Neuropragmatics: Extralinguistic Communication after Closed Head Injury

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This work is concerned with the decay of communicative abilities after head trauma. A protocol composed of 16 videotaped scenes was devised in order to investigate the comprehension of several types of communicative actions realized with extralinguistic means, like pointing or clapping. The protocol was administered to 30 closed-head-injured individuals. The results showed that performance decreased from simple standard acts to complex standard acts, deceits, and ironies. The subjects' performance was worse with the scenes reproducing failing, rather than successful, communicative actions. The results are compared with those we previously obtained with a linguistic protocol. A theory of the cognitive processes underlying intentional communication is outlined and used to explain the results.　© 2001 Academic Press

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I. INTRODUCTION

Communicative competence is an agent's capability of intentional activity overtly aimed at affecting the mental states of other agents and thereby possibly their behavior. This article is concerned with the decay of certain basic components of this cognitive faculty after closed head injury.

The impairment of communication that is observed in this disease is particularly interesting in that it is often neither linguistic in nature nor related to a linguistic deficit. Many patients, while scoring more or less normally on tests for aphasia, find nonetheless mild to severe difficulties both in production and comprehension of socially appropriate communication. Their impairment, in other words, consists primarily in an impoverished capability of engaging in and maintaining a meaningful interaction. However, knowledge of this type of decay is fragmentary and wide, systematic analyses are still lacking, in part because theorists of communication and neuropsychologists have made few attempts at collaboration (Bara & Tirassa, 2000)—much differently from what has happened, e.g., between neuroscientists and linguists.

In previous research we studied how linguistic communication decay in nonaphasic closed head-injured individuals (Bara, Tirassa, & Zettin, 1997). Language, however,

is not the only means that is available to humans for expressing their communicative intentions. It is the aim of this work to investigate whether and how closed head injury affects extralinguistic communication as well. By *extralinguistic communication* we refer to any facial expression, hand gesture, or body movement that is intentionally and overtly used by an agent to share a communicative meaning with another. Nonintentional components of social interaction, such as certain gesticulations that may accompany speech (emotional displays, blushing, etc.), fall outside this definition and therefore outside the scope of this research.

There are two main theoretical claims behind this research. The first is that linguistic and extralinguistic forms of communication are but superficial manifestations of a single communicative competence whose nature is neither linguistic nor extralinguistic, but mental. The physiological and pathological functioning of this faculty is independent of the functioning of the superficial means of expression it employs and can be described accordingly. Consequently, the communicative performance of an individual whose communicative faculty is damaged, as we hypothesize to be the case in closed head injury, will present a similar pattern of decay, whether he or she uses a linguistic or extralinguistic mode of expression.

Our second theoretical claim is that, conversely, each superficial means of expression has features that are unique and make it easier to generate or understand specific types of communicative actions. Corresponding local differences in communicative performance should therefore be found when extralinguistic, rather than linguistic, communication is considered. Irony, for example, is a typically linguistic phenomenon that is harder to handle with extralinguistic means.

Both claims are supported by the evidence reported in this article. We explored what might be called a few fundamentals of human communicative competence. The general framework of this research was provided by the cognitive theory of pragmatics advanced by Airenti, Bara, and Colombetti (1993a) and by the work of Bara and Tirassa (1999) on communicative meaning and the differences between linguistic and extralinguistic communication. Starting from these theoretical works we drew several predictions concerning four types of pragmatic phenomena, namely simple communicative acts, complex communicative acts, ironies, and deceits; each phenomenon was investigated both in the case of success and in the case of failure. We then tested these predictions on a group of closed head-injured individuals and on a corresponding control group, measuring their performance in the comprehension of a series of brief videotaped scenes reproducing simple communicative interactions between two or more actors.

2. CLOSED HEAD INJURY AND COMMUNICATION

The violent acceleration which the cranium undergoes in head trauma results in two types of cerebral lesions: ecchymoses, caused by the brute force of the impact, and axonal damages and tissular sufferance, caused by the overstretching of the neurons, the blood vessels, and their supporting structures. Both types of damages are not confined to the area of first impact, but are typically diffused to the whole brain, although with preferential localizations that depend on the anatomy of the various structures involved. The consequent involvement of several cognitive subsystems makes closed head injury unique among the brain diseases with a focal etiology.

The trauma is often followed by coma, lasting from minutes to weeks or months. The neuropsychological picture that emerges after regained consciousness includes a generalized deterioration of the individual's cognitive functions and in particular of those related to the frontal lobes. Attention, learning, memory, judgment, and

planning are frequently involved, resulting in an impaired management of the agent/world interactions, a poor capacity of abstraction, and the intrusion of inappropriate associations in thought.

Difficulties in communication have also been described by clinicians in addition to these (comparatively) better known symptoms. The discourse of closed-head-injured patients often is poor and confusedly organized and the flow of their conversation is hampered with irrelevant details and digressions (McDonald, 1992; McDonald & van Sommers, 1993; Sherratt & Penn, 1990). This impairment is permanent, enduring even after a satisfactory recovery of other cognitive faculties (Ehrlich & Barry, 1989; Mentis & Prutting, 1987; Wyckoff, 1984).

One of the aims of this work is to provide a better understanding of this problem. As has been argued by several researchers (Bara, Tirassa, & Zettin, 1997; Joanette & Brownell, 1991; Stemmer, 1994), this goal can only be achieved if sound and unitary theories of human communication are utilized to generate well-motivated experimental questions and if the answers to these questions are then reinterpreted to shed light on what components of the cognitive subsystems involved in communication are damaged and how.

3. COMMUNICATION

After the works of Austin (1962), Grice (1989), and Searle (1969, 1979), cognitive theories of communication are generally cast in terms of the types of mental states (such as beliefs, desires, and intentions) that grant an otherwise nonsocial agent the capability of engaging in communicative interaction and of the modifications that these states undergo in the course of such interaction. Tirassa (1999) discusses some foundations of this framework and the role it can play at the crossroads of theories of communication, theories in the neurosciences, and the philosophy of the cognitive sciences (see also Bara & Tirassa, 2000).

A whole class of theories can be formulated within a mental states framework (e.g., Clark, 1996; Sperber & Wilson, 1986; Tirassa, 1997). The one we adopt is the theory of cognitive pragmatics that has been advanced by Airenti, Bara, and Colombetti (1993a).

3.1. A Cognitive Theory of Communication

In Airenti, Bara and Colombetti's (1993a) theory, communication is defined as the intentional and manifest attempt of an actress to affect a partner's mental states in a certain desired way by overtly displaying his current ones.[1]

The relevant cognitive phenomena are analyzed on two levels. On the first, communication is described as the joint execution of a social action plan (called a *behavior game*) whose knowledge is shared between the agents. On the second, communication is described as a specific sequence of defeasible inferences (collectively referred to as the *conversation game*) that bring an understander from the comprehension of the actress's utterance to the generation of a relevant response. The behavior game currently at play provides the background against which the inferences of the conversation game are drawn.

As an example, let us give a sketch of the process whereby Bob successfully understands Ann's utterance ''Can you open the window?'' The conversation game in this

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[1] Conventionally, we use the feminine for the first agent of a communicative interaction and the masculine for the other(s), also referring to them as *actress* and, respectively, *partner(s)*.

case is made up of five phases, each comprising one or more base-level inferential steps:

1. Understanding the expressive meaning.   Bob comprehends Ann's expressive act as a question concerning his capability to open the window.

2. Understanding the actor's meaning.   He then realizes the communicative intention that underlies Ann's utterance, thereby interpreting it as a request that he open the window. This corresponds to viewing the utterance as one move of a behavior game that can be summarized as ''An agent asks a favor of another agent; the latter may either comply with the request or offer a socially acceptable reason for refusal.'' From now on, all of Bob's inferences will be drawn, and intentions generated, in accordance with the idea that Ann is trying to play that particular behavior game (unless, of course, some further event proves this belief wrong).

3. Communicative effect.   As a result of the comprehension of the actor's meaning, Bob's mental states are further modified. In particular, he now has to decide whether to comply with Ann's request, that is, whether to accept to play the game she has started, and, if so, to determine which of its possible outcomes to choose. His private beliefs, desires, and motivations play a role in this phase.

4. Reaction.   As a consequence, Bob forms the intention to react to Ann's expressed desire; that is, he forms the intention to actually play, among the moves that the behavior game leave open for him, the one he has chosen in the previous phase.

5. Response generation.   Bob finally generates an appropriate action which will also provide Ann with a feedback about the outcome of her request. He may thus get up and open the window or reply that he thinks it is already too cold in the room.

The roles then reverse: It is now Ann's turn to understand and to appropriately react to Bob's explicit or implicit reply, and so forth until the conversation comes to an end. Communication is thus a circular process, founded on each agent's capability of going through the conversation game and on the expectation that the partner will be able to do the same.

To go through the conversation game requires an agent to be able to entertain, in addition to private beliefs and intentions, two mental state types that are specifically dedicated to communicative purposes, namely shared belief and communicative intention.

Two agents mutually believe *p* when each of them believes *p,* believes that the other believes *p,* believes that the other believes that each believes *p,* and so on. In order to overcome certain drawbacks of previous approaches, Airenti, Bara, and Colombetti (1993a) (and more formally Colombetti, 1993) take *shared belief* to be a primitive mental state: Ann shares *p* with Bob if and only if she believes *p* and also believes that Bob shares the belief in *p* with her. In this definition, the circularity that is intrinsic to the idea of common knowledge is captured without falling into an infinite chain of acknowledgments of the ''*I know that you know that I know . . .*''sort.

In this approach, shared belief is a primitive mental state type that humans are able to entertain, with the same ontological status as private beliefs. As such, it is subjective: What matters is not what is objectively (that is, in a ''God's eye'' perspective) mutually known to two interacting agents, but what each *takes as shared* with the other. Consequently, various types of misunderstandings and failures may occur in conversation if they take different pieces of knowledge as shared with each other.

A communicative action may now be defined as the overt execution of one move of the shared behavior game that the agents are jointly playing, where ''overt'' means that both the move and the intention to play must be shared between the interlocutors. Accordingly, Airenti, Bara, and Colombetti (1993a) define *communicative intention* as a second type of circular mental state: Ann's intention to communicate *p* to Bob

consists of Ann's intention to make it shared between her and Bob both that *p* and that she intends to make the whole communicative intention itself shared with him.

It is a consequence of these definitions that an agent may choose between different means to affect a partner's mental states, but all of them will not be communicative. Only when an actor's intentions are both overt (communicative) and recognized as such by the partner can a true instance of communication be said to be taking place—which, of course, does not preclude failures, e.g., about what was actually meant to be communicated.

3.2. Base-Level and Metalevel Inferences

The conversation game consists of the mental processes from comprehension of a communicative act to the generation of a suitable response. Each of its phases may be decomposed into several subphases, so that the overall game consists not of five *inferences,* but of five *inferential phases.*

The sequence of the five phases we have reported above captures the way things typically, but not necessarily, go: it constitutes what Airenti, Bara, and Colombetti (1993a) call the *standard path,* beside which a *nonstandard path* (or, better, a whole set of nonstandard paths) can be described.

All the inferences in the conversation game are defeasible. A default inference (Reiter, 1980) is one that can be blocked, that is, one whose consequent can be rejected when it is inappropriate to the context, e.g., because it contrasts with another piece of knowledge or evidence.

When none of the inferences in the conversation game is so blocked, the agent goes down the standard (default) path. Each possible nonstandard path is instead the consequence of a specific blockage of one inference and consists of a specific, unique sequencing of the phases. For example, if the understander is unable to find a plausible meaning to the actress's communicative act (that is, if one of the inferences of the first or second phase is blocked), then the conversation game is short-circuited to the generation of a request for clarification; if he understands the actress's communicative intentions, but does not believe she is sincere, then he is detecting a deceit, and so on. A few nonstandard paths are described below.

This web of possible paths makes it necessary that some control be exercised in the conversation game. The cognitive apparatus behind communication thus works on two levels. The base level is composed of the inferences that the understander draws from the actress's actions and conveyed mental states. These inferences are described by default rules such as the following (all belong to the second phase of the conversation game and are taken from Airenti, Bara, & Colombetti, 1993a).

Rule R5. In the shared-belief space, if the actress expresses the belief that *p,* then by default she intends to communicatively make it shared with the partner that *p.*

Rule R6. In the shared-belief space, if the actress expresses the intention to perform action *a,* then by default she intends to communicate that she intends to perform *a.*

Rule R8. In the shared-belief space, if the actress plays a move of a valid behavior game, then by default she intends to communicate that she intends to play that game with the partner.

The base level is controlled by an inferential metalevel. The tasks of the metalevel are, first, to overview the correct functioning of each base-level phase; second, to control the transition from a phase to the subsequent one; third, and most important for our current discussion, to decide what should be done when one of the inferences of a phase has been blocked (e.g., because the belief that the actress believes that *p,*

in R5, or intends to perform *a,* in R6, is inconsistent with some previous and more reliable belief).

To sum up: The understander goes down the standard path when the normal course of his inferences—however complicated in terms of knowledge or resources necessary—is not blocked by contrasting knowledge or evidence and down the nonstandard path when it is. In the latter case he has to explore an alternative inferential course, chosen according to which inference of which phase has been blocked. The grounds for this exploration may be provided by the beliefs he shares with the actress, the private beliefs he entertains or those that he ascribes to her, his current context, his reading of the superficial form of the communicative act, and so on.

3.3. Three Nonstandard Paths

Let us consider, for example, the first two phases of the conversation game, that is, those whose functioning after head trauma we investigated in this research. The respective goals of these two phases are to understand the expressive act produced by the actress and then to determine the underlying communicative meaning (that is, which move of which behavior game is being used). These goals may be achieved via the standard inferential path when a straightforward inferential link exists from the utterance to the behavior game or, more precisely, when one appears to the understander's mind to exist. Since this is not always the case, different types of exploitations, deceits, misunderstandings, and failures may arise.

The protocol we present in this article explores the standard path and three different nonstandard cases, that is, three types of situations where the relationship between what is expressed and what is intended is not straightforward. These are ironies, deceits, and failures.

3.3.1. Irony. This is a situation where, in the understander's view, the mental states that the actress declares do not *overtly* correspond to those she actually entertains. In irony, one or more rules of the conversation game are exploited in the pursuit of a communicative effect that differs from that normally associated with the superficial form of that communicative act. A communicative act may become ironic when its pragmatic meaning is overtly different from its expressed one. Thus, to say ''You had quite a placid holiday'' to a friend who has just described an amazing series of troubles occurred during a journey is certainly ironic because the interlocutors share that the opposite of the apparent meaning of the utterance holds. Irony is a way to play with sharedness: indeed, the utterance would be interpreted seriously by a third person who entered the room at that very moment and was therefore uninformed of the traveler's adventures.

3.3.2. Deceit. A deceit occurs when the mental states that the actress entertains are *covertly* different from those she communicates. Communication is neutral with respect to honesty or sincerity; therefore, it is left to the understander to suspect and then to possibly become convinced that the actress is insincere. Only in this case is deceit detected; that is, the understander is following a nonstandard path.

Both in deceit and in irony the mental states that the actress declares do not correspond to her real ones. The difference between the two situations, and hence our rationale for investigating both, is that an ironic utterance is aimed at making this discrepancy manifest to the partner, while a deceitful one is aimed at precisely the opposite, that is, at concealing it from the partner.

3.3.3. Failure. A communicative act fails if it does not achieve the goals it was planned for. From an understander's point of view, the actress's communicative intentions are a matter of uncertain attribution; this may give rise to several types of mistakes. Extreme cases of failure occur when the understander does not recognize

an action of the actress's as communicative, thus incorrectly believing that she was acting privately, or when he incorrectly takes as communicative an action that was instead meant as private. A less extreme situation occurs when he realizes that the actress intends to communicate, but is nonetheless incapable of finding any seemingly reasonable meaning in her action, that is, of referring it to a behavior game mutually known.

The most interesting and common cases of failure, however, have a more subtle nature: The understander correctly recognizes the actress's attempt to communicate and ascribes a reasonable, but wrong, meaning to it. He is therefore unaware of the misunderstanding, which may instead become manifest as the interaction proceeds, e.g., because an inappropriate response on his part allows the actress to realize what has happened and provide for a correction. Until this happens, however, the (mis-)understander's conversation game proceeds on the standard path. It is with these more subtle kind of failures that our work deals.

3.4. Respective Difficulties of the Standard and Nonstandard Paths

The inferential metalevel is concerned with determining that the phases of the conversation game are functioning correctly and are being activated in the right sequence and with what to do when the implausibility of some standard inference suggests going down a nonstandard path. What actually goes on within each phase is described as base-level inferences, that is, inferences that make up a phase independent of how the phase itself will be handled by the metalevel.

The differences between standard and nonstandard communicative acts thus belong to the metalevel, while the differences between the various instances of each of these phenomena belong to the base inferential level. To carry out a phase (or a single inference) may be more or less difficult in terms of working memory, amount and type of knowledge required, and so on. Therefore, all communicative acts, even those belonging to the same type, will not be equally hard to understand.

Consider the following examples:

(1) *a.* Open the window.
   b. Can you please open the window?
   c. I wonder whether you would be so kind as to open the window.
   d. The window is closed.
   e. What about that window?
   f. How hot in here!
   g. Have I ever told you that I am claustrophobic?

While the complexity of the inferences needed to understand each of these utterances is obviously different, what makes them alike is that they all belong to the same species, namely to the standard path, and are therefore equal *on the metainferential level.* An ironic utterance with the same underlying meaning, such as (in the same context of [1]):

(2) Leave the window closed, please: I have always wished to die suffocated!

however simple on the base inferential level, is nonetheless a nonstandard case, because it forces the conversation game into a detour.

Thus, what we are saying is not that nonstandard utterance will necessarily be harder to understand than standard one: it is certainly easier to understand (2) than the most difficult case in (1). Our point relates not to the difficulties occurring within each phase of the conversation game, but to the difficulties inherent in their correct sequencing. Therefore, all that can be said is that a *simple nonstandard* communicative act is intrinsically more difficult to understand than a *simple standard* one, be-

cause it blocks the default course of the conversation game and forces the metalevel to find an acceptable alternative.

In other words, there are two sources of difficulty in the comprehension of communication. The first concerns the metalevel, that is, which phases are sequenced, in what order, and why, independent of the complexity of what is going on inside each phase [cf. the difference between (1*a*–1*g*) and (2)].

The experimental work we describe in this paper explored this source of difficulty by administering both standard and nonstandard instances of communication; among the latter, to repeat, were ironies, deceits, and failures. The data we collected show that the communicative performance of closed head-injured individuals decays significantly when this source of difficulty is explored.

The second source of difficulty concerns the base level: a certain instance of a certain path of understanding (e.g., a standard utterance or an ironic one) may be more difficult to understand than another because the inferences it requires are more complex [cf. the difference between (1*a*) and (1*g*) above]. We have described these differences in terms of the difficulty of referring an utterance to the behavior game to which it pertains (see also Bara, Bosco, & Bucciarelli 1999). However, the meta-inferential path followed by the conversation game will be exactly the same in both cases.

Our protocol dealt with this source of difficulty only in the standard case: it comprised three sample standard communicative acts and three complex ones. To also explore it in the nonstandard case would have made little sense, since the subjects already encountered significant problems with the most simple instances of nonstandard communication.

4. EXTRALINGUISTIC COMMUNICATION

A competence theory of human communication must be able to deal with any type of intentional communicative act and therefore must be independent of the various expressive means that may be used in conversation. However, the empirical work we present here makes it necessary to further discriminate between different ways of expressing a communicative intention.

The types of communicative actions in which humans may engage range from language to gestures, drawings, music, and so on. In our work on closed head injury, we have been concerned first with linguistic communication (Bara, Tirassa, & Zettin 1997) and now with extralinguistic communication, namely manual gestures and other body movements (this paper).

Language is an autonomous faculty, not to be identified with communication at large. It involves specific brain areas and exhibits specific patterns of acquisition in the child and of decline after brain damage. Most interestingly for our current discussion, a double dissociation is often found between proper linguistic capabilities and broadly communicative ones (see Tirassa, 1999, for further discussion of the implications of this fact). On the one hand, communicative competence is often spared in aphasia (Caplan, 1992; Feyereisen & Seron, 1982; Foldi, Cicone, & Gardner, 1983; Holland, 1982). On the other hand, the decay of high-level communicative skills in closed head injury often is unrelated to aphasia, since the linguistic capabilities of these patients may be fully preserved (Bara, Tirassa, & Zettin, 1997).

By *extralinguistic communication* we refer to actions such as gestures or pointing when they are intentionally performed by an agent with the goal of overtly conveying a communicative meaning (that is, of making it shared with a partner).

A line has therefore to be drawn between communicative and noncommunicative

gestures. If communication is defined as the intentional and overt attempt to modify a partner's mental states, then gesticulations accompanying speech, paralinguistic phenomena (prosody, intonation, and so on) and facial and postural manifestations of emotions, etc., are not always communicative. An agent's mental states may certainly be modified by, say, another agent's gesticulating or blushing, but this is a true instance of communication only insofar as both agents construe it as intentional and shared. What counts as intentional communication is not the event (like, say, a certain movement of the hand or the eyebrow) *per se,* but the way it is employed in the aim of making certain mental states shared with a partner.

In this perspective, extralinguistic communication in the human species turns out to be as symbolic as linguistic communication. The difference between the two may be summarized in these terms: The latter is the communicative use of a *system of symbols,* while the former is the communicative use of a *set of symbols* (Bara & Tirassa, 1999).

To say that language is a symbol system means that it is compositional. Linguistic expressions are made up of *constituents,* that is, of expressions that are either atomic or molecular and can be composed in meaningful structures. The meaning of a sentence like ''The cat is under the table'' results from the meaning of its constituents (''the cat,'' ''is,'' and ''under the table'') and subconstituents (''the,'' ''cat,'' ''is,'' ''under,'' ''the,'' and ''table'') and from the overall structure in which they are arranged (''the cat is under the table'' rather than ''the table is under the cat'' or ''table the under the is cat'').

Extralinguistic communication is instead made of parts whose meanings ends in themselves: There is no superordinate structure. Extralinguistic symbols may be associated rather than composed; that is, they may be juxtaposed so as to generate complex meanings. There is, however no syntactic rule to govern the relationships between them.

It should be remembered that means of communication like American Sign Language and other sign languages are not gestural but linguistic: Their lexicon is (at least in part) arbitrary; they exhibit an arbitrary, compositional, and productive syntax; and the brain areas they involve and their patterns of acquisition in the child (Petitto, 1987) and of decline after neuropsychological damage (Poizner, Klima, & Bellugi 1987) correspond to those of standard spoken languages.

5. EXPERIMENTAL SETTING

5.1. *Overview and General Predictions*

We explored the comprehension of standard and nonstandard extralinguistic communication in closed-head-injured individuals. With regard to the standard path we explored simple and complex standard communicative acts; for the nonstandard path we explored simple instances of irony, deceit, and failure recognition.

In previous work on linguistic communication after closed head injury (Bara, Tirassa, & Zettin, 1997) we found communicative performance to be impaired in this pathology. We investigated the comprehension of simple linguistic interactions taking place between two characters in a series of brief videotaped scenes. The subjects scored significantly lower than the controls on each scene but the simplest. This decay followed a theoretically predicted trend of difficulty, whose main feature was a dramatic decrease in the subjects' performance from standard to nonstandard communicative acts. Further differences were found between the different nonstandard phenomena that were tested.

The logically subsequent step was therefore to examine what happens in extralin-

guistic communication. There were thus two questions we wanted to answer with this experiment:

(1) *Is the difference between the respective difficulties of the standard and the nonstandard paths we found in linguistic communication also found in extralinguistic communication*?

As discussed in Section 3, when the base-level inferences of the standard path are blocked, the inferential metalevel is forced into a search for an alternative (nonstandard) communicative meaning. This may happen only after an initial meaning has been ascribed to the expressive act and evaluated (that is, after phase 1 of the conversation game—see Section 3.1). The activation of the metalevel, and therefore the choice between the two paths, is therefore independent of the nature of the communicative act and in particular of its having a linguistic or an extralinguistic formulation.

If, as we argue, the difference between the two paths does not depend on the expressive means used, it can be predicted that the performance on linguistic and extralinguistic acts will follow the same trend; that is, that (simple) standard acts will always be easier than (simple) nonstandard ones.

(2) *How do the specific features of extralinguistic communication affects its comprehension compared to that of linguistic communication? And do these features affect different pragmatic phenomena in different ways?*

Part of the neuropsychological symptomatology of closed head injury has been explained as a consequence of the difficulty to integrate different pieces or sources of knowledge. Accordingly, these patients' performance improves if they are provided with a structure within which to frame knowledge (Shallice & Burgess, 1991). The relationship between symbols in extralinguistic communication is associative; that is, there is no superordinate structure able to provide a coherent framework. Language is instead systematic, so the superordinate structure which extralinguistic communication lacks is provided by syntax. The performance on extralinguistic communicative acts can therefore be predicted to be systematically lower than that on equivalent linguistic ones.

Irony will be particularly affected in the extralinguistic condition because it heavily depends on language and is therefore more difficult to understand (and to generate) with extralinguistic means.

Deceits, whose difficulty lies entirely at the cognitive (rather than the expressive) level, should instead be equally affected in the linguistic and the extralinguistic cases. We make a final point with regard to failure recognition. This task was different from the others, since it required the subject to simultaneously take into account two communicative intentions instead of one, as was the case in the other tasks. These were the intent underlying the actress's action and the one underlying the partner's reply; the failure consisted in the latter being not relevant to the former (see below for further details). The subjects were asked to express their comprehension of the latter, which was only possible if they had understood both communicative acts and realized they were inconsistent. It can therefore be predicted that the complexity inherent in failure recognition will yield the lowest performance.

5.2. Method

To do empirical research in cognitive pragmatics poses several problems. The comprehension of a communicative act is an abductive process; that is, it requires inference to the best explanation known rather than the derivation of true conclusions from true premises, as is the case in deduction. Given that communication is a social event by definition, the ultimate meaning of a communicative act is a matter of negotiation between actress and partner. Consequently, there seldom, if ever, exists anything like a ''correct answer'' and the concept of a good performance can only be defined very loosely. To evaluate someone's communicative skills is accordingly difficult.

We wanted to put our subjects in an as ecological a situation as possible, while at the same time meet the constraints of measurability and repeatability that are typical of laboratory experiments. The method that comes closest to natural communicative situations is to show subjects videotaped scenes of actors involved in everyday communicative interactions, each representative of one of the pragmatic phenomena we wanted to investigate.

5.2.1. Protocol.   The protocol comprised 16 videotaped scenes, each lasting approximately 30 s and showing two or more characters engaged in a brief and simple communicative interaction in an everyday context. All communicative acts were completely extralinguistic, that is, only performed via gestures, with no linguistic utterance, as in a silent movie.

For each type of pragmatic phenomenon we investigated (namely simple communicative act, complex communicative act, deceit, and irony) we generated three such scenes for the case of success and one for the case of failure.

Examples of each successful pragmatic act are presented below (the entire protocol is described in the Appendix).

(3) Simple standard communicative act: *The chair.*
     A woman is sitting at a desk. A man enters the room and walks toward the desk. The woman greets him and points at a nearby chair, inviting him to sit in front of her.
(4) Complex standard communicative act: *The shop window.*
     A mother and her son are strolling down a street. They reach a toy shop where the child notices a toy he likes. He repeatedly points at it while looking at the mother. The woman takes out her purse and shows him that it is empty.
(5) Deceit: *The broken vase.*
     Two children are playing in a room. While they chase each other around a table, one knocks down a vase that is placed on it. Alarmed with the noise, their mother enters the room and looks at the scene. The child who has broken the vase looks back at her and points at the other child.
(6) Irony: *The chocolate.*
     Two girls sit at a table. One has a box of chocolates and eats them one by one. The other girl asks her for one, stretching forth the palm of her open hand. The first girl takes one more piece from the box and eats it. The asking girl caresses her on her cheek.

Each scene stopped immediately before one actor's reaction to a communicative gesture performed by the other. For example, scene (3) stopped with the woman's act of pointing, that is, just before the man's reaction; scene (6) stopped with the caress, that is, just before the eating girl's reaction.

Four scenes, one for each type of pragmatic act investigated in the protocol, were concerned with the case of failure. For example, the scene regarding the failure of a complex pragmatic act proceeded as follows:

(7) Failure of a complex pragmatic act: *Silence*!
     A girl is hammering a nail into a wall. Another girl is trying to study at a nearby table, but the noise disturbs her too much. She then calls the first girl, showing her the book she is reading. The first girl takes out a drill and continues to work.

In order to understand a failure, it is necessary to detect what has gone wrong: In (7), for example, it may have been that the second girl has not seen the gesture, has not understood it, or that she is simply unwilling to comply with the request. The scenes concerning failures were thus meant to find out whether the subjects comprehended both the communicative act performed by the actor (the studying girl's request) and the partner's misunderstanding of it (the second girl continuing to make noise).

The 16 scenes were presented in random sequence so that two instances of the same pragmatic phenomenon never followed each other. Furthermore, in order to avoid the subjects conjuring up some story linking the various scenes, thereby possibly modifying their interpretations, each actor only appeared in one scene.

5.2.2. Task.   At the end of each scene, the subjects were shown a large (29.5×21 cm) photograph reproducing the last picture of videotaped sequence. A white balloon was pasted on the photograph near the head of the character who had performed the crucial communicative act to represent the character's thought, as in comics. The subjects' task was to choose, of four photographs that were given to them in random order, one with which to fill the balloon, that is, the one representing the intention that they wanted to attribute to the character.

Of these four photographs, one represented the correct (that is, in light of the above discussion, most reasonable) option; we label it *a.* Another option, labeled *b,* was less correct, but still relevant; that is, something that might have been chosen by someone who partially misunderstood the actor's intentions. The two remaining options, *c* and *d,* were misleading; that is, they were somehow related to the story, but had nothing to do with the communicative acts represented in the videotape.

For example, the four photographs that were proposed after scene (3) (*The chair*) depicted:

(3*a*) The man sitting on the chair that had been pointed at by the woman.
(3*b*) The man sitting on the floor in the direction that the woman had pointed at.
(3*c*) The man and the woman both sitting on the floor.
(3*d*) The man and the woman both standing and drinking coffee.

The task given to the subjects was to pick one of the photographs. They did not have to explain their choice unless they wanted to. In order to avoid the subjects' performance being affected by a short-term memory impairment, they were allowed to view the scene again, with no limitation on time or on the number of repetitions. Only when an answer had been given was the subsequent scene shown.

5.3. Subjects

The protocol was administered individually to 30 closed head-injured individuals (21 males, 9 females) ranging in age from 17 to 40 ($M = 26.6$) and to a control group, matched for number, sex, age, and education.

The subjects were chosen among the patients of a hospital in Torino, to which they had been admitted for postacute neuropsychological, motor, and speech rehabilitation. The criterion used for the choice was the patient's ability to pass a pretest, consisting of six items meant to assess the capability of ascribing a mental state to a comics character; it makes no sense to test a complex task such as communication if this basic skill is damaged.

The individuals who had passed this test were then trained for the experimental task. To this aim we used two scenes, similar in all aspects to those of the protocol. The experimenter explained the task, telling the subjects that they would be asked first to carefully watch a videotaped story and then to tell what, in their opinion, one of the characters was trying to communicate to the other. After the first of these two scenes, the experimenter helped the subjects find the solution, explaining the task to them again and having them notice and correct the mistakes they might have made. When the subjects' comprehension of the task appeared satisfactory, the second training scene was shown; the subjects who were able to solve it with no further help (possibly with self-repaired mistakes) were then submitted the experimental protocol.

5.4. Other Neuropsychological Tests

The subjects were also given several classic neuropsychological tests, namely four WAIS subtests (picture completion, block design, picture arrangement, and picture assembling), spatial span, verbal span, and story recall. Since communication is a sophisticated activity that reflects a high-level of cognitive competence, while neuropsychological tests are typically meant to examine impairments in specific, low-level functions, performance on the latter is unlikely to predict performance on the former. Therefore, we expected no specific correlation between a subject's performance on the experimental protocol and that on these collateral neuropsychological tests.

6. RESULTS

In this section we compare the results of the subjects and controls; in the next section the former are discussed in greater detail and compared with the data previously obtained with the linguistic protocol.

6.1. Standard vs Nonstandard Communication

The results obtained by the experimental subjects vary according to the type of pragmatic phenomenon investigated. Their performance on standard communicative acts is good: they made seven errors on simple acts (7.8% of the total, $3 \times 30 =$ 90 items) and nine (10%) on complex ones. The controls also encountered no problem with these tasks: none of them made errors on simple acts, and only three made one mistake each on complex ones (3.3%). The performance of the subjects was thus worse than that of the controls; since, however, the difference is not significant ($p = .18$ on simple acts and $=.19$ on complex acts, Mann–Whitney), this is only suggestive of a slight difficulty with standard communication.

The subjects' performance on nonstandard communication was instead strikingly different, decreasing on deceits and still more dramatically on ironies. They gave 64 correct answers of 90 (71.1%) on deceits and 40 (44.4%) on ironies. The corresponding figures from the controls were 88 (97.8%) and 84 (92.3%), respectively. The comparison is highly significant ($p < .0001$, Mann–Whitney) in both cases.

With regard to communication failures, we expected them to be more difficult to handle than the corresponding successful cases, both for the subjects and for the controls, because of the greater attentional and inferential problems they pose. This prediction was confirmed for every task in the controls and for every task but irony in the subjects, where the distinction between felicitous and unsuccessful cases was blurred by the low rate of correct responses given even by controls. Nonetheless, the difference between the two groups is highly significant ($p < .0001$, Mann–Whitney).

Table 1 reports the percentages of correct answers of the subjects and the controls for each type of communicative act as well as the comparisons between the two groups.

6.2. Trends in Difficulty

According to the theory we have outlined above a principal difference exists between standard and nonstandard communication. A corresponding difference in performance can therefore be expected when the two paths, taken as a whole, are compared.

Further differences may also be predicted within each path. In standard communication, a difference should exist between simple and complex acts; in nonstandard communication, ironies should be more difficult to comprehend than deceits, because it is a typically linguistic phenomenon, whose intelligibility should decrease when language cannot be used. Again, the latter point does not mean that any possible

TABLE 1
Global Results in Closed-Head-Injured Subjects and Controls
(Percentage of Correct Answers)

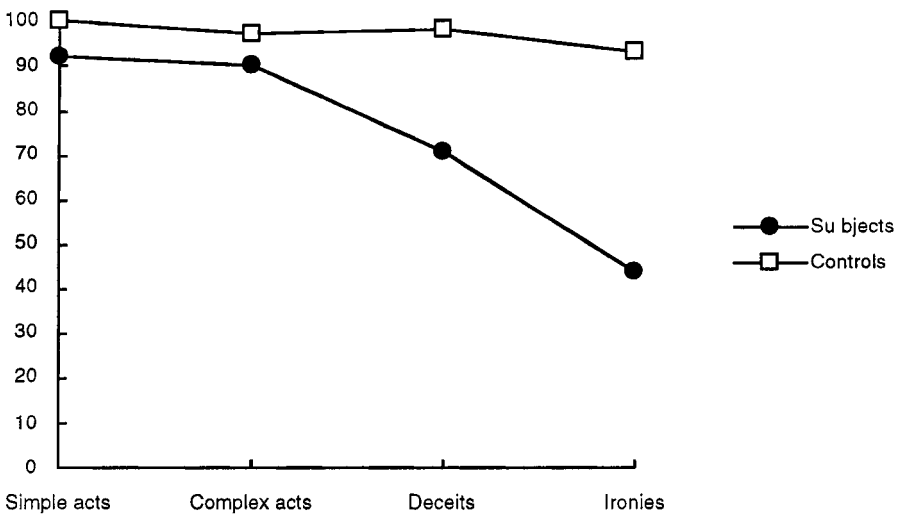|	Simple standard acts ($n = 3$)	Complex standard acts ($n = 3$)	Deceits ($n = 3$)	Ironies ($n = 3$)	Failure recognitions ($n = 4$)
Subjects ($n = 30$)	92	90	71	44	56
	($n = 83$)	($n = 81$)	($n = 64$)	($n = 40$)	($n = 67$)
Controls ($n = 30$)	100	97	98	92	92
	($n = 90$)	($n = 87$)	($n = 88$)	($n = 84$)	($n = 110$)
Subjects vs controls (Mann–Whitney)	$p = .18$	$p = .19$	$p < .0001$	$p < .0001$	$p < .0001$

FIG. 1. Results for each type of extralinguistic phenomenon in closed-head-injured subjects and controls.

deceit is intrinsically easier to understand than any possible irony: each of these phenomena is governed by a complete and autonomous path of comprehension and will therefore comprise instances of variable difficulty. Our point is instead that, in the case of extralinguistic communication, a simple deceit will be easier to understand than a simple irony because irony is typically a linguistic phenomenon whose intelligibility decreases when language cannot be used. Our protocol comprised only simple examples of each pragmatic act.

To sum up, we expected the following trend of decreasing performance in the experimental group:

simple communicative acts > complex communicative acts ≫ deceits > ironies.

This hypothesis was confirmed by Page's L test ($p < .01$; Page, 1963).

No such trend was found in the controls, given the substantial homogeneity of their performance.

Figure 1 shows a graph of the results of the two groups, each taken as a whole. The differences between subjects and controls concern mostly nonstandard communication.

6.3. Failure Recognition

We expected to find a corresponding decreasing trend in the subjects' (but not in the controls') performance on failure recognition. This prediction was confirmed as well ($p < .05$, Page's test). Table 2 and Fig. 2 show these results as percentages of correct answers and respectively as a graph. Again the control group showed no similar trend.

6.4. Other Neuropsychological Tests

As stated above, we expected to find no specific correlation between the experimental protocol and the collateral neuropsychological tests. We actually found no such correlation.

TABLE 2
Percentages of Correct Answers on Failure Recognition

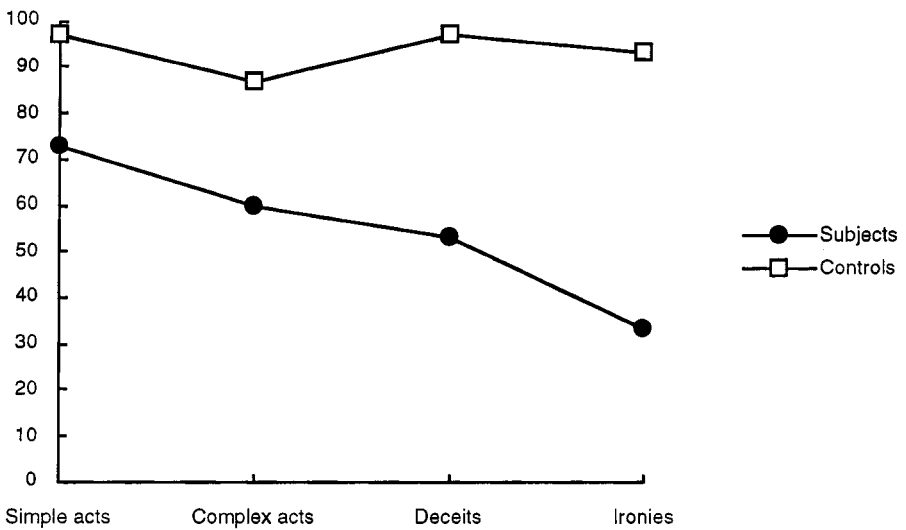|	Failure of a simple standard act (n = 1)	Failure of a complex standard act (n = 1)	Failure of a deceit (n = 1)	Failure of an irony (n = 1)
Subjects (n = 30)	73	60	53	33
	(n = 22)	(n = 18)	(n = 16)	(n = 10)
Controls (n = 30)	97	87	97	93
Subjects vs controls (Mann–Whitney)	p = .12	p = .04	p = .0015	p < .0001

FIG. 2. Correct failure recognition in closed-head-injured subjects and controls.

7. DISCUSSION

Our results show how communication may be specifically affected by comparatively diffused cognitive damage, as is manifest after closed head injury. Several studies on this pathology described the difficulty that these patients encountered with complex reasoning and inferences; our research analyzed the impairment in the comprehension of communicative meaning.

In our theoretical approach, communicative meaning is not intrinsic to the superficial act per se; it lies instead in the relation that the act has with the behavioral game of which it is a move. In order to understand the meaning of a communicative act, it is therefore necessary to understand its connection to a particular step in the relevant game it realizes. This requires in turn that certain more or less difficult inferences be drawn from the act itself as well as from the context where it has taken place.

The deficit we found in our subjects can therefore be interpreted as a difficulty in performing communication-related inferences. It is interesting to remark that these inferences are specific to communication: they involve dedicated mental states as well as the dedicated machinery we have described as the conversation game.

7.1. Standard vs Nonstandard Communication

The subjects encountered no particular difficulties with the comprehension of standard communication: their performance here did not significantly differ from that of the control group. This confirms that, on the average, closed-head-injured individuals find no real problems with simple, everyday communication, only that of the extralinguistic type. When compared to this satisfactory performance, the decay of nonstandard communication is maybe the most striking result of our experiments.

We have used the terms *standard* and *nonstandard comprehension path* to refer to the different types of inferences that may connect a communicative act to its intended meaning. As was discussed in Section 3.2, the standard path is described as the base-level default rules of the conversation game, while a nonstandard path is activated by the metainferential level whenever a default inference is blocked.

The difference between the two paths may seem to hardly merit consideration: after all, who would deny that, say, an ironic statement is, *ceteris paribus,* more difficult to understand than a serious one? However, our work goes beyond this simple intuition because it provides empirical evidence that ironic (or deceptive or unsuccessful) statements are indeed more difficult to handle than standard ones and, still more importantly, because our theory explains why it is so. We discuss this topic in terms of the phase of the conversation game where the events we investigated take place.

The general pattern of the standard vs nonstandard difference turned out to be identical in the extralinguistic protocol we describe in this paper and in the linguistic one used by Bara, Tirassa, and Zettin (1997). In other words, nonstandard situations are systematically more difficult to understand than standard ones, regardless of the superficial expressive means used. The difference therefore has to be due to a general difference in the respective difficulties of the two paths rather than to the linguistic or extralinguistic nature of the particular communicative action performed.

The standard vs nonstandard difference cannot therefore pertain to the first phase of the conversation game. This is the phase where the superficial meaning of the communicative act is understood, and it is here that the difference between linguistic and extralinguistic types of expressive actions would therefore be expected to most heavily affect comprehension. But, to repeat, no such difference exists between the linguistic and the extralinguistic protocols. Since the only other possible branching point in the conversation game we explored is found in the second phase (that is, during the transition from the comprehension of the expressive act to the comprehension of the actor's meaning), it must be here that the nonstandard paths deviate from the standard one. Because this is exactly what our theory predicts, the experimental results provided evidence in its favor.

7.2. The Nonstandard Path

The difference between simple and complex standard acts has already been explained and does not deserve further discussion. What happens with nonstandard communication is more interesting and is the focus of this subsection.

7.2.1. Irony.
Our prediction of a lower performance on the comprehension of irony than on the comprehension of deceits, in the extralinguistic case, was grounded in our analysis of the superficial means that communicative competence employs in its service. Irony is conveyed precisely by the means that are used to express it. Differently from what usually happens in communication, language here is more than just a tool to convey an ironic intention: it is part of the very meaning of the communicative act. Consequently, irony, when expressed by extralinguistic means, becomes vague and loses much of its power and clarity.

Another point worth discussing about irony concerns the types of mistakes that were made by the subjects. Irony, we said in Section 3.3, is a way to play with sharedness: the caress in scene (6) (*The chocolate*) would be taken seriously if reported to someone unaware of its specific context of production. Actually, this was precisely what many subjects seemed to do: Forty percent of the time the photograph chosen was *b;* that is, the one that represented what might be called the literal meaning of the ironic gesture. Alternative *a,* that is, the correct answer, was chosen 36% of the times and alternatives *c* and *d* (that is, the completely wrong ones) were chosen 24% of the times.

7.2.2. Deceit   Airenti, Bara, and Colombetti (1993b) define a deceit as a premeditated breach of a behavior game. To recognize that a deceit is being attempted requires the ability to simulate the deceiver's point of view and to understand what her private mental states are and how they differ from those she is pretending to entertain. In our protocol, the subjects therefore had to explore the double level of the actress's private beliefs (and of her consequent actions) and of the beliefs she shares with the partner. This is obviously more complicated than handling a single level.

7.2.3. Failure recognition   A communicative act fails when it does not achieve the goal it had been planned for. Multiple layers of mental states have to be taken into account in order to comprehend failures: those that each actor entertains, those that she ascribes to the partner, those that she believes the partner ascribes to her, and so on. Since these difficulties add to those that are already inherent to the specific type of pragmatic phenomenon investigated, the failure of a complex standard act will be more difficult to handle than the failure of a simple standard act, the failure of a deceit will be more difficult than the failure of a complex standard act, and the failure of an irony will be more difficult than the failure of a deceit. The overall trend in the difficulty of failures should therefore be parallel to that of successful communication, but lower. This prediction was confirmed as well (compare Figs. 1 and 2).

7.3. Linguistic and Extralinguistic Protocol

A proper statistical comparison between our results on extralinguistic communication and Bara, Tirassa, and Zettin's (1997) results on linguistic communication is not feasible because the two protocols were slightly different. The differences were particularly pronounced in deceit: while the linguistic protocol studied the subjects' ability to plan deceits in three different situations, the extralinguistic protocol studied their ability to comprehend the deceits performed in the stories. The two series of data therefore cannot be compared, especially in a disease that, like closed head injury, typically implies a decay in planning.

Nonetheless, a qualitative comparison is possible and reveals a general trend behind the two performances. For each pragmatic task, the subjects' performance on the extralinguistic protocol was consistently lower than that on the linguistic protocol (see Table 3 and Fig. 3).

In other words, for closed-head-injured patients extralinguistic communication seems to be systematically more difficult than linguistic communication. This can be explained by its associative nature, that is, by its lack of a superordinate structure capable of providing a coherent frame of reference. In the case of language, syntax provides such a coherent and redundant guide to comprehension. (The topic has been explained in Section 4.) Closed-head-injured persons find difficulties with the integration of scattered information, but not if they are given a conceptual structure within which to frame it. Therefore, to understand an expressive act compounded by independent pieces of information whose superordinate structure has to be inferred ought

TABLE 3
Percentages of Correct Answers on the Linguistic and Extralinguistic Protocols (Closed-Head-Injured Subjects)

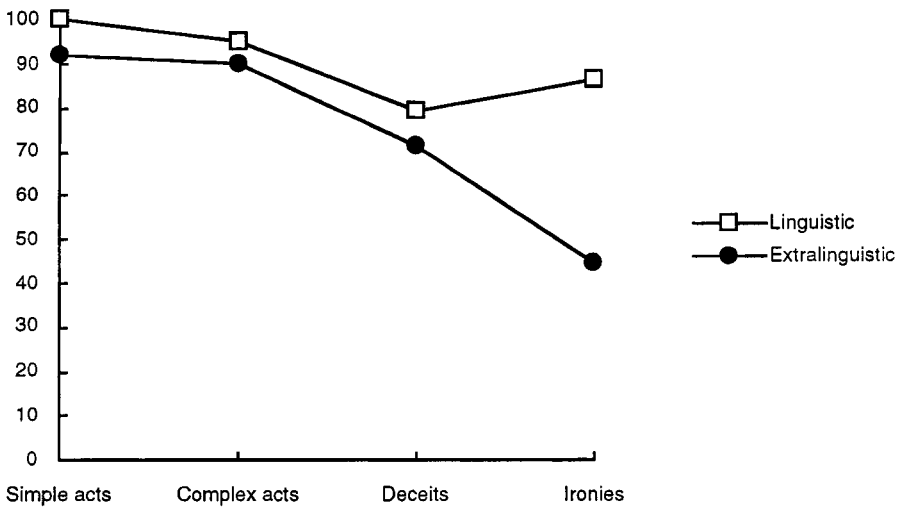|	Linguistic	Extralinguistic
Simple standard acts	100.0	92.2
Complex standard acts	94.9	90.0
Deceits	79.5	71.1
Ironies	86.4	44.4

FIG. 3. Results for each type of pragmatic phenomenon in the linguistic and the extralinguistic protocols in closed-head-injured subjects.

to be more difficult to these subjects than to understand one that carries a structure within itself.

Our results reflected this difference. It may also be interesting to compare them with the performance of Alzheimer's patients, when tested with a similar extralinguistic protocol. The results obtained with these patients by Bara, Bucciarelli, and Geminiani (2000) are equivalent to those of our subjects. The two groups have a similar pattern of decay, although with a more severe impairment in the case of Alzheimer's patients.

8. CONCLUSIONS

From a theoretical point of view, our work yielded three main results. The first was a confirmation of our assumption that the cognitive processes underlying human intentional communication are independent of the superficial means of expression. Our theory of human intentional communication is cast in terms of the mental states involved and therefore holds for every communicative act, regardless of its superficial nature. The data we collected with this extralinguistic protocol and their comparison with those of Bara, Tirassa, and Zettin's (1997) linguistic protocol confirms the validity of this assumption.

The second result of theoretical import was the dramatic difference in the subjects'

performance in the standard vs the nonstandard comprehension paths. Closed head-injured persons maintained a relatively unimpaired performance in the former, while encountering heavy problems with the latter because they require metalevel inferences. The cognitive difficulties of these patients thus reflected on their communicative abilities, affecting in a distinct way the various types of pragmatic acts. This phenomenon occurred both in linguistic and in extralinguistic communication, adding further evidence to the assumption that there exists a single, unitary communicative competence.

The third result was the confirmation that there exist differences between the various superficial means of expression. These were particularly manifest in nonstandard communication, where the difference in the respective difficulty of irony and deceit was reversed in the extralinguistic vs the linguistic protocol. The dramatic decay in extralinguistic irony was due, we have argued, to the unique role that language plays in this phenomenon.

From a clinical point of view, our results provided a theoretically guided description of the decay of communicative abilities that had often been described, albeit in less formal terms, in closed head injury.

APPENDIX: THE PROTOCOL

Simple Standard Acts

The shivers.   Two girls are in a room. One is standing near an open window. The other nods in her direction, showing her that she is cold by pretending to be prey to big shivers.

The alternatives for the cold girl's thought are:
(a) The other girl closes the window.
(b) The other girl comes close to her, talking to her.
(c) The two girls play together.
(d) The cold girl eats an apple.

The narrow door.   Two boys are walking in a corridor. They reach a narrow door. One boy stops and invites the other to pass first.

The alternatives for the kind boy's thought are:
(a) The other boy passes first.
(b) The kind boy passes first.
(c) The kind boy pushes the other.
(d) The kind boy stands back the door.

The chair.   A woman is sitting at a desk. A man enters the room and walks toward the desk. The woman greets him and points at a nearby chair, inviting him to sit in front of her.

The alternatives for the woman's thought are:
(a) The man, sitting on the chair that had been pointed at by her.
(b) The man, sitting on the floor in front of the woman, in the direction she had pointed at.
(c) The man and the woman, both sitting on the floor.
(d) The man and the woman, both standing and drinking a coffee.

Complex Standard Acts

The shop window.   A mother and her son are strolling down a street. They reach a toy shop where the child notices a toy he likes. He repeatedly points at it while looking at the mother. The woman takes out her purse and shows him that it is empty.

The alternatives for the mother's thought are:

(a) The mother and the boy go away.

(b) The mother and the boy get out of the shop, with the boy keeping the toy in his hand.

(c) The mother and the boy walk with ice-creams in their hands.

(d) The mother stops to tie up a shoe.

Homework. A child is at home with his mother. A second child, with a ball in his hands, calls him and invites him to go out and play football. His mother calls him back and points at an exercise book.

The alternatives for the mother's thought are:

(a) The child is sitting at the table, doing his homework.

(b) The child is playing football with the second child.

(c) The child is in the garden with his mother.

(d) The child is at the telephone.

Roller-skates. Two girlfriends meet. One has an evident plaster on her left arm. The second girl shows her astonishment and the first pulls out a pair of roller-blades.

The alternatives for the first girl's thought are:

(a) She falls while skating.

(b) She falls while riding a bike.

(c) The two girls water the garden.

(d) She reads a newspaper.

Nonstandard Path: Deceit

Comics. A classroom of children are reading a passage on their textbook. One of them is actually reading a comic strip book concealed behind the textbook. The teacher comes close and the child puts the comic strip book under the table, showing his textbook to the teacher instead.

The alternatives for the child's thought are:

(a) The teacher caresses his head.

(b) He stands in a corner behind the blackboard.

(c) He plays with his schoolmates.

(d) He reads the comic strip with a schoolmate.

The broken vase. Two children are playing in a room. While they chase each other around a table, one knocks down a vase that is placed on it. Alarmed with the noise, their mother enters the room and looks at the scene. The child who has broken the vase looks back at her and points at the other child.

The alternatives for the child's thought are:

(a) The mother rebukes the other child.

(b) The mother rebukes him.

(c) The two children eats a cake.

(d) The mother reads a book.

Hide-and-seek. Two children are playing hide-and-seek: one counts and the other hides under a table. A third child observes the scene. The hidden child calls the third one, asking him to not reveal his hiding place. Then the first child asks the third where the second is. The third child points at a wardrobe.

The alternatives for the third child's thought are:

(a) The first child looks inside the wardrobe.

(b) The first child looks under the table.

(c) The three children play together.

(d) It is the second child's turn to count.

Nonstandard Path: Irony

Lego.   Two children are building a high Lego tower. One of them, with a sudden movement, breaks it down. The second child claps his hands.

The alternatives for the second child's thought are:
    (a) He is evidently angry with the other.
    (b) He is happy and smiles to the other.
    (c) He shows the other that he has caught a fly.
    (d) He paints.

Wrestling hand.   At the end of a wrestling hand game, the winner touches the arm of the loser, pretending admiration for his strength.

The alternatives for the winner's thought are:
    (a) The loser is weak: he cannot lift a light weight.
    (b) The loser is strong: he can easily lift a heavy weight.
    (c) The two are sitting around a table.
    (d) The loser dries his hair.

The chocolate.   Two girls sit at a table. One has a box of chocolates and eats them one by one. The other girl asks her for one, stretching forth the palm of her open hand. The first girl takes one more piece from the box and eats it. The asking girl caresses her on her cheek.

The alternatives for the asking girl's thought are:
    (a) She is evidently angry with the eating girl.
    (b) The eating girl kisses her back.
    (c) The two girls study together.
    (d) She plays the piano.

Recognition of Communication Failures

Failure of a simple standard act.   A child is walking down a street with her mother. As they approach a traffic light, the mother tries to take the child by the hand. The child retreats her hand.

The alternatives for the child's thought are:
    (a) She and her mother cross the road with their hands free.
    (b) She and her mother cross the road hand in hand.
    (c) The mother gives her a bag.
    (d) She takes a photograph.

Failure of a complex standard act.   A girl is hammering a nail into a wall. Another girl is trying to study at a nearby table, but the noise disturbs her too much. She then calls the first girl, showing her the book she is reading. The first girl takes out a drill and continues to work.

The alternatives for the hammering girl's thought are:
    (a) She keeps on making noise.
    (b) She stops making noise.
    (c) The two girls have a tea together.
    (d) The second girl continues her work.

Failure of a deceit.   A mother gives spinach to her son. He doesn't like it and throws it on the floor. The mother sees that the plate is empty, realizes that he cannot have already eaten it all, and scolds him.

The alternatives for the child's thought are:
    (a) He eats the spinach.
    (b) He throws away the spinach.
    (c) His mother takes him in her arms.
    (d) He drinks a glass of milk.

Failure of an irony.   A girl is sitting with a friend on a staircase, eating an ice-cream. The ice-cream falls on the ground, but she takes it up and goes on eating it. The friend makes a gesture of ''what a good taste!''. The eating girl offers her the ice-cream.

The alternatives for the eating girl's thought are:
    (a) Her friend eats the ice-cream.
    (b) Her friend refuses the ice-cream.
    (c) She ties up her friend's hair.
    (d) Her friend leaves on a bike.

REFERENCES

Airenti, G., Bara, B. G., & Colombetti, M. (1993a). Conversation and behavior games in the pragmatics of dialogue. *Cognitive Science, 17,* 197–256.

Airenti, G., Bara, B. G., & Colombetti, M. (1993b). Failures, exploitations and deceits in communication. *Journal of Pragmatics, 20,* 303–326.

Austin, J. L. (1962). *How to do things with words* (2nd ed., revised by J. O. Ormson & M. Sbisà, 1975). London: Oxford Univ. Press.

Bara, B. G., Bosco, F. M., & Bucciarelli M. (1999). Simple and complex speech acts: What makes the difference within a developmental perspective. In *Proceedings of the 21st Annual Conference of the Cognitive Science Society,* Vancouver, BC. M. Hahn & S. Stones (Eds.), Wahwah, NJ: Erlbaum, pp. 55–60.

Bara, B. G., Bucciarelli, M., & Geminiani G. (2000). Development and decay of extralinguistic communication. *Brain and Cognition, 43,* 1–3.

Bara, B. G., & Tirassa, M. (1999). A mentalist framework for linguistic and extralinguistic communication. In *Proceedings of the 3rd European Conference on Cognitive Science (ECCS '99),* Siena, Italy.

Bara, B. G., Tirassa M. (2000). Neuropragmatics: Brain and communication. *Brain and Language* (in press).

Bara, B. G., Tirassa, M., & Zettin, M. (1997). Neuropragmatics: Neuropsychological constraints on formal theories of dialogue. *Brain and Language, 59,* 7–49.

Caplan, D. (1992). *Language: Structure, processing, and disorders.* Cambridge, MA: MIT Press.

Clark, H. H. (1996). *Using language.* Cambridge, UK: Cambridge Univ. Press.

Colombetti, M. (1993). Formal semantics for mutual belief. *Artificial Intelligence, 62,* 341–353.

Ehrlich, J., & Barry, P. (1989). Rating communication behaviours in the head-injured adult. *Brain Injury, 3,* 193–198.

Feyereisen, P., & Seron, X. (1982). Nonverbal communication and aphasia: A review. *Brain and Language, 16,* 191–236.

Foldi, N. S., Cicone, M., & Gardner, H. (1983). Pragmatic aspects of communication in brain-damaged patients. In S. J. Segalowitz (Ed.), *Language functions and brain organization.* New York: Academic Press.

Grice, H. P. (1989). *Studies in the way of words.* Cambridge, MA: Harvard Univ. Press.

Holland, A. (1982). Observing functional communication of aphasic adults. *Journal of Speech and Hearing Disorders, 47,* 50–56.

Joanette, Y., & Brownell, H. H. (Eds.). (1991). *Discourse ability in brain damage: Theoretical and empirical perspectives.* New York: Springer-Verlag.

McDonald, S. (1992). Differential pragmatic language loss after closed head injury: Ability to comprehend conversational implicature. *Applied Psycholinguistics, 13,* 295–312.

McDonald, S., & van Sommers, P. (1993). Pragmatic language skills after closed head injury: Ability to negotiate requests. *Cognitive Neuropsychology, 10,* 297–315.

Mentis, M., & Prutting, C. A. (1987). Cohesion in the discourse of normal and head injured adults. *Journal of Speech and Hearing Research, 30,* 88–98.

Page, E. B. (1963). Ordered hypotheses for multiple treatments: A significance test for linear ranks. *Journal of the American Statistical Association, 58,* 216–230.

Petitto, L. (1987). On the autonomy of language and gesture: Evidence from the acquisition of personal pronouns in American Sign Language. *Cognition, 27,* 1–52.

Poizner, H., Klima, E. S., & Bellugi, U. (1987). *What the hands reveal about the brain.* Cambridge, MA: MIT Press.

Reiter, R. (1980). A logic for default reasoning. *Artificial Intelligence, 13,* 81–132.

Searle, J. R. (1969). *Speech acts: An essay in the philosophy of language.* Cambridge, UK: Cambridge Univ. Press.

Searle, J. R. (1979). *Expression and meaning.* Cambridge, UK: Cambridge Univ. Press.

Shallice, T., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain, 114,* 727–741.

Sherratt, S. M., & Penn, C. (1990). Discourse in a right-hemisphere brain-damaged subject. *Aphasiology, 4,* 539–560.

Sperber, D., & Wilson, D. (1986). *Relevance. Communication and cognition.* Oxford, UK: Blackwell.

Stemmer, B. (1994). A pragmatic approach to neurolinguistics: Requests (re-)considered. *Brain and Language, 46,* 565–591.

Tirassa, M. (1997). Mental states in communication. In *Proceedings of the 2nd European Conference on Cognitive Science (ECCS '97),* Manchester, UK, pp. 103–114.

Tirassa, M. (1999). Communicative competence and the architecture of the mind/brain. *Brain and Language, 68,* 419–441.

Wyckoff, L. H. (1984). *Narrative and procedural discourse following closed head injury.* Unpublished doctoral dissertation, University of Florida.