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Impaired gesture performance in schizophrenia: Particular vulnerability of meaningless pantomimes

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ABSTRACT

Schizophrenia patients frequently present with subtle motor impairments, including higher order motor function such as hand gesture performance. Using cut off scores from a standardized gesture test, we previously reported gesture deficits in 40% of schizophrenia patients irrespective of the gesture content. However, these findings were based on normative data from an older control group. Hence, we now aimed at determining cut-off scores in an age and gender matched control group. Furthermore, we wanted to explore whether gesture categories are differentially affected in Schizophrenia. Gesture performance data of 30 schizophrenia patients and data from 30 matched controls were compared. Categories included meaningless, intransitive (communicative) and transitive (object related) hand gestures, which were either imitated or pantomimed, i.e. produced on verbal command. Cut-off scores of the age matched control group were higher than the previous cut-off scores in an older control group. An ANOVA tested effects of group, domain (imitation or pantomime), and semantic category (meaningless, transitive or intransitive), as well as their interaction. According to the new cut-off scores, 67% of the schizophrenia patients demonstrated gestural deficits. Patients performed worse in all gesture categories, however meaningless gestures on verbal command were particularly impaired ($p=0.008$). This category correlated with poor frontal lobe function ($p<0.001$).

In conclusion, gestural deficits in schizophrenia are even more frequent than previously reported. Gesture categories that pose higher demands on planning and selection such as pantomime of meaningless gestures are predominantly affected and associated with the well-known frontal lobe dysfunction.

1. Introduction

Schizophrenia patients may suffer from a variety of motor disturbances, such as neurological soft signs, parkinsonism, catatonia, abnormal involuntary movements, or psychomotor slowing (Docx et al., 2012; Walther & Strik, 2012). Motor disturbances may only be subtle, but are frequent in both medicated and unmedicated patients. Particularly, deficits in movement coordination or sequencing often go unrecognized without specific tests. Besides deficits in motor functioning, schizophrenia is often associated with cognitive impairment (Tandon, Nasrallah, & Keshavan, 2009).

Gesturing is a higher order motor function aiding nonverbal communication. Schizophrenia patients are impaired in imitating meaningless hand gestures (Matthews, Gold, Sekuler, & Park, 2013; Park, Matthews, & Gibson, 2008), produce fewer co-verbal gestures (Lavelle, Healey, & McCabe, in press; Mittal et al., 2006; Troisi, Spalletta, & Pasini, 1998), and have problems understanding nonverbal communication (Toomey, Schuldberg, Corrigan, & Green, 2002). Semantic categories of gestures used in examination are meaningless, transitive (i.e. related to object use) or intransitive (i.e. emblematic such as waving good bye) in nature. Furthermore, gestures can be tested in two domains: as pantomimes following verbal command or as imitation of demonstrated gestures. The term 'pantomime' has previously also been used to describe open hand demonstrations of tool use. However, throughout this paper, the term pantomime always refers to gesture production on verbal command.

Previously, we reported 40% of the schizophrenia patients to have a deficit performing pantomime gestures (Walther, Vanbellingen, Muri, Strik, & Bohlhalter, 2013). In this paper, we focused exclusively on the gesture domain (i.e. pantomime vs. imitation) irrespective of the semantic category of the tested gestures. The prevalence rates were determined by cut-off scores from a previous publication of the test of upper limb apraxia (TULIA) (Vanbellingen et al., 2010).

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However, these cut-off scores stem from a group of healthy elderly matched to a sample of brain damaged patients. In fact, gesture performance and gesture recognition decline with age (Mozaz, Crucian, & Heilman, 2009; Rodrigues Cavalcante & Caramelli, 2009). Therefore, the cut-off scores determined in an older population may be overestimated. In our previous studies mean age was 61 years in controls (Vanbellingen et al., 2010) and 40 years in schizophrenia patients (Walther et al., 2013). Hence, the aim of the present study was to first calculate TULIA cut-off scores for an age and gender matched control group and second to compare the gesture performance of the controls with schizophrenia patients. Furthermore, we wanted to explore for the first time whether gesture performance in schizophrenia was defective in each domain and every semantic category of the TULIA. As noted above, the previous analysis did not include a specific investigation of the three semantic categories of gestures. Since meaningless gestures are most difficult to produce in healthy subjects, we assumed that they were particularly challenging to patients (Carmo & Rumiati, 2009). In contrast, performance of intransitive or transitive gestures may be easier, since highly overlearned information may be engaged, that is more likely preserved in schizophrenia. In addition, we investigated associations of motor impairments or symptom severity with their performance in different gesture domains. We hypothesized that younger controls would have better performance and thus increase cut-off scores. As a consequence, performance of schizophrenia patients would be classified even poorer than previously reported. We expected patients to have more pronounced deficits during performance of meaningless gestures.

2. Methods

2.1. Subjects

In total, 30 patients with DSM-IV schizophrenia were included from our previous study (Walther et al., 2013). In addition, from a database of 67 healthy subjects 30 were matched for age and gender. These control subjects had participated in other studies using the TULIA (Bohlhalter et al., 2011; Vanbellingen et al., 2011). Matching was performed blind to the TULIA performance. Groups were not different in terms of age (patients: mean=40.2 years, controls: mean=42.2 years; $T=0.6$, $df=58$, $p=0.537$) and gender (both groups included 19 men and 11 women). Patients were recruited from the University Hospital of Psychiatry Bern, Switzerland. Diagnoses were given according following clinical interviews and review of all case files, according to the DSM-IV criteria. Exclusion criteria were substance abuse or dependence other than nicotine, history of head injuries with subsequent loss of conscience, medical or neurological impairments that would interfere with motor or praxis testing. Patients were on stable antipsychotic medication, except two who had been medication free at the time of testing. All participants were right-handed. The protocol adhered to the Declaration of Helsinki and had been approved by the local ethics committee. All participants provided written informed consent.

2.2. Measures

The structured TULIA assessment was recorded on video. The procedure of the TULIA is described elsewhere (Vanbellingen et al., 2010). Shortly, sitting face to face at a table subjects were instructed to imitate gestures demonstrated by the examiner or to pantomime gestures on verbal command. Special care was taken that every verbal instruction was understood by the participant. The TULIA consists of 48 items incorporating the imitation and pantomime of meaningless and communicative (emblematic and tool-related) gestures. Item ratings range from 0 to 5. In the lower range, 0–2, content errors (e.g. substitutions, perseverations), temporal and spatial errors (e.g. body-part-as-object errors, errors in spatial orientation, overshoot and extra movements, omissions) are included. The upper score range, 3–4, includes minor temporal and spatial errors, which are either corrected or not, affecting movement trajectory. The highest score, 5, is given for entirely correct gestures. The TULIA maximum score is 240. The anonymous video recordings of the participants were rated by an independent expert (T.V.) who never met the participants or had any information on their condition. Patients were tested on both arms, controls only on the left. Therefore, only the TULIA scores for the left arm entered the analyses. Patients were further assessed for motor symptoms and severity of schizophrenia using the Modified Rogers Scale (MRS) (Lund, Mortimer, Rogers, & McKenna, 1991) to assess catatonia, the Abnormal Involuntary Movement Scale (AIMS) (Guy, 1976), the Unified Parkinson's Disease Rating Scale motor part (UPDRS-3) (Fahn, Elton, & Members, 1987) for parkinsonism, the Positive And Negative Syndrome Scale (PANSS) (Kay, Fiszbein, & Opler, 1987), as well as the Frontal Assessment Battery (FAB) (Dubois, Slachevsky, Litvan, & Pillon, 2000).

2.3. Statistical analysis

Cut-off scores were determined in the control group by subtracting two standard deviations from the mean. The cut-off scores were calculated for all TULIA categories. Based on these cut-off scores, we determined the proportion of patients presenting with gesture deficits.

To further investigate differences between patients and controls, we computed a $2\times2\times3$ analysis of variance (ANOVA) using the TULIA scores with the factors group (patients vs. controls), domain (imitation vs. pantomime), and semantic categories (meaningless, intransitive, transitive). In a second step we calculated separate 2×3 ANOVAs (factors group and semantic category) for imitation and pantomime. Post-hoc tests were Bonferroni corrected. Partial correlations with correction for age and chlorpromazine equivalents (CPZ) were computed to test associations of the TULIA subscores with motor rating scales (MRS, AIMS, UPDRS-3), the FAB, PANSS positive, PANSS negative and the PANSS general psychopathology. These correlations were Bonferroni corrected for multiple comparisons in 42 tests ($p<0.0012$). Exploratory analyses correlated gesture performance with the 3rd item of the MMSE, in which patients had to spell backwards the word RADIO. This item was chosen because backward spelling requires verbal working memory. Statistical analyses were performed with SPSS 20.

3. Results

3.1. Cut-off values

The cut-off scores determined in the matched control group are given in Table 1. The new cut-off scores led to the classification of 23–60% of the patients as presenting with a deficit in the TULIA domains, and 67% had a deficit according to the TULIA total score. *Z*-scores indicated that most pronounced group differences can be observed in pantomimes as well as in both pantomime and imitation of meaningless gestures.

3.2. Differential gesture performance

3.2.1. Overall gestural impairment in schizophrenia

The $2\times2\times3$ ANOVA of the TULIA scores indicated significant main effects for group ($F=112.4$, $df=1, 360$, $p<0.001$), domain ($F=6.3$, $df=1, 360$, $p=0.013$), and semantic category ($F=18.9$, $df=2, 360$, $p<0.001$), as well as interactions of group × domain ($F=5.0$, $df=1, 360$, $p=0.026$), group × semantic category ($F=6.1$, $df=1, 360$, $p=0.002$), but not for group × domain × semantic category see Figure 1. In all of the above mentioned group comparisons, patients performed worse than controls (see Table 1). Main effect of domain favored imitation over pantomime. Main effect of semantic category demonstrated that intransitive gestures were performed better than meaningless ($p<0.001$) or transitive gestures ($p<0.001$).

3.2.2. Differential impairment of meaningless gesture pantomime in schizophrenia

Based on the significant interaction effects mentioned above we further explored the differential gestural performance between schizophrenic patients and controls by analyzing imitation and pantomime separately. Accordingly, the ANOVA of the imitation performance indicated an effect of group ($F=39.4$, $df=1, 180$, $p<0.001$), and an effect of semantic category ($F=7.4$, $df=2, 180$, $p=0.001$), but no interaction effect. Thus, the group difference in imitation performance is of comparable magnitude across semantic categories. By contrast, the ANOVA of the pantomime performance indicated not only significant main effects of group ($F=74.0$, $df=1$,