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Schizophrenia patients have higher-order language and extralinguistic impairments

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ABSTRACT

Introduction: The extralinguistic and paralinguistic aspects of the language refer to higher-order language functions such as lexical-semantic processes, prosody, indirect speech acts or discourse comprehension and production. Studies suggest that these processes are mediated by the Right Hemisphere (RH) and there is also some evidence of RH dysfunctions in schizophrenia. The aim of the paper is to investigate the extralinguistic and paralinguistic processing mediated by Right Hemisphere in schizophrenia patients using a validated and standardized battery of tests.

Methods: Two groups of participants were examined: a schizophrenia sample (40 participants) and a control group (39 participants). Extralinguistic and paralinguistic processing was assessed in all subjects by the Polish version of the Right Hemisphere Language Battery (RHLB-PL), which measures comprehension of implicit information, naming, understanding humor, inappropriate remarks and comments, explanation and understanding of metaphors, understanding emotional and language prosody and discourse understanding.

Results: Schizophrenia patients scored significantly lower than controls in subtests measuring comprehension of implicit information, interpretation of humor, explanation of metaphors, inappropriate remarks and comments, discernment of emotional and language prosody and comprehension of discourse. No differences were observed in naming, understanding metaphors or in processing visuo-spatial information.

Conclusions: Extralinguistic and paralinguistic dysfunctions appear to be present in schizophrenia patients and they suggest that RH processing may be disturbed in that group of patients. As the disturbances of higher-order language processes mediated by the RH may cause serious impairments in the social communication of patients, it is worth evaluating them during clinical examination.

1. Introduction

Successful communication involves not only the ability to process phonemes, syllables, words or sentences, but also the ability to process extralinguistic and paralinguistic aspects of the language. These processes refer to lexical-semantic processes, to the understanding and production of vocal non-verbal speech components (prosody), the comprehension of indirect speech acts (idioms, metaphors, irony), discourse comprehension and production, as well as the appreciation of shared knowledge and reflection. They allow the context of the interaction to be taken into account, and regulate communicative exchange by a developed and shared system of rules (Balconi, 2010; Bryan, 1995; Łojek, 2009). When present, disturbances in the area of extra- and paralinguistic abilities can cause major obstacles which interfere with everyday life. Such dysfunctions hamper social communication by obscuring the intentions and emotions of others, making it difficult to keep track of the conversation topic or comprehending inferred meanings. In speech production, they lead to focusing on details, interjecting inappropriate remarks or omitting important information and making it difficult to convey a message or an intention (Joanette et al., 2008; Jodzio et al., 2005; Łojek, 2009; Myers, 2001). As a consequence, these dysfunctions seriously disturb communication and the relationships of affected people, leading to impairment of their social interaction or sometimes even to disintegration from society due to their inappropriate manners.

There is growing evidence that the processing of extralinguistic and paralinguistic language systems is associated with the Right Hemisphere (RH) (Joanette et al., 2008). Clinical and experimental data suggest it plays a specific role in language processing and that RH lesions may cause higher-order language dysfunctions (Joanette et al., 1990). Research indicates that RH damage (RHD) is associated with a difficulty in identifying emotion from the tone of voice of the speaker (Schmitt et al., 1997), as well as with disturbances in the expression of emotional prosody (Pell, 1999a, 1999b). A case study of a RHD individual also revealed impairment in reporting and expressing modality of a sentence

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(Threoux, 1987). RH is believed to influence lexical-semantic processes (Code, 1997; Grindrod and Baum, 2005) and RHD patients have been described as having specific problems using words. Regarding metaphorical language, the research results are inconsistent, with some studies showing the presence of its dysfunctions in RHD (Brownell et al., 1984; Brownell et al., 1990; Rinaldi et al., 2004) and others describing its disturbances after both RH and LH damage (Papagno et al., 2006; Tompkins, 1990; Tompkins et al., 1992). Recent meta-analyses (Bohrn et al., 2012; Rapp et al., 2012) have found no selective relationship between the RH and metaphorical language, suggesting also that the RH plays a greater role in the processing of novel figurative meanings, whereas conventionalization of metaphorical meanings is mediated bilaterally. The RH is found to be crucial for the appreciation of humor and sarcasm (Bartolo et al., 2006; Heath and Blonder, 2005; Joanette et al., 2008; Marinkovic et al., 2011) as well as for processing indirect speech acts (Vanhalle et al., 2000). Chantraine et al. (Chantraine et al., 1998) report it plays a role in appreciating the degree of shared knowledge between interlocutors. The RH has also been found to be involved in the comprehension of narrative speech (Babajani-Feremi, 2017; Robertson et al., 2000) and discourse comprehension (Blake et al., 2015; Johns et al., 2008; Tompkins et al., 2008).

There is some evidence for dysfunctions of the RH in schizophrenia patients. Neuroanatomical studies with schizophrenia patients have demonstrated a decrease in the grey matter of the right ventral striatum (Stegmayer et al., 2014), increased grey matter concentration in the right striatum (Ha et al., 2004), increased right putamen volume (Rimol et al., 2010) and an increased or more complex cortical folding in the right hemisphere compared to the left one (Harris et al., 2007; Harris et al., 2004; Narr et al., 2004; Stanfield et al., 2008). Apart from the above, structural differences of shape or volume have also been observed in the right palnum temporale (Oertel et al., 2010; Petty, 1999), the superior temporal gyrus (Highley et al., 1999), fusiform and parahippocmpal gyri (McDonald et al., 2000) when compared to the left relevant structures. Studies have reported an exaggerated rightward asymmetry of the thalamus (Csernansky et al., 2004), hippocampus (Wang et al., 2001) and amygdala (Qiu et al., 2009). Functional Magnetic Resonance Imaging (fMRI) has shown that schizophrenia patients, when compared to controls, exhibit increased RH activity when generating verbs and processing semantic material (Sommer et al., 2001a; Sommer et al., 2003), fail to activate the right fusiform gyrus during facial information processing (Quintana et al., 2003), show reduced right hippocampal and cerebellar activation during facial encoding (Leube et al., 2003), and reduced right thalamus and prefrontal cortex during visual and auditory stimuli processing (Braus et al., 2002). There is also evidence for attenuated asymmetry of functional connectivity in RH. For example, Rotarska-Jagiela et al. (Rotarska-Jagiela et al., 2010) have shown a lower degree of right-sided laterality for the right fronto-parietal network in schizophrenia patients. Prior studies have revealed not only altered brain asymmetry in schizophrenia but also abnormal brain functional lateralization (Okada et al., 2016; Ribolsi et al., 2014) e.g. reduced lateralization of language to the left hemisphere (Aydin et al., 2001; Sommer et al., 2001a; Sommer et al., 2001b).

According to neuropsychological and neuroanatomical research associated with RH functions, it can be assumed that extralinguistic and paralinguistic processing could be disturbed in schizophrenia. Several previous studies suggest the presence of some higher-order language and extralinguistic disturbances in schizophrenia patients (Kuperberg, 2010a, 2010b). They indicate that schizophrenia patients tend to make literal rather than figurative interpretations (Brune and Bodenstein, 2005; Chapman, 1960; Kiang et al., 2007), exhibit impairment of indirect speech act processing (Corcoran, 2003) and of comprehending stories (Langdnon et al., 2002). Furthermore, a distorted sense of humor (Corcoran et al., 1997; Rosin and Cerbus, 1984) and the inability to appreciate irony (Drury et al., 1998) have also been described. Some studies highlight discourse deficits in schizophrenia patients (Andreasen et al., 1995; Brune and Bodenstein, 2005; McKenna and Oh, 2005), a lack of cohesion (Noel-Jorand et al., 1997), a lowered sensitivity to linguistic violations (Kuperberg et al., 1998) and a higher erroneousness in decoding communicative intent (Tenyi et al., 2002). Schizophrenia patients also appear to have a decreased ability to comprehend and express emotional prosody (Edwards et al., 2001; Ross et al., 2001), but no difficulty in comprehending and expressing non-emotional prosody (Murphy and Cutting, 1990). However, significant changes were observed in the study comparing spontaneous speech prosody in schizophrenia and fronto-temporal dementia patients (Martinez et al., 2015).

There is some evidence suggesting that patients with schizophrenia have dysfunctions of the RH and a number of papers have described the presence of language dysfunctions in schizophrenia spectrum disorders; however, few studies have examined selected aspects of higher-order language functions in homogeneous groups, and there is a dearth of research on a wide range of extralinguistic and paralinguistic dysfunctions, including the understanding and interpretation of metaphors or linguistic prosody, in one clinically homogenous group. Only one case study (Talarowska et al., 2012) has used a standardized neuropsychological test, the RHLB, to evaluate extralinguistic processing in schizophrenia patients. The purpose of this paper is twofold: to further investigate extralinguistic and paralinguistic dysfunctions in schizophrenia patients, and to make these assessments using a validated and standardized battery of tests. As examining a homogenous group of patients will allow the detection of specific language disturbances for a particular group of patients, decrease intragroup variability and increase the probability of detecting signs of dysfunction, the present study examines a homogenous group of schizophrenia patients. Our predictions are that most of the extralinguistic and paralinguistic functions will be decreased in schizophrenia subjects when compared to healthy controls, and that the RHLB could prove to be a validated tool in evaluating language and communication abnormalities in a group of schizophrenia patients. The presence of higher-order language dysfunctions might suggest the existence of abnormalities in RH functioning in that group of patients.

2. Materials and methods

2.1. Participants

Seventy-nine participants were enrolled: a schizophrenia sample consisting of 40 subjects and a control group of 39 subjects. The members of the schizophrenia group met the ICD-10 criteria for schizophrenia and were considered clinically stable by their physicians, i.e. they had been on the same oral antipsychotic therapy for the treatment of schizophrenia with a change in the Clinical Global Impression-Severity (CGI-S) (Guy, 1976) score of ≤1 for six or more weeks prior to enrolment. The mean duration of illness was 3.89 years (range: min. one year and three months, max. seven years). The severity of illness was evaluated with the PANSS (Positive and Negative Syndrome Scale) (Kay et al., 1987; Rzewuska, 2002) which was administered by a specialist psychiatrist (T.P. and M.K.-A.) who had undertaken intensive training in PANSS application. The background antipsychotic therapy and concomitant medications were chosen and titrated according to the Polish standards of pharmacotherapy of mental disorders (Jarema, 2015). Daily doses of antipsychotics used were converted into chlorpromazine equivalents using an equivalency table provided by Gardner et al. (Gardner et al., 2010). The average chlorpromazine equivalent dose for schizophrenia patients is given in Table 1.

The inclusion criteria for healthy controls were no psychiatric history and no family history of psychiatric illness. They were confirmed mentally healthy after an evaluation using a Polish version of the Mini International Neuropsychiatric Interview: M.I.N.I. (Sheehan et al., 1998). The exclusion criteria for all participants were as follows: a history of neurological or chronic somatic disorder, head injury, or alcohol or substance abuse or dependence. The groups were matched according to

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