Right Hemisphere and Verbal Communication: Conceptual, Methodological, and Clinical Issues

Yves Joanette and Pierre Goulet

This paper is a version of a conference keynote that was intended to provoke a collective debate about some of the issues concerning the effects of right brain damage (RBD) on the verbal communication abilities of right-handers. It should probably have been kept oral, but this version will at least allow a larger number of people to enter the discussion. Still, it should be read with the ears more than with the eyes. Moreover, the reader should be aware that this material is not meant to be a data-driven contribution to the field. It simply reflects some of the authors' present thoughts. Thus, some readers may feel that there are too many questions and not sufficient answers, or that some of the ideas put forward are not supported by the appropriate experimental demonstration, and they will be right. The wealth of unanswered questions is immense. The ideas introduced here have been favored by some convergence of facts, but their final demonstration has yet to come.

Moving from historical perspectives to clinical issues, we will mention eight different but complementary aspects of the problem. These points are not the only possible topics; rather, they are taken here only as examples of the kinds of questions we think should be discussed more explicitly. Some of these questions are of purely epistemological value, others are very practical, and most of them relate to some conceptual or methodological problems. But all of them are crucial for anyone who is interested in better understanding and helping those individuals with a nonaphasic verbal communication deficit following right brain damage.

THE FALL AND RISE OF THE RIGHT HEMISPHERE

After hesitating for many centuries between Aristotle and Hippocrates, between the heart and the brain (and thereafter, between the cavities of the brain and its substance), science finally convinced itself that language and other cognitive activities were based in the convolutions of the brain, along with some of the subcortical structures. After the regularity of the brain's convolutions was finally discovered and coupled with the conviction that the different aspects of human activities could be conceived atomistically, the essence of modern neuropsychology was laid down through one of the first of a series of excesses, the phrenological approach. Franz Joseph Gall, his pupils, and his colleagues thus proposed in the early 19th century a notion that still lies at the core of modern conceptions about the neurobiological bases of intellectual activities, namely, that discrete components of the brain are responsible for discrete components of what we now call cognitive functions. But for all those centuries, whatever the conceptions proposed, *both* halves of the brain—or of the heart!—were thought to contribute equally. No distinction was made whatsoever between the relative contributions of the right and the left hemispheres to an individual's cognitive functions.

However, at the same time that phrenological proposals were being popularized in northern France, a clever and observant surgeon in southern France came to some clinical conclusions that would change the way both hemispheres would be regarded. This surgeon was Marc Dax. From 1800 to 1834 he had to treat a series of patients who had lost the ability to speak after suffering brain lesions (some of them from saber blows). In a paper given in Montpellier in 1836, Dax first presented the principle that the brain's hemispheres make asymmetrical contributions to language. Even though Dax's claim was never published in his lifetime, it was the origin of modern conceptions about the brain's asymmetry vis-à-vis language functions. According to Ombredane (1951), it was the discussions around the official recognition of Marc Dax's paper by the *Académie de médecine de Paris* that forced Broca to take his position. Approximately three weeks after Dax's paper was authenticated in May 1865, Broca popularized the asymmetry concept on June 15, 1865, in an address to the *Société d'anthropologie* in Paris.

The essence of Dax's oral and Broca's written contributions is that articulated language is essentially a product of the left hemisphere. Although most of those who refer to this period insist that the privileged role of the left hemisphere for language was thus unveiled, it must be realized that it was not the role but its privileged status that was new; in part, Dax and Broca simply restated the left hemisphere's long-known contribution to language. The real revolution was that the right hemisphere *lost* its presumed contribution to language. Thus, the end of the 19th century should

be remembered as the period during which the right hemisphere lost its postulated contribution to language whereas the left hemisphere kept its presumed abilities. For nearly a century researchers would deny the right hemisphere any role in language functions, the few exceptions being some sporadic and ill-received contributions, such as those of Huglings-Jackson (1879).

The right hemisphere blackout in language functions lasted until the mid-20th century. At that point, some other trailblazing clinicians, as clever and observant as Dax had been, suggested that right hemisphere lesions, although usually not the origin of an aphasia proper, nonetheless could cause limitations in right-handed patients' communicating abilities. Pioneers such as MacDonald Critchley (1962), Jon Eisenson (1962), and Ed Weinstein (1964) thus came up with the notion that an acquired right hemispheric lesion could produce communication problems. The terms delineating those problems were clumsy, though, such as Eisenson's (1962) notion of the "super-ordinary" aspects of language. Nonetheless, the right hemisphere was more and more suspected of having some capacities for some aspects of verbal processing. Thus, a century after its exclusion and only some 30 years ago, the right hemisphere was again recognized as playing a role in language.

It is now well known that an acquired lesion to a nondominant right hemisphere, though not responsible for an aphasia, can be at the root of some impairments in the ability to communicate. Apart from those at the prosodic level, impairments have been reported potentially to involve the processing of the semantic aspects of words and text-level abilities, as well as the adequacy between language and context (for reviews, see Code, 1987; Joanette, Goulet, & Hannequin, 1990; Myers, 1984, 1986). Most of the conceptual frameworks needed to describe these problems were not available when the term *aphasia* was coined, which probably explains why the impairments were not recognized as aphasic. Also, these impairments were so mild as to sometimes escape notice by clinicians. Thus, most authors, past and present, have referred to these problems as *nonaphasic.* Labeling these problems as either aphasic or nonaphasic, however, is essentially an arbitrary decision. We will refer to them as *verbal communication deficits,* because they usually involve more than the traditional components of linguistic functioning (e.g., phonology, morphology, syntax) and frequently include text-level processes (see Joanette & Brownell, 1990) as well as pragmatic aspects of language.

As we near the dawn of the 21st century, the left hemisphere is conceived to be necessary but not sufficient for normal communication ability. Numerous studies and clinical reports have clearly demonstrated that the integrity of the right hemisphere is also needed. The question now is to identify clearly the components of communication for which the integrity of the right hemisphere is needed. In doing so, though, numerous

problems arise in terms of the available conceptual frameworks or methodologies. At the same time, the clinical approach to these problems suffers because this field is still young. Consequently, our purpose in this chapter is not to provide an overview of the current teaching and knowledge about the verbal communication deficits in right-brain-damaged (RBD) right-handers; some of us already have provided the literature with such comprehensive reviews. Rather, the goal here is to raise questions about some of the current conceptual, methodological, and clinical issues in the field. The first six sections will treat intermingled conceptual and methodological issues, and the last two sections will deal with clinical issues. In doing so, we hope to generate discussion and a collective effort toward understanding the effective contribution of the right hemisphere to verbal communication.

AN INTEGRATED MODEL OF VERBAL COMMUNICATION: WHERE TO LOOK

One of the first problems with the research on and clinical approaches to the impairments reported among RBD patients is the limit inherent to the conceptual framework used to refer to these impairments. There is no available conceptual framework that can situate, in an integrated manner, each of the aspects of the communicative impairments found among RBD patients.

It has been stressed already that the kinds of impairments exhibited by RBD patients can affect one or another of the cognitive components allowing for verbal communication. The term *verbal communication*—or its equivalents, such as *communicative abilities*—refers to a series of cognitive abilities that permit exchange of information between two or more individuals in a given context. The concept of *verbal communication* includes, linguistic abilities, among other things, even though the impairments found among RBD patients do not mainly affect the linguistic skills *per se*.

The concept of *verbal communication* is useful in referring in a general manner to the impairments among RBD patients, but it lacks theoretical support. Indeed, to our knowledge, there is no theoretical framework sufficiently integrated and complete to cover all the possible levels of impairments found in RBD patients. For example, Garrett's (1984) model has been frequently cited in many neurolinguistic studies on aphasia. This model contains a series of representation levels allowing for language production, from the message level to the motor control level. Unfortunately, the content of each of these levels is not always clearly detailed. Moreover, many of the different communicative deficits reported among RBD patients are found at the message level. Thus, the message

level corresponds in fact to a whole area of communication, a condition that prevents it from being useful for our purpose.

Authors interested in text-level processes have proposed other possible theoretical frameworks. For example, Frederiksen's (1990) model is more explicit than Garrett's. Frederiksen treats Garrett's message level as numerous levels of representation of the message, his model has its own limitations. Among other things, it fails to integrate the communicative context sufficiently to account for the role of shared knowledge in discourse production. Also, this model is oriented toward some types of discourse production and comprehension, but it overlooks conversational discourse and abilities such as topic shifts and topic maintenance.

Other models, such as Ellis and Beattie's (1986) model, seem to incorporate more of the context and thus palliate some of the previously mentioned limitations. The Ellis and Beattie model remains a very general sketch of verbal and nonverbal communication, however, and does not allow for an operationalization of the different components included, overtly or covertly.

In conclusion, none of these models offers a satisfactory integrated, specific theoretical framework that allows systematic exploration of the verbal communication deficits among RBD patients. (Of course, that was not the initial goal of these conceptual frameworks.) Given that no specific theoretical framework exists, the concept of *verbal communication* itself is ill-defined and lacks theoretical support. This concept essentially denotes a domain of cognitive abilities that depends on the contribution of specific linguistic components (e.g., syntactic processes) and other cognitive components (e.g., inference-making processes). The expression remains useful with regard to the kind of difficulties RBD patients have, but the fact that it corresponds to nothing in particular must be kept in mind. It is hoped that studies aimed at elaborating an integrated conceptual framework for verbal communication will soon be available.

VERBAL COMMUNICATION OR GENERAL INTELLECTUAL DEFICITS? A CIRCULAR QUESTION

An issue frequently raised in the literature concerns the linguistic specificity of the communicative impairments that RBD patients exhibit. Indeed, authors such as Gainotti, Caltagirone, & Miceli (1979) have proposed that, at least for lexico-semantic deficits, RBD impairments could reflect diminished intellectual functioning. This suggestion was made after these authors noted that those RBD patients who had lower IQs were the ones with communicative deficits, as measured at the lexico-semantic level. How-

ever, as will be suggested, this is a very difficult question to tackle; indeed, it may turn out to be a false question.

The suggested IQ deficit in RBD patients leads to the following questions: What is intelligence, and is it possible to appreciate general intellectual functioning apart from verbal communicative abilities? The first of these two questions lies at the heart of a longstanding debate in psychology. However, we must remember that there is no such thing, in cognitive models, as an *intellectual module.* In other words, the concept of general intellectual functioning is a clinical concept that is either the overall reflection in each cognitive component of some deeply nested intellectual abilities or potential or, conversely, the summation of all the cognitive potential and abilities found in a given individual. The current clinical appreciation of intelligence relies heavily on linguistic abilities. In fact, most of the standardized tests of intellectual functioning (e.g., WAIS, Wechsler, 1955) are heavily loaded on language that is either appreciated directly (e.g., vocabulary) or used as a tool by which to appreciate other cognitive abilities (e.g., similarities). This brings us to the second point: If, as many would have it, the kind of communication problems seen among RBD patients involves more than merely linguistic abilities and should incorporate aspects of cognition (e.g., the ability to make inferences), it has to be realized that many of the same abilities could be appreciated in so-called general intellectual abilities.

In sum, the attribution of the impairments that RBD patients have in verbal communication to an altered general intellectual functioning is very difficult to explore experimentally. Depending on the relevant concept of intelligence, the attribution might even be tautologous. Indeed, not only is language, and verbal communication in general, highly involved in the appreciation of general intellectual functioning, but the kind of impairments RBD patients have extends beyond—or underlies—the limits of linguistic abilities *per se.* These impairments probably reflect impaired cognitive abilities that are the basis of an individual's intellectual functioning. Thus, it is not certain that the intellectual-functioning hypothesis could account for all types of verbal communication deficits. Trying to dissociate these two notions is probably circular. Instead, we need to identify the cognitive abilities that are indeed necessary for good verbal communication.

THE SEMANTIC PROCESSING OF WORDS: HOW TO LOOK AND WHAT TO LOOK FOR

One of the most productive research areas regarding the right hemisphere's effective contribution to verbal communication pertains to the

semantic processing of words (see Chapter 4 in Joanette, Goulet, & Hannequin, 1990, for an up-to-date review). It is well known that a right hemisphere lesion can result in an inability to access or to process certain kinds of words adequately. This inability converges with the wealth of data coming from the split-brain and the normal subject literature about the capabilities of the right hemisphere. These studies demonstrated that the right hemisphere has its optimal potential for automatically activated, concrete, picturable, and frequent substantives. However, it is still to be discovered whether the effects of right hemispheric lesions can be described by reference to this potential. Though interest in the effects of right hemispheric lesions on lexico-semantic abilities generates more and more research questions, our impression is that there are a number of methodological and conceptual limitations that should be discussed for those contributions to be even more relevant. The following are examples of these issues.

The Representation–Access Debate: The Priming Paradigm Disillusion

A persistent question in aphasiology, and one that is present in the RBD literature, is whether the lexico-semantic difficulties of a patient are due to a representation or an access problem.[1] In other words, does the problem stem from some weakened lexico-semantic network, or is it to be attributed to limitations in the mechanisms that provide access to the presumed semantic network? Trying to sort out these two possibilities is not an easy task, but cognitive psychology has contributed some answers to this question over the last decade, for example, provided Milberg and Blumstein's (1981) seminal work in aphasia using what is known as the priming paradigm. Although this particular contribution lacked the methodological sophistication to distinguish between automatic and controlled priming conditions (Posner & Snyder, 1975), others *can* differentiate these two notions, which can contribute significantly to the access/representation debate. For instance, according to Siéroff (1991), automatic semantic priming essentially informs us about the quality of the representation, whereas controlled semantic priming depends on both the quality of the representation *and* the quality of the access mechanisms. Thus, this was the better paradigm with which to study the nature of the lexico-semantic impairment among RBD patients. This paradigm has been used in only

1. At the time this paper was written, the representation–access dichotomy was still popular. Since then, the field has evolved toward a rephrasing of this dichotomy along an activation continuum.

two studies with RBD patients, however, one by Gagnon, Goulet, and Joanette (1989) and another one by Tompkins (1990).

The use of lateralized priming in normal subjects can shed light on the use of the priming paradigm with RBD patients. After studying right and left hemifield automatic and controlled semantic-priming conditions with undergraduate students, Chiarello, Senehi, and Nuding (1987) suggested that, whereas right hemifield (left hemisphere) presentations were associated with efficient automatic *and* controlled priming effects, left hemifield (right hemisphere) presentations were associated with automatic, but not controlled, priming. In a study of automatic and controlled priming in left- and right-brain-damaged patients, Gagnon et al. (1989) came up with nonconvergent results. Gagnon et al. (1989) showed that both automatic *and* controlled priming conditions were unaffected in both left-brain-damaged (LBD) mild aphasics and RBD patients. However, using a third task—a semantic judgment task that required even more effort—they showed that both LBD and RBD patients were impaired. Assuming that the priming condition this study investigated was in fact controlled, the results suggest that, contrary to the conclusions of Chiarello et al. (1987), normal access to the semantic network requires the integrity of both the left and the right hemisphere.

However these priming studies might contribute to the representation/access debate in the RBD literature, there are a number of problems with the priming paradigm itself. First, not every researcher has determined the presence of circumstances sufficient to distinguish automatic from controlled priming conditions. An automatic priming condition is characterized by some benefits in the related condition (e.g., the existence of a semantic relation) in the absence of any costs from the unrelated condition (see Siéroff, 1991, for a review). In controlled priming, more benefits are expected in the related condition, but they are accompanied by costs in the unrelated condition. Most aphasia studies have not adequately checked for the presence of such effects. Thus, many authors simply propose the experimental setup that *should* yield such distinctive priming conditions without verifying, through a cost-benefit analysis, whether these conditions are respected, such as was done in the Gagnon et al. (1989) study. As for the two studies reported in the RBD literature, neither Tompkins (1990) nor Gagnon et al. (1989) obtained costs in a priming paradigm that was supposedly of a controlled type. These results raise further questions: Did this result reflect an experimental setup that did not induce a properly controlled type of priming, or is the absence of costs also characteristic of controlled priming? If it is the latter case, the theory behind priming conditions should be revised.

But this is only part of the issue. Another part is the problem inherent to the method used to verify the automatic or controlled nature of the priming condition. Indeed, the cost-benefit analysis can be done only if

related and unrelated primes are compared with what is referred to as a *neutral* prime (e.g., XXXX, BLANK, or a nonword). However, the neutral status of these "neutral" primes is an object of debate. Even more problematic is the fact that most of the reference studies of the priming paradigm have been done on undergraduate students. It is not at all certain that the normal mature or aged population performs on those tasks in the same way as undergraduates do.

Thus, it becomes apparent that the priming paradigm can offer an interesting solution to disentangle the representation/access debate. Nonetheless, a number of preliminary studies are needed to obtain a theoretically and pragmatically valid experimental paradigm with a normal subject population that will be representative of the brain-damaged patients about whom we would like to increase our knowledge.

Oral Naming: What to Look For

One of the lexico-semantic production tasks frequently proposed to RBD patients—either for direct evaluation of their performance or because they were a control group in a study of LBD patients—is the oral-naming, verbal fluency, or lexical evocation task (also labeled the FAS test or the Category test). Typically, this task requires the subject to produce words orally using a given selection criterion within a certain amount of time, usually 1 or 2 minutes. The criteria used are either formal (e.g., the letter *B*) or semantic (e.g., names of animals).

Oral-naming tasks are useful in determining whether the right hemisphere contributes to the lexical or the semantic aspects of lexical semantics in production and, consequently, in knowing how to characterize the effects of a right hemisphere lesion. For example, Joanette and Goulet (1986), as well as Laine and Niemi (1988), claimed that only semantic, but not formal, criteria were associated with diminished oral-naming performance among RBD patients. Even though there were nonconvergent results in the literature (Joanette et al., 1990), this result was still in line with the numerous studies done with normal subjects using divided-field presentations. The results also converged with split-brain studies showing that the right hemisphere is capable of processing some semantic aspects of words but is much less capable of handling their formal aspects. Up to this point, everything seemed clear, but some recent results could challenge this interpretation in a dramatic manner.

Sabourin, Goulet, and Joanette (1988) showed that, regardless of the semantic or formal nature of the criteria, RBD patients exhibited significantly lower performance only if the criteria were highly productive, not when they were moderately or slightly productive. The criteria's productivity was defined as the normal subject's ability, for a given criterion, to

generate words associated to it. In this study, two semantic and two formal criteria were used for each of three levels of productivity. Obviously, this result, if confirmed, would put a focus on a different set of interests about the nature of the right hemisphere's contribution to lexical semantics. It certainly shows how much our knowledge about the nature of the right hemisphere's contribution to lexical semantics is constrained by the current methodological as well as conceptual limits of our era. This is probably just the evolution of science, but we might want to be aware of it.

Is the Concreteness Effect Due to Concreteness?

In addition to the problems about the type of activation involved and the role that the right hemisphere plays in lexical semantics, another problem lies in the nature of the words that are best processed by the right hemisphere. That is, for a given kind of activation, and for a given type of contribution, the question is whether the right hemisphere has a preference for certain word types that could be characterized semantically. If one looks at the normal subject and the split-brain literature, the most frequently documented difference between the right and the left hemispheres' capabilities concerns concreteness effects. It is known that, whereas the left hemisphere can process both concrete and abstract nouns, the right hemisphere can process only concrete ones. Concreteness is certainly not the only lexical characteristic that may point to a difference between the two hemispheres, but it is the one that has generated the most studies (Joanette et al., 1990).

Only a few studies have investigated the concreteness effect among RBD and LBD patients. However, numerous studies have used lateralized presentation of concreteness in normal subjects to document each hemisphere's potential. Results of these studies are controversial, because some studies indicated that the right hemisphere can process concrete words, whereas others did not (Searleman, 1977). The reason for this discrepancy may be that there are methodological differences between the studies, including subject selection, but another explanation might find its source in psycholinguistics and the literature of cognitive psychology. Indeed, the question is whether concreteness by itself is the determining factor; whether it is a composite factor expressing other more basic features; whether it is intimately linked with other features to the point that its independent existence could be threatened; or whether concreteness is a genuine elementary factor but one that generates methodological problems because it is difficult to control for linked factors. The latter questions have been recently raised by Schwanenflugel, Harnishfeger, and Stowe (1988), who, when looking at normal subjects' performance in

central vision, compared concreteness to imagery, frequency, semantic association, and meaningfulness, as well as to context availability. These authors found that context availability accounted most for the "concreteness" effect. Given the importance of the concreteness effect in understanding the contribution of the right hemisphere to lexical semantics, as well as to the effects of a right hemisphere lesion on lexico-semantic abilities, we need to undertake a series of studies to see what is (or are) the factor (or factors) that most suitably accounts for it. The question is still open, but the results obtained by Schwanenflugel et al. are certainly sufficient to question the legitimacy of the concreteness effects with regard to the right hemisphere.

In sum, the question regarding the concreteness effect is whether the concepts invoked are adequate. Although there may well be common lexical characteristics of the words that are best processed by the right hemisphere, concreteness might not be one of them. Again, this is how science evolves, but let us be reminded of it!

INFERENCING DEFICITS AMONG RIGHT-BRAIN-DAMAGED SUBJECTS: THE RIGHT RABBIT TO CHASE?

One of the most recurrent hypotheses about RBD patients' difficulties at the text level has been that they have a problem with inferencing abilities (for a review, see Joanette et al., 1990). Indeed, authors of numerous studies—many due to the original contributions of Hiram Brownell, Howard Gardner, and their colleagues in Boston—have proposed an inferencing deficit as a possible explanation for RBD individuals' impaired abilities at the text level. These studies looked at abilities such as understanding metaphors (Winner & Gardner, 1977), understanding indirect speech acts (Weylman et al., 1986), organizing the content of sentences (Delis, 1980), extracting the moral of a story (Wapner et al., 1981), inferring actors' attitudes (Cicone et al., 1980), or incorporating nonexplicit information in narratives (Joanette et al., 1986). However, the existence of an inferencing deficit has only been ***suggested*** by these studies, **not** *demonstrated.*

A certain number of studies did look at inferencing abilities *per se,* that is, the ability to produce new information by mentally manipulating other pieces of readily available information. These studies looked at either *pragmatic* inferencing or *logical* inferencing. The former refers to an inference for which at least one of the premises is previously known to the subject (usually part of semantic memory), whereas the latter is based entirely on new information or premises.

Only a few published studies have looked at logical inferencing abilities among RBD patients (e.g., Caramazza, Gordon, Zurif, & De Luca, 1976; Read, 1981). The results of these studies are not easy to interpret, though, given the problems they raise. For example, in the Caramazza et al. (1976) study, the authors conclude that RBD subjects have difficulties solving syllogisms because they have difficulties with the spatially based processes the authors claim to be necessary to accomplish the task. However, only the linguistic, determinants of the syllogisms have been investigated. In fact, Caramazza et al.'s results show that RBD subjects have difficulties when the adjective of the question is not the same as the adjective of the premise, that is, the so-called congruency of the predicates.

Searching for a way to cope with these problems, Joanette and Goulet (1987a) looked at the logical-inferencing performance of a group of RBD subjects compared to the performance of a group of normal age-, sex-, and education-matched controls. Logical inferencing was evaluated through the use of three-term two-relation syllogisms similar to the following: "John is taller than Paul, and Paul is taller than Bill. Who is the tallest?" To control for all possible determinants, both linguistic and spatial determinants of syllogism resolution were controlled for in the preparation of the stimuli. Thus, linguistic determinants such as the congruence and markedness of the comparators were considered. Syllogisms were also constructed in such a way that spatial determinants were controlled for. Thus, some syllogisms were *end anchored* (e.g., "Jane is taller than Linda, and Rachel is shorter than Linda"), whereas others were *center anchored* (e.g., "Linda is shorter than Jane, and Linda is taller than Rachel"). The results showed no difference whatsoever between RBD subjects' and normal control subjects' performances. For one or two types of syllogisms, however, there was a tendency for normal controls to perform at chance level, so one should interpret these results prudently. Nevertheless, the performances of the RBD subjects reflected a hierarchy in the spatial and linguistic determinants used to construct the syllogisms. Thus, the RBD subjects' performances were not simply random. In any case, these results, taken together with the ones previously cited in the literature, call into question the claim that RBD patients suffer from an inferencing deficit. Better controlled studies are needed to answer this question.

Convergent results were obtained for pragmatic inferencing. It must first be noted that a certain number of studies in the literature have been looking at such inferencing abilities among RBD patients (Brookshire & Nicholas, 1984; Brownell, Potter, Birhle, & Gardner, 1986; Goodenough et al., 1982; McDonald & Wales, 1986; Tompkins & Mateer, 1985). However, the results of these different studies are inconsistent and, taken together, inconclusive. In another study (Joanette & Goulet, 1987b), we looked at the pragmatic-inferencing abilities of a group of 30 RBD subjects compared to those of a group of normal age-, sex-, and education-matched

controls. Pragmatic inferencing was studied in the context of sentences, a short text, and within produced narratives on the basis of iconographic material in which not all information was explicit. The details of the respective methods cannot be discussed here, but the results are very much convergent: There was no difference whatsoever between RBD subjects' and normal controls' performances. This series of convergent results is, by itself, in convergence with those obtained in the previously mentioned logical-inferencing study (Joanette & Goulet, 1987a).

In sum, from our experience with logical and pragmatic inferencing in RBD subjects, and from the literature that looked specifically at logical or pragmatic inferencing abilities among RBD subjects, it is certainly difficult to conclude that an inferencing deficit characterizes patients with a right hemisphere lesion. If, as it seems, this result is to be ascertained by future studies, reasons remain to be found that can account for RBD subjects' lower performances when faced with text-level tasks such as humor, sarcasm, or other previously mentioned abilities. Certainly, inferencing *per se* does not seem to be the only source of the problem. If this conclusion were to be confirmed by future studies, then what is the source of RBD patients' difficulties? One possible line of exploration is the concept of plausibility metrics put forward by Gardner, Brownell, Wapner, and Michelow (1983). In trying to understand a text, a listener regularly has to choose between many different possible meanings and submit these meanings to an evaluation of the relative *plausibility* of each in view of the specific context in which the verbal material has been provided. One example of this is the understanding of indirect speech acts. A given sentence such as *"The door is open"* can yield an incredibly large number of meanings, from the most literal to the most figurative. Just think of this sentence told at 10:00 A.M. by the person who is responsible for opening a museum and the same sentence expressed by a White House spokesperson after a Yeltsin-Bush meeting on denuclearization. Thus, plausibility evaluation and choosing the most plausible meaning are everyday necessities in verbal communication. However, the need for plausibility evaluation is not restricted to text-level processes; indeed, many of the experimental conditions used in research ask for such a plausibility evaluation. For example, Lesser (1974) asked RBD subjects to choose the best picture associated with a word in a study meant to aid in understanding lexico-semantic abilities.

A very large number of the tasks that have been reported in the literature as possible indicators of an inferencing impairment are also tasks in which the need for plausibility evaluation is high. For instance, in Brownell et al.'s (1986) study of backward inferencing, the results reported could be alternatively explained by difficulties in evaluating the relative plausibility of the different meanings. In this study, short texts induced first one inference in the subject and then another, forcing the subject to

revise the first inference. To answer the experimenters' questions, subjects had to state whether a given more-or-less-plausible affirmation was the most convenient by reference to the initial set of sentences. Among these possibilities were the initial and the revised inferences. According to Brownell et al. (1986), RBD subjects performed less capably than did normal control subjects, choosing the revised inference significantly less frequently. At first glance, this result could indicate that RBD subjects had difficulties inferencing, as the title of the paper suggests. Looking at the RBD subjects' performances, however, the authors reported that RBD subjects did not choose the revised inference mainly because the first inference was maintained. In other words, the problem could also arise from a difficulty in choosing the right inference or from an inability to reject the first inference. Thus, one possibility is that RBD subjects had both inferences available to them but that the evaluation of the relative plausibility of these two inferences provided the context of the task, and the text was so limited that the first inference was chosen much more frequently. This possible explanation still has to be explored systematically, though, before the whole literature on the subject shifts from inferencing to plausibility in accounting for the verbal communication problems in RBD patients. In any case, it would be most surprising if there were only one possible cause to all the text-level verbal communication impairments found among RBD patients.

In fact, another avenue that will certainly be explored further is linked with the fact that RBD patients are impaired mostly on those aspects of verbal communication that could be characterized as the most difficult ones. In other words, when sufficiently precise and integrated conceptual frameworks are implemented, it may turn out that the aspects of verbal communication for which RBD patients have problems correspond to more effortful processes or to less common representations. One example of this pertains to the presumed specific impairments RBD subjects have with the metaphorical meaning of sentences or words (e.g., Brownell, Potter, & Michelow, 1984). In a recent study that looked at the ability of RBD patients to process the literal meanings of words (e.g., *pupil* as a part of the eye, or *warm* as a cue temperature), the secondary nonmetaphorical meanings (e.g., *pupil* as a student), and the secondary metaphorical meanings (e.g., *warm* as a cue on the nature of the relationship with someone), Gagnon (1992) suggested that it was nearly impossible to come up with a task in which the secondary nonmetaphorical meanings of words were precisely equivalent to the secondary metaphorical ones. Indeed, the strength of the association between a given word and its secondary nonmetaphorical meanings is only rarely equivalent to the strength of its association with any metaphorical meanings. Such a limitation could explain why RBD patients are said to have specific problems with the metaphorical meanings of texts or words: The integrity of the two hemispheres

might be more important when the task is more complex, a simple bit of reasoning that makes simple sense. Applying this principle to the inferencing problem, one could argue that maybe part of the problems RBD subjects have is because to infer is more complex than not to infer, and that different types of inferences in different contexts may ask for greater contributions than other types and other contexts.

In conclusion, it is not certain that the text-level impairments documented among RBD patients are best understood as an inferencing impairment. In fact, inferencing may not be the issue. Plausibility evaluation appears to be a potentially interesting avenue to explore further, but even this might not be the answer. Ultimately, we need a more precise and integrated understanding of these text-level processes to eliminate the possibility that we may be facing a simple complexity hierarchy according to which the more complex the task is, the more the two hemispheres participate.

THE QUESTION OF THE CONTROL GROUPS: AN UNSOLVED ENIGMA

When we study how a right hemisphere brain lesion affects a right-hander's verbal communication abilities, there are at least two basic questions that require an equal number of control groups. The first question is whether a right hemisphere lesion affects verbal communication. For this purpose, verbal communication abilities are evaluated by reference to the performance of a group of normal control subjects matched according to all the factors thought to influence performance (e.g., age, sex, handedness, education). This procedure has been followed by many researchers in the field and has provided interesting results, despite the fact that not all the factors that might influence performance have been adequately controlled for in all studies (e.g., hospitalization).

However, strategies to address the second question are much less easy to implement. This question relates to the specificity of the right hemisphere's contribution and is typically expressed by asking whether the impairments in a given verbal communication ability are specific to RBD patients or whether they are present in any brain-lesioned patient. To answer this second question adequately requires a second control group, this one made up of non-RBD brain-lesioned subjects; given that there are only two hemispheres, the control subjects must be LBD patients. This is where the problems begin. Which LBD patients should be included in such a study? The first of many possibilities is to choose LBD patients with aphasia. The problem here is that the aphasia usually prevents those patients from executing the experimental task. The alternative is to rely

on a group of mildly aphasic LBD patients. Now the problem is that this group might not be comparable with the RBD group, because the sizes and the localizations of the lesions might differ. Another possibility would be to gather a group of nonaphasic LBD patients with lesions equivalent in size. The problem here is that most of the RBD patients will have perisylvian lesions, whereas the nonaphasic LBD patients will have lesions of the frontal or the occipital poles. But let us imagine that someone is very patient and stubborn and does indeed find a certain number of nonaphasic or very mildly aphasic patients with similarly sized left hemisphere lesions in the perisylvian area. This would take time and effort, but it could be done. This time, however, the problem lies in the representatives of this group. Indeed, such a group inevitably will include individuals with a very unexpected and maybe deviant functional organization of the brain as regards language. It could be, for instance, that many of these individuals would develop an aphasia following a right hemisphere lesion, thus realizing a crossed aphasia (Joanette, 1989).

In other words, it may be easy to identify a control group for a study that assesses the presence of a deficit, but to identify one in a study that addresses the specificity question is much more difficult. In fact, it is our impression that no such ideal group exists. It may thus be necessary to look for convergences of results from many different control groups, including subjects whose deficits have a more general involvement of the brain, such as in dementia of the Alzheimer's type.

WILL THE REAL RBD PATIENT WITH VERBAL COMMUNICATION DEFICITS PLEASE STAND UP?

One question only rarely discussed in the literature is whether *all* RBD patients exhibit verbal communication deficits. Every clinician knows that this is not the case; anyone who has had the opportunity to evaluate a series of patients with a right hemisphere lesion can testify that not all RBD patients appear to have verbal communication impairments. Nonetheless, this reality has only rarely been echoed in studies of the verbal communication deficits among RBD patients. Indeed, in most studies, RBD patients are amalgamated in an experimental group not chosen with regard to the presence of such deficits. Thus, according to chance, some RBD groups of subjects may contain a higher proportion of communication-impaired subjects than others, which may account for some of the inconsistency in the literature.

In a previous study, Joanette, Goulet, and Daoust (1991) skimmed the RBD literature to document this question, highlighting two complemen-

tary sets of information. The first set of information consisted of 64 studies that pertained to more or less the same aspects of verbal communication; for example, 17 studies were about the performance of RBD subjects on an oral-naming task. Of those 64 studies, approximately half reported the presence of an impairment among RBD patients, whereas the other half did not conclude that such an impairment existed. In other words, if patients in these studies are indeed representative of the RBD population, one could infer that approximately half of all RBD patients present verbal communication deficits.

A second set of information comes from nine studies that distinguished between "impaired" and "nonimpaired" RBD patients. Indeed, some authors have looked at their group of RBD patients and tried to distinguish between those that performed more poorly than the controls and those that did not. The proportion of impaired RBDs was reported as highly variable. However, if one looks at the median, the figure is not incompatible with the 50% identified by Joanette et al. (1991). It is also somewhat comparable to the figure reported by Deal, Deal, Wertz, Kitselman, and Dwyer (1979). Indeed, these authors previously suggested that approximately two-thirds of RBD patients had communicative deficits, as measured by the *Porch Index of Communicative Ability.* Our clinical impression is that the figure is probably somewhat similar with regard to the proportion of LBD patients who show signs of an aphasia. If this latter impression were confirmed by a study, it could be concluded that the likelihood of a left hemisphere lesion producing an aphasia is roughly equal to the likelihood of a right hemisphere lesion producing verbal communication deficits—which also makes simple sense.

The subsequent question, of course, concerns the characteristics of those RBD patients with a verbal communication deficit. Why do some patients show such impairments and not others? Some years ago, one of the authors of this chapter participated in a study that provided some tentative answers (Joanette, Lecours, Lepage & Lamoureux, 1983). In this study, RBD patients' abilities were documented on a number (N = 42) of mostly traditional linguistic tasks. Results indicated three factors associated with the intensity of overall impairment ("none," "mild," and "severe," even though the most severe were still quite discrete clinically): first, the presence of a cortical lesion (versus a subcortical lesion, i.e., one involving the basal ganglia and thalamus); second, a family history of left-handedness; and third, a low level of education. These three factors are determined by the brain, genetics, and the environment, respectively. The first one—presence of a cortical lesion—is somewhat reassuring, if not unexpected. Even though a lesion affecting the subcortical structure can probably produce verbal communication impairments among RBD patients, just as it can produce an aphasia when the left hemisphere is involved, this

finding testifies that cortical lesions are still more relevant. The second factor—familial left-handedness—is in convergence with many papers in the literature (e.g., Hécaen, de Agostini, & Monzon-Montes, 1981) that show familial left-handedness in right-handers to be associated with a lesser degree of left hemisphere lateralization for language. Consequently, a right hemisphere lesion may thus result in more important deficits. Finally, the third factor—education—is also convergent with the current literature on the relationship of education and the degree of the brain's functional organization for language. Indeed, according to Lecours et al. (1988), there is a tendency for less-educated individuals to exhibit a lesser degree of brain lateralization for language. Thus, if the right hemisphere makes a relatively more important contribution to language among less educated individuals, it is logical to note a more important effect of a right hemisphere lesion among those less educated individuals. This is what was found in that third factor. In addition, other factors have been suggested in the literature. As was previously mentioned, Gainotti et al. (1979) have suggested that RBD patients with communication impairments are those with a diminished intellectual functioning; we have already discussed this contribution as potentially circular. For Weinstein (1964), RBD patients with a communicative impairment would be those showing anosognosia. Even though this observation might be correct, the exact link between this clinical sign and the presence of a verbal communication deficit is still to be clearly understood.

As can be seen, not all RBD patients present a verbal communication deficit: The inclusion criterion—the presence of a right hemisphere lesion—is not sufficient to obtain a homogeneous group. Using this criterion appears more and more like trying to understand aphasia by studying groups of LBD patients, whether they are aphasic or not! It thus seems important to identify those subjects **with** a verbal communication impairment and to concentrate on those. This field could thus probably benefit from single-case studies, as is the case for the aphasia field. Given the problems in identifying those patients beforehand, an alternative way of facing this problem is to include a *post hoc* subgrouping analysis in each study. For example, Joanette, Goulet, Ska, and Nespoulous (1986) have used a hierarchical clustering technique to sort the subgroups of RBD patients with and without a given impairment. The exercise becomes interesting when one also includes normal control subjects in this process, because that allows for the identification of those normal controls who would behave like impaired RBD patients. The fact that not all RBD patients show a verbal communication impairment also has important clinical consequences. Indeed, it becomes more and more important to identify which patient has a problem before considering whether to offer some support.

PATTERN(S) OF VERBAL COMMUNICATION DEFICITS AMONG RBD PATIENTS: SINGULAR OR PLURAL?

The last aspect of the question of the verbal communication deficits among RBD patients that will be discussed here follows the preceding question logically. Indeed, if one is now convinced that not all RBD patients exhibit such a deficit, what about the pattern of verbal communication deficits among those who *are* impaired? In other words, is there only one pattern of impairments among all those who are affected? As one can imagine, there have been few contributions on this topic. The only indications known to us come from the previously cited study by Joanette et al. (1991). In this study the authors used three different tasks that tackled the word level (oral naming, or ON), sentence level (sentence completion, or SC), and text level (narrative production, or NP), respectively. Using a cutoff point based on the performance of the normal controls, results showed that of a total of 33 patients, 4 of them were affected on all three abilities, whereas 9 were not affected. However, the most interesting results come from the other 20 RBD subjects: These subjects showed that all possible patterns were possible and that opposite patterns could be shown to exist. Thus, 3 RBD subjects showed no impairment on ON and NP along with an impaired SC, whereas 6 subjects exhibited the reverse pattern, showing impairments on ON and NP with an intact SC. All three opposite patterns were found.

The next step is to look for the causes for these contrastive patterns. One possibility is that they reflect some kind of interindividual differences present before the occurrence of the lesion that result in distinctive expression of a similar lesion in different individuals. These interindividual differences could in turn result from genetic as well as environmental factors, some of them still to be unveiled.

However, another possibility is that these distinctive patterns are the expression of the extent and the localization of the lesion in the right hemisphere, presuming that the right hemisphere does contribute distinctively to verbal communication abilities. Hints for this possibility are found in the Joanette et al. (1983) study in which 42 RBD patients were classified according to the nature of the language deficits, that is, according to their pattern of impairments. A *post hoc* analysis indicated that two factors were at the source of these distinctive patterns: the extent of the lesion, and its pre- versus retrorolandic localization. Given that these two factors are linked, this result reduplicated for the right hemisphere what is probably the most universal characteristic about the relation between the left hemisphere and the different types of aphasia—namely, that an aphasia following a prerolandic lesion usually differs from an aphasia following a retrorolandic lesion.

Even though this study's results have to be further documented, they suggest that when the right hemisphere contributes to verbal communication, it does so distinctively. One of the biggest challenges of our field is to discover exactly how the right hemisphere is organized for verbal communication. Given that more than 100 years of contributions did not allow us to obtain satisfying answers with regard to the left hemisphere and language, this may be quite a challenge.

CONCLUSION: WHAT IS LEFT IN THE RIGHT HEMISPHERE, OR WHAT IS RIGHT IN THE LEFT HEMISPHERE?

The series of conceptual, methodological, and clinical issues that should be addressed with regard to the verbal communication deficits among right-brain-damaged patients is certainly not limited to the list of topics discussed in the present paper. This list was simply a start-up to which many other points could have been added, like the question of the evaluation and the treatment of those verbal communication deficits. But the present list may be sufficient to demonstrate clearly that the field is far from being able to produce all the answers it would like to produce. This conclusion is important for those interested in research opportunities because it opens a large number of avenues still to be explored. It is also of the utmost importance for determining the clinical approach to be used with these patients, for prudence must be taken in evaluating, labeling, and treating them.

But maybe the most serious issue to which this conclusion will provide any answer is the usefulness of the concept of a right hemisphere verbal communication deficit. Up to now, no particular aspect of verbal communication other than prosody has been unequivocally demonstrated to be affected following a right hemisphere lesion. Worse, there are indications that in some cases, nonaphasic LBD subjects can present some of the signs reported following a right hemisphere lesion. It may be that, by focusing on the RBD subjects' verbal communication deficits, we are focusing on one particular example of a "nonaphasiogenic" acquired brain lesion that affects one or many of the cognitive components necessary for normal verbal communication. We might do better to consider our subjects of interest to be those patients with one form or another of these verbal communication deficits, usually following a right hemisphere lesion, but not in all cases. Because it has been shown that the right hemisphere's integrity is needed for some of the more linguistic components of language, and that prosody depends on both left- and right-hemisphere-based processes, it might be suggested that we abandon the concept of a

right hemisphere syndrome and replace it with the concept of a verbal communication syndrome that includes aphasia when the impairment mostly affects the properly linguistic abilities. This is not to say that all patients would be the same, but it might help all of us to consider these communicative impairments to be on a single continuum of verbal communication. Such a continuum would be under the constraints of many factors, including the localization of the lesion, both inter- and intrahemispherically speaking. However, what is right is left to be discovered.

REFERENCES

Broca, P. (1865). Sur la faculté du langage articulé [On the faculty of speech]. *Bulletin de la société d'anthropologie, 6,* 337–393.

Brookshire, R. H., & Nicholas, L. E. (1984). Comprehension of directly and indirectly stated main ideas and details in discourse by brain-damaged and non-brain damaged listeners. *Brain and Language, 21,* 21–36.

Brownell, H. H., Potter, H. H., Birhle, A. M., & Gardner, H. (1986). Inference deficits in right-brain-damaged patients. *Brain and Language, 27,* 310–321.

Brownell, H. H., Potter, H. H., & Michelow, D. (1984). Sensitivity to lexical denotation and connotation in brain-damaged patients: A double dissociation? *Brain and Language, 22,* 253–265.

Caramazza, A., Gordon, J., Zurif, E. B., & De Luca, D. (1976). Right-hemispheric damage and verbal problem solving behavior. *Brain and Language, 3,* 41–46.

Chiarello, C., Senehi, J., & Nuding, S. (1987). Semantic priming with abstract and concrete words: Differential asymmetries may be post-lexical. *Brain and Language, 31,* 43–60.

Cicone, M., Wapner, W., & Gardner, H. (1980). Sensitivity to emotional expressions and situations in organic patients. *Cortex, 16,* 145–158.

Code, C. (1987). *Language aphasia and the right hemisphere.* Chichester: Wiley.

Critchley, M. (1962). Speech and speech-loss in relation to duality of the brain. In V. B. Mountcastle (Ed.), *Interhemispheric relations and cerebral dominance* (pp. 208–213). Baltimore: Johns Hopkins University Press.

Dax, M. (1836). Lésions de la moitié gauche de l'encéphale coïncidant avec l'oubli des signes de la pensée (Read at the Southern Conference held at Montpellier in 1836). *Gazette Hebdomadaire de Médecine et de Chirurgie, 2ème série, 2,* 259–262.

Deal, J., Deal, L., Wertz, R. T., Kitselman, K., & Dwyer, C. (1979). Right hemisphere PICA percentile: Some speculations about aphasia. In R. H. Brookshire (Ed.), *Clinical Aphasiology Conference proceedings* (pp. 30–37). Minneapolis: BRK Publisher.

Delis, D. C., Wapner, W., Gardner, H., & Moses, J. A. (1983). The contribution of the right hemisphere to the organization of paragraphs. *Cortex, 19,* 43–50.

Eisenson, J. (1962). Language and intellectual modifications associated with right cerebral damage. *Language and Speech, 5,* 49–53.

Ellis, A., & Beattie, G. (1986). *The psychology of language and communication.* New York: Guilford.

Frederiksen, C. H., Bracewell, R. J., Breuleux, A., & Renaud, A. (1990). The cognitive representation and processing of discourse: Function and dysfunction. In Y. Joanette & H. H. Browell (Eds.), *Discourse ability and brain damage: Theoretical and empirical perspectives* (pp. 69–110). New York: Springer Verlag.

Gagnon, L. (1992). Appréciation du sens métaphorique chez des sujets cérébrolésés droits. Unpublished master's thesis, Université de Montréal.

Gagnon, J., Goulet, P., & Joanette, Y. (1989). Activation automatique et contrôlée du savoir lexico-sémantique chez les cérébrolésés droits. *Langages, 24,* 95–111.

Gainotti, G., Caltagirone, C., & Miceli, G. (1979). Semantic disorders of auditory language comprehension in right-brain-damaged patients. *Journal of Psycholinguistic Research, 8,* 13–20.

Gardner, H., Brownell, H. H., Wapner, W., & Michelow, D. (1983). Missing the point: The role of the right hemisphere in the processing of complex linguistic materials. In E. Perecman (Ed.), *Cognitive processing in the right hemisphere* (pp. 169–191). New York: Academic.

Garrett, M. (1984). In D. Caplan, A. R. Lecours, & A. Smith (Eds.), *Biological perspectives on language* (pp. 172–193). Cambridge: MIT Press.

Goodenough-Trépanier, C., Powelson, J., & Zurif, E. (1982). Bridging in right-hemisphere patients. Paper presented at the Academy of Aphasia Annual Meeting, Lake Mohonk.

Hécaen, H., de Agostini, M., & Monzon-Montes, A. (1981). Cerebral organization in left-handers. *Brain and Language, 12,* 261–284.

Huglings-Jackson, J. (1879). On affections of speech from disease of the brain. *Brain, 2,* 203–222.

Joanette, Y. (1989). Aphasia in left-handers and crossed aphasia. In F. Boller & J. Grafman (Eds.), *Handbook of neuropsychology* (Vol. 2, pp. 173–184). Amsterdam: Elsevier.

Joanette, Y., & Brownell, H. (Eds.). (1990). *Discourse ability and brain damage: Theoretical and empirical perspectives.* New York: Springer-Verlag.

Joanette, Y., & Goulet, P. (1987a). Syllogistic reasoning in right-brain-damaged right-handers: Preliminary results. Paper presented at the Annual Meeting of the Academy of Aphasia, Phoenix.

Joanette, Y., & Goulet, P. (1987b). Inference deficits in right-brain-damaged right-handers: Absence of evidence. *Journal of Clinical and Experimental Neuropsychology, 9,* 271.

Joanette, Y., & Goulet, P. (1986). Criterion-specific reduction of verbal fluency in right-brain-damaged right-handers. *Neuropsychologia, 24,* 875–879.

Joanette, Y., Goulet, P., & Daoust, H. (1991). Incidence et profils des troubles de la communication verbale chez les cérébrolésés droits. *Revue de Neuropsychologie, 1,* 3–28.

Joanette, Y., Goulet, P., & Hannequin, D. (1990). *Right hemisphere and verbal communication.* New York: Springer-Verlag.

Joanette, Y., Goulet, P., Ska, B., Nespoulous, J. L. (1986). Informative content of narrative discourse in right-brain damaged right-handers. *Brain and Language, 29,* 81–105.

Joanette, Y., Lecours, A. R., Lepage, Y., Lamoureux, M. (1983). Language in right-handers with right-hemisphere lesions: A preliminary study including anatomical, genetic, and social factors. *Brain and Language, 20,* 217–248.

Laine, M., & Niemi, J. (1988). Word fluency production strategies of neurological patterns: Semantic and phonological clustering. *Journal of Clinical and Experimental Neuropsychology, 10,* 28.

Lecours, A. R., Mehler, J., Parente, M. A., et al. (1988). Illiteracy and brain damage: 3. A contribution to the study of speech and language disorders in illiterates with unilateral brain damage (initial testing). *Neuropsychologia, 26,* 575–589.

Lesser, R. (1974). Verbal comprehension in aphasia: An English version of three Italian tests. *Cortex, 10,* 247–263.

McDonald, S., & Wales, R. (1986). An investigation of the ability to process inferences in language following right hemisphere brain damage. *Brain and Language, 29,* 68–80.

Milberg, W., & Blumstein, S. E. (1981). Lexical decision and aphasia: Evidence for semantic processing. *Brain and Language, 14,* 371–385.

Myers, P. (1986). Right hemisphere communication impairment. In R. Chapey (Ed.), *Language intervention strategies in adult aphasia* (pp. 444–461). Baltimore: Williams & Wilkins.

Myers, P. (1984). Right hemisphere impairment. In A. Holland (Ed.), *Language disorders in adults* (pp. 177–208). San Diego: College-Hill.

Ombredane, A. (1951). *L'Aphasie et l'élaboration de la pensée explicite.* Paris: Presses Universitaires de France.

Posner, M. I., & Snyder, C. R. R. (1975). Facilitation and inhibition in the processing of signals. In P. M. A. Rabbit & S. Dornic (Eds.), *Attention and performance* (pp. 669–682). New York: Academic.

Read, D. E. (1981). Solving deductive reasoning problems after unilateral temporal lobectomy. *Brain and Language, 12,* 92–100.

Sabourin, L., Goulet, P., & Joanette, Y. (1988). La disponibilité lexicale chez les cérébrolésés droits. *Canadian Psychology/Psychologie canadienne, 29,* 2a.

Schwanenflugel, P. S., Harnishfeger, K. P., & Stowe, R. W. (1988). Context availability and lexical decisions for abstract and concrete words. *Journal of Memory and Language, 27,* 499–520.

Searleman, A. (1977). A review of right hemisphere linguistic capabilities. *Psychological Bulletin, 84,* 503–528.

Siéroff, E. (1991). Introduction à l'attention sélective: définitions et propriétés. *Revue de Neuropsychologie, 2,* 3–28.

Tompkins, C. A. (1990). Knowledge and strategies for processing lexical metaphor after right or left hemisphere brain damage. *Journal of Speech and Hearing Research, 33,* 307–316.

Tompkins, C., & Mateer, C. A. (1985). Right hemisphere appreciation of prosodic and linguistic indications of implicit attitude. *Brain and Language, 24,* 185–203.

Wapner, W., Hamby, S., & Gardner, H. (1981). The role of the right hemisphere in the apprehension of complex linguistic materials. *Brain and Language, 14,* 15–33.

Wechsler, D. (1955). *Wechsler Adult Intelligence Scale, Manual.* New York: Psychological Corporation.

Weinstein, E. A. (1964). Affections of speech with lesions of the non-dominant hemisphere. *Research Publications of the Association for Research in Nervous and Mental Disease, 42,* 220–228.

Weylman, S. T., Brownell, H. H., & Gardner, H. (1986). Comprehension of indirect requests by organic patients. Presented at the Annual Meeting of the Academy of Aphasia, Nashville, October

Winner, E., & Gardner, H. (1977). The comprension of metaphor in brain-damaged patients. *Brain, 100,* 717–723.