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Neuropsychological Evidence for Linguistic and Extralinguistic Paths in Communication

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Abstract

Aim of the present study is the validation of a series of predictions concerning the ability to comprehend different pragmatic phenomena expressed through linguistic or gestural means. According to the Cognitive Pragmatics Theory, it exists a gradation of difficulty in the comprehension of different pragmatic phenomena, depending upon the complexity of the mental representations involved; furthermore, the construction of the meaning of a communicative act is relatively independent by the input modality. Thus, we predict that the same gradient of difficulty in the comprehension of different pragmatic phenomena should be detected in both the linguistic and the extralinguistic communication. As right hemisphere injured patients are well known for having pragmatic deficit, also when tested through extralinguistic communication, we aim at comparing their performance on linguistic versus extralinguistic pragmatic ability. An experiment conducted with 11 healthy individuals and 11 right hemisphere damaged patients, tested on two experimental protocols designed to investigate the same sorts of pragmatic phenomena, confirmed our expectations.

Communication Comprehension: Understanding the Actor's Communicative Intention

Communication is a form of social activity, and it can be seen as an agent's intentional and overt attempt to affect a partner's mental states. Cognitive pragmatics is the study of the mental events that are involved in intentional communication (Airenti, Bara & Colombetti, 1993). Pragmatic competence requires the ability to perceive the communicative intentions of others, as well as the personal decisions about what to communicate in relation to the individual's own intentions, beliefs and desires. Individuals can express their communicative intentions not only with language, but also through extralinguistic means, that is any hand gesture, body movement or facial expression that is intentionally used to share a communicative meaning. A main theoretical claim of our research is that linguistic and extralinguistic forms of communication are merely superficial manifestations of a single communicative competence whose nature is neither linguistic nor extralinguistic, but mental (Bara & Tirassa, 2000; Bucciarelli, Colle & Bara, 2003). Authors claims the existence of a unitarian "*core pragmatic ability*" (Bara & Tirassa, 1999) that is independent of the different expressive means that could be used to communicate (namely the linguistic and the extralinguistic one).

Everyday linguistic communication is usually coupled with spontaneous gesticulation, body movements, postures, and

facial expressions. The actor might be more or less aware of his spontaneous gesticulation, which is not always intentionally chosen or performed. Spontaneous gesticulation is strictly coupled with the corresponding verbal expression(s), so that the two series of expressive acts contribute to determine the same communicative meaning. Consequently, when we refer to *linguistic pragmatics*, we intend pragmatics as performed through both language and its accompanying gesticulations. Instead, when we refer to *extralinguistic communication*, we refer to gestures, most of the time symbolic, intentionally used by an actor to convey information in absence of language (see Section 2). In extralinguistic communication, meaning is realized exclusively through intentionally performed gestures.

We follow the tenets of Cognitive Pragmatics Theory (Airenti et al., 1993), within which the analysis of communication is viewed on two levels: one behavioral and one conversational. When the actor communicates, he executes a social action plan, called *behavioral game*, whose knowledge is shared between himself and his partner, with the aim of achieving a certain effect on the latter (namely, to change his mental states and possibly to induce him to perform some action). The actor's aim is to share with his partner a certain meaning. The partner's task is to fully understand the actor's communicative intention through the recognition of the behavioral game. The choice of a communicative way to perform the behavioral game constrains the actor to follow a series of conversational rules: this is the *conversational level*.

The process of comprehending a communicative act consists in drawing inferences from the recognition of the communicative act (i.e. the overt attempt to perform a communicative act) to the communicative intention of the actor, i.e. the actor's meaning. The actor's communicative intention is fully understood only when it is clear to his partner which move of a behavioral game it realizes. From the partner's viewpoint, the behavioral game currently bid provides the background against which he draws inferences.

In comprehending the actor's communicative intention, the partner uses default rules of inference, i.e. rules which are always valid unless their consequent is explicitly denied (Reiter & Raymond, 1980). When the partner infers the actor's meaning through default inference rules, he goes down a *standard path of communication*. On the contrary, if the default inference rules are blocked, then the partner follows a *non-standard path of communication*. In a non-standard path an inferential meta-level rejects the consequent of the standard inferences when it is inappropriate to the

context (e.g. because it contrasts with another piece of knowledge or evidence), and triggers a new inferential chain. The difference between standard and non-standard communication can be expressed in terms of the mental representations involved (Bucciarelli et al., 2003): in case of no conflict between what it is communicated and what it is privately entertained by the actor, the communication is called *standard*; in case of conflict between what it is communicated and what it is privately entertained by the actor, the communication is called *non-standard*.

Standard communication comprises simple (directs and conventional indirects) and complex (non-conventional indirects) standard acts, and it involves an actor whose beliefs and communicative purposes are in line with what he communicates.

Non-standard communication comprises figurative language, deceptions and ironies, and involves more complex mental representations. It follows the prediction that standard phenomena are easier to deal with than non-standard phenomena. Such a prediction is confirmed in the literature on normal (Bucciarelli et al., 2003) and abnormal (Bara, Bosco & Bucciarelli, 1999) development, on closed-head-injured patients (Bara, Tirassa & Zettin 1997; Bara, Cutica & Tirassa, 2002), and on Alzheimer patients (Bara, Bucciarelli & Geminiani, 2000).

Linguistic and Extralinguistic Communication

The analysis of the processes of comprehension of a communicative act briefly sketched above is cast in terms of the mental representations involved in the process itself; thus what we stated above should be valid for the understanding of both the actor's communicative intentions expressed through language, and those expressed through extralinguistic means.

An actor who uses extralinguistic communication (just like one who uses linguistic communication) aims at sharing a communicative meaning with a partner, and does this through the intentional use of facial expressions, hand gestures, and body movements. Any communicative meaning begins and ends in a mental representation: the understanding of an actor's communicative intention consists of representational processes whose input data can be either linguistic or gestural. Also, the output of the process of comprehension is always a mental representation: thus, we assume that the form of the data in input does not affect the representational and inferential processes involved in comprehending a phenomenon (see also Bucciarelli et al., 2003). A research stream whose data seems to support this assumption is the one that studies the American Sign Language (ASL) processing. Indeed, several researches show that some cerebral regions process language independently of the modality of presentation of language (see for instance Neville et al., 1998). Thus, apart from the fact that language is presented linguistically, for instance, to an English native speaker, or visually to an ASL native speaker, the language processes took mainly place in the same classical language areas of the left hemisphere. This can support the assumption that, in language comprehension, the input format is little relevant at the representational and inferential levels.

As we assumed that different pragmatic phenomena (in particular simple standard acts, complex standard acts, deceptions and ironies) requires, to be understood, mental representations of different degrees of complexity, we predict that the degree of difficulty that people encounter in comprehending a pragmatic phenomenon (that we hypothesize depends on the type of mental representations involved), should hold for both linguistic and extralinguistic communication. With the experiment described in Section 4 we aim at verifying this prediction.

Pragmatic Ability in Right Hemisphere Damaged Patients

Most studies concerning right hemisphere damaged (RHD) patients reveal their difficulties in linguistic pragmatics. In particular, RHD patients have difficulties in comprehending indirect requests (Weylman, et al., 1989; Stemmer, Giroux & Joannette, 1994), sarcasm and deception (Tompkins & Mateer, 1985), metaphors and idiomatic sentences (Myers & Linebaugh, 1981; Schmitzer, Strauss & DeMarco, 1997; Winner & Gardner, 1977). More in general, RHD patients seem to be impaired in using context to interpret speech acts (Kaplan, et al., 1990; Richards & Chiarello, 1997), and they seem to "miss the point" of complex discourse, particularly oral conversation (Gardner, et al, 1983; Hough, 1990).

Briefly, all the evidence found in literature supports the idea that the RH is heavily involved in pragmatic ability, i.e. the ability to properly use language in a social context. If this is the case, then there is a main reason for investigating pragmatic ability in RHD patients. Indeed, we know from literature that RHD patients are preserved in their ability to manage the syntactic aspects of sentences, and they largely rely on their intact syntactic ability in processing the discourse (Brownell, et al., 1992). Therefore, it is possible that syntax facilitate patients' comprehension of an actor's communicative intention, when that intention is expressed linguistically. Thus, patients can partially counterbalance their pragmatic deficit by using linguistic ability. If this is true, then patients should find it easier to comprehend linguistic than extralinguistic communication.

Cutica, Bara & Bucciarelli (2003) find that RHD patients are impaired in comprehending extralinguistic communication, but they do not compare the patients' performance on linguistic versus extralinguistic tasks. Indeed, authors tested only the extralinguistic pragmatic ability of 13 RHD patients and 13 control subjects, finding that patients were impaired with respect to controls in each pragmatic task (the tasks require to understand an actor's communicative intention toward a partner). The pragmatic phenomena examined were direct communicative acts, non-conventional indirect communicative acts, deceptions, ironies, and failures of communication.

The present study is designed to compare RHD patients' and controls' performance on linguistic versus extralinguistic tasks, using two pragmatic protocols, designed to be comparable.

Experiment

The aim of our experiment is to investigate into possible differences in the process of comprehension of linguistic and extralinguistic communicative acts. For this purpose, we tested both healthy individuals and RHD patients.

Predictions:

1. In comparing performance to linguistic and extralinguistic tasks, we expect to find that both participants' groups show the same pattern of difficulty among the different pragmatic phenomena.

Furthermore, we expect that, as concerning the overall performance to each protocol, RHD patients are more impaired in the extralinguistic communication respect to the linguistic communication, as due to the characteristics of RHD patients' pragmatic impairment.

2. In comparing performance to standard versus non-standard communicative acts, we expect to find that, for both participants groups, standard communication is easier to comprehend than non-standard communication.

3. In between-groups comparisons, RHD patients should be impaired, with respect to healthy individuals, in comprehending both linguistic and extralinguistic communication.

Participants

The RHD group consisted of 11 right hemisphere injured patients (9 males, 4 females), whose age ranged from 51 to 70 years (mean age: 56;4), and whose education ranged from 0 to 18 years (mean: 8). Patients did not suffer multiple vascular damage, they had a minimum score of 26 at the Mini Mental State Examination (to avoid any incipient dementia); none of them was apraxic, as resulted at the Apraxia Subtest of the Western Aphasia Battery (Kertesz, 1982). All of them had suffered vascular damage (ischemia or haemorrhage). Six of them had an anterior lesion (frontal lobe, of fronto-temporal areas), five a posterior lesion (parietal or temporal lobes).

The healthy individuals group consisted of 11 adults matched for sex (9 males, 4 females), age (mean age: 54;6) and education (mean years: 8,6).

Materials and procedures

The participants dealt with the experiment individually, in a quiet room. They were told that the experiment was concerned with humans' communicative ability.

The experiment consisted of three experimental sessions for patients, and two for healthy subjects, with a break of one week between sessions. As regards patients, in the first session they had to pass three entrance tests: the MMSE (Mini Mental State Examination), a theory of mind test (Smarties test), and a visuo-perceptive test. The visuo-perceptive test consisted of four videotaped scenes, depicting objects in movement according to laws of physical causality, designed to test if the patient could correctly perceive the whole screen of the television. Only patients with 26 or more at the MMSE, and with a full score on the other two tests

were admitted to the experimental sessions. Anyway, none of the patients was excluded, because all of them succeeded in each test. Then, half of the patients dealt with the linguistic protocol in the second session, and with the extralinguistic protocol in the third session. The order was reversed for the remaining patients. As regards the healthy subjects, they dealt only with the two pragmatic protocols in two experimental sessions; the order of presentation of the two protocols was balanced for them, too. Each session lasted about 50 minutes for patients, and about 35 minutes for controls.

The linguistic protocol (originally devised by Bara et al., 1997) comprised 12 videotaped fictions: 3 directs, 3 non-conventional indirects, 3 deceits, and 3 ironies. An example of a videotaped scene of the linguistic protocol is the following irony:

[1] *The run*. Children A and B are racing in a yard. Child A wins; Child B arrives with a remarkable delay and puffing. Child A says: "You run real fast".

The prosody and the facial expressions of the actors are coherent with their communicative intentions.

The extralinguistic protocol was originally devised by Bara and colleagues (2000). It comprises 3 directs, 3 non-conventional indirects, 3 deceits, and 3 ironies. An example of extralinguistic irony is the following:

[2] *Lego*. Two children are building a high Lego tower. One of them, with a sudden movement, knocks it down. The other child claps his hands looking at him.

Each videotaped fiction of both protocols lasts about 16-20 seconds, and depicts a single communicative act performed by an actor toward a partner. Each fiction ends immediately before the partner's reaction to the communicative act performed by the actor: there was only one communicative act per scene. The facial expressions of the actors are coherent with their communicative intentions.

Participant's comprehension was assessed differently for the linguistic and the extralinguistic protocol. In the former they were asked, at the end of each fiction, what they believe the communicative intention of the actor was (i.e., "What does she mean, by saying that?"). In the extralinguistic protocol, participant's comprehension was instead assessed by asking subjects to choose, from a set of four photographs given in random order, the one depicting the communicative intention of the actor. For instance, the four alternatives for the second child's communicative intention in the fiction [2] are:

- (a) He is evidently angry with the other child.
- (b) He is happy and smiles at the other child.
- (c) He shows the other that he has caught a fly.
- (d) He paints.

Thanks to such procedure language plays no role in the extralinguistic protocol, since it appears neither in the material presented, nor in the response requested.

For both protocols, we assigned one point per each correct answer, that is each time the participants correctly recognizes the communicative intention of the actor.

Results

Prior to the analysis of the data we verified an implicit assumption of our study, namely that participants experienced the same easiness/difficulty in comprehending the 3 communicative acts utilized to investigate each single pragmatic phenomenon (e.g. the 3 ironic communicative acts). Results reveal that, for both protocols, all the communicative acts of a given sort were comparable in difficulty both for patients (Friedman non parametric analysis of variance: p value ranging from .417 to .913) and for controls (Friedman non parametric analysis of variance: p value ranging from .549 to .717).

Within the group of patients it is possible to distinguish between those with an anterior lesion site (n=6) and those with a posterior lesion site (n=5). The performance of the two subgroups of patients do not differ significantly nor in the linguistic protocol (Mann Whitney test: $z=-512$, $p=.321$), nor in the extralinguistic protocol (Mann Whitney test: $z=-531$, $p=.284$). Thus, we pooled together their results.

Within Groups Comparisons. *Comparisons between linguistic and extralinguistic communication*

The means of correct performance of patients and healthy individuals with both linguistic and extralinguistic communicative acts are in Table 1 and 2.

Table 1. Means of correct performance by RHD patients with linguistic and extralinguistic acts. Standard deviations in parentheses.

RHD patients	Standard acts		Non-standard acts	
	Simple (n=3)	Complex (n=3)	Deceits (n=3)	Ironies (n=3)
Linguistic	3	3	2.24 (.84)	1.95 (.74)
Extraling.	2.68 (.64)	2.28 (.72)	1.41 (.65)	1.64 (.79)

As concerning the global performance, RHD patients perform better with linguistic communication than with the extralinguistic one (Wilcoxon test: $z=-2.942$, $p=.0016$). We detected a significant difference in performance both for standard communication (Wilcoxon test: $z=-1.82$, $p=.034$) and for non-standard communication (Wilcoxon test: $z=-2.234$, $p=.008$): in both cases, patient performed better in the linguistic protocol. In more detail, the difference is significant for simple standard acts (Wilcoxon test: $z=-1.98$, $p=.034$), for complex standard acts (Wilcoxon test: $z=-2.26$, $p=.0044$), for deceptions (Wilcoxon test: $z=-1.83$, $p=.033$) and for ironies (Wilcoxon test: $z=-1.79$, $p=.042$).

Also the healthy individuals group perform better with linguistic communication than with extralinguistic communication (Wilcoxon test: $z=-2.792$, $p=.016$), as concerning the global performance (see Table 2). In particular, the difference in performance is marginally

significant for standard communication (Wilcoxon test: $z=-1.603$, $p=.051$), whereas it is fully significant for non-standard communication (Wilcoxon test: $z=-1.807$, $p=.035$). In more detail, the difference is not significant for simple standard acts (that obtained full-score correct performance), whereas it is significant for complex standard acts (Wilcoxon test: $z=-1.88$, $p=.045$); as concerning non standard communication, the difference is significant for deceptions (Wilcoxon test: $z=-2.20$, $p=.027$) but it is not significant for ironies (Wilcoxon test: $z=-1.60$, $p=.108$).

Table 2. Means of correct performance by healthy individuals with linguistic and extralinguistic acts. Standard deviations in parentheses.

Healthy individuals	Standard acts		Non-standard acts	
	Simple (n=3)	Complex (n=3)	Deceits (n=3)	Ironies (n=3)
Linguistic	3	3	3	2.51 (.44)
Extraling.	3	2.73 (.60)	2.61 (.68)	2.60 (.50)

Comparisons between standard and non-standard communicative acts.

In the *linguistic protocol* RHD patients perform better with standard acts than with non-standard acts (Wilcoxon test: tied $z=-3.059$, tied $p=.0001$). Control subjects instead do not show a significant difference between standard and non-standard acts (Wilcoxon test: $z=-1.825$, $p=.067$); it has to be noticed that healthy individuals obtain a full-score performance in 9 tasks (3 simple, 3 complex, 3 deceit) out of 12.

In the *extralinguistic protocol* RHD patients perform better with standard acts than with non-standard ones (Wilcoxon test: $z=-2.760$, $p=.003$). The same result holds for healthy subjects (Wilcoxon test: $z=-2.201$, $p=.028$).

Between Groups Comparisons In the *linguistic protocol* considered as a whole, RHD patients perform worse than controls (Mann-Whitney test: $z=-3.37$, $p=.0003$). In particular, the difference in performance is significant for non-standard phenomena (deceptions: Mann-Whitney test: $z=-3.281$, $p=.0005$; ironies: Mann-Whitney test: $z=-2.373$, $p=.009$), but not for standard phenomena (in each of them both groups performed 100% correct interpretations).

In the *extralinguistic protocol* considered as a whole, RHD patients perform worse than controls (Mann-Whitney test: $z=-3.698$, $p=.0001$). The difference is significant for each pragmatic phenomenon: simple standard acts (Mann-Whitney test: $z=2.126$, $p=.02$), complex standard acts (Mann-Whitney test: $z=2.219$, $p=.01$), deceptions (Mann-Whitney test: $z=-3.413$, $p=.0003$), and ironies (Mann-Whitney test: $z=2.926$, $p=.001$).

Interactions Finally, we detected a significant interaction: as regards the extralinguistic protocol, the difference in performance between standard and non-standard tasks in patients is significantly higher than the difference in performance between standard and non-standard tasks in healthy individuals (Mann-Whitney test: $z=-3.021$, $p=.0001$).

Conclusions and Discussion

A main aim of our experiment is to compare the participants' ability to comprehend the actor's communicative meaning *via* linguistic and extralinguistic means.

Results show that both healthy individuals and RHD patients have more difficulties in comprehending extralinguistic communication than linguistic communication. Furthermore, RHD patients, who are impaired in understanding a communication realized through linguistic modalities, show even more pragmatic difficulties in comprehending a communication realized through extralinguistic modalities.

In any case, participants in both groups shows the same pattern of difficulty: they find it easier to comprehend standard communication than non-standard communication. This result holds for both participants' groups as concerning extralinguistic communication, and as concerning linguistic communication it holds for the RHD patients' group only. As regards the healthy individuals performance on linguistic protocols, we obtained a ceiling effect on standard communication, and a performance close to the ceiling effect on non-standard communication. The easiness of linguistic fictions (that had to be comprehensible for patients also), thus, does not allow healthy individuals to fully show the upper limit of their ability (with the exception of ironies).

The results show that the sort of the mental representation involved in comprehending a communicative act (conflicting mental representation for non-standard communication versus not conflicting mental representation for standard communication) can account for the difficulty experienced in comprehending the communication, independently of its being expressed linguistically or extralinguistically. Indeed, results confirm that both RHD patients and healthy individuals find it harder to comprehend non-standard communication than standard communication.

Nevertheless, the finding that extralinguistic communication is systematically more difficult to comprehend (for each task considered, except than simple standard acts and ironies in healthy subjects) needs to be accounted for. It is possible that there are some features of the communicative expressive mean that could facilitate or, by the contrary, hinder, the comprehension of a communicative act. It is possible that language, that evolved as the main communicative tool of human beings, and that is so widely and abundantly used in everyday conversations, has reached a sort of "privileged status" respect to any other communicative tool; thus a communication entirely sustained by gestures is, in any case, less immediate to understand than the correspondent linguistic communication.

Alternatively, it is possible that something in the protocol construction made easier the linguistic tasks; in particular,

actors in the linguistic fictions communicate in an ecological way, that is using both language and its spontaneous accompanying gestures. Thus, it is possible that the communication that took place in the linguistic fictions was more informative than communication that took place in the extralinguistic ones. Furthermore, in healthy subjects the difference in performance between linguistic and extralinguistic communication does not occur on each pragmatic phenomena; indeed, as concerning standard communication, the difference is only marginally significant ($p=.051$). It means that some other factor affected the RHD performance with the extralinguistic communication, other than elements listed below. Probably, RHD patients pragmatic abilities are more damaged than their performance on linguistic tasks let us suppose: indeed, they can use their intact linguistic ability to little counterbalance their pragmatic deficit. But when no language can help, patients' performance is fully indicative of their pragmatic deficit.

Among other things, these results suggest that a proper assessment of pragmatic competence in patients ought to consider both linguistic and extralinguistic pragmatic competence.

Finally, relative to healthy subjects, patients show an higher degree of difference in performance, between standard and non-standard communication. This finding is compatible with the well-known RHD patients difficulty in integrating different sorts of information (see for instance Richards et al., 1997), particularly when some piece of information contrasts with another piece of information or with previous knowledge.

Summarizing, the results suggest that the differences in dealing with conflicting versus not conflicting mental representations (that is, non-standard communication versus standard communication, respectively) can be found with similar patterns both in the linguistic and in the gestural communication comprehension; thus, the presence/absence of conflicting mental representations accounts for different degrees in the difficulty of understanding different types of pragmatic phenomena.

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