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Research paper

Assessment of pragmatic impairment in right hemisphere damage

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ABSTRACT

Aim of the present study is to provide a multifocal assessment of pragmatic abilities in patients with right hemisphere damage (RHD). Pragmatics refers to the ability to use language and non-verbal expressive means (e.g., gestures) to convey meaning in a given context, and it also involves the appropriate use of connotative elements such as rhythm and prosody. Patients with RHD frequently report a wide range of pragmatic disorders: despite the heterogeneity of their clinical profiles, these difficulties can seriously undermine their ability to effectively communicate in everyday situations. We analysed the performance of 17 patients with RHD and 17 healthy controls using the Assessment Battery for Communication, a clinical tool for assessing a wide range of pragmatic phenomena - both in comprehension and production - and considering different expressive means. The results suggest patients have difficulties both in comprehending and producing pragmatic phenomena of differing complexity; in particular, patients seem to be significantly impaired when dealing with non-verbal modality, i.e., gestures and facial expressions. Moreover a hierarchical cluster analysis revealed the presence of a number of clusters corresponding to different outcomes of pragmatic performance, in line with the heterogeneity of communicative profiles following RHD frequently reported in the literature.

1. Introduction

Patients with right hemisphere damage (RHD) frequently report a wide range of communicative disorders that can seriously undermine their ability to effectively communicate in everyday contexts (Mackenzie, Brady, Begg, & Lees, 2001; Cummings, 2014). RHD individuals rarely exhibit deficits that affect the microlinguistic aspects of language, such as phonological, morphological and syntactical aspects (e.g., Brownell, Carroll, Rehak, & WingWeld, 1992; Marini, 2012; Marini, Carlomagno, Caltagirone, & Nocentini, 2005; Tompkins, Fassbinder, Lehman-Blake, & Baumgaertner, 2002), which are generally associated with lesion at the left hemisphere (LHD).

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By contrast, one of communicative aspects that is most seriously impaired after RHD is the pragmatic one. Pragmatics can be defined as the ability to communicatively act in an appropriate way in a given context (Levinson, 1983), and it involves the appropriate use of a wide range of expressive means, such as language, gestures, proxemics, body movements, facial expressions. Pragmatic ability is thus not limited to the use of linguistic elements (i.e., phonological, morphological and syntactical aspects), but it also requires contextual information and inferential ability, which allow people to fill the gap between the literal and the speaker's meaning of utterances, as for example in the case of indirect speech acts, i.e., "Do you mind opening the door?" and of figurative expressions. It is now established that RHD can compromise the pragmatic domain, undermining patients' ability to understand indirect speech acts (Weylman, Brownell, Roman, & Gardner, 1989), non-literal and figurative expressions such as idioms and proverbs (Brundage, 1996; Papagno, Curti, Rizzo, Crippa, & Colombo, 2006), humour (Cheang & Pell, 2006), lies and jokes (Winner, Brownell, Happe, Blum, & Pincus, 1998), and irony and sarcasm (McDonald, 2000). These studies showed that RHD patients are able to comprehend the meaning of literal sentences whereas they fail to grasp the meaning of non-literal and figurative expressions such as metaphor and irony. The characterization of communicative deficits in RHD patients suggests that the origin of these difficulties can be referred to high-level of language processing: what is compromised is the ability to correctly draw contextual inferences, in order to appreciate the speaker's intention and accomplish the demands of the surrounding communicative context (Gardner, Brownell, Wapner, & Michelow, 1983; Kaplan, Brownell, Jacobs, & Gardner, 1990; Sabbagh, 1999).

Furthermore, impairment in terms of conversational and discursive skills was often detectable in RHD patients, resulting in egocentric and irrelevant responses, tangential comments, digressions from the topic, lack of coherence in discourse and difficulties in respecting turn-taking (Bartels-Tobin & Hinckley, 2005; Chantraine, Joanette, & Ska, 1998; Hird & Kirsner, 2003; Lehman-Blake, 2006; Marini et al., 2005; Myers, 1999; Sherratt & Bryan, 2012).

Moreover, RHD can also lead to a reduction in the ability to understand and produce those paralinguistic elements, such as tone, intonation, rhythm and prosody, which contribute to generate the pragmatic meaning of a communication act (Krauss, 1998; Krauss, Morrel-Samuels & Colasante, 1991; Vaissière, 2005).

Indeed, RHD patients exhibit difficulties in recognizing both linguistic and emotional prosody: difficulties in recognizing emotions from tone of voice and facial expressions (Kucharska-Pietura, Phillips, Gernand, & David, 2003; Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005), in using prosody to distinguish between different basic speech acts, such as to distinguish between declarative and interrogative sentences (Pell, 1998, 2006), and in recognizing paralinguistic contradictions, namely the inconsistency between the semantic message and the intonational meaning conveyed through an utterance (Tompkins & Mateer, 1985). They also do not adequately modulate prosodic elements to comply with the requests set by the communicative context, producing monotonous or atypical prosodic contours (Lehman-Blake, 2007; Pell, 1999).

Another significant area of impairment in RHD communicative competence seems to be represented by difficulties in the use of non-verbal communicative modality. Most of the studies in the relevant literature evaluated communicative abilities in RHD patients focusingon the linguistic aspects of the pragmatic ability (e.g., Cheang & Pell, 2006; Joanette, Goulet, & Hannequin, 1990; McDonald, 2000), while few researchers have attempted to analyse the role of non-verbal modality, i.e. gesture and facial expressions, in generating communication disorders in RHD patients. Cocks, Hird, and Kirsner (2007) observed a reduction in gesture production during spontaneous conversation in RHD patients, compared to healthy controls, especially when the examiner elicited discourses with an emotional content. Cutica, Bucciarelli, and Bara (2006) analysed the comprehension of gesture during communicative interaction comparing the performance of LHD and RHD patients. The RHD patients exhibited greater impairment in gestural modality compared to the LHD patients: the RHD patients also failed to appreciate the simplest communicative acts (i.e., direct communicative acts) when expressed through gesture. Overall, these studies seem to suggest that RHD can undermine the ability to comprehend and produce the pragmatic aspects of communication when also expressed through non-verbal modality. However, the limited number of studies evaluating non-verbal expressive meaning given RHD do not allow us to draw firm conclusions on the relationship between gestures and language, and further investigations into this aspect are required.

The researches described above highlight that communicative-pragmatic impairments represent a typical outcome following RHD; this supports the hypothesis that communicative competence can be ascribed to the conjoint activity of both hemispheres and overcoming the traditional view which associates it with the linguistic areas of the left hemisphere (e.g., Goodglass & Kaplan, 1983; Tompkins, 1995; Zaidel, Kasher, Soroker, & Batori, 2002). Several recent neuroimaging studies have confirmed that processes are distributed across several brain areas, involving an extended bilateral cerebral network (e.g., Bambini, Gentili, Ricciardi, Bertinetto, & Pietrini, 2011; Mason & Just, 2006).

1.1. Communicative assessment of RHD patients

Some theoretical and methodological issues affect the assessment procedures of communicative-pragmatic abilities in RHD patients.

As previously reported, few pragmatic approaches for assessing acquired communicative deficits have combined the assessment of linguistic abilities with a systematic evaluation of both the comprehension and production of communicative gestures and facial expressions: the assessment tools developed to diagnose communication impairments following RHD, such as the "Right Hemisphere Communication Battery" (RHCB, Gardner & Brownell, 1986), the "Right Hemisphere Language Battery" (RHLB; Bryan, 1995) and the "Batteria sul Linguaggio dell'Emisfero Destro" (Rinaldi, Marangolo, & Lauriola, 2004) have focused on some aspects of communication (i.e., the linguistic and prosodic components) without providing a detailed

description of the ability to communicate through other expressive means, such as gestures and facial expressions. The lack of instruments able to evaluate the ability to communicate using non-verbal modality could be problematic. Previous studies reported that RHD individuals can use their preserved ability to manage syntactical aspects during discourse comprehension (Brownell et al., 1992) to compensate for their pragmatic difficulties; thus, RHD patients can be facilitated when a message is expressed through linguistic modality. Indeed, the study of Cutica et al. (2006) confirmed that RHD patients (compared to LHD patients) found communicative acts expressed through language easier to comprehend than those expressed through gesture. These data suggest that communicative assessment tools developed for RHD should concomitantly evaluate all the expressive modalities of pragmatic competence in order to avoid the risk of underrating patients' difficulties.

In addition, previous studies revealed that communicative deficits can vary widely across participants, generating highly variable clinical profiles. Studies that have examined the problem directly (Champagne-Lavau & Joanette, 2009; Cote, Payer, Giroux, & Joanette, 2007) have identified clusters of RHD patients characterized by different patterns of performance. This heterogeneity represents a critical problem for clinicians working with RHD patients, as it makes it fairly difficult to characterize the disorder and define the neurological condition. Deficits can be subtle or limited to certain expressive modalities, making it difficult to ascertain the presence of impairment. This variability has prevented the definition of a univocal clinical label to identify communicative disorders following RHD, with negative effects for assessment approaches (Myers, 2001).

Finally, a limited number of clinical batteries devised for assessing pragmatic abilities in RHD individuals are based on precise theoretical frameworks of communicative processes. The use of a theoretical framework that allows for the identification of the specific level at which the impairment is placed is important, and represents a necessary step to plan effective rehabilitative programmes focused on patients' difficulties (Lehman-Blake, 2006).

In order to overcome the above-mentioned limitation, in recent years the Assessment Battery for Communication (ABaCo; Sacco et al., 2008; Angeleri, Bosco, Gabbatore, Bara, & Sacco, 2012; Bosco, Angeleri, Zuffranieri, Bara, & Sacco, 2012) has been developed within the framework of Cognitive Pragmatics theory (Airenti, Bara & Colombetti, 1993; Bara, 2010). The ABaCo consists of different pragmatic tasks aimed at investigating a broad range of communicative phenomena expressed through different communicative modalities (see the Methods section for a detailed description of the clinical tool). It has already been used to efficiently assess pragmatic abilities in psychiatric and neuropsychological disorders (Bosco et al., 2015; Colle et al., 2013; Gabbatore et al., 2014). Moreover, the normative data of the ABaCo (Angeleri et al., 2012) enable us to determine more precisely the specific levels of communicative impairment. The ABaCo's structure and its reference to a precise theoretical framework make this clinical tool particularly suitable for diagnosing communicative-pragmatic disorders in RHD individuals.

1.2. Cognitive pragmatics theory

Cognitive Pragmatics (Airenti, Bara & Colombetti, 1993; Bara, 2010) is a theory of human communication that focuses on the inferential processes underlying communicative interactions. Communicative intentions can be expressed not only through the linguistic expressive modality (i.e., language) but also through extralinguistic or non-verbal (i.e., the use of gestures and facial expressions, etc.) and paralinguistic modalities (i.e., intonation, rhythm, tone of voice, pitch, intensity and quality). In line with Cognitive Pragmatics theory and the labels used in the assessment tool that we have adopted (i.e., ABaCo), we use the terms 'linguistic'/'extralinguistic' instead of the classical 'verbal'/'non-verbal' (for further details, please see Bara and Tirassa (2000). According to the Cognitive Pragmatics theory (Bara, 2010) pragmatics is grounded on a person's cognitive processes as the basis for communicative interaction, regardless of the expressive means used, linguistic, as speech acts, or extralinguistic, as gestures or facial expressions. According to this view linguistic and extralinguistic communicative acts share the most relevant mental processes in each specific pragmatic phenomenon (as in case of direct and indirect communicative acts, irony and deceits). Empirical studies support this view showing that communicative acts expressed by language or gestures share the same cognitive processes (Bara, Enrici, Cappa, Tettamanti, & Adenzato, 2011; MacSweeney, Capek, Campbell, & Woll, 2008; Xu, Gannon, Emmorey, Smith, & Braun, 2009).

However, even though the theory postulates common cognitive processes underpinning both linguistic and extralinguistic communicative competence, selective impairment that affects just one expressive modality can contribute to make the pragmatic deficits expressed in that specific modality more evident.

Cognitive Pragmatics theory distinguishes between standard and non-standard communication: while in standard communication (i.e., direct and indirect communicative acts) there is a correspondence between what an actor (literally) says and his private knowledge, non-standard communication (i.e., irony and deceit) is characterized by the presence of a conflict between what an actor overtly and literally says and his private knowledge. Non-standard communicative acts are more difficult to handle than standard communicative acts since they require more inferential ability in order to be understood or produced (see Angeleri et al., 2008; Bucciarelli, Colle, & Bara, 2003). Inferential ability is the cognitive process allowing speakers to go beyond the literal meaning of an utterance in order to understand or to reach a specific communicative meaning. The more conflicts there are underlying a given pragmatic phenomenon, the more difficult it is to understand it (see Angeleri et al., 2008; Bosco & Bucciarelli, 2008). In particular, the comprehension (and production) of deceit requires the speaker (and the listener) to produce (and recognize) the presence of such conflicts. With irony, instead, the speaker (and the listener) must also keep in consideration that the speaker (and the listener) wants him to recognize this conflict on the basis of the knowledge they share with each other: irony is therefore more difficult to understand than deceit. Consider the following example (Bosco, 2006) to clarify this concept: *Angela and Bob share that the lesson they have just attended was really*

boring. Angela is annoyed with Carl because Carl had not come to the lesson and she wishes not to let him know that she lost the whole morning for nothing. After the lesson Angela and Bob meet Carl who asks them: "How was the lesson?" Ann answers: [1] "It was wonderful!" Bob is able to comprehend that Angela is deceiving Carl because he recognizes the difference between the knowledge she is expressing and the knowledge she actually - though privately - entertains.

Furthermore, a statement becomes ironic when, along with this difference, the partner also recognizes (or produces) the contrast between what is expressed and the scenario provided by the knowledge that the actor shares with the partner. In our example, Bob might also interpret [1] as ironic because he shares with Angela the knowledge that the lecture was not interesting at all. For an observer, the simultaneous activation of the representation of the actor's utterance ("It was wonderful") and of the contrasting shared belief ("The lesson was boring") makes an ironic communicative act more difficult to comprehend (or to produce) than a deceitful one.

According to the theory, the number of conflicts involved in every communicative act, and thus the complexity of the inferential processes necessary to handle it, is able to explain the increasing trend of difficulty shown by typically developing children (Bosco, Vallana, & Bucciarelli, 2009; 2012; Bosco, Angeleri, Colle, Sacco, & Bara, 2013) and adults with neurological disease, i.e. traumatic brain injury (Angeleri et al., 2008), aphasia (Gabbatore et al., 2014) and psychiatric disorders, i.e. schizophrenia (Colle et al., 2013) in the comprehension and production of different kinds of pragmatic phenomena, i.e. standard communicative acts (i.e., direct and indirect speech acts), deceit and irony.

1.3. The present study

In the present study, we used the ABaCo to evaluate the pragmatic comprehension and production of different communicative acts (i.e., direct and indirect communicative acts, deceit and irony) expressed through linguistic and extra-linguistic modalities (i.e., gestures and facial expressions). Moreover, we evaluated patients' ability to comprehend and produce paralinguistic elements of communication, such as tone, intonation, rhythm and prosody. We expected RHD patients to be impaired in all the assessed abilities in terms of both comprehension and production.

Furthermore, concerning both the linguistic and extralinguistic expressive modalities, we expected to observe an increasing trend in difficulty in the comprehension and production of communicative acts of differing complexity (standard communicative acts, i.e., direct and indirect communicative acts, deceit and irony) in line with the assumption of Cognitive Pragmatics theory (Bara, 2010).

Nevertheless, considering the results of Cutica et al. (2006), we also hypothesized that patients' pragmatic difficulties would be more evident in the extralinguistic modality that in the linguistic modality. Finally, we examined the presence of a sub-cluster of performance in the RHD individuals group: we expected RHD patients to show different patterns of impairments, confirming the heterogeneity of communicative profiles following RHD.

2. Material and methods

2.1. Participants

Seventeen patients (10 males, 7 females) with unilateral right hemisphere damage due to a single vascular accident (ischemic or haemorrhagic) participated in the study (lesion site and demographic data are reported in Table 1). Their age ranged from 43 to 72 years ($M = 60.0$; $SD = 8.68$), their years of education ranged from 5 to 18 years ($M = 11.58$; $SD = 4.44$).

Table 1
Demographic and neurological details of RHD patients.

Subject	Sex	Age	Education	Time post-onset (months)	Brain lesion	Cluster
RHD1	F	49	13	3	Fronto-temporal	2-LEI
RHD2	M	61	5	1.5	Parietal	3-PLEI
RHD3	F	65	8	4	Temporal	2-LEI
RHD4	F	59	5	1	Temporal	3-PLEI
RHD5	M	49	13	1.5	Fronto-temporal	1-PI
RHD6	M	71	8	1	Fronto-parietal	2-LEI
RHD7	M	43	13	2	Temporal	1-PI
RHD8	F	52	13	1	Temporal	1-PI
RHD9	F	72	8	1	Parietal	2-LEI
RHD10	M	66	13	2	Parietal	1-PI
RHD11	M	55	13	1	Temporal	1-PI
RHD12	F	71	5	4	Fronto-temporal	1-PI
RHD13	M	69	18	2	Temporal-parietal	1-PI
RHD14	M	59	18	5	Fronto-parietal	2-LEI
RHD15	M	62	11	5	Fronto-parietal	2-LEI
RHD16	F	62	15	3	Occipito-temporal	1-PI
RHD17	M	53	18	4	Fronto-temporo-parietal	2-LEI

Note. 1-PI: Paralinguistic impaired; 2-LEI: Linguistic and Extralinguistic impaired; 3-PLEI: Paralinguistic, Linguistic and Extralinguistic impaired.

See Table 1 for a detailed description of the sample. Participants with brain lesion were recruited at rehabilitation centres in Turin and Milan. The study was approved by the local ethics committee, University of Turin.

We recruited post-stroke patients, with an onset time ranging from one to five months (M = 2.47; SD = 1.45) in order to provide a detailed characterization of their communicative profiles immediately after being admitted to the rehabilitation centre.[1]

The inclusion criteria for participation in the study were: (1) at least 18 years of age, (2) native Italian speakers, and (3) right-handedness (minimum of 90% on the Edinburgh Handedness Inventory; Oldfield, 1971). Moreover, neuropsychological tests were administered in order to exclude those patients for whom basic cognitive or linguistic impairments prevented them from correctly understanding the video material presented during the tasks. Thus, we adopted as an inclusion criterion: (4) the achievement of a cut-off score in the following neuropsychological tests:

1. Mini Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975); cut-off score $\geq$ 24/30. MMSE was administered to get a general overview of the cognitive profile of each patient. The cut-off score was set so to exclude severe cognitive impairments.
2. Token Test (De Renzi & Vignolo, 1962; Spinnler & Tognoni, 1987); cut-off score $\geq$ 29/36. The Token Test was administered to ensure that patients were able to comprehend simple linguistic commands and instructions, excluding the presence of aphasic symptoms. Our aim was to evaluate pragmatic ability, and so we needed to rule out the possibility that basic linguistic impairments (i.e., phonological, morphological and syntactical) were responsible for the observed pragmatic deficits.
3. Ideomotor Apraxia Test (Spinnler & Tognoni, 1987); cut-off score $\geq$ 19/20. The Ideomotor Apraxia Test was used to ensure patients were able to correctly produce symbolic gestures, converting the "idea" of a gesture into a correct execution. Indeed, we did not evaluate the ability to produce gestures at all but rather the pragmatic ability to produce the correct gesture on the basis of contextual information provided by the pragmatic task.
4. The Simple Test of Visual Neglect (Albert, 1973); cut-off score > 34/36. The Simple Test of Visual Neglect was used to exclude the presence of visual neglect, ensuring that patients were able to properly watch the video material that made up the pragmatic tasks.

The cut-off figures represent the normal limit of performance based on the Italian standardization of the tests (Spinnler & Tognoni, 1987). All the participants scored within normal limits.

Exclusion criteria were: (1) presence of significant cortical atrophy, (2) presence of a concomitant diagnosis of dementia or psychiatric disorder, (3) a prior history of neurological or psychiatric disorders and (4) a prior history of drug or alcohol addiction. All patients were informed about the aims and the procedures of the study and they provided their informed consent to participate in the research.

A control group of seventeen healthy controls was recruited, comparable with the clinical group in terms of age (*T-Test*; $t = .66$; $p = .93$) and years of education ($t = .54$; $p = .58$).

2.2. Materials and procedures

2.2.1. Assessment Battery for Communication

All participants were administered the Linguistic, Extralinguistic and Paralinguistic scales of the Assessment Battery for Communication (ABaCo; Angeleri, Bara, Bosco, Colle, & Sacco, 2015; Sacco et al., 2008). The tasks consisted of a series of videos, each lasting 20–25 sec.; all the tasks comprised a controlled number of words (range: 7 ± 2) and they were characterized by the same lexical and syntactical complexity. In each task, the actors were to play out a communicative exchange using, respectively, language (the linguistic scale), gestures and facial expressions (the extralinguistic scale) or prosody only (the paralinguistic scale). At the end of every scene, the examiner would investigate the correct comprehension of the protagonist's conclusive communicative act or else elicit the production of a communicative act in response to the protagonist's sentence or gesture. The linguistic and extralinguistic scales in the ABaCo assess the comprehension and production of pragmatic phenomena of differing complexity according to the different knowledge of the speaker and the listener and the inferential complexity underlying every phenomenon: *standard communication acts* (i.e., direct and indirect communicative acts), *deceit* and *irony*, expressed verbally on the linguistic scale and through gestures and facial expressions on the extralinguistic scale.

In the comprehension tasks, the subjects are shown short videos where two actors are engaged in a communicative interaction: the actor asks his partner a question and the partner replies. The subject has to understand the communicative act he has just observed.

[1] According to the local system, patients are usually transferred from the hospital to a specialized functional rehabilitative centre when they get out of the acute phase and they arrive at stable clinical conditions. Patients are, then, included in specific rehabilitative programmes according to their needs and the identification of the most impaired abilities. It is therefore important to provide an early overview of pragmatic competence at the time of the entrance of patients into rehabilitative units (nearly one month post-onset) in order to plan an effective rehabilitation programme.

Table 2
Examples of tasks in the comprehension and production of the linguistic and extralinguistic scales of the ABaCo.

Comprehension task deceit, extralinguistic scale	Production task irony, linguistic scale
Nadia and Sergio are arguing - having a pillow fight - in their bedroom. In all the confusion, Nadia hits the lamp on the bedside table, and it falls onto the floor. Having heard the noise, their father comes to their room, puts his hands on his hips and, with a questioning air, at the same time assuming a cross expression as if to say "What's going on?" he points with his finger to the lamp on the floor. Nadia immediately picks up a book and shows it to her father, as if to say "I was reading". The subject is then asked: - *What did the girl want to say to her father?* - *Was she speaking seriously?*	*Fabio and Claudia are having their breakfast.* *Fabio is enchanted in front of the TV and he doesn't realize he has involuntarily placed his elbow on the jam. Claudia is amused and looks at him smiling. Fabio, still looking at the TV screen, asks: "Could you please pass me the jam?"* The subject is then asked: - *What could Claudia answer, in order to be ironic?* - If the answer is not clear: *What does it mean?*

In the production tasks, subjects are shown short videos where two actors are engaged in a communicative interaction: the actor says something to the partner, the video stops and the subject is requested to assume the partner's perspective in answering the actor.

In both the comprehension and the production tasks, on the linguistic scale the actors communicate verbally, whereas on the extralinguistic scale they communicate through gestures and facial expressions, without language-support. In the production tasks belonging to the extralinguistic scale, the actor performs communicative gestures and the subject has to reply using gestures alone. Examples of the items are provided in Table 2.

The Paralinguistic scale investigates the comprehension and production of prosodic elements using different communicative phenomena:

(1) *Basic speech acts* (questions, statements, requests or commands): 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. According to Kasher (1991), basic speech acts are the simplest form of utterance. In the present investigation, the subject has to comprehend the type of act conveyed by the paralinguistic components only. To measure production abilities, the examiner asks the subjects to produce questions, statements, requests or commands using exclusively the adequate paralinguistic indicators.
(2) *Basic emotions* (anger, happiness, fear and sadness): 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 only. 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 the 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.

Examples of items of the paralinguistic scale are provided in Table 3.

All the participants performed the ABaCo individually in a quiet room; the entire administration lasted approximately one hour and 30 min. Their performance was video-recorded and transcribed by the examiner. For a detailed explanation of the organization and administration of the ABaCo, see Sacco et al., (2008), Angeleri et al., (2012) and Bosco, Angeleri, et al., 2012).

2.3. Scoring procedure

Data were coded by an independent judge, blind to the composition of the experimental groups and to the experimental hypothesis. He was trained in the coding procedure reported in the ABaCo instruction manual, and coded the data individually watching the video recordings. Possible scores for each task were 0 or 1: A score of 1 was awarded for correct answers, and a score of 0 for incorrect answers. The reliability of the ABaCo has already been measured in several studies which have shown it to have high inter-rater agreement and suggested that it can be administered and scored by any trained judge (Sacco et al., 2008).

3. Results

In order to have a general overview of the results, we compared performance obtained by patients and healthy controls in each scale using a series of *T-test* (the scores are summarized in Table 4). Taken as a whole, patients performed worse than healthy participants on all of the scales investigated, i.e. linguistic, extralinguistic and paralinguistic tasks, in both comprehension and production (*T test*: $2.48 < t < 3.64$; $.001 < p < .03$). The results for each single scale are reported in the next section. We set the threshold of significance to $p < .05$. For multiple comparison we adopted Bonferroni correction, which provided the corrected threshold of significance.

Table 3
Examples of tasks in comprehension and production of the paralinguistic scale of the ABaCo.

	Comprehension	Production
Basic speech acts	The actor asks a question. The subject is asked to choose among the following options: 1. Ask a question (Target) 2. Give an order 3. Say something he thought 4. Make a request	Request *Ask me to give you the pen.* Order *Order me to give you the pen.*
Basic emotions	The actor laughs while he speaks. The subject is asked to choose among the following options: 1. Amused (Target) 2. Surprise (Liable to be confused) 3. Angry (Opposite) 4. Disgusted	*Ask me what time it is.* Ask me as if you were bored.
Paralinguistic contradiction	It's Robert's birthday. Monica gives him a gift. Monica: "Happy Birthday!" Robert opens the package and finds a tie with terrible colours. With a bored face and voice, he says: "Thanks. Really, I really needed it … beautiful!" Test question*: In your opinion, what did the boy want to say to the girl?* If the participant repeats the actor's reply: *What does it mean?* In-depth question: *In your opinion, did the boy like the tie? Why?*	–

3.1. Linguistic scale

To analyse subjects' performance on the Linguistic scale 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: standard communication acts, deceit and irony). The same analyses were conducted for both comprehension and production tasks. We then introduced a linear contrast for each scale in order to verify the presence of a linear trend into the data (i.e., that the mean performance of individuals decreased or increased in a linear way). The scores obtained by patients in the different pragmatic phenomena are reported in Table 5.

In comprehension, the results revealed a main effect of the type of subject ($F_{(1,32)} = 8.34$; $p = .007$; $\eta^2 = .20$): patients performed worse than control subjects. Moreover, there was a main effect of the type of task ($F_{(2,64)} = 8.10$; $p = .001$; $\eta^2 = .20$). We introduced a linear contrast and observed the presence of a linear decrease in scores due to the complexity of the communicative act analysed ($F_{(1,32)} = 9.48$; $p = .004$; $\eta^2 = .229$): standard communication acts were the easiest to understand, followed by deceit and irony (Fig. 1). We then analysed the differences in performance between patients and controls for each individual communicative phenomenon. Pairwise comparisons revealed that the patients and the controls did not differ in their comprehension of standard communicative acts ($p = .69$), while the differences in performance tended to increase in terms of the comprehension of deceit (although not statistically significant) ($p = .074$) and irony ($p = .011$) (see also Table 5). In order to verify whether the effect of the type of task was significant both in patients and controls, we performed an ANOVA for each sub-sample. The results showed that effect of the type of task is observable only in the patients ($F_{(2,32)} = 8.40$; $p = .001$; $\eta^2 = .345$), while in the controls it is not significant ($F_{(2,32)} = .91$; $p = .410$; $\eta^2 = .054$). The difficulty of the patients in this task seems to be mainly due to their performance of irony comprehension; conversely, the controls did not find irony more difficult to comprehend than standard communicative acts or deceit.

As regards production abilities, the results revealed a main effect of the type of subject ($F_{(1,32)} = 5.55$; $p = .025$; $\eta^2 = .14$): patients performed worse than control subjects. Moreover, there was a main effect of the type of task ($F_{(2,64)} = 7.41$; $p = .003$; $\eta^2 = .18$). We introduced a linear contrast and observed the presence of a linear decrease in scores due to the complexity of the communicative act analysed ($F_{(1,32)} = 14.27$; $p < .001$; $\eta^2 = .30$): standard communication acts were the easiest to produce, followed by deceit and irony (Fig. 2). We then analysed the difference in performance between the patients and the controls for each communicative phenomenon. Pairwise comparison revealed that no statistically significant difference was detectable for the communicative phenomena investigated ($.24 > p > .097$) (Table 3). To control whether the effect of the type of task was significant both in the patients and the controls, we performed an ANOVA for each sub-sample. The results showed that the effect of the type of task was observable both in the patients ($F_{(2,32)} = 4.03$; $p = .027$; $\eta^2 = .201$) and in the controls ($F_{(2,32)} = .3.64$; $p = .037$; $\eta^2 = 186$).

3.2. Extralinguistic scale

Group differences on the extralinguistic scale were examined using 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 communication acts, deceit and irony). The same analyses were conducted for both comprehension and production tasks. The scores obtained by patients in the different pragmatic phenomena are reported in Table 6.

Table 4
Mean and standard deviation of Linguistic, Extralinguistic and Paralinguistic Scales in both comprehension and production.

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

Table 5
Linguistic scale: mean and standard deviation of the scores obtained for standard communication acts (direct and indirect), deceit and irony in both comprehension and production.

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

In comprehension, 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 ($F_{(2,64)} = 4.60$; $p = .014$; $\eta^2 = .12$). We introduced a linear contrast and observed the presence of a linear decrease due to the complexity of the communicative act analysed ($F_{(1,32)} = 7.64$; $p = .009$; $\eta^2 = .193$): standard communication acts were the easiest to understand, followed by deceit and irony (Fig. 1).

We then analysed the difference in performance between the patients and the controls for each individual communicative phenomenon. A pairwise comparison showed that the patients found deceit and irony more difficult to comprehend than the controls ($.012 > p > .005$), whereas no significant difference was observed in the comprehension of standard communicative acts ($p = .72$) (Table 4). In order to verify whether the effect of the type of task was significant in both the patients and the controls, we performed an ANOVA for each sub-sample. The results showed that the effect of the type of task was present only in the patients ($F_{(2,32)} = 6.03$; $p = .006$; $\eta^2 = .274$), while it was not significant in the controls ($F_{(2,32)} = .35$; $p = .708$; $\eta^2 = .021$). The patients' difficulty in this scale seems to be due to their performance in relation to non-standard communication acts (i.e., deceit and irony); conversely, the controls did not find non-standard communicative acts more difficult to comprehend than standard communicative acts.

As regards production, 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 ($F_{(2,64)} = 27.37$; $p < .0001$; $\eta^2 = .46$). We introduced a linear contrast that revealed the presence of a linear decrease in scores due to the complexity of the communicative act analysed ($F_{(1,31)} = 50.77$; $p < .0001$; $\eta^2 = .62$): standard communication acts were the easiest to produce, followed by deceit and irony (Fig. 2). We then analysed the differences in performance between the patients and the controls for each individual communicative phenomenon. A pairwise comparison revealed that the patients produced deceit and irony significantly worse than the controls ($.002 > p > .001$), while no significant difference was observed in the production of standard communicative acts ($p = .117$) (Table 4). The effect of the type of task was present both in the patients ($F_{(2,32)} = 22.12$; $p < .001$; $\eta^2 = .596$) and in the controls ($F_{(2,32)} = 6.35$; $p = .005$; $\eta^2 = .286$).

3.3. Paralinguistic scale

We investigated subjects' performance on the paralinguistic scale in both comprehension and production. The scores obtained by patients in the different pragmatic phenomena are reported in Table 7.

To analyse 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 communication 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 ($F_{(2,64)} = 19.23$; $p < .0001$; $\eta^2 = .37$). We introduced a linear contrast that revealed the presence of a linear decrease ($F_{(1,32)} = 26.5$; $p < .001$; $\eta^2 = .45$): paralinguistic contradictions were the easiest to understand, followed by basic emotions and basic communication acts (Fig. 3). We then analysed the differences in performance between the patients and the controls for each individual communicative phenomenon: the results revealed that the patients performed worse than the

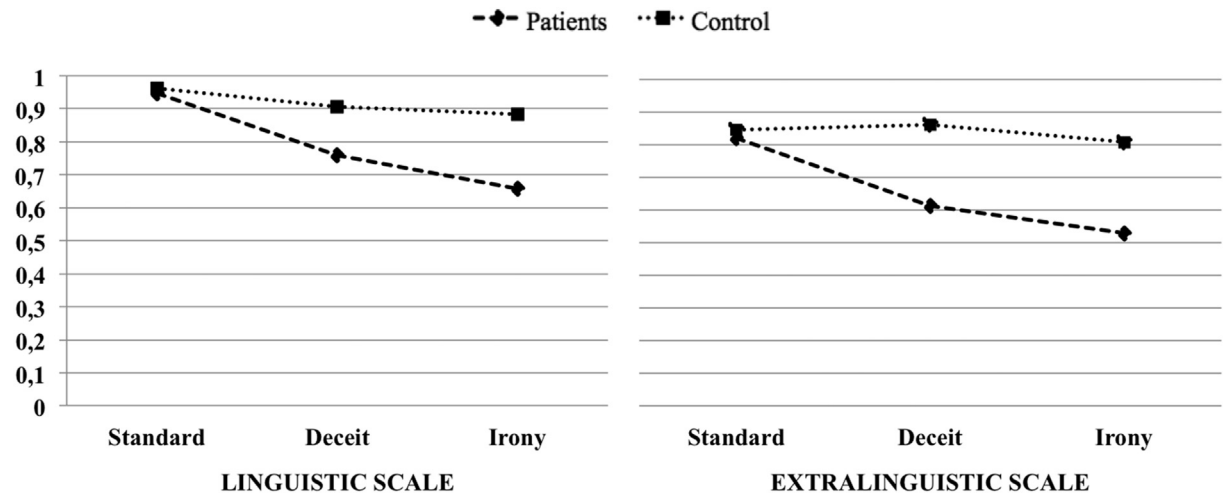


Fig. 1. Performance by patients and controls in linguistic and extralinguistic tasks in the comprehension of standard communication acts, deceit and irony.

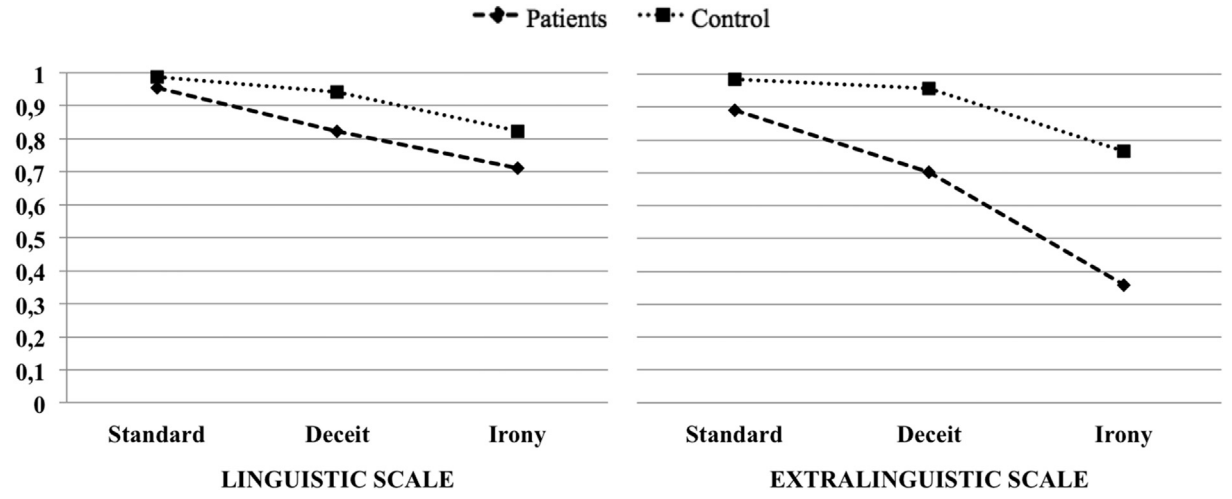


Fig. 2. Performance by patients and controls in linguistic and extralinguistic tasks in the production of standard communication acts, deceit and irony.

controls in relation to paralinguistic contradictions ($p < .046$), while no significant differences were observable in terms of basic emotions and basic communication acts ($.10 < p < .35$).

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-subjects factor (type of task, with two levels: basic communication acts and basic emotion). The results revealed a main effect of the type of subject ($F_{(1,32)} = 8.46$; $p = .007$; $\eta^2 = .20$): patients performed worse than control subjects. There was also a main effect of the type of tasks ($F_{(2,32)} = 25.96$;

Table 6
Extralinguistic scale: mean and standard deviation of standard communication acts (direct and indirect), deceit and irony in both comprehension and production.

	Patients	Controls	t	p
Comprehension				
Standard communication acts	.82 (.20)	.85 (.22)	.62	.720
Deceit	.61 (.32)	.86 (.22)	2.65	.012
Irony	.53 (.26)	.81 (.29)	3.00	.005
Production				
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

Table 7
Paralinguistic scale: mean and standard deviation of the obtained scores, in both comprehension and production.

	Patients	Controls	t	p
Comprehension				
Basic communication acts	.63 (.20)	.69 (.15)	.94	.353
Basic emotion	.81 (.14)	.89 (.14)	1.69	.101
Paralinguistic contradiction	.84 (.20)	.96 (.10)	2.07	.046
Production				
Basic communication acts	.96 (.06)	.98 (.07)	1.01	.321
Basic emotion	.82 (.14)	.96 (.06)	3.59	.002

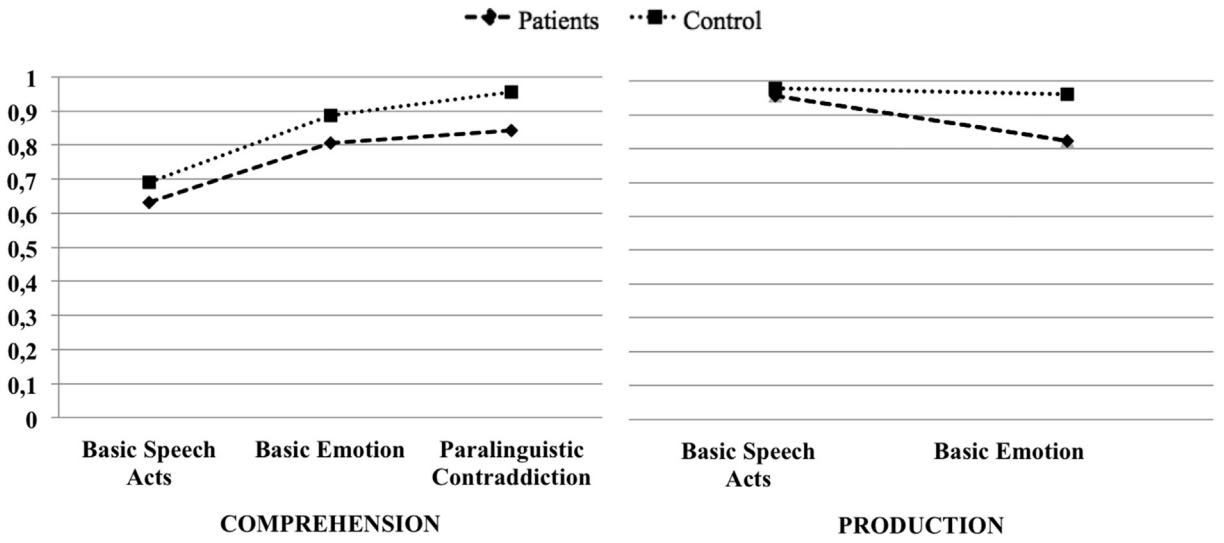


Fig. 3. Performance by patients and controls in paralinguistic tasks, both in comprehension and production.

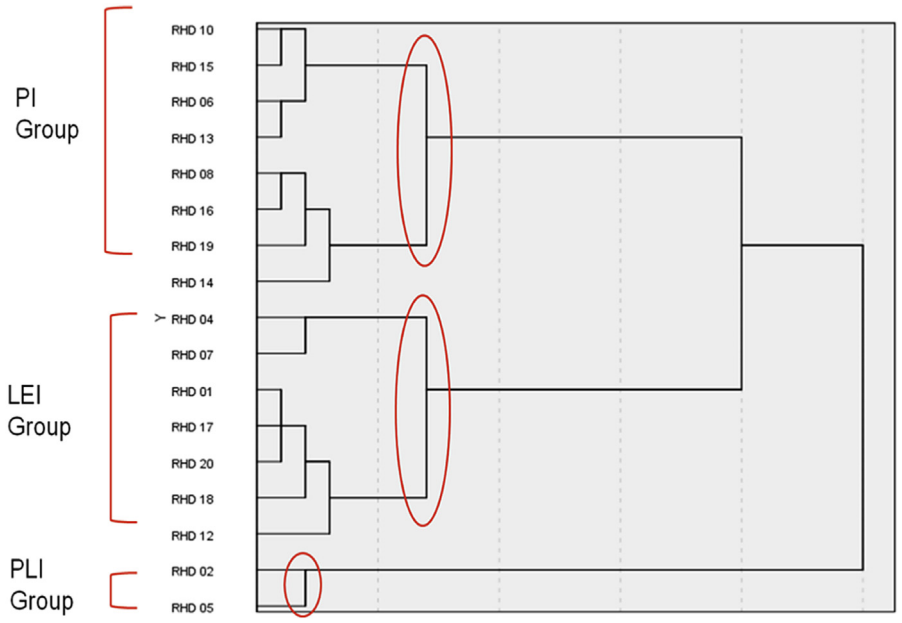
$p < .0001$; $\eta^2 = .44$): basic communication acts are easier to produce than basic emotions (Fig. 3). We investigated the differences in performance between the patients and the controls for each individual communicative phenomenon: the results revealed that the patients performed worse than the controls in terms of basic emotion ($p = .002$), while no significant differences were observable for basic communication acts ($p = .32$).

3.4. Comparison between linguistic and extralinguistic tasks

To compare participants' performance on linguistic and extralinguistic tasks, 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 two levels: linguistic and extralinguistic tasks). The analysis 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 also 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 between subject and task factors revealed that only patients, and not healthy controls, performed significantly worse on the extralinguistic scale than on the linguistic scale. Patients therefore exhibited poorer performance in both extralinguistic and linguistic tasks compared to healthy controls, but they were more severely impaired in extralinguistic tasks.

3.5. Hierarchical cluster analysis

Patients' performance in the various tasks revealed a great deal of variability across subjects. We therefore performed hierarchical cluster analysis to explore whether our experimental sample could comprise different sub-groups of patients. We conducted a cluster analysis using Ward's Method, which minimizes the total within-cluster distance, using patients' level of performance in both comprehension and production in linguistic, extralinguistic and paralinguistic tasks, as classifying variables. The analysis revealed the presence of three different sub-groups (Fig. 4), characterized by three main patterns of performance. In order to control which variables are responsible for the difference between clusters, we conducted a MANOVA using six dependent variables (linguistic comprehension, linguistic production, extralinguistic comprehension,



Note. The circles represent the three clusters that characterize the RHD clinical group. The clusters are described as PI: patients impaired in paralinguistic abilities; LEI: patients impaired in linguistic and extralinguistic abilities; PLEI: patients impaired in linguistic, extralinguistic and paralinguistic abilities.

Fig. 4. Dendrogram of hierarchical cluster analysis using Ward's method on the RHD group (17 patients).

extralinguistic production, paralinguistic comprehension, paralinguistic production) with a between-subjects main factor (type of cluster, with three levels: Cluster 1, Cluster 2 and Cluster 3). To explore genuine differences between clusters we conducted a series of *post hoc* pairwise comparisons using Bonferroni correction that revealed the following: Cluster 1 and Cluster 2 were significantly different on the linguistic comprehension ($p < .001$), extralinguistic comprehension ($p = .002$) and paralinguistic production ($p = .003$) variables. Cluster 1 and Cluster 3 were significantly different on the extralinguistic production ($p < .001$) and paralinguistic production ($p = .018$) variables. Cluster 2 and Cluster 3 were significantly different on the linguistic comprehension ($p = .026$), extralinguistic comprehension ($p = .045$), extralinguistic production ($p < .001$) and paralinguistic production ($p < .001$) variables. On the basis of these differences we were able to identify three main patterns of performance characterizing the three clusters (Table 8):

- Cluster 1 (*PI group*, Paralinguistic Impaired group): this cluster ($n = 8$) was composed of individuals who performed better in linguistic and extralinguistic comprehension tasks, and less well in paralinguistic production tasks compared to Cluster 2.
- Cluster 2 (*LEI group*, Linguistic and Extralinguistic Impaired group): this cluster ($n = 7$) comprised individuals who performed better in paralinguistic comprehension tasks, and performed significantly worse than the *PI group* in linguistic and extralinguistic comprehension tasks.
- Cluster 3 (*PLEI group*, Paralinguistic, Linguistic and Extralinguistic Impaired group): these patients were clustered together due to their poor performance on extralinguistic production and paralinguistic production tasks, which was significantly worse than that of the two other groups.

In order to control that the differences between the three clusters cannot be explained by factors other than RHD-related deficits, and given the small number of participants composing the three clusters, we performed a Kruskall-Wallis non-parametric test, that revealed no significant differences between the three clusters on age ($p = .79$), educational level ($p = .08$) and time of onset ($p = .21$). Thus deficits resulting from right hemisphere damage appear to be responsible for cluster composition.

4. Discussion

The present study aimed to provide a multifocal assessment of communicative abilities in a sample of RHD patients, evaluating different aspects of pragmatic competence, i.e. linguistic, extralinguistic and paralinguistic abilities. Our main expectation was to observe an overall impairment in all the abilities considered, in both comprehension and production, and

Table 8
Demographic data and pragmatic abilities of RHD patient sub-groups (PI, LEI and PLEI groups) and healthy controls (HC).

	HC (n = 17)	PI (n = 8)	LEI (n = 7)	PLEI (n = 2)
Age	58.2 (8.9)	58.4 (10.1)	61.6 (8.6)	60.0 (1.4)
Education	11.7 (4.0)	12.9 (3.6)	12.0 (4.5)	5.0 (.0)
Post-onset time	–	2.1 (1.0)	3.3 (1.7)	1.3 (.4)
Pragmatic abilities				
Linguistic comprehension	.92 (.12)	.89 (.10)	.66 (.72)	.79 (.14)
Linguistic production	.92 (.11)	.83 (.13)	.84 (.06)	.79 (.18)
Extralinguistic comprehension	.84 (.19)	.77 (.11)	.49 (.07)	.76 (.01)
Extralinguistic production	.90 (.12)	.74 (.09)	.74 (.18)	.18 (.14)
Paralinguistic comprehension	.84 (.09)	.79 (.07)	.75 (.11)	.66 (.02)
Paralinguistic production	.97 (.06)	.87 (.06)	.96 (.06)	.72 (.04)

Note. PI: patients Impaired in Paralinguistic abilities; LEI: patients Impaired in Linguistic and Extralinguistic abilities; PLEI: patients Impaired in Linguistic, Extralinguistic and Paralinguistic abilities.

in particular we expected to find a substantial impairment in the extralinguistic modality (i.e. gestures and facial expressions), in line with the results reported by Cutica et al. (2006).

4.1. Linguistic and extralinguistic scales

Considering performance on the linguistic scale, our results confirmed that RHD patients have difficulties in both comprehending and producing communicative acts expressed verbally. The patients were found to be capable of comprehending and producing standard (i.e. direct and indirect communicative acts) as well as the controls, but their performance decreased in comprehending and producing deceit and irony. However, the difference between the patients and the controls was significant for the comprehension of irony but not for its production; furthermore, even though patients' scores were lower than controls' score in terms of the comprehension and production of deceit, these differences are only close to be statistically significant. This datum is quite surprising in light of the presence of the main effect of the type of subject revealed by the ANOVA. A possible explanation could be that the difference between the patients and the controls did not raise a significant statistical threshold because of the high variability characterizing the patients' performances. Moreover, these results might be due at least in part to the presence of different sub-clusters of patients considering that only RHD patients in Cluster 2 (LEIG) performed worse than the controls in linguistic tasks. At the same time, this result confirms - in line with previous studies - that the linguistic-pragmatic difficulties of RHD patients are limited to the comprehension of most complex pragmatic phenomena, such as irony, while RHD patients do not encounter significant difficulties in the comprehension of literal expressions (e.g., McDonald, 2000; Winner et al., 1998).

Considering the extralinguistic scale, we observed a similar pattern of results, with patients exhibiting difficulties in comprehending and producing communicative acts expressed through the use of gesture and facial expressions. This data are in line with Cocks et al. (2007), who reported a significant reduction in gesture production during spontaneous conversation. Moreover, our results confirmed those obtained by Cutica et al. (2006), who observed a greater impairment in the comprehension of extralinguistic aspects during a communicative exchange in RHD patients, compared to LHD; results of the present study allow us to extend the presence of deficits also to the production of communicative gesture. Patients in our study understood and produced the easiest communicative acts (i.e., direct and indirect communicative acts) as well as healthy controls, but they performed significantly worse than controls in comprehending and producing deceit and irony.

In both the linguistic and extralinguistic scales, a linear trend of difficulty in terms of the comprehension and production of communicative acts was detected. In line with previous studies (Angeleri et al., 2008; Colle et al., 2013; Gabbatore et al., 2014), the patients found standard communicative acts easier than deceit; in turn, they found deceit easier than irony, which was the most difficult pragmatic phenomenon. The presence of a linear trend of increasing difficulty in the comprehension and production of communicative acts follows the main assumption of Cognitive Pragmatics theory: non-standard communicative acts (deceit and irony) are more difficult to handle than standard communicative acts since they involved the presence of conflicts between what the speaker says and his private knowledge and thus require more inferential ability in order to be understood or produced. In particular, the use of a deceit requires to keep into consideration the presence of a conflict between shared and private knowledge; irony, moreover, requires to keep into consideration the recognition of this conflict and its mutual sharing (Bara, 2010; see also Bosco & Bucciarelli, 2008).

The trend of increasing difficulty detected both in linguistic and extralinguistic tasks confirmed that the communicative deficits of RHD individuals could refer to a high-level of linguistic processing: when communicative acts become more complex in terms of inferential complexity, such as in the case of deceit and irony, RHD patients' difficulties increase significantly. Our results are not surprising considering that deficits in non-literal and figurative language comprehension and production in RHD patients have been widely reported in the literature (e.g., Brundage, 1996; McDonald, 2000; Papagno et al., 2006). Deficits mainly occur when a specific task requires patients to select, update and adapt contextual information in order to infer the intention of a conversational partner or to produce an adequate response to the specific communicative context. The more complex communicative acts, such as deceit and irony, require additional inferential demands, and consequently

contribute to highlight patients' pragmatic impairments. A reduction in inferential ability, frequently reported after RHD (e.g., Beeman, Bowden, & Gernsbacher, 2000; Tompkins, Lehman, & Baumgaertner, 1999), can be considered as one of the cognitive factors responsible for patients' difficulties in dealing with such tasks.

4.2. Comparison between the linguistic and extralinguistic scales

The results obtained in the linguistic and extralinguistic scales confirmed that pragmatic impairment in RHD individuals is not limited to linguistic modality, but that it extends to the use of communicative gestures and facial expressions in both comprehension and production: extralinguistic as well as linguistic abilities per se require an actor to make context-relevant inferences in order to produce or comprehend the meaning beyond a specific communicative act.

Comparing performance on the linguistic and extralinguistic scales, our data revealed that even though patients showed deficits in pragmatic ability expressed through both linguistic and extralinguistic modalities, their impairment was more evident at the extralinguistic level: impairment in the linguistic abilities assessed through ABaCo was more subtle, probably due to the fact that RHD patients seem to be able to partially compensate for pragmatic deficits by using preserved syntactic ability. On the contrary, pragmatic-extralinguistic deficits are difficult to compensate in an accurate manner, becoming more evident and critical. Deficits that affected the extralinguistic modality in our sample cannot be referred to more basic motor or visual impairments, given that patients with such disabilities were initially excluded from the study. Their extralinguistic deficits therefore appear to be referable to specific damage of the right hemisphere, thus supporting the hypothesis that the RH is primarily involved in these aspects of communication (e.g., Tompkins, 1995; Zaidel et al., 2002).

4.3. Paralinguistic scale

Another communication disorder that is typically associated with RHD is a reduced ability to manage the paralinguistic aspects of communication, such as tone, intonation, rhythm and prosody. Consistent with previous studies (Kucharska-Pietura et al., 2003; Lehman-Blake, 2007; Pell, 1998, 1999, 2006; Shamay-Tsoory et al., 2005; Tompkins & Mateer, 1985), we found the RHD patients to be severely impaired in terms of both the linguistic and emotional aspects of prosody, and such deficits are detectable in both comprehension and production tasks. In particular, the patients performed as well as the controls in the comprehension of basic speech acts (assertions, commands, requests and orders) and basic emotions (anger, happiness, fear and sadness), displaying a preserved ability to recognize paralinguistic cues (e.g., to distinguish a question from an assertion) and emotional cues such as tone of voice and intonation. By contrast, their ability to recognize when semantic content does not cohere with the paralinguistic elements accompanying it (i.e., paralinguistic contradictions) was impaired. They also exhibited difficulties in conveying emotional states through the use of appropriate paralinguistic cues.

4.4. Heterogeneity of performance

Overall, the present study provided a comprehensive description of the clinical outcome resulting as a consequence of RHD. However, as we have shown in the introduction, RHD patients are often heterogeneous in their clinical pictures. Thus, in order to identify possible subgroups within our sample, we conducted a hierarchical cluster analysis: it revealed the presence of three main clusters corresponding to three main patterns of performance. The first group (*PI group*, $n = 8$) comprised patients reporting a partial preservation of linguistic and extralinguistic abilities with severely impaired performance on the paralinguistic scale. Conversely, the second group (*LEI group*, $n = 7$) consisted of patients characterized by a substantial impairment in the linguistic and extralinguistic scales who showed less severe deficits in terms of the paralinguistic aspects. Two subjects (PLEI group, $n = 2$) exhibited severe impairments in both the extralinguistic and paralinguistic scales, showing overall defective performance. These dissociations could not be explained by other factors such as age, educational level or post-onset time, reflecting genuine differences between profiles of impairment. It should be noted that the communicative-pragmatic performances exhibited by the patients belonging to the three clusters were not comparable to those exhibited by healthy controls; this datum confirms that the incidence of communication disorders following RHD is high and invalidating.

4.5. Limitations

The study has some limitations. Further investigations need to be carried out to provide a precise neuropsychological assessment in order to identify cognitive functions potentially responsible for the deficits we observed. Studies in the literature suggest that some pragmatic deficits may refer to the cognitive disability generally associated with RHD in terms of attentional and executive functions and theory of mind deficits (e.g., Griffin et al., 2006; Rainville, Giroire, Periot, Cuny, & Mazaux, 2003). McDonald (2000) explored the bases of RHD pragmatic disorders, finding that pragmatic performance was closely related to visuo-perceptual ability. Champagne-Lavau and Joanette (2009) found that the association - with high degree of variability among patients - of ToM deficits with executive dysfunction might be a predictor of different patterns of pragmatic deficits. Inferential deficits could also contribute to communicative difficulties following RHD (Beeman et al., 2000; Lehman-Blake, 2009; Tompkins et al., 1999). For these reasons, more research is needed to clarify the relation between pragmatic impairment and cognitive abilities.

Moreover, a detailed anatomical description of the patients' lesion sites would allow us to make more precise considerations concerning the relation between the pattern of pragmatic performance and the neural profile of impairment of each patient. Finally, the sample of the present study is relatively small: performing an assessment with a larger number of patients would confirm and strengthen the present results.

5. Conclusions

Despite the aforesaid limitation, our assessment allows us to draw some relevant considerations from a clinical perspective. Firstly, it represents an attempt to systematically describe the pattern of pragmatic-communicative impairments following RHD, considering different expressive modalities, i.e., linguistic, extralinguistic and paralinguistic. The relevance of a systematic description of communicative deficits after RHD could be crucial in clinical settings: as suggested by Lehman-Blake (2006), the use of a theoretical framework is necessary in order to identify the level at which a specific deficit is located and successfully plan and implement a rehabilitative program focused on the patient's difficulties (Gabbatore et al., 2015; Tompkins, 2012). Another feature of our work was the evaluation of extralinguistic pragmatic abilities, an aspect that has generally been neglected in previous studies, apart from some rare exceptions (Cocks et al., 2007; Cutica et al., 2006): we found patients to be severely impaired in communication using the extralinguistic modality, in both comprehension and production. Considering that the microlinguistic abilities of patients with RHD are generally not impaired (e.g., Brownell et al., 1992; Marini, 2012; Marini et al., 2005; Tompkins et al., 2002), so that they can sometimes partially compensate for pragmatic deficits using preserved, e.g. syntactic, linguistic abilities, the evaluation of the extralinguistic modality could help to avoid the risk of underrating their difficulties (see Cutica et al., 2006). Finally, our results totally confirmed the heterogeneity of communication disorders following RHD, as reported in previous studies (Champagne-Lavau & Joanette, 2009; Cote et al., 2007). Myers (2001) stated that the lack of a univocal label to identify communicative impairments following RHD has a negative impact on the possibility of diagnosing such disorders in these patients: the ABaCo has proved sensitive to the variability that characterizes communicative deficits following RHD, making it possible to identify different patterns of impairment and contributing to clarify the nature of pragmatic disorders following RHD.

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