Linguistic, extralinguistic and paralinguistic abilities in patients with right hemisphere damage (RHD)

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Abstract

Patients with right hemisphere damage (RHD) often show communicative-pragmatic deficits involving different expressive modalities, i.e. linguistic, extralinguistic and paralinguistic. Most previous research has evaluated pragmatic ability using linguistic tasks only, while the extralinguistic aspects of communication have received less attention. The aim of the present study was to provide a multifocal assessment of communicative abilities in RHD patients, describing their communicative impairment and abilities, both in comprehension and production. The study revealed communicative deficits in RHD patients in all the expressive modalities investigated, i.e. linguistic, extralinguistic and paralinguistic, with patients performing worse in extralinguistic tasks than in linguistic tasks.

Keywords: Communication, right hemisphere damage, assessment, extralinguistic

Introduction

Communicative-pragmatic competence is the ability to draw appropriate inferences in order to recognize the partner's communicative intention (Levinson, 1983). The contribution of the right hemisphere in sustaining communicative-pragmatic competence has been confirmed by a huge body of evidence, including neuropsychological and neuroimaging data (e.g. Tompkins, 1995; Zaidel et al., 2002). While basic linguistic abilities, i.e. phonological, morphological and syntactical skills, are almost entirely preserved after right hemisphere damage (RHD), impairment affects the ability to use language in social contexts (Cummings, 2009).

Communicative-pragmatic competence can be considered as a complex high-order ability, encompassing different skills that make it possible to comprehend and produce relevant messages in a flexible way, adapting them according to the demands of a specific social context: almost all of these abilities can be impaired as a consequence of RHD. First of all, RHD can compromise conversational and discursive abilities: egocentric and tangential comments, reduced use of cohesive devices, difficulties in maintaining the theme of a discourse and in respecting turn-taking have been reported (e.g. Myers; 1999; Marini et al., 2005; Hird & Kirsner, 2003). Patients can also lose knowledge of the rules that regulate communication in a social context: they are sometimes unable to attune their communicative register to a specific situation, or to produce appropriate responses. Patients often fail to grasp the pragmatic meaning of a communicative exchange, especially when the message expressed is indirect or ambiguous, remaining attached to a literal interpretation. This is the case of non-literal and figurative forms of language, such as humor (Cheang & Pell, 2006), idioms and metaphors (Papagno et al., 2006), sarcasm (McDonald, 2000) and lies (Winner et al., 1998).

Another typical area of impairment traditionally associated with RHD is the management of paralinguistic components. The term paralinguistic refers to those aspects that contribute to modifying, marking or clarifying the content of a message, such as intonation of voice, facial expressions, body and eyes movements. Such aspects can be compromised in many ways after RHD. Patients with RHD have difficulties in the comprehension of emotional prosody (Pell, 2006) and, when compared with LHD (left hemisphere damaged) patients, they have been found to be more impaired in recognizing emotions from tone of voice

or facial expressions (Kucharska-Pietura et al., 2003). Moreover, patients showed impairments in recognizing and distinguishing prosodic features (Brownell et al., 1995) and in adequately regulating their own production, with alterations in vocal frequencies in the production of prosodic elements (Pell, 1999).

Few studies have investigated extralinguistic ability in patients with RHD. Cutica et al. (2006) reported that patients with RHD are more impaired than LHD patients in the comprehension of communicative gestures, and even have difficulties in comprehending the easiest form of communicative gesture. Cocks et al. (2007) reported that RHD patients produce fewer spontaneous gestures during a conversation, especially when it refers to an emotional content. These studies revealed that RHD could seriously undermine the ability to communicate using extralinguistic pragmatic skills. The Cognitive Pragmatic Theory (Bara, 2010) conceives communicative competence as the ability to draw correct inferences in order to recognize the partner's communicative intention. Communicative intentions can be expressed not only verbally, but also using extralinguistic behavior, such as body gestures and hand movements. This model maintains that comparable processes, aimed at the pragmatic decoding of the interlocutor's communicative intention, may be recruited regardless of whether linguistic or extralinguistic communicative modality is used to convey a meaning.

Taken as a whole, these studies have shown that communicative-pragmatic disorders represent a typical outcome after RHD. Such deficits can seriously undermine social functioning, preventing patients' full recovery and limiting their prospects for reintegration at work and into family life (Lehman, 2006). A comprehensive assessment of communicative deficits in the early stages is necessary to provide effective rehabilitative treatment.

Clinical assessment of RHD patients

The assessment of communicative-pragmatic abilities in RHD patients presents some theoretical and methodological issues. First of all, although communicative deficits are frequently reported, RHD patients have heterogeneous clinical profiles. RHD does not generate a predictable list of impairments: deficits can be subtle and limited to certain expressive modalities. Assessment tools should therefore concomitantly evaluate all the expressive modalities of pragmatic competence, in order to avoid the risk of underrating patients' difficulties. Cote et al. (2007) and Champagne-Lavau et al. (2009) examined this problem, delineating subgroups of RHD patients characterized by different patterns of communicative impairment.

This variability has contributed to the lack of a univocal clinical label to identify communicative disorders following RHD, with serious consequences for assessment approaches. The availability of a label for a specific disorder, as in the case of the term aphasia to clearly identify symbolic-language disorders after LHD, can be helpful for facilitating communication between professionals, and creating assessment devices and rehabilitative treatments (Myers, 2001). Moreover, most of the tools for assessing pragmatic abilities are not based on a theoretical framework of communicative processes. As reported by Lehman (2006), the use of a theoretical framework to identify the specific level of the observed deficits is fundamental in order to plan an effective rehabilitative program focused on the patient's difficulties.

A limited number of assessment tools, such as the "Right Hemisphere Communication Battery" (RHCB, Gardner & Brownell, 1986), the "Right Hemisphere Language Battery" (Bryan, 1995) and the "Batteria sul Linguaggio dell'Emisfero Destro" (Rinaldi et al., 2004) have been developed specifically to assess communicative deficits after RHD. Although these batteries provide a comprehensive evaluation of communicative ability, they focus on the comprehension of verbal aspects of communication, without providing a detailed description of other important aspects of pragmatic ability such as extralinguistic competence. Recent studies have in fact clearly shown that RHD patients have difficulty using extralinguistic components.

The Assessment Battery for Communication (ABaCo, Sacco et al., 2008; Angeleri, et al. 2012; Bosco et al. 2012), developed within the framework of Cognitive Pragmatics (Bara, 2010), was conceived to provide a systematic evaluation of pragmatic ability, both in comprehension and production, in order to determine the profile of impairments in various clinical populations (Angeleri et al., 2008; Gabbatore et al., 2014; Colle et al., 2013).

Aim of the study

The aim of the present study was to provide a detailed description of communicative impairments in a sample of RHD patients, by examining their pragmatic abilities expressed through different expressive modalities, i.e. the linguistic, extralinguistic and paralinguistic modalities, both in comprehension and production. We expected RHD patients to perform significantly worse than controls in all the investigated abilities, consistently with previous research. In particular, we focused on the analysis of comprehension and production of communicative gestures. In line with Cutica et al. (2006), we expected RHD patients to be impaired in comprehending communicative gestures; we also evaluated the production of communicative gestures, expecting this ability to be inadequate as well. Finally, we expected the impairment to be more evident in the extralinguistic modality than in the linguistic modality, in line with the view that RH plays a major role in sustaining extralinguistic and paralinguistic aspects of communication.

Participants

The sample comprised 17 patients (10 males, 7 females) with unilateral right hemisphere damage (RHD) due to a single vascular accident. Their age ranged from 43 to 72

years (M = 60.0, SD = 8.68), and their years of education from 5 to 18 years (M = 11.58; SD = 4.44). Patients were recruited at rehabilitation centers in the Piedmont Region, immediately after being admitted to the rehabilitation center (months post-onset M = 2.47; SD = 1.45), in order to provide an early description of communicative impairments following RHD. In addition to having a RHD, patients had to meet the following criteria for inclusion in the study: (1) at least 18 years of age, (2) Italian native speakers, (3) right-handers and (4) basic cognitive and linguistic abilities, assessed by the achievement of a cut-off score in the following neuropsychological tests: Mini Mental State Examination: cut-off score ≥ 24/30; Token Test: cut-off score ≥ 29/36; Ideomotor Apraxia Test: cut-off score ≥ 19/20; The simple Test of Visual Neglect; cut-off score > 34/36. A control group of healthy participants (n = 17), matched to the RHD group for age, sex and education, was recruited according to the same inclusion criteria reported above.

Material and methods

Pragmatic assessment: We administered the (1) Linguistic (2) Extralinguistic and (3) Paralinguistic Scales of the *Assessment Battery for Communication* (*ABaCo*; Sacco et al., 2008; Bosco et al., 2012).

Linguistic and Extralinguistic scales: Linguistic tasks evaluate the ability to comprehend and produce communicative acts expressed through the linguistic modality. Extralinguistic tasks evaluate the ability to comprehend and produce communicative acts expressed through gestures. The scales comprise 48 items presented in videos in which two actors play out a communicative exchange, using linguistic or extralinguistic expressive modalities. At the end of each scene the examiner evaluates the correct comprehension of the protagonist's conclusive sentence or gesture, or elicits the production of a communicative act in response to the protagonist's communicative act. The scales evaluate abilities to understand and produce different pragmatic phenomena: (1) standard communicative acts, i.e., direct and indirect communicative acts (2) deceits and (3) ironies.

Paralinguistic scale: The paralinguistic scale evaluates the ability to comprehend and produce paralinguistic aspects of communication, using the following tasks: (1) Basic speech acts: the examiner shows the subjects a video in which an actor, speaking an invented language, makes a statement, asks a question, makes a request or gives a command. The subject has to comprehend the type of act conveyed by the paralinguistic components. To measure production abilities, the examiner asks the subjects to produce questions, statements, requests or commands using the adequate paralinguistic indicators. (2) Basic emotions: the examiner evaluates comprehension by showing the subjects short videos in which an actor, speaking an invented language, conveys one of the basic emotions. The subject has to recognize the correct emotion using paralinguistic indicators. The examiner investigates production by asking the subjects to pronounce a sentence conveying a specific emotional tone. (3) Paralinguistic contradiction: the examiner evaluates comprehension by showing subjects short videos in which an actor verbally communicates a message that is in overt contradiction with the paralinguistic indicators. The subject has to recognize this discrepancy.

All participants performed the tasks individually during a single session lasting approximately 1 hour. The examiner video-recorded and transcribed each patient's performance. A trained rater, blind to the experimental group composition and research aims, coded the data individually. For each task, a score of 1 was assigned to each correct response, and a score of 0 to each incorrect response.

Results

The overall performance of RHD patients on the ABaCo scales is summarized in Table 1. In line with our hypothesis, the results confirmed that RHD patients performed significantly worse than healthy controls in both comprehension and production in all the tasks considered, i.e. linguistic, extralinguistic and paralinguistic (T test: 2.48 < t < 3.64; .001 < p < .03). The results of each scale are analyzed separately in the following section.

Table 1. Mean and standard deviation of Linguistic, Extralinguistic and Paralinguistic Scales.

	Comprehension			
Scale	Patients	Controls	t	p
Linguistic	.79 (.14)	.92 (.12)	2.89	.007
Extralinguistic	.65 (.16)	.84 (.19)	3.08	.004
Paralinguistic	.76 (.09)	.84 (.07)	2.92	.006
	Production			
	Patients	Controls	t	p
Linguistic	.83 (.10)	.92 (.11)	2.36	.025
Extralinguistic	.67 (.23)	.90 (.12)	3.71	.001
Paralinguistic	.89 (.10)	.97 (.06)	2.91	.007

Linguistic Scale: A repeated measures ANOVA, with one between-subjects factor (type of subject, with two levels: patients and controls) and one within-subjects factor (type of task, with three levels: standard communicative acts, deceit and irony) was conducted to analyze subjects' performance. The same analyses were conducted for both comprehension and production tasks.

As regards comprehension abilities, the results revealed a main effect of the type of subject ($F_{(1,32)}$ = 8.34; p = .007; η^2 = .20): patients performed worse than control subjects. Moreover, there was a main effect of the type of task ($F_{(2,64)}$ = 8.10; p = .001; η^2 = .20). Concerning production abilities, the results revealed a main effect of the type of subject ($F_{(1,32)}$ = 5.55; p = .025; η^2 = .14): patients performed worse than control subjects. Moreover, there was a main effect of the type of task ($F_{(2,64)}$ = 7.41; p = .003; η^2 = .18) (Table 2).

Table 2. Linguistic Scale: mean and standard deviation of the scores obtained for standard communicative acts, deceit and irony.

	Comprehension			
	Patients	Controls	t	p
Standard acts	.95 (.08)	.96 (.12)	.40	.69
Deceit	.76 (.30)	.90 (.13)	1.85	.074
Irony	.66 (.21)	.88 (.27)	2.72	.011
	Production			
	Patients	Controls	t	p
Standard acts	.95 (.11)	.99 (.04)	1.19	.244
Deceit	.82 (.25)	.94 (.14)	1.71	.097
Irony	.71 (.29)	.82 (.29)	1.14	.265

Extralinguistic Scale: A repeated measures ANOVA, with one between-subjects factor (type of subject, with two levels: patients and controls) and one within-subjects factor (type of task, with three levels: standard communicative acts, deceit and irony) was conducted to analyze subjects' performance in the extralinguistic tasks. The same analyses were conducted for both comprehension and production tasks. As regards comprehension abilities, the results revealed a main effect of the type of subject ($F_{(1,32)} = 9.48$; $p = .004$; $\eta^2 = .22$): patients performed worse than control subjects. There was also a main effect of the type of task ($F_{(2,64)} = 4.60$; $p = .014$; $\eta^2 = .12$). Concerning production abilities, the results revealed a main effect of the type of subject ($F_{(1,31)} = 17.22$; $p < .0001$; $\eta^2 = .46$): patients performed worse than control subjects. There was also a main effect of the type of task ($F_{(2,64)} = 27.37$; $p < .0001$; $\eta^2 = .46$) (Table 3).

Table 3. Extralinguistic Scale: mean and standard deviation of standard communicative acts, deceit and irony.

	Comprehension			
	Patients	Controls	t	p
Standard acts	.82 (.20)	.85 (.22)	.62	.720
Deceit	.61 (.32)	.86 (.22)	2.65	.012
Irony	.53 (.26)	.81 (.29)	3.00	.005
	Production			
	Patients	Controls	t	P
Standard acts	.89 (.22)	.99 (.06)	1.61	.117
Deceit	.70 (.27)	.96 (.13)	3.46	.002
Irony	.36 (.35)	.76 (.31)	3.50	.001

Paralinguistic Scale: We analyzed performance on Paralinguistic tasks in both comprehension and production. To analyze comprehension abilities, we conducted a repeated measures ANOVA, with one between-subjects factor (type of subject, with two levels: patients and controls) and one within-subjects factor (type of task, with three levels: basic speech acts, basic emotion, paralinguistic contradiction). The results revealed a main effect of the type of subject ($F_{(1,32)} = 8.54$; $p = .006$; $\eta^2 = .21$): patients performed worse than control subjects. There was also a main effect of the type of task ($F_{(2,64)} = 19.23$; $p < .0001$; $\eta^2 = .37$). Similar analyses were conducted for production abilities, using a repeated measures ANOVA, with one between-subjects factor (type of subject, with two levels: patients and controls) and one within-subject factor (type of task, with two levels: basic speech acts and basic emotion) (Table 4).

Table 4. Paralinguistic Scale: mean and standard deviation of the obtained scores for basic speech acts (BSA), basic emotion and paralinguistic contradiction (P.Contradiction)

	Comprehension			
	Patients	Controls	t	p
BSA	.63 (.20)	.69 (.15)	.94	.353
Basic Emotion	.81 (.14)	.89 (.14)	1.69	.101
P. Contradiction	.84 (.20)	.96 (.10)	2.07	.046
	Production			
	Patients	Controls	t	p
BSA	.96 (.06)	.98 (.07)	1.01	.321
Basic Emotion	.82 (.14)	.96 (.06)	3.59	.002

Comparison between Linguistic and Extralinguistic tasks: We performed a repeated measures ANOVA with one between-subjects factor (type of subject, with two levels: patients and controls) and one within-subjects factor (type of task, with two levels: linguistic and extralinguistic tasks) to compare subjects' performance on linguistic and extralinguistic tasks. The analyses revealed a main effect of the type of subject ($F_{(1,32)} = 22.21$; $p < .0001$; $\eta^2 = .41$): patients performed worse than controls. Moreover there was a main effect of type of task ($F_{(1,32)} = 28.63$; $p < .0001$; $\eta^2 = .47$): performance in extralinguistic tasks was significantly worse than performance in linguistic tasks. We found an interaction effect between the two main factors, type of subject and type of task ($F_{(1,32)} = 7.48$; $p = .010$; $\eta^2 = .19$). The interaction effect between subject and task showed that only patients performed significantly worse on the Extralinguistic Scale than on the Linguistic Scale. Patients exhibited difficulties in extralinguistic and linguistic tasks, but were more severely impaired in extralinguistic tasks compared to healthy controls.

Discussion and conclusion

The aim of the present study was to provide a detailed description of communicative deficits following RHD. In line with previous literature, RHD patients showed a wide range of pragmatic disorders compared to healthy controls: they exhibited difficulties in both comprehension and production in all the tasks examined, i.e. linguistic, extralinguistic and paralinguistic.

Previous studies suggested that RHD patients do not have difficulties in dealing with literal forms of communication, but perform less well in high-order tasks, that require the comprehension of non-literal, figurative and ambiguous forms of language: deficits in the comprehension of jokes, irony, sarcasm, metaphors, idioms and lies have been reported extensively (e.g. Cheang & Pell, 2006; McDonald, 2000). Given that inferential deficits are frequently present after RHD (e.g. Beeman, 2000) it is not unexpected that the patients in our study reported such difficulties with communicative tasks involving high inferential demands. The role of neural regions of right hemisphere in sustain the comprehension of non-literal language has been confirmed by recent neuroimaging studies (e.g. Eviatar & Just, 2006).

The main finding of this paper refers to the impairment that RHD patients exhibit in extralingustic modality, in

particular in comprehension and production of communicative gestures. The results for extralinguistic tasks showed that patients performed similarly to healthy controls in comprehending and producing standard communicative acts, while they performed significantly worse than controls in comprehending and producing deceit and irony. These data confirmed those obtained by Cutica et al. (2006), suggesting that RHD patients are impaired in their ability to decode extralinguistic aspects of communication; these data also allow us to extend the results reported by Cutica and colleagues to the production of extralinguistic aspects.

Communicative gestures could be important during everyday life conversation, helping people to clarify or enrich the verbal content of their message: describing the nature of these deficits in RHD patients is a necessary step to provide an effective rehabilitative treatment. In addition, we have excluded patients with visual or cognitive basic impairment, so the observed extralinguistic deficits point to a specificity of RH in sustaining this competence.

This finding is relevant in a theoretical perspective, given that models describing human communication rarely considered the role of gestural ability. We observed a similar pattern of performance characterizing linguistic and extralinguistic tasks, with patients exhibiting difficulties in comprehending and producing non-standard forms of communication, such as irony and deceit. This common pattern is in line with the tenets of Cognitive Pragmatics (Bara, 2010): the theory proposes a unified model of human communication where linguistic and extralinguistic modalities rely on an underpinning communicative ability to handle the mental representations and inferential processes involved in the management of a communicative act. This ability seems to be impaired in RHD patients.

Performance comparison on linguistic and extralinguistic tasks showed that patients presented deficits in linguistic and extralinguistic tasks, but they were more impaired in the extralinguistic modality than in the linguistic modality. These data are in line with the view that primarily associates the RH with non-linguistic aspects of communication, i.e. extralinguistic and paralinguistic aspects (e.g.; Tompkins, 1995; Zaidel et al., 2002).

Indeed, in our study patients also performed worse than healthy controls in paralinguistic tasks. With regard to paralinguistic comprehension tasks, patients exhibited deficits in the comprehension of paralinguistic contradictions. Patients' performance in comprehension of basic emotions and basic speech acts did not result significantly different from healthy controls, however this could be due to the high heterogeneity that characterized RHD patients' impairment. In fact, examining individual performance we found that about 35% patients showed a performance at least a SD below healthy controls in these tasks. The results for paralinguistic production tasks revealed that patients were not able to use paralinguistic indicators, i.e. tone of voice and facial expressions, to convey an emotional content, while their ability to produce basic speech acts was preserved. These results confirm the possibility that deficits following RHD might impair both emotional and non-emotional paralinguistic aspects, suggesting a widespread impairment that is not only related to emotional difficulties. These data are in line with those coming from anatomical, neuroimaging and brain stimulation studies (Witterman et al., 2011; Kraitewolf et al., 2014) and suggest that both hemispheres contribute in sustain recognition and production of paralinguistic aspects, but that the role of the RH is predominant when an emotional content is present. In conclusion, our results confirmed the importance of assessing pragmatic abilities in RHD patients by considering both comprehension and production in different expressive modalities: a complete overview of the patients' difficulties is necessary in order to obtain a comprehensive profile of their impairment and, thus, develop appropriate rehabilitative programs. Secondly, our study confirmed the importance of using a wide range of communicative phenomena varying in complexity: the heterogeneity characterizing RHD patients' communicative abilities could make certain deficits more difficult to identify, especially when the administered task is not particularly demanding in terms of inferential ability.

It will be useful for future studies to concomitantly provide an evaluation of neuropsychological and theory of mind abilities, to investigate the cognitive functions that can contribute to sustaining these deficits in the RHD population.

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