences. According to Puccetti, we do indeed have two such experiences, one of them does occur in each hemisphere, but the left stream has no awareness of the experience belonging to the right stream, and vice versa. Another, similar example which Puccetti (e.g., 1989b) uses in various places is one with reference to which he asks why the commissural-integrative hypothesis does not imply that we should constantly have an experience of two entire visual fields side by side, for the two primary half-field visual experiences are immediately duplicated in the respective other hemisphere.

Similarly, H_1 holds that the consciousness that we have of (some of) our experiences takes place within the integrative conscious focus where they occur. The integrative conscious focus on the other side gives us privileged access only to the experiences that take place at that focus. In effect, Puccetti is arguing above against the idea that privileged access could take place at a distance; that is, he is arguing against the vague sort of view which holds that a mere causal connection is the basis for such access. According to such a view, if two loci in the brain have connecting fibers between them, so that a process at the one locus can contribute to the occurrence of a process at the second locus, then a process at the second locus might be a direct awareness of a process at the first locus. Indeed, it is true that an experience can be duplicated in this way, so that highly similar experiences occur at both loci, but this is far from direct awareness of an experience taking place due just to a certain effect that an experience has. The duplication of an experience should not be conflated with privileged access to the experience though there be privileged access to both experiences, the duplicated and the duplicate experience. According to H_1 two experiences, one occurring at each integrative conscious focus, would both be, simultaneously, objects of privileged access. However, still according to H_1 these two experiences

belong to different streams which do not have privileged access to each other's components.

However, the above — which might be summarized by saying that it is "an inconceivable expectation" (cf. Puccetti, 1985) that a stream of consciousness can have privileged access to the contents of a different stream of consciousness — apparently does not suffice for Puccetti (1985), who states,

> Selective pressure in all twin-brained species (all vertebrates) . . . [introduces] an inhibitory mechanism that prevents each half brain from having introspective access to the conscious content of the other (to prevent, for example, a doubling of the subjective visual field). (p. 647; cf. Puccetti, 1988, p. 13)

What inhibitory mechanism did Puccetti have in mind here? Which brain processes are the ones that get inhibited with the result that a hemisphere cannot have introspective access to the conscious content of the other hemisphere? How does this inhibitory mechanism work? If introspection is something that can take place, as H_1 holds, within streams of consciousness and never between streams, it would seem that no special mechanism is needed to prevent one hemisphere from, as it were, "tuning in" on the other. Our not being perceptually conscious of two full visual fields side by side, for example, results from our having two hemispheres, not from the inhibition of processes on either side. Puccetti (1985, 1988), too, is saying the latter (e.g., "two minds"), but he still feels a need to mention an inhibitory mechanism, though without further comment.

Positive Evidence?

An experimental report titled "Dissociated Awareness of Manual Performance on Two Different Visual Associative Tasks: A 'Split-brain' Phenomenon in Normal Subjects?" (Landis, Graves, and Goodglass, 1981) suggests that one may demonstrably secure conscious behavior from the nondominant hemisphere of a normal subject, just as one can from the commissurotomized. If achievable without inactivating the dominant hemisphere, this result would be important in helping decide the merits of H_1 and H_2. Landis, Graves, and Goodglass (henceforth, "the Es") reasonably believed the left hemisphere produced their subjects' ("Ss'") verbalized second thoughts ("whenever you think you have made a mistake") concerning the correctness of manual responses: pressing (or not pressing) a telegraph key to indicate "same" (or "different") after an 150 msec., or less, stimulus presentation. The second thoughts were accurate (93% correct) after Ss responded to a drawing and a photograph of a common object, but inaccurate (58% correct) after they responded to drawings and photographs of facial expressions. Based on research with unilaterally brain damaged people, commissurotomized people,

and normal subjects (e.g., Landis, Assal, and Perret, 1979), the Es held that categorizing objects is a left-hemispheric function; and so, very good second thoughts should be found. In contrast, research indicates the right hemisphere's special role in processing emotional information and faces; verbal corrections should be no better than chance with such materials.

We are supposed to conclude from this study that the left hemisphere performs the matching task involving objects and the right hemisphere performs the matching task involving facial expressions. The poor quality of the verbal corrections on the trials with facial expressions is supposed to be evidence that the left hemisphere is not responsible for the manual responses on those trials. An advocate of H_2 would probably raise questions about whether the performance that the Es attributed to the right hemisphere suffices to implicate not simply some cognitive processes of the right hemisphere but, specifically, a second activated integrative conscious focus, which is located in the right hemisphere. Does the study give evidence of a second stream of consciousness, as H_1 and Puccetti hold does normally flow? An advocate of H_2 might well argue as follows. *All* the manual matches are (conscious) behaviors performed by the left hemisphere, though the facial-expression matches differ from the object matches by crucially involving processes on the nondominant side. These processes deliver their outputs via interhemispheric connecting fibers to the left hemisphere, which produces the required pressing of a telegraph key to indicate "same," or refraining from pressing the key to indicate "different." Inputs from the nondominant side are not due to an activated stream of consciousness, but to cognitive processes that proceed and have effects in the absence of any privileged access to the processes themselves (cf. Davidson, 1981).

Perhaps there are phenomenological differences in performing the above task with the different materials. For example, the left hemisphere may feel itself to be performing more uncertainly in matching facial expressions than in matching objects. As a result, the left hemisphere might issue a greater number of verbal corrections after facial-expression matches — though these corrections were not found to improve the matching performance on facial expressions, perhaps because the left hemisphere did not further process the relevant information received from the right hemisphere. However, with a total of 1536 opportunities to correct their manual responses or nonresponses to matching facial expressions, the 16 Ss made a total of only 163 verbal corrections. These corrections were not many more than the 139 verbal corrections of the 1536 total manual responses or nonresponses that the same group of 16 Ss produced for the objects presented. Manually, the Ss performed equally well on both kind of materials (though this was arranged by shortening stimulus exposures for objects); and the difference between 163 and 139 verbal corrections was not found to be statistically significant. Perhaps more

strongly encouraging Ss to make verbal corrections, when they think them appropriate, would increase this difference, as H_2 would expect. And, of course, there may be other detectable signs of differences between the conscious process of overtly responding to the different materials that might bear on H_1 versus H_2.

Phenomenological Differences

For example, when asked, does the S (left hemisphere is presumably speaking) say he or she feels himself or herself to be initiating the manual responses equally so to the facial expressions as to the objects? Gazzaniga is well known for arguing that the left hemisphere of commissurotomized people appropriates, even if it needs to confabulate to do so, any action that issues from its body. Here is how Gazzaniga (1988) summarized his observations of many years:

> It is interesting to note that, although the patients possess at least some understanding of their surgery, they never say things like, "Well, I chose this because I have a split-brain and the information went to the right non-verbal hemisphere." Even patients who are brighter than PS, based on IQ testing, view their responses as behaviours emanating from their own volitional selves, and as a result, incorporate these behaviours into a theory to explain why they behave as they do. (pp. 233–234; cf. Gazzaniga, 1987, pp. 63–65)

I have recently discussed this view of Gazzaniga's together with relevant reports from other researchers (Natsoulas, 1992). Some researchers claim, contrary to Gazzaniga, that the left hemisphere of patients is sometimes alienated from the right hemisphere's behavior. In such cases, the left hemisphere does not have immediate awareness of performing the behaviors. In contrast to other behaviors, which it is aware of doing, it simply observes the behaviors of the right hemisphere as they take place.

The latter is not an unknown kind of experience to normal people. Who among us has not been aware of particular instances of one's behavior as though this behavior was not one's own, as though this behavior was performed by a different agent than the one who is oneself? For example, somewhere Brian O'Shaughnessy tells of being at a public meeting, hearing someone begin to speak from among the people assembled, and only then realizing that the speaker is O'Shaughnessy himself. Similarly, Oakley and Eames (1985) discuss someone who is intending not to make again the same mistake upon entering a certain elevator, yet he watches his finger press the button for a certain wrong floor, just as happened the previous time. People vary widely in the frequency of their behavioral alienations, as can be judged from Grene's (1968) statement regarding "the inevitability . . . of that strange but central fact . . . that, for all my actions, even the most considered or the

most self-consciously responsible of them, I never really know whether it is *I* who performs them or something in me that is not 'really' I" (p. 466). As Searle (1983) argues, when I raise my arm, not only does my arm go up and I observe its going up, I also have an experience of raising the arm. Without this experience of acting, or performing this action, it will seem to me (a) that my arm is going up, or went up, on its own or (b) that another agent is responsible for the act; that is, the act is someone else's doing (cf. Penfield, 1975, p. 76).

There are (a) behaviors which issue from one's own organism and which one experiences as initiated by oneself and (b) other behaviors which arise from the same body but which one experiences as produced otherwise than by oneself. Now, *if* it is true that the nondominant hemisphere of the healthy, intact, normally functioning human being can manage to produce behavior under conditions that are not special but simply dependent on the nature of the task (e.g., spatial vs. verbal), then experimenters may be able to secure verbal reports that vary in the degree to which the speaker (the dominant hemisphere) experienced his or her doing that which was done in performing the task. The construction or selection of these tasks should be such as to make them vary a lot in the extent to which they involve psychological functions that can be held, on good empirical grounds including research on commissurotomized patients, to be lateralized to the nondominant side. Tasks might be made to vary with respect to the ratio of psychological functions theoretically expected to be performed by each of the hemispheres. From the perspective of H_1, on the assumption that both hemispheres can produce behavior, it would be expected that the more "nondominant" the task, the greater the frequency of verbal reports (from dominant hemisphere) to the effect (a) that the subject did not undergo experiences of acting in accomplishing the task, or (b) that experiences of acting were more sparse or less definite during performance of the task.

A Complication

Levy's (1990) proposal regarding the "metacontrol of hemispheric function" complicates the above expectation, which is simply based on the objective competencies of the two hemispheres in performing the particular task assigned. Levy holds, instead, that processing is allocated in the brain "according to belief systems about its competencies for various cognitive tasks" (p. 239). According to Levy's account (see also Levy and Trevarthen, 1976), when the individual is presented with an experimental task, (a) both hemispheres independently process whatever the individual is told regarding the task, including the instructions. And (b) each hemisphere independently decides, based on past experience, whether it has the required capabilities itself

for performing the task. Then (c) both hemispheres send to the brainstem signals that vary in strength depending on each hemisphere's self-confidence regarding its ability to handle the particular task. On this basis, (d) the brainstem reacts accordingly; in effect, it gives control to the hemisphere that shows the greater confidence with regard to the task that is given to the subject.[6] Levy emphasized that the hemisphere that is assigned processing control is likely the more competent of the two on this task, but not necessarily so, for example because the task's requirements were not well assessed. In some cases, the "specific characteristics of the task" may be beyond the controlling hemisphere's "effective field of operation" though it fails to grasp that this is the case.

Briefly discussing Levy's account as she applied it to the commissurotorized, I stated, "Of course, neither deconnected hemisphere thinks of itself as a hemisphere, but rather as the person" (Natsoulas, 1992, p. 62). I suggested that a hemisphere's acknowledging an incapacity is its way of reducing its involvement in the task. In this way, by in effect losing interest in the task, a hemisphere allows mental activities to proceed that seem to the hemisphere to be less under its deliberate control.[7] As a matter of fact, these mental activities are controlled by the other hemisphere. However, in my brief previous comments, I did not focus on the requirement, within Levy's account, that the hemispheres make reference each to itself. Obviously, a hemisphere would have to distinguish its own past performance on a kind of task from that of the individual as a whole. Thus, for example, the left hemisphere might think when faced with a task involving spatial relations: "I seem to get good results on this kind of task, but I don't know how I do it." But what kind of self-reference is this, given that neither hemisphere has awareness of itself as such? The use of "I" by the left hemisphere, it would seem, has ultimate reference to the human being as a whole, though as including essentially the mental life of which the hemisphere is immediately aware, namely, the stream of consciousness that proceeds within it. Often if not always, a hemisphere's thoughts about its capacities and incapacities would be components of its stream of consciousness.

Levy's account of the metacontrol of hemispheric function is based on investigations of commissurotomized and unilaterally brain-damaged

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[6]Levy (1985): "The midbrain reticular formation sends arousal input to higher regions under the control of both sensory input and descending cortical commands that either facilitate or inhibit the brainstem arousal system" (p. 22).

[7]Judging from a study of a normal woman's hemispheric functioning, the assignment of a task to a hemisphere may be more self-conscious in some people than I have indicated in the text (Gott, Hughes, and Whipple, 1984). A greater degree of self-consciousness in this regard would not mean the individual must refer to cerebral hemispheres, but simply (a) to a second agent operating from the same body, or (b) to something else which somehow accomplishes the tasks one assigns it.

patients. If her account is true of normal people, then, according to H_1, marked phenomenological differences between different kinds of tasks should be found in such people. This is because firsthand verbal reports concerning states of consciousness — in this case, concerning experiences of acting while performing a task — are issued by the left hemisphere. Owing to the confidence in their respective abilities that the left and right hemisphere convey to the brainstem, each hemisphere, in effect, chooses to work deliberately only on certain tasks. Therefore, as work on a left-hemispheric task goes on, the left hemisphere's reports about its experiences should describe a more active and purposeful mental life. As right-hemispheric tasks are performed, the left hemisphere's introspective reports will be relatively lacking in reports of experiences of acting — though the subject should not appear to be distracted from the task. H_2 would expect no fewer reports of experiences of acting, since it holds that all behavior in the normal is performed by the dominant hemisphere. The complication that I mentioned bears on the choice or construction of tasks. If H_1 is right, the best phenomenological differences should appear between "dominant" and "nondominant" tasks for which the dominant hemisphere clearly and accurately judges itself to be, respectively, competent and noncompetent.

At no point did I mean to imply that, according to H_1 or H_2, a task will be performed by a single hemisphere in normal individuals, in the sense that the pertinent processing will proceed entirely in one hemisphere. Rather, according to H_1, one hemisphere or the other will be the controlling hemisphere for a time, will be actively engaged in performing the task, depending on factors that include those mentioned above. Thus, the controlling hemisphere's use of inputs from processes on the other side is by no means denied, either by H_1 or H_2. Levy (1985) suggests it may be only when a task fails to challenge us that our brain functions in the special way that the brains of commissurotomized people do.

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