



The right hemisphere's contribution to discourse processing: A study in temporal lobe epilepsy



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ABSTRACT

Objective: Discourse skills - in which the right hemisphere has an important role - enables verbal communication by selecting contextually relevant information and integrating it coherently to infer the correct meaning. However, language research in epilepsy has focused on single word analysis related mainly to left hemisphere processing. The purpose of this study was to investigate discourse abilities in patients with right lateralized medial temporal lobe epilepsy (RTLLE) by comparing their performance to that of patients with left temporal lobe epilepsy (LTLE).

Methods: 74 pharmacoresistant temporal lobe epilepsy (TLE) patients were evaluated: 34 with RTLLE and 40 with LTLE. Subjects underwent a battery of tests that measure comprehension and production of conversational and narrative discourse. Disease related variables and general neuropsychological data were evaluated.

Results: The RTLLE group presented deficits in interictal conversational and narrative discourse, with a disintegrated speech, lack of categorization and misinterpretation of social meaning. LTLE group, on the other hand, showed a tendency to lower performance in logical-temporal sequencing.

Significance: RTLLE patients showed discourse deficits which have been described in right hemisphere damaged patients due to other etiologies. Medial and anterior temporal lobe structures appear to link semantic, world knowledge, and social cognition associated areas to construct a contextually related coherent meaning.

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1. Introduction

Discourse skills imply the inference of meaning from larger multi-sentence units called discourse: conversations, narrations or instructions, rather than expressing or receiving isolated words or sentences (AbdulSabur et al., 2014; Abusamra, Côté, Joannette, & Ferreres, 2009; Johns, Tooley, & Traxler, 2008). Discourse study enables society characterizes language functioning to its full extent. Deficits in discourse processing affect interpersonal communication and text comprehension, and thus could impact the whole educational career and social life (Cornoldi & Oakhill, 1996).

Processing discourse successfully requires building a mental model that is maintained in an active fashion, being revised and updated as new information becomes available (Johns et al., 2008). This includes constructing a coherent microstructure - the relationship between individual incoming sentences - and macrostructure - the knowledge of the overarching message or theme that organizes sentences into a unified whole - and making the correct inferences about that which is not explicit (Johns et al., 2008; Prat, Long, & Baynes, 2007). Thus, sentence information meaning is integrated and combined with the prior discourse, world knowledge, information about the speaker and semantic information from extra-linguistic domains to get a message-level representation (Hagoort & van Berkum, 2007).

In the last decades there has been an increasing interest in studying how the right hemisphere (RH) contributes to communi-

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cation and social skills. In patients with right brain hemisphere damage (RHD) - due to stroke or head trauma - a wide range of language and communication deficits have been described at a discourse, pragmatic, lexico-semantic, and prosodic level (Abusamra et al., 2009; Ferré, Fonseca, Ska, & Joannette, 2012; Ferré, Ska, Lajoie, Bleau, & Joannette, 2011a; Johns et al., 2008). Ferré et al. (2012) found that 50–78% of patients with RHD caused by stroke lesions have language deficits. Regarding discourse skills in particular, patients with RHD produce less informative and coherent discourse than that of control subjects, while maintaining a similar number of enunciations. In addition, these individuals often speak tangentially (i.e. introducing personal digressions and critiques), make inappropriate comments, and stray off topic (Abusamra et al., 2009; Johns et al., 2008). At a receptive level, they fail to integrate elements of a story into a coherent whole and fail to infer the correct pragmatic and social interpretations (Abusamra et al., 2009; Ferré et al., 2012; Marini & Ph, 2012).

Until the last decades, the most widespread neurobiological model for language was the classical left-perisylvian Wernicke-Lichtheim-Geschwind model. This model is incomplete for several reasons: lesion in both Broca's and Wernicke's region can impair language production and comprehension, it does not describe other relevant fiber tracts beyond the arcuate fasciculus, and does not explain higher-order, language-communication skills that are subserved throughout both hemispheres (Hagoort & Indefrey, 2014; Poeppel, Emmorey, Hickok, & Pylkkanen, 2012). Recent approaches include a dual stream model (Hickok & Poeppel, 2004, 2007) which describes a dorsal phonological route (sounds into words) mostly represented in the dominant hemisphere, and a ventral semantic route (sounds into meaning) with bilateral representation. In the last years, evidence from functional neuroimaging methods enabled to describe other cortical and subcortical areas involved in language (Price, 2012). Catani and Bambini (2014) proposed a social communication and language evolution, and development model (SCALED), that extends the dual-stream model and includes frontal, fronto-parietal and temporo-parietal networks. This model consists of five levels, from the representation of informative actions and communicative intentions, to lexico-semantic processing, syntactic analysis and pragmatic integration.

Although functional Magnetic Resonance Imaging (fMRI) studies in healthy population have shown broadly bilateral activation of language attention and theory of mind-associated cortical areas during discourse production and comprehension, some studies have shown that inferring meaning from pragmatic and social contexts seems to be more represented at the right or non-dominant hemisphere (AbdulSabur et al., 2014; Mar, 2011; Mason & Just, 2009; Swett et al., 2013). Theory of mind (ToM) - involves the construction of a theory concerning one's own or others' affective and epistemic mental states - is one of complex social cognition abilities that contribute to construct mental representations of social relations and to flexibly use them in the social environment (Giovagnoli et al., 2011).

The anterior temporal lobes have been related to different functions such as being a domain-general semantic hub, having a domain-specific role in social or 'person-related' processing, being a personal episodic and semantic memory store and mediating the access to emotional and social contexts for meaning construction (Baez, Rattazzi, Gonzalez-gadea, & Torralva, 2012; Kennedy & Adolphs, 2012; Petrides, 2013; Price, 2012; Wong & Gallate, 2012).

Medial Temporal Lobe Epilepsy (TLE) is the most frequent type of pharmacoresistant epilepsy in young adults which can lead to epilepsy surgery. It is described as a localized form of epilepsy that involves brain networks of medial temporal lobe, amygdala, hippocampus, uncus, parahippocampal gyrus, and the entorhinal cortex. The main cause of lesional TLE is the hippocampal sclerosis,

in over 80% of cases (Cendes, 2005; Tatum, 2012). The functional and structural properties of the abnormal epileptogenic networks and their anatomic location contribute to the defined electro-clinical syndrome and the individual's clinical characteristics (Bell, Lin, Seidenberg, & Hermann, 2011; Gleichgerricht, Kocher, & Bonilha, 2015; Hermann, Meador, Gaillard, & Cramer, 2010; Richardson, 2012). The main goals of the neuropsychological evaluation in TLE are the detection of cognitive deficits and prediction of cognitive surgical outcome (assessing functional integrity of the tissue to be resected and cognitive reserve of the rest of the brain), (McAndrews & Cohn, 2012).

Most of the previous literature about interictal language evaluation in TLE adults has focused on the production and comprehension of single word and sentence -level analysis, evaluating mainly quantitative aspects of word production like semantic and phonologic fluency or naming abilities (Bartha-Doering & Trinkka, 2014; Bell, Seidenberg, Hermann, & Douville, 2003; Hamberger & Tamny, 1999; Lomlondjian, Solis, Medel, & Kochen, 2011; Trebuchon Da Fonseca et al., 2009). Few studies have evaluated conversational discourse (Bartha, Benke, Bauer, & Trinkka, 2005; Howell, Saling, Bradley, Samuel, & Hospital, 1994) and narrative discourse production (Bell, Dow, Watson, Woodard, & Seidenberg, 2003; Field, Saling, & Berkovic, 2000), but most of them did not analyze the epileptic zone (EZ) laterality. Many recent studies in TLE patients showed deficits in ToM abilities (Brocher et al., 2012; Giovagnoli et al., 2011; Schacher et al., 2006), however little is known about social communication abilities in this population.

The goal of this study was to investigate discourse abilities in patients with right lateralized medial temporal lobe epilepsy (RTLE) by comparing their performance to that of patients with left TLE (LTLE). Right hemisphere structures associated with discourse performance may be affected by the EZ directly or indirectly and, given reports in the RHD literature, they would be expected to produce interictal deficits in narrative and conversational discourse abilities in RTLE patients.

2. Methods

2.1. Ethical approval and participants consent

All participants provided written informed consent approved by the Institutional Ethics Committee at Ramos Mejia Hospital and El Cruce Hospital, which follows the guidelines of the Declaration of Helsinki.

2.2. Participants

From December 2011 to November 2015, 74 patients with pharmacoresistant TLE and unequivocal lateralized EZ were included for this study: 34 with a right epileptic zone (RTLE) and 40 with a left EZ (LTLE). Subjects were evaluated by the same professional team at the Epilepsy Center, Ramos Mejia Hospital, Buenos Aires and at the National Neuroscience and Neurosurgery Center, El Cruce Néstor Carlos Kirchner Hospital, Florencio Varela, both in Argentina.

Inclusive criteria were: subjects from 18 to 50 years-old, with at least seven years of formal education (completed primary school in Argentina), Full Scale IQ > 80, clearly defined EZ, and strong right handedness determined by the Edinburgh Inventory and the Grooved Pegboard Test (Lezak, 2012). Patients were not included if they had history of psychiatric disorders, other neurological diseases, or a clinical condition that could modify cognitive performance. In order to determine lateralization and localization of the EZ, video-EEG monitoring was performed in all patients over

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