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NARRATIVE DISCOURSE, TEXTUAL COHESION AND HEMISPHERIC SPECIALIZATION FOLLOWING AN ACQUIRED BRAIN INJURY: A LITERATURE REVIEW

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ABSTRACT

A number of studies have been conducted in the search for evidence of hemispheric specialization with regards to right hemisphere (RH) participation in the processing of narrative discourse and cohesion after an acquired brain injury. Objective: The study aims at reviewing and discussing research evidence on brain specialization on the processing of narrative discourse, more specifically on cohesion and narrative macrostructure following an acquired brain injury. Method: Searches were carried out in the PubMed and Web of Science databases for papers using the following keywords: "cohesion", "language", and "brain damage". Results: Of the total number of papers found in the databases (n=81), 11 were selected for this review. Conclusion: Some cognitive skills depend on a roughly equal participation of RH and LH (left hemisphere). On the other hand, there are specific skills which depend more on the expertise of one or the other hemisphere. Some studies showed that individuals with a right hemisphere damage (RHD) had difficulties in cohesion and hence in structuring their discourse.

Keywords: Narrative Discourse; Cohesion; Hemispheric specialization; Brain injury.

RESUMO

Pesquisas têm buscado evidências sobre as especializações hemisféricas, particularmente no que se refere à participação do hemisfério direito (HD) no processamento do discurso narrativo e da coesão textual após lesão cerebral adquirida. Objetivo: O estudo tem o objetivo de revisar e discutir evidências de pesquisas sobre o processamento do discurso narrativo, mais especificamte, sobre a coesão textual e as especializações hemisféricas após lesão cerebral. Método: Foi realizada uma busca por artigos nos bancos de dados PubMed e Web of Science usando as seguintes palavras-chave: "coesão", "linguagem" e "lesão cerebral". Resultados: Do número total de artigos encontrados nas bases de dados (n = 81), 11 foram selecionados para esta revisão. Conclusão: Algumas habilidades cognitivas dependem da participação tanto do HD quanto do HE (hemisfério esquerdo). Por outro lado, existem especialidades que dependem mais especificamente de um ou outro hemisfério. Alguns estudos mostraram que indivíduos com lesão no hemisfério direito (LHD) tiveram dificuldades na coesão e consequentemente na organização do discurso.

Palavras-chave: Discurso narrativo; Coesão; Especializações hemisféricas; Lesão cerebral.

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1 INTRODUCTION

Many of the recent findings about language processing in the brain result from studies on language disorders caused by cerebrovascular accident (CVA), traumatic brain injury (TBI), dementia, and Alzheimer's disease (ORTIZ, 2010). Post-stroke lesions may cause changes that, to varying degrees, may impair the functional independence of patients, their effects ranging from motor sequelae to disability and/or difficulties in speech articulation, production or comprehension. The degree of language impairment depends on several factors, such as the region affected in the brain, the extent and intensity of the injury, the time after the onset, implementation or not of speech treatment, age and education, among others.

Speech loss or impairment is a greatly feared complication experienced by about 20% of stroke patients (YOURGANOV et al., 2016). Language is one of the most complex brain functions, since it involves interconnections between many areas in both hemispheres. Obler et al. (2010) point to the fact that although research has pointed to perisylvian cortical regions in the left hemisphere (LH) as crucial for language, brain imaging techniques have shown other LH brain regions activated in language processing, as well as in the right hemisphere (RH).

The first studies on the relationship between brain and language are attributed to Paul Broca, who in 1860 carried out the first scientific demonstration of functional asymmetry between the hemispheres. The neurologist associated difficulty in language production, with almost intact comprehension, to the third convolution of the left frontal lobe, next to the lateral sulcus. Recent studies continue to corroborate this finding (BELIN; FAURE; MAYER, 2008; HUTSLER; GALUSKE, 2003; KRISTENSEN; ALMEIDA; GOMES, 2001). Since Broca's study, and particularly in the past three decades, many studies on brain dominance have been conducted with improved methods and theoretical background, which resulted in a better understanding of the role of the cerebral hemispheres, their specializations and cooperative processing (BELIN; FAURE; MAYER, 2008; FRANKLIN et al., 2010). For instance, inter-hemispheric cooperation is very common following a stroke, occurring when the contralateral or an adjacent region assumes the role of an injured area.

Although some cognitive abilities depend more on the expertise of one or the other hemisphere (BLOOM et al., 1996; CORINA; VAID; BELLUGI, 1992; MASON; JUST, 2006) other abilities depend on a shared participation of RH and LH (WOOD et al., 2002). However, factors such as aging and brain damage challenge the roles attributed more specifically to one hemisphere. In these cases, the RH may help maintain certain language skills that are mainly processed by LH.

As the LH was initially believed to be almost uniquely responsible for language processing, many studies were confined to this assumption. However, since the 1990s, the RH has been investigated and pointed as playing a decisive role in language processing, especially at the discourse level. Studies like those of Myers (1999) and Joanette, Brownell and Kempler (1990) demonstrated that the RH has a significant share in discourse comprehension and production. In a literature review on the role of the RH in language, by analyzing mainly RHD studies, Paradis (2004) stated that difficulties have been found in metaphors, connotations, the construction of meaning at a textual level, such as the moral of a story, and difficulties in establishing textual cohesion. In another study,

Scherer (2009) pointed out that RH participation seems to be more important at the speech level, and that the activation of contralateral areas in the RH both in comprehension and production has been consistently presented in studies on linguistic processing using neuroimaging techniques.

Individuals with RH lesions may present, according to the literature, difficulties in at least one of the following aspects, among others: cohesion and logical coherence of the text ((BROWNELL; MARTINO, 1998; JOANETTE; GOULET, 1990; MYERS, 1999); differentiating the main ideas and understanding the purpose of the text (HOUGH, 1990), and in processing narrative stories (JOANETTE et al., 1986; JOANETTE; GOULET, 1990).

The aim of our study is to specifically look into one aspect of discourse processing, namely discourse cohesion at the level of narrative production following an acquired brain injury (traumatic brain injury - TBI) and cerebrovascular accident (CVA). Narratives are part of people's everyday life, and understanding their functioning following a brain injury can help understand language changes, losses, and rehabilitation. With specific regards to textual cohesion, it has been pointed as the most important criterion for assessing textuality (MARCUSCHI, 2012). A systematic review of the literature was developed to analyze data brought by previous studies, as described below.

2 METHOD

PubMed and Web of Science databases were searched in January, 2017 for papers including the following three indexers: "cohesion" AND "language" AND "brain damage". Additionally, articles were retrieved using variation forms such as: 1) cohesion: "textual cohesion" OR "ties"; 2) language: "linguistic" OR "communication" OR "discourse"; 3) brain damage: "brain" OR "right hemisphere damage" OR "left hemisphere damage" OR "stroke" OR "cerebrovascular accident" OR "brain injury".

The database search was carried out as follows: first, the first combination of the displayed indexers <cohesion" AND "language" AND "brain"> were investigated. Then, a combination with other words was undertaken and hand-filtered. The titles and the abstracts were independently read by the reviewers and the following inclusion criteria were adopted: a) studies should be experimental; b) focus on textual cohesion in oral production c) following an acquired brain injury (TBI and CVA); d) with an adult population.

3 RESULTS AND DISCUSSION

From the total number of articles identified in the database (n=81), 58 papers were excluded after reading the title or abstract and 23 articles were selected for full reading. After reading, 12 papers were excluded because they were repeated or not pertinent to the aim of this review. Finally, 11 studies were selected for this review following the filter of our established exclusion/inclusion criteria, as can be observed in Table 1.

Note: CVA = cerebrovascular accident; TBI: traumatic brain injury/ NBI: No brain injury/ RBD: Right brain-damage/ RH: right hemisphere/ LH: left hemisphere; M: man/W:woman; MTL: medial temporal lobe; vmPFC: ventromedial prefrontal cortex; LIFG: left inferior frontal gyrus; EG: experimental group, CG: control group

Source: The authors (2017)

According to the survey portrayed in Table 1, 10 studies out of 11 included ¨control groups¨ and the number of controls ranged from 7 to 95 participants. With regard to the tests and tasks used, not all studies specified the instruments in the article, especially in the case of the neuropsychological tests. Some of these tests mentioned in the papers were the Western Aphasia Battery (KERTESZ, 1982), Level of Cognitive Functioning (HAGAN C, MALKMUS D, 1980), The Galveston Orientation and Amnesia Test (LEVIN; O'DONNELL; GROSSMAN, 1979), Dementia Rating Scale (MATTIS, 1976), Aachener Aphasia Test (LUZZATTI; WILLIEMS; DEBLESER, 1991), Wisconsin Card Sorting Test (HEATON et al., 1993), Mini-Mental Status Examination (FOLSTEIN; FOLSTEIN; MCHUGH, 1975), National Adult Reading Test (CRAWFORD et al., 1991; NELSON, 1982); Aphasia Quotient in the Western Aphasia Battery (KERTESZ, 1982), Right Hemisphere Language Battery (BRYAN, 1995), BADA test (MICELI et al., 1988), Token test (DE RENZI; VIGNOLO, 1962) and Neuropsychological Battery (ORSINI et al., 1987; P. ZIMMERMANN AND B. FIMM, 1994). All of these tests are validated and frequently used in this type of research.

Concerning the types of narrative tasks used in the reviewed studies, we verified that some used one scene, a scene sequence and/or personal stories for the production of narratives by the participants. The tasks are commonly used in studies with participants with injuries, such as The Picnic Scene (KERTESZ, 1982), The Flower Pot story (HUBER; GLEBER, 1982) and Quarrel (NICHOLAS; BROOKSHIRE, 1993). The Picnic Scene was used by Marini et al. (2011), Carlomagno et al. (2011) and Peach and Coelho (2016). The Flower Pot story was used by Davis, O'Neil-Pirozzi and Coon (1997) and in addition to these texts used as tasks, there were other stories, as shown in Table 1, for example, "The Bear and the Fly" story (WINTER, 1996) and references to interviews and texts used on a day-to-day basis. The choice of each task certainly stems from the objectives of each study. To better understand the findings, we present below each study and a general discussion.

The study conducted by Davis, O'Neil-Pirozzi and Coon (1997) compared a group with RHD to controls regarding referential cohesion and logical coherence in narrative production. Results showed deficits in the experimental group in narrative referential cohesion, logical coherence, and accuracy. The authors point out that the occurrence of these deficits depended on the circumstances in which the narration took place. More specifically, this study analyzed the production of four narratives in two different modalities: visually elicited and auditory-retelling. The most consistent and pronounced difficulty occurred with accuracy of narrations elicited by picture-sequences, while impairment in referential cohesion was found in the orally presented story-retelling task.

Similarly, Marini et al. (2005) aimed at describing the cohesive linguistic skills of RHD participants in the processing of complex textual structures, using different modalities for narrative production: (i) retelling of previously read stories; ii) description of well-structured cartoon stories and iii) the arrangement and description of unstructured cartoon stories. They analyzed narratives produced by 11 RHD participants compared to those of 11 left hemisphere brain damage (LHD) participants without aphasia[1], to the production of healthy control participants. The three groups

1 Aphasia is common in individuals after a stroke. It is a language disorder due to focal lesion acquired in the Central Nervous System (MORATO, 2012). This change is characterized by reduction and dysfunction manifested in varying degrees of impairment in both expressive and receptive modes (comprehension, production, reading, and

were administered three conditions of story description tasks. In the first condition, they were asked to retell previously read stories. In the second, they described what was going on in a set of cartoon picture stories. In the third condition, they had to arrange a set of pictures to reconstruct a well-formed story. The three groups performed quite well in the first condition on both within- and between-sentence measures and in the two picture description tasks; however, RHD participants' performance was lower than that of the other two groups in terms of information content and coherent aspects of narrative production. These findings are in line with the hypothesis that participants with RHD are impaired in deriving the mental model of a story from visual information.

The following study presented in Table 1 was conducted by Marini et al. (2011) and aimed to investigate the features of narrative discourse impairment in a group of adults with TBI - as in the previously presented study. The results showed that the linguistics deficits observed in the participants with TBI may reflect a deficit at the interface between cognitive and linguistic processing rather than a specific linguistic disturbance. This was the case because the results showed the participants produced a normal amount of thematic units in their narratives. But on the other hand, the story was not properly organized at microlinguistic and macrolinguistic levels of processing. What is important to highlight in this article is that the authors point to the conclusion that their data suggest that "linguistic problems" (MARINI et al., 2011) encountered by these group of non-aphasic participants with TBI may not be the result of specific linguistic deficits but of a more generalized cognitive dysfunction - which points to the need for more studies with this population.

Differently from the two previous studies that analyzed participants with TBI, Sherratt and Bryan (2012) investigated the production of textual cohesion by RHD participants. Their study investigated the effects of TBI in oral discourse production using a multi-layered discourse processing model. The results showed statistically significant differences in syntactic complexity, discourse grammar, clausal structure in the narratives, and cohesion in the comparison of RHD groups and controls. In a longitudinal study, Ellis et al. (2005) investigated narrative discourse cohesion of LHD participants who had not been diagnosed with expressive language disorder. The researchers analyzed data from a semi-structured interview (a typical day in the participants' life). The results pointed to the fact that, while the average number of cohesive "links" in narrative discourse remained generally constant during the first post-stroke year, the percentage of the properly used cohesive ties increased significantly over the same period of time later. This would suggest that some deficits in expressive language may be initially present in narratives, and that their recovery can occur naturally over time.

Kurczek and Duff's study (2012) analyzed the impact of the impaired region in discourse cohesion and coherence in a wide range of discourse tasks. The results showed that bilateral ventromedial prefrontal cortex (vmPFC) damage does not impair cohesion and coherence in spoken discourse. Yet Race, Keane and Verfaellie (2015) verified to what extent the hippocampus is necessary to effectively promote communication of one's mental simulations, by examining the discourse of amnesic patients with medial temporal lobe damage. As a result, the research demonstrated that the hippocampus supports the integration of individual narrative elements into coherent and cohesive discourse when constructing complex verbal accounts, and plays an important role in the effective communication of information.

writing) (CHAPEY, 1994; ORTIZ, 2010).

The study by Marangolo et al. (2014) analyzed the beneficial effects of tDCS (transcranial direct current stimulation) on spontaneous speech and the ability to use words to establish cohesion between adjoining statements among a group of eight participants with aphasia - who were not fluent and suffered from chronic aphasia. The data corroborated the view that the left inferior frontal gyrus plays a key role in connecting words in a coherent discourse. The positive effects of tDCS could be extended to different linguistic domains – and thus assist in language recovery. Another study also involving participants with TBI, but in this case non-aphasics, Carlomagno et al., (2011) used three texts (The Picnic Scene (KERTESZ, 1982), Quarrel (NICHOLAS; BROOKSHIRE, 1993) and The Flower Pot story (HUBER; GLEBER, 1982)) and aimed to have an index of the occurrence of macrolinguistic errors in three speech samples in order to study the effect of density of the errors on the Correct Information Unit (CIU) rating scale. For this study, the aphasic participants with TBI did not produce relevant within-sentence errors and information content of their narratives was not different from that of the control participants. However, their production of errors of cohesion, local coherence and global coherence was significantly higher.

Following, Coelho et al. (2005) analyzed microlinguistic deficits in the narrative discourse of adults with TBI. Results indicated that the group with TBI produced significantly fewer propositions per T-unit. These findings are in accordance with the notion that the participants with TBI presented with impairments of both micro- and macrolinguistic processes present difficulties with the organization of semantic information in discourse. In the last study, Peach and Coelho (2016) also analyzed adult participants with TBI. They investigated the relationship between impairments of inter-sentential cohesion and intra-sentential processing in the discourse of severe TBI participants. The results demonstrated a significant relationship between the production of cohesive ties and instances of intra-sentential impairment, which suggests that the utilization of resources for adequate cohesion appears to negatively affect intra-sentential processing following TBI.

This paper aimed at reviewing and discussing research evidence on brain specialization on the processing of narrative discourse, more specifically on cohesion and narrative macrostructure following an acquired brain injury. Thus, it is possible to synthesize the results of the research on the proposed theme and on how we can advance in the aspects of language in the researched population. The results pointed to the active participation of the right hemisphere in the processing of language. In addition, RHD seems to affect the performance of the participants in narrative tasks concerning textual cohesion and coherence (MARINI et al., 2005; SHERRATT; BRYAN, 2012). The results of Sherratt and Bryan's study (2012) showed that RBD participants presented statistically significant differences in syntactic complexity, discourse grammar, clausal structure in the narratives, and in cohesion. On the other hand, Kurczek and Duff (2012) showed that bilateral ventromedial prefrontal cortex (vmPFC) damage does not impair cohesion and coherence in spoken discourse.

In the case of the studies with participants with TBI, the findings are in accordance with the notion that TBI participants show impairment in both micro- and macrolinguistic processes (COELHO et al., 2005). Yet Peach and Coelho (2016) support a resource account for discourse production following TBI that is consistent with previous work indicating that intra-sentential deficits following TBI are related to executive difficulties with the recruitment and control of attention (PEACH, 2013). They proposed that macrolinguistic and microlinguistic levels dependent one of another and share cognitive resources that support the planning and production of both microlinguistic and macrolinguistic relationships expressed through discourse.

It is important to emphasize that Race, Keane and Verfaellies's study (2015) demonstrates that the hippocampus supports the integration of individual narrative elements into coherent and cohesive discourse when constructing complex verbal accounts, and plays a critical role in the effective communication of information to others. Although the lesion site is not determinant in the speech/language implications, further studies are needed to better understand the impact of the lesion site on narrative production. In this context, studies with neuroimaging techniques such as DTI (Diffusion Tensor Imaging*)* and fMRI (Functional Magnetic Resonance Imaging) can bring great contributions.

In relation to the narrative text, it has been extensively investigated, not only in linguistics but also in the areas of anthropology, psychology, and speech therapy. This interest parallels the very diffusion and ubiquity of this textual form in the daily life of individuals in markedly distinct communities, whether situated in rural or urban contexts, in different parts of the world (FLANNERY, 2011). Under different and varied conceptions, it has been investigated and the large number of research involving the narrative text reflects its importance in our society. In this way, there is a negative impact on the life of an individual by being abruptly deprived of an ability like this. About the narrative tasks, there seems to be a concern for the use of the diversification of tasks, mainly with the visual support of pictures - as we presented in table 1 and previously described. Most studies merge between a single picture/scene (for example, The Picnic Picture) and sequences of scenes (for example, The Flower Pot story). It is important to determine the criteria for the choice of narrative tasks since studies point to the occurrence of deficits depended on the condition of the narration (retelling, elicited and recall condition) (DAVIS; O'NEIL-PIROZZI; COON, 1997). For instance, RBD participants show impairment in deriving the mental model of a story from visual information (MARINI et al., 2005).

Interestingly, despite dealing with the discourse level, not one of the studies included in their protocols an instrument to measure reading and writing habits. Several recent studies have pointed reading and writing habits and their frequency as being more influential in discourse processing (and language in general) than the years of formal education (COTRENA et al., 2015; PAWLOWSKI et al., 2012). Lastly, regarding participants' sociodemographic characterization, in all the studies they had a high level of education (12-14 years spent at school). This suggests a need for further research including lower levels of education or illiteracy to analyze its impact in narrative cohesion production.

4 CONCLUSION

Many investigations have been developed in recent years on brain specializations and they have pointed out important aspects that contribute to the understanding of language processing in the brain. However, the exact participation of each of the cerebral hemispheres in this processing has not yet been fully unveiled. Despite the gaps, much progress has been done in the past decades, mainly due to the advance of neuroimaging techniques (for example, DTI and fMRI). These techniques need to be more widely used for discourse studies, since the majority of the studies at the discourse level occurs at the word and sentence levels. In studies involving language and speech – the focus of this review, some aspects need to be considered concerning individual factors, such as chronological age,

level of education, reading and writing habits, as well as aspects regarding methodological issues, such as the type of tasks (whether auditorily or visually presented, and the type of visual stimuli, just to mention some). All of these factors impact on the level of participation of each hemisphere in discourse processing regarding both comprehension and production.

Our review suggests that the RH plays an important role in language, more specifically in narrative production following an acquired brain injury, such as in CVA and TBI, together with areas in the LH, including hippocampus and prefrontal cortex. Due to some inconclusive findings regarding interhemispheric participation, for instance, regarding participants' age, there is still a need for further research in an attempt to understand the involvement of the hemispheres with regard to textual cohesion in narrative production. Moreover, we suggest the inclusion of multidisciplinary-based studies in order to reach a more complex and comprehensive knowledge of language processing and. Since language is a social, historical, political and cultural activity, it "involves a set of skills (cognitive, textual and interactive) and situational factors" (ANTUNES, 2005, p. 20), to address the cohesive textual production of narrative after an acquired brain injury and, thus, to assist the individual "in the struggle with words" (ANTUNES, 2005, p. 20). This can enable him to produce the text – with cohesion and coherence – and give significance to what he says in an interlocution.

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