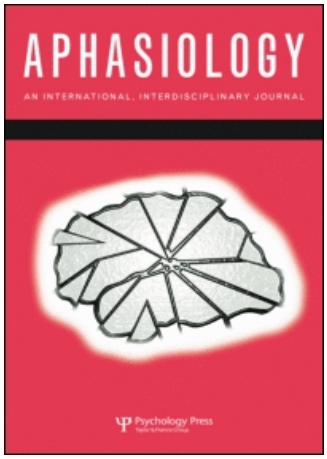

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Towards a description of clinical communication impairment profiles following right-hemisphere damage

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Towards a description of clinical communication impairment profiles following right-hemisphere damage

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Background: It is estimated that approximately 50% of individuals who incur right-hemisphere damage (RHD) have subsequent communication disorders. Lexical-semantic, discourse, prosodic, and pragmatic deficits have been reported following RHD, but the co-occurrence of these deficits within the same individual has not yet been systematically investigated. Therefore clinical profiles of communication impairments in individuals with RHD still have to be identified and described in order to appreciate their communication impairment and provide strategies for rehabilitation.
Aims: The goal of the present study was to explore the clinical profiles of communication impairments subsequent to a right hemisphere lesion.
Methods and Procedures: A total of 28 French-speaking individuals with a right-hemisphere lesion were evaluated using the *Protocole MEC* (Joanette, Ska, & Côté, 2004), a normalised battery allowing the assessment of communication deficits after RHD. A hierarchical cluster analysis was used to group participants according to similarities in their results on the 14 tasks.
Outcomes and Results: Four subgroups of RHD individuals were identified on the basis of the overall similarities of performance on the 14 tasks of the *Protocole MEC*. Participants in the first cluster showed impairments in all four language components evaluated, whereas the second cluster of participants was also impaired in prosodic, lexical-semantic, and pragmatic abilities, but was characterised by a relative preservation of discourse abilities. The third cluster of participants did not show any abnormal results. Finally, two individuals were mainly characterised by some lexical-semantic deficits.
Conclusions: The *Protocole MEC* used in conjunction with a cluster analysis provided a first step towards the identification of communication impairment profiles among the population of individuals with RHD. In the present study it was not possible to clearly identify the relationship between a given profile and factors such as lesion site, age, or

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education. Incidence of communication impairments was estimated to be higher in a rehabilitation centre setting than the generally accepted 50% in the literature.

Almost 50 years have elapsed since Eisenson (1959) suggested that right-hemisphere brain damage (RHD) could lead to communication disorders. First vaguely referred to by Eisenson as *supra-ordinary alterations* or *loss of fine abilities*, these deficits have since been described more systematically, particularly over the past two decades. The non-exclusivity of the left hemisphere for language abilities is now widely endorsed, and the necessity of the integrity of the right hemisphere for a number of language components has been confirmed through the descriptions of communication impairments that can be observed in individuals with RHD (Code, 1987; Joanette, Goulet, & Hannequin, 1990; Myers, 1999; Tompkins, 1995). Thus, prosodic (Pell, 1999; Walker & Daigle, 2000), lexical-semantic (Gagnon, Goulet, Giroux, & Joanette, 2003; Joanette et al., 1990; Myers & Brookshire, 1995), discourse (Lojek-Osiejuk, 1996), and pragmatic (Chantraine, Joanette, & Ska, 1998; Gardner, Ling, Flamm, & Silverman, 1975; Vanhalle et al., 2000) deficits have been reported to occur in individuals following a right-hemisphere lesion.

Although such communication deficits have been described at length, there is growing evidence that they are not present in all individuals with RHD. No epidemiological studies have been undertaken on this topic, but some cues are available. Indeed, Joanette, Goulet, and Daoust (1991), as well as Benton and Bryan (1996), estimated that 50% of individuals with RHD are likely to present with communication disorders. Moreover, it is unclear if, when present, these communication deficits express themselves in the same way across individuals. Most studies on this question have considered components of communication separately, such as pragmatic or prosodic disorders. Surprisingly few attempts have directly addressed the question of the possible clinical profiles of communication deficits that might follow RHD. A clearer description of clinical profiles would allow a better appreciation of the communication impairments of an individual, and would also lead to the introduction of more adapted and relevant rehabilitation strategies for individuals with RHD in clinical settings. To our knowledge, only two studies examined this question directly.

In an attempt to explore the relationship between perceptual integration deficits and verbal expression after a right-hemisphere lesion, Myers (1979, 2005) partly addressed the question of clinical profiles of communication impairments in adults with RHD. Although only eight participants were included in this study, Myers (1979) reported the presence of some heterogeneity in the communication deficit profiles of the individuals with RHD evaluated, without being able to clearly identify distinctive profiles. One factor considered by Myers to limit the identification of clinical profiles of communication impairments in RHD individuals is the lack of a comprehensive published instrument to evaluate all components of RHD communication.

Joanette et al. (1991) made a first attempt at estimating the incidence of verbal communication deficits after RHD, and explored in preliminary terms the question of the clinical profiles of communication impairments. They analysed the performance of 33 participants with RHD who completed three different tasks: word naming, sentence completion, and story narration. Their results showed that, out of the 33 participants tested, four had overall performance similar to those of

matched control participants, confirming that a lesion to the right side of the brain does not automatically impair communication abilities. Conversely, nine individuals with RHD were impaired on all tasks. However, the most interesting result was that the other 20 participants exhibited poorer performance on one or two tasks only, in such a way that some participants with RHD showed distinctive—and even contrasting—profiles of communication deficits that expressed themselves through double dissociations in some cases. The authors first concluded that not all individuals with RHD present with communication disorders, at least for the language components considered in their study. They also noted that, when communication impairments are present, the impaired abilities varied among participants, leading to heterogeneity of profiles. This first attempt had a number of limitations; one being that it was an a posteriori exploration, and another that it was based on the evaluation of only a limited number of communication components.

Blake, Duffy, Myers, and Tompkins addressed a similar question in 2002, searching for prevalence and patterns of right hemisphere cognitive and communicative deficits. To do so, they reviewed medical charts from 123 patients. Some correlations were reported (e.g., attention deficits were closely related to learning and memory deficits, hyporesponsivity was related to other cognitive deficits), but overall interpretation of the results was limited by the fact that no task was systematically used with all patients. Therefore, the analysis was solely based on health professionals' often subjective impression as to the presence or absence of communication and/or cognitive deficits.

Because the lack of a comprehensive assessment tool limits the exploration and description of clinical profiles associated with RHD, this issue will be briefly explored next. Very few batteries have been designed to specifically evaluate communication skills in individuals with RHD (e.g., Bryan, 1989, 1995; Halper, Cherney, Burns, & Mogil, 1996). Those that do exist appear to have both theoretical and methodological limits (Eck, Côté, Ska, & Joanette, 2001). Some of these batteries appear to lack coherence concerning what should be evaluated in order to address the communication impairments after RHD. Indeed, some of these clinical batteries tend to focus on non-communicative abilities, such as the evaluation of visual neglect. Of course, neglect may have an impact on the processing of written language, but it does not per se represent a communication deficit. Also, mainly inspired by the literature from the 1980s or earlier, these batteries did not benefit from the important theoretical advancements introduced in psycholinguistics and cognitive psychology over the last two decades.

In order to lessen the problem, our group recently developed such a clinical tool, now available in French (language- and culture-adapted versions are being currently prepared and normed in English, Spanish, Portuguese, and Italian). The *Protocole Montreal d'Évaluation de la Communication* (Joanette et al., 2004) allows the systematic evaluation of four components of verbal communication possibly affected following a right-hemisphere lesion. The *Protocole MEC* was standardised with 180 normal control participants representing three age groups (30–49, 50–64, 65–85) and two levels of education (HIGH and LOW by reference to each cohort's mean number of years of education). The *Protocole MEC* inter-rater reliability as well as its validity of content were shown to be good (Côté, Moix, & Giroux, 2004). Two aspects of the *Protocole MEC* are sources of obvious limitations. The first limitation results from the fact that the *Protocole MEC* does not provide exhaustive evaluation of the components of communication included; for instance, comprehension of

humour and sarcasm is not evaluated, and only a limited number of tasks assess the semantic processing of words. The second limitation is shared by numerous clinical protocols; the *Protocole MEC* does not provide specific information as to the underlying sources of the verbal communication impairments. Nevertheless, and despite these limitations, the 14 tasks of the *Protocole MEC* appear to be the best compromise as a published and validated clinical tool that allows the evaluation of prosodic, lexical-semantic, discursive, and pragmatic abilities (see Table 1).

In summary, the clinical profiles of communication impairments that can be present in individuals with RHD are still largely unknown, despite some valuable but limited attempts to study them. The availability of a clinical battery allowing the evaluation of the main communication components likely to be impaired in individuals with RHD now permits us to revisit this longstanding question. The goal of the present study was to explore whether there are distinctive clinical profiles of communication impairments following RHD by using the *Protocole MEC* applied to consecutively admitted post-CVA patients with RHD recruited in specialised rehabilitation units. More specifically, it was intended to (a) estimate the proportion of individuals with RHD with communication impairments in rehabilitation settings, and (b) contribute to the description of clinical profiles of communication impairments subsequent to RHD.

METHOD

Participants

A total of 28 French-speaking volunteer participants (15 men and 13 women) were evaluated. Participants ranged in age from 26 to 90 years and had between 5 and 18 years of formal education. All but three participants were right-handers and had incurred a single vascular brain lesion ascertained by a CT or MRI scan, with no other neurological history. The remaining three had experienced a previous transient RH ischaemia. All were 3 to 14 weeks post-onset (with an average of 6 weeks post-onset). None had a history of psychiatric disease or drug and alcohol addiction. Recruited participants were unselected incoming patients admitted to the neurological unit of five different rehabilitation centres; they were thus not selected to participate in the study on the basis of the presence or absence of communication impairments.

Tasks

All 14 tasks of the *Protocole MEC* (Joanette et al., 2004) were used in the present study. See Table 1 for a brief description of each task.

Procedure

Each participant with RHD was evaluated by a trained speech and language pathologist (main evaluator) using the 14 tasks of the *Protocole MEC*. Evaluation was done in two or three 45–60-minute sessions in a quiet environment. All tasks were presented to each participant in the indicated sequence in the *Protocole MEC* in order to allow comparison between their results and the available norms. All participants' oral productions were audio-recorded and disagreements were resolved

TABLE 1
Description of the 14 tasks of the *Protocole MEC*

Language component		*Task*	*Description*
Prosody	Linguistic prosody	Comprehension	12 pre-recorded sentences (4 sentences of neutral content, each said with three different linguistic intonations). Participant identifies the intonation by pointing to a multiple choice of modality icons (previously ascertained as well recognised)
		Repetition	Same stimuli as previous. Participant repeats the sentences
	Emotional prosody	Comprehension	12 pre-recorded sentences (4 sentences of neutral content, each pronounced with three different emotional intonations). Participant identifies the intonation by pointing to a multiple choice of emotion icons (previously ascertained as well recognised)
		Repetition	Same stimuli as previous. Participant repeats the sentences
		Production	Nine short situational paragraphs inducing an emotion (three situations, three target sentences). Participant produces the target sentence orally with the appropriate intonation
Lexical-semantic	Verbal fluency	Unconstrained	Participant says as many words as possible in 2.5 minutes, without any criterion
		Semantic criterion	Participant says as many "clothes" names as possible in 2 minutes
		Orthographic criterion	Participant says as many words as possible starting by the letter "P" in 2 minutes
	Semantic judgement		24 pairs of words, 12 of them semantically related and 12 without semantic relationship. Participant indicates by YES or NO the presence of a semantic relationship and has to explain the nature of the semantic relationship
Discourse	Conversational discourse		10-minute conversation between participant and examiner on two different topics. 17-point observation grid filled in by the evaluator
	Narrative discourse – recall and questions		Five-paragraph narrative first recalled one paragraph at a time and then recalled globally, with 12 comprehension questions including inferences
Pragmatics	Metaphor interpretation		20 metaphors of which 10 are idioms (*frozen* or lexicalised) and 10 creative (*creative* or non-lexicalised) metaphors. Open question and multiple choices
	Indirect speech act interpretation		20 situations of which 10 end with a direct speech act, 10 end with an indirect speech act. Open question and multiple choices
Awareness of deficits	Questionnaire on deficits awareness		Seven yes/no questions

through consensus by two evaluators. Moreover, all results were reviewed by a single expert to ensure homogeneity in scoring and a strict comparison to the normative data. Reliability of results was not evaluated in the present study, but a previous study provided a good inter-rater reliability for the *Protocole MEC* (Côté et al., 2004). For each participant with RHD, a three-step *structured clinical impression* was also collected. First, the main evaluator filled out a 15-point screening questionnaire with a relative to collect information on pre-morbid communicative abilities of the individual with RHD and on any communicative changes noted by the relative since the stroke. Then a second trained speech and language pathologist had a 10-minute conversation with the participant with RHD, before completing a 17-point conversational discourse observation grid (part of the *Protocole MEC*), in order to obtain clinical impressions of possible deviant communicative behaviour, be they prosodic, lexical-semantic, discursive, or pragmatic. In the last step, both speech and language pathologists—the main evaluator having used the *Protocole MEC* and the second evaluator having used the conversational discourse observation grid—agreed on a "clinical impression", also taking into account the relative's perspective, as collected by the main evaluator. To do so, each judge made a decision (+/–) and then compared results with the other judges. A structured clinical impression was called positive when communication disorders were thought to be present by at least two of three judges—main evaluator, second evaluator, and relative. Conversely, the structured clinical impression was called negative when at least two of three judges considered the communication abilities to be preserved. The result of the structured clinical impression would later be used as a factor to describe the clusters.

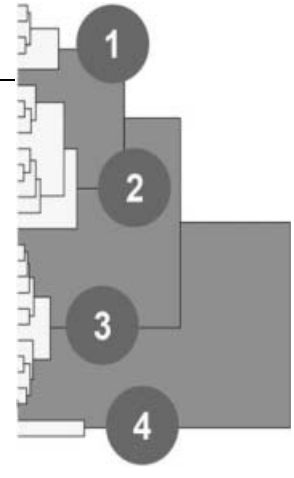
RESULTS

Participants' communicative performance on each of the 14 tasks was first described in terms of the *Protocole MEC* standardised scoring procedure using the "*alert points*" (Côté et al., 2004). The *alert point* is the level of performance at which a behaviour is considered deviant for the task under examination (*cut-off*). It is the age- and education-adjusted performance and generally corresponds to the 10th percentile based on control participants' results obtained during the normalisation. The performance of all participants with RHD for all tasks was submitted to a hierarchical cluster analysis (Aldenderfer & Blashfield, 1985) to allow for the identification of subgroups of participants with RHD characterised by distinctive communication impairment profiles. However, before doing so, the results of each participant was transformed into z scores by reference to the normative data of the *Protocole MEC*. The z score permitted comparison of participants to each other, taking into account the normal impact of age and education. The hierarchical cluster analysis allowed the identification of three clusters. See Table 2 for a summary description of each cluster including participants' age, education, and cerebral region affected.

Following the identification of subgroups with a cluster analysis, a description of impaired communication abilities in each the subgroup was undertaken. In order to achieve this characterisation, the result for each task was considered impaired for a given subgroup under the following two conditions: (1) the overall mean z score of the cluster was below -1.5; and (2) more than 50% of the members of the cluster had a z score below -2 (see Table 3).

TABLE 2
Results of the hierarchical cluster analysis

Clusters (number of participants and gender)	*Age (years)*	*Education (years)*	*Brain lesion (Number of participants in which a cerebral region was affected by the lesion)*
Cluster 1 ($n = 5$) 3♀ 2♂	26–61 ($x = 44$)	8–12 ($x = 11$)	Frontal 1 Temporal 0 Parietal 1 Sub-cortical 4
Cluster 2 ($n = 10$) 3♀ 7♂	46–79 ($x = 64$)	6–16 ($x = 11$)	Frontal 3 Temporal 3 Parietal 5 Sub-cortical 5
Cluster 3 ($n = 11$) 6♀ 5♂	50–90 ($x = 73$)	5–16 ($x = 9$)	Frontal 0 Temporal 2 Parietal 3 Sub-cortical 8
Group 4 ($n = 2$) 1♀ 1♂	74–85 ($x = 80$)	9–16 ($x = 13$)	Frontal 0 Temporal 2 Parietal 0 Sub-cortical 0



Each RHD participant represents a line on the left-sided ordinate axis of the figure; tinted areas indicate each of the four clusters.

Table 3 allows the identification of the communication profiles of each subgroup of participants with RHD. A qualitative analysis of all individual results—clinical notes—allowed a finer description of the impairments.

TABLE 3
Clusters mean *z* score for each task of the *Protocole MEC*

Variables	*Cluster 1 ($n = 5$)*	*Cluster2 ($n = 10$)*	*Cluster 3 ($n = 11$)*	*Group 4 ($n = 2$)*
Linguistic prosody – Comp	−1.10	**−2.02**	−0.33	0.33
Linguistic prosody – Rep	−1.84	**−4.35**	0.27	0.70
Emotional prosody – Comp	**−2.34**	−1.63	−0.29	−0.79
Emotional prosody – Rep	−1.02	−1.97	−0.88	−0.85
Emotional prosody – Prod	−1.09	−1.40	−0.72	−1.31
Verbal fluency unconstrained	−1.87	−1.82	−0.78	−1.24
Verbal fluency – semantic	−1.24	−1.67	−1.01	−0.48
Verbal fluency – orthographic	−1.84	−1.55	−0.44	−2.12
Semantic judgement	−0.64	**−2.70**	−0.04	**−17.14**
Conversation discourse	**−9.78**	**−3.53**	−1.26	−4.49
Narrative discourse – Recall	**−1.89**	−0.11	0.26	0.35
Narrative disc. – Questions	**−1.97**	−0.41	0.33	−0.67
Metaphors	**−2.61**	−1.72	−0.87	−3.89
Indirect speech acts	−1.40	−1.25	−1.19	**−2.77**

Bold results indicate tasks for which the group *z* score was $\leqslant -1{,}5$ AND for which 50%+1 of the participants obtained a *z* score $\leqslant -2$.

- Participants in the first cluster showed impairments in all four language components evaluated by the *Protocole MEC*. A qualitative analysis of these participants' results showed reduced verbal fluency, poor story recall, reduced comprehension of non-literal language, major difficulty in adapting their speech to their communication partner, and prosodic impairments. One of these five participants was evaluated as anosognosic.
- The second cluster of participants was characterised by a relative preservation of discourse abilities. Participants in that cluster also showed a reduced verbal fluency and difficulty in adapting their speech to the interlocutor, although less so than members of cluster 1. Out of 10 participants, 5 were anosognosic.
- Participants in cluster 3 showed globally normal communication abilities by reference to the *Protocole MEC* normative data. For five of these patients, both speech and language pathologists as well as a relative considered the participant to have normal communicational abilities (negative clinical impression). The six other participants of this cluster were suspected by the clinicians to have some degree of communication impairment. Each of these participants had at least one score below the norm at the *Protocole MEC*, but no task was impaired for all members of the group, and all mean *Z* scores were within normal range. Of the 11 participants, 2 did not notice any change in their communication behaviour although they scored below the norm on some measures.
- Two other participants fell outside the three clusters. They both presented severe deficits at the semantic judgement task and deficits in the indirect speech acts interpretation. Clinical notes for these two participants included difficulty in processing word semantics, reduced comprehension of indirect speech acts, slight prosodic impairments, conversational "malaise", and absence of emotional facial expression. Both participants were aware of changes in their communication abilities.

The descriptive analysis of the localisation of the brain lesion for every participant in each cluster did not allow the identification of a specific lesion site strongly associated with a specific cluster. However, the following observations were made. Three-quarters of the participants presenting a frontal lesion are in cluster #2, but we also see a variety of lesion sites affected in that same cluster. Cluster #3, presenting with normal results, seemed to be characterised by a high incidence of subcortical lesion. Age and education were fairly evenly distributed among the four subgroups, except that older and less-educated participants were over-represented in the third subgroup in which participants with RHD were most similar to normal participants. Participants of both genders were also evenly distributed in all clusters apart from a slight over-representation of women in the second cluster. No factor other than the right-hemisphere lesion itself thus appears to be responsible for the formation of the subgroups, despite the fact that the number of observations reported here probably does not allow for the identification of a given lesion site with a given communication impairment profile.

DISCUSSION

The use of the *Protocole MEC* in conjunction with a cluster analysis applied to the performance of individuals with RHD on 14 tasks including prosodic, lexical-semantic, discourse, and pragmatic abilities allowed the exploration of the possible

profiles of communication impairments following a right-hemisphere lesion. Results showed the presence of heterogeneous profiles of communication impairments; however, this heterogeneity was not random—individuals with a right-hemisphere lesion actually share a number of communication impairments.

The presence of the three clusters and two outliers suggests two important points about the impact of a right-hemisphere lesion on verbal communication abilities. First, results confirm that a right-hemisphere lesion does not result in communication disorders in all individuals. Out of the 28 participants with RHD, a subgroup of 11 was identified by the cluster analysis as presenting with communication abilities globally comparable to that of age- and education-matched normal control participants, as none of their group average performances was below the alert point indicated in the *Protocole MEC*. However, 6 of these 11 participants with RHD were thought by expert clinicians to present some degree of communication impairment via positive structured clinical impression, but these were not apparent in the quantitative results obtained using the *Protocole MEC*. The other five participants of this group had a negative structured clinical impression, which means that these participants had both a clinical and a *Protocole MEC*-based indication that their right-hemisphere lesion was not a source of interference with their communication abilities. This number (5 out of 28, or approximately 18%) leads one to believe that the 50% incidence of communication disorders after RHD often stated in the literature (e.g. Joanette et al., 1991) is not descriptive of individuals in rehabilitation settings. Indeed, it suggests that the incidence of communication impairments in an unselected population of individuals requiring rehabilitation is more than 80%. This figure, which would have to be confirmed over a larger sample number of participants in rehabilitation clinical settings, probably expresses the fact that the less-impaired individuals with RHD do not require rehabilitation and are thus not referred to rehabilitation settings. However, this means that the incidence of communication impairments in RHD individuals who receive attention in a rehabilitation setting is very high. The systematic evaluation of possible communication impairments over a larger sample of individuals is necessary to gather more data on the actual incidence of communication impairments after RHD. Now that assessment tools are available, it would be of major interest for the field, as for public health planners, to use the instruments to estimate the incidence of communication disorders following RHD.

The second important point revealed by the presence of subgroups in the cluster analysis is that, when present, the combination of communication impairments can vary from one individual to another, although not in a totally random fashion, as is the case in aphasia after left-hemisphere stroke. The present exploratory study did not allow identification of factors possibly accounting for the observed subgroups, and collaborative studies done with a national sample would be needed in order to explore the impact of various factors such as lesion site and extent, age, education, and pre-morbid communication profiles. Although the limitations of the present study preclude an answer, lesion site and extension may represent a determinant factor in the profiles reported. If lesion site and extent in the right hemisphere are confirmed to correlate to communication profiles, there would be further evidence for specific contributions of the right hemisphere for communication. (Joanette & Goulet, 1994). On the contrary, if the different profiles of communication impairments were shown to be independent of site and extent of the lesion, this would argue for the non-specific contribution of the right hemisphere to

communication abilities, as the heterogeneity would be due to other factors. Consequently, the question of the different profiles of communication impairments and their relationship with one another helps to reveal whether the contribution of the functional neural networks of the right hemisphere to components of communication is specific or not. A surprising finding was that participants in cluster 3—with relatively preserved language abilities—had predominantly subcortical lesions, therefore leading to the possible interpretation that subcortical structures are not essential for the treatment of language abilities under investigation in the present study. However, such an interpretation is mostly improbable considering the important recent literature pointing to the role of subcortical structures for language, especially for the processing of prosodic abilities (e.g., Van Lancker Sidtis, Pachana, Cummings, & Sidtis, 2006). More observations are needed in order to explore further this question.

The main limitation of the present study is surely the small number of participants evaluated, restricting the generalisation of results to the population of RHD. It will therefore be essential to reproduce a similar study with a larger number of participants.

Despite its limitations, this study represents a further attempt to describe clinical profiles of communication deficits following RHD. It now clearly appears that the occurrence of a right-hemisphere lesion is not responsible for communication impairments in all individuals, neither does it always express itself through the exact same profiles of disorders when impairments are present. The impact of such knowledge, hopefully enriched with more studies to come in the future, will be major in clinical settings, mainly for the development of rehabilitation strategies. These strategies would have to be adapted for each clinical profile. More studies concerning the incidence and the nature of the communication impairment profiles of individuals suffering from a right-hemisphere lesion will eventually guide clinicians in planning and adapting their interventions with this still under-served population.

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