



Sense of agency and mentalizing: Dissociation of subdomains of social cognition in patients with schizophrenia

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ABSTRACT

The sense of agency, i.e., the sense that “I am the one who is causing an action”, and mentalizing, the ability to understand the mental states of other individuals, are key domains of social cognition. It has been hypothesized that an intact sense of agency is an important precondition for higher-level mentalizing abilities. A substantial body of evidence shows that both processes rely on similar brain areas and are severely impaired in schizophrenia, suggesting a close link between agency and mentalizing. Yet this relationship has not been explicitly tested. We investigated 40 individuals with schizophrenia and 40 healthy controls on an agency and mentalizing task. On the agency task, participants carried out simple mouse movements and judged the partially manipulated visual feedback as either self- or other-generated. On the mentalizing task, participants inferred mental states from pictures that depicted others' eyes (“Reading the mind in the eyes test”). Neuropsychological, psychopathological and social functioning levels were also evaluated. Both sense of agency and mentalizing were impaired in schizophrenia patients compared to healthy controls. However, testing for a relationship revealed no significant correlations between the two processes, either in the schizophrenia or the control group. The present findings demonstrate a dissociation of agency and mentalizing deficits in schizophrenia, suggesting that the multifaceted construct of social cognition consists of independent subdomains in healthy and psychiatrically ill individuals.

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1. Introduction

Disturbed social cognition, defined as the “perception, cognitive processing and interpretation of social information” (Penn et al., 1997) is regarded by many psychiatrists as a main feature of schizophrenia, resulting in impaired social skills and social alienation (Penn, et al., 1997; Brüne, 2005; Brüne and Brüne-Cohrs, 2006). Two core processes of social cognition have been intensely studied in patients with schizophrenia: “mentalizing” (also referred to as “theory of mind”) and “sense of agency” (Gallagher, 2000).

Sense of agency or “self-other distinction” is defined as the sense or identification of oneself as the agent of one's own actions. It enables the distinction between actions generated by oneself from those generated by others, and determines the feeling of being the author of an action (Gallagher, 2000, David et al., 2008b, Jeannerod, 2009). Experiments on the sense of agency are primarily philosophically or clinically motivated. Patients with schizophrenia may exhibit a specific group of symptoms, so-called first-rank symptoms, which include passivity symptoms such as thought insertion or delusions of

control (Blakemore et al., 2002). Patients with these symptoms experience others' actions as a consequence of their own intentions or attribute their own actions to external sources. Several authors have explained such delusions as a breakdown of the sense of agency (Frith and Done, 1988, Frith and Done, 1989, Frith, 1992, Blakemore, et al., 2002). However, schizophrenia patients without first-rank symptoms also show sense of agency impairments, albeit to a lesser degree (Daprati et al., 1997, Franck et al., 2001).

The ability to attribute mental states to oneself and other people, mentalizing (or “theory of mind”), allows a person to understand, manipulate and predict behavior (Frith and Corcoran, 1996). Schizophrenia patients show significant and stable mentalizing impairments as demonstrated in numerous studies (Harrington et al., 2005, Sprong et al., 2007, Bora et al., 2009). Mentalizing is commonly thought to be a complex social-cognitive process that depends on the development of several precursor mechanisms (Frith and Frith, 1999, Stone and Gerrans, 2006). Amongst other social-cognitive processes such as joint attention, gaze monitoring and the detection of animacy or intentional movements, the sense of agency has also been considered an important precursor to mentalizing (Bischof-Köhler, 1994, Abu-Akel, 2003, Decety and Chaminade, 2003), necessary to avoid confusion about one's own and another person's beliefs or feelings. More specifically, when someone demonstrates deficits in understanding another person's false beliefs,—before

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understanding that this person's belief is false—he first has to recognize and evaluate his own belief and understand that the other person may have a belief different from his own (Flavell, 1977, Flavell, 1999). This idea is supported by evidence from clinical populations in which both processes are subject to impairments, such as in schizophrenia. Moreover, in self-rating questionnaires, schizophrenia patients indicate lower levels of perspective taking compared to controls, but higher levels of personal distress when confronted with emotions of other people (Shamay-Tsoory et al., 2007, Fujiwara et al., 2008, Derntl et al., 2009, Haker and Rössler, 2009). This could be explained by impairments in the self-other distinction, and hence a disturbed sense of agency, which could hinder the appropriate understanding of another individual's perspective. This leads us to ask: are deficits in mentalizing a mere epi-phenomenon of an inability to differentiate or disengage from other people's mental states? What is the exact nature of the relationship between sense of agency and mentalizing? Although the self-other distinction seems fundamental to mentalizing, there is evidence suggesting that they represent two independent processes. Van Hooren et al. (2008) investigated the association between a range of social-cognitive processes, finding a lack of overlap between a sense of agency and mentalizing, and more broadly, between all the social-cognitive processes investigated. More specifically, David et al. (2008a) assessed the two processes in individuals with high-functioning autism and Asperger's Syndrome (HFA/AS), which is characterized by prominent deficits in social cognition and interaction. They showed dissociation between impaired mentalizing but an intact sense of agency in autism. In addition, evidence from functional imaging studies also suggests neurobiological dissociation or independence: David et al. (2006) for example reported that sense of agency and mentalizing, despite being assessed with the same stimulus material, showed no interaction at the neural level. In conclusion, it remains unclear whether these two processes represent two independent domains of social cognition or whether they can be conceptualized as interrelated processes. In order to further elucidate the exact nature of the relationship between the self-other distinction ability and mentalizing, and to reconcile results on dissociation between the two processes, we sought to study them in conjunction in both healthy and psychiatrically ill participants in whom impairments in both sense of agency and mentalizing processes have been shown. More specifically, we first assessed whether or not a relation between both processes could be detected by applying a widely used mentalizing test ("Reading the mind in the eyes test") and an established agency manipulation task (David et al., 2007, David et al., 2008a) in a sample of schizophrenia patients and a healthy control group. Deficits in both tasks or correlated task performance in the clinical population would strongly indicate a close relationship between sense of agency and mentalizing. Second, we aimed at assessing the influence of cognitive variables and levels of social functioning on sense of agency and mentalizing by using a comprehensive neuropsychological battery and a social functioning questionnaire (SDI), in order to reveal other variables suggesting a common functional basis.

2. Method

2.1. Participants

We recruited 40 patients (28 men and 12 women) who fulfilled the ICD-10 criteria for a diagnosis of schizophrenia and were in full or partial remission (ICD-10 F20.x4/x5) from the outpatient service of the Psychiatric University Hospital Zurich ($N=35$) and an inpatient ward of a Teaching Hospital of the University of Zurich, the "Sanatorium Kilchberg" ($N=5$). Of these 40 patients, 17 were diagnosed with schizophrenia of the paranoid type, 2 of the hebephrenic type and 21 of the undifferentiated type. Symptoms were rated on the day of testing by two trained psychologists using the German version of the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). A total of 33 out of 40 patients received antipsychotic medicine: mean chlorpromazine equivalents (CPZe) = 410.8 (S.D. = 360.3); CPZe for second generation antipsychotics were calculated following Woods (2003). We assessed the presence of first-rank-symptoms with the German version of the "ego-disturbance scale" from the "Working Group on Methodology and Documentation in psychiatry" instrument (AMDP) (Fähndrich and Renfordt, 1985,

Stieglitz and Fähndrich, 1988) containing the items: thought broadcasting, thought withdrawal, thought insertion, derealization, depersonalization and other symptoms of alien control. Each item was scored from 0 to 4, for a max. score of 24 in total. In addition, 40 healthy control participants (23 men and 17 women) were recruited from the University of Zurich campus ($N=15$), in adult education facilities ($N=20$) and among hospital staff ($N=5$).

Exclusion criteria for both groups included history of a traumatic brain injury or a neurological illness, the presence of a developmental disorder, cognitive impairment, habitual alcohol or drug abuse, vision reduction, lack of fluency in the German language and age less than 20 or over 55 years. Control participants with a history of psychiatric illness were excluded. Handedness (Edinburgh Handedness Inventory, Oldfield, 1971) and familiarity with computers (i.e., the number of hours per day spent at a computer) were assessed for each subject. Written informed consent was obtained from all participants. The study was approved by the local ethical committee and conducted in accordance with the guidelines of the Helsinki Declaration.

2.2. Materials and procedure

2.2.1. The agency task

The present task can be considered an established agency manipulation task closely based on previous agency paradigms (Fournoret et al., 2001, Franck et al., 2001, David, et al., 2007, David, et al., 2008a). Participants were seated in front of a computer screen to perform simple right-handed mouse movements towards a white object (i.e., an asterisk) which appeared either on the upper left or right side of the black screen. The movements were visible to the participants in the form of a cursor. The cursor movement or visual feedback matched the participants' executed movement only in 50% of the trials (real feedback: RF). In the other 50% a randomly selected movement from a previous trial of the subject was replayed (false feedback: FF); (for more details on the task, see David et al., 2007, 2008a). The cover story was that on several trials they would not see their own movements, but the experimenters' movements who performed the task in the next room. False movements could differ in onset, pace and path deviations. After each trial, the words "self" and "other" appeared on the screen. Participants were told to indicate whether they were the agent of the observed movement (self) or not (other) by pressing the corresponding button. Thus, a 2×2 design with the first factor feedback (real vs. false feedback) and the second factor evaluation (self vs. other) was employed (see Fig. 1). The task was administered on a DELL Optiplex 755 computer (1680×1050 resolution), using Presentation software (Neurobehavioral Systems, Albany, CA, USA). Prior to the experiment, participants practiced the task to get used to the trial procedure. The paradigm consisted of 200 trials, of which 100 were RF and 100 were FF (50 trials to the left and 50 to the right target). The task was conducted in three short runs of approximately 8 min.

After the experiment, participants completed a debriefing questionnaire in which they had to indicate (1) the cues (temporal, spatial or both) they had used to differentiate real and false feedback, (2) how fast they had detected the false feedback and (3) how difficult they found the task to be.

2.2.2. Mentalizing task

Mentalizing ability was assessed with the "Reading the mind in the eyes test" (Baron-Cohen et al., 2001), which is aimed at assessing first-order mentalizing abilities. The test consists of 36 pictures showing expressive pairs of male or female eyes. Each picture is presented with four choices of adjectives. Participants are asked to choose the adjective that best describes the mental state of the person (i.e., as expressed by his/her eyes). A global accuracy score according to Baron-Cohen et al. (2001) ranging from 0 to 36 was computed.

2.2.3. Neuropsychological assessment

All participants completed a neuropsychological battery which tapped into executive functions (Trail-Making Test, Parts A and B (Reitan, 1955) (TMT-A/B), verbal intelligence (Multiple Choice Vocabulary Test) (Lehrl, 2005), concentration and attention (d2) (Brickenkamp, 1994), selective attention and cognitive flexibility (Victoria Stroop Test) (Regard, 1981), word fluency (Aschenbrenner et al., 2000) and working memory (digit span, Wechsler Intelligence Scale for Adults) (Wechsler, 1997).

2.2.4. Social dysfunction index (SDI)

The SDI (Munroe-Blum et al., 1996) is a questionnaire consisting of nine scales to assess social functioning with respect to nine aspects: public self, independent living, occupational functioning, family relationships, important relationships other than family, community leisure recreation, acceptance and adherence to health regimens, communication and locus of control. The overall dysfunction is calculated as a percentage of total possible score.

2.3. Statistical analysis

All statistical analyses were performed using the software SPSS 16 for Windows. Level of significance was set at $P<0.05$ for two-tailed testing. Normal distribution of the data was verified by the Kolmogorov-Smirnov test. To investigate significant differences between patient and control groups, a one-way ANOVA was applied to dependent variables, given that the normality assumption was met; group differences on non-normally distributed data were analyzed using the non-parametric Mann-Whitney *U*-Test.

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