

## PRAGMATIC LANGUAGE ABILITIES, MENTALISING SKILLS AND EXECUTIVE FUNCTIONING IN SCHIZOPHRENIA SPECTRUM DISORDERS

Britta Binz and Martin Brüne

### Abstract

**Objective:** Several studies have shown that patients with schizophrenia spectrum disorders (SSD) have difficulties in appreciating the pragmatic rules of language. However, the underlying neurocognitive deficits are only partially known. In this study we investigated the relationship between the violation of pragmatic maxims (both regarding encoding and decoding of speech) and impairments in mentalising ability and executive functioning in patients with SSD.

**Method:** Forty-nine patients and 29 healthy subjects were asked to describe in their own words six cartoon picture stories depicting social interactions between two or three characters.

We evaluated participants' descriptions regarding the Gricean maxims of "quantity" and "relation" as an estimate of encoding relevant information. Pragmatic language comprehension (decoding) was investigated using a proverb test. Finally, we assessed the participants' mentalising abilities using the same cartoons, as well as general intelligence and executive functioning.

**Results:** The patient group differed from controls both with regard to quantity and relation in free descriptions of the cartoon stories. Patients interpreted proverbs literally, as opposed to controls, and performed more poorly on mentalising and executive functioning tasks. In the patient group, multiple correlations between pragmatic language use, proverb comprehension, mentalising and executive functioning were found, where mentalising predicted the maxim of relation best.

**Conclusions:** In patients with SSD, the ability to follow pragmatic rules of conversation depends on their mentalising skills.

**Key Words:** pragmatics, free narratives, mentalising, executive functioning, schizophrenia

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**Declaration of interest:** none

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### Introduction

For at least a century, psychiatrists have recognised that patients diagnosed with "dementia praecox" or schizophrenia are impaired in their ability to comprehend metaphorical speech (e.g., Finckh 1906). Moreover, spoken language of patients with schizophrenia is often characterised by a marked bluntness and lack of figurative language elements, which has been attributed to formal thought disorder and conceptual disorganisation (Vigotsky 1934). More recent accounts have interpreted such deficits in schizophrenia spectrum disorders (SSD) as violations of pragmatics rather than syntax and semantics (Andreasen et al. 1985, Frith and Allen 1988), affecting both the ability to decode and to encode the relevant information of verbal material.

The term "pragmatics" refers to the ability to follow certain "maxims" during conversation. These

maxims, put forth by the English philosopher H. Paul Grice (1975), comprise four principles that usually characterise a dialogue between two or more individuals, based on the assumption that interlocutors cooperate with one another (Sperber and Wilson 1987). These principles are referred to as the maxims of "quantity", "quality", "relation", and "manner" (Grice 1975). "Quantity" implies to be informative, but not to provide information that is unnecessary. The maxim of "quality" requires statements which are true and for which the speaker has good evidence. The maxim of "relation" indicates that an utterance should be relevant and to the point. Finally, the maxim of "manner" relates not to the "what", but to the "how", that is, ambiguity, circumstantiality and impoliteness should be avoided (Grice 1975, Sperber and Wilson 2002).

Psychopathological signs and symptoms associated with SSD often reflect pronounced difficulties in appreciating the Gricean maxims of

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conversation. For example, patients with formal thought disorder often give irrelevant information, which clinically appears as derailment or incoherence (Abu-Akel 1999). Similarly, unstructured thinking and lack of social knowledge may lead to violations of the maxims of relation and manner (Cutting and Murphy 1990a, b), whereas the maxim of quality is flouted by deficits in content-related thinking (Alexander et al. 1989).

Recent research suggests that violations of the Gricean maxims of conversation in SSD are associated with distinct neurocognitive deficits. For example, to follow pragmatic maxims depends on one's ability to decipher the meaning of a conversational partner's speech, because information conveyed by verbal material is usually encrypted rather than literal (Sperber and Wilson 1995, Langdon et al. 2002). Accordingly, the actual content of an utterance must, in part, be extracted by using the ability to adopt the mental perspective of one's interlocutor. This so-called "mentalising" ability, also known under the term "theory of mind", is central to represent one's own and other persons' thoughts, feelings, intentions or knowledge states (Premack and Woodruff 1978, Leslie 1987, Rowe et al. 2001). Likewise, when encoding a certain meaning, a person needs to take into account what his or her interlocutor knows or does not know (Abu-Akel 1999), otherwise one's utterance is incomprehensible to others. In light of the obvious relationship between mentalising and pragmatics, it has been suggested that human language could not have evolved without the capacity to reflect upon one's own and others' mental states (Sperber and Wilson 2002).

Numerous studies into SSD have shown that patients with SSD have deficits in mentalising skills that are partly associated with neurocognitive abilities such as intelligence or executive functioning (Corcoran et al. 1995; Frith and Cocoran 1996; Cocoran et al. 1997; Sarfati et al. 1997a, b; Doody et al. 1998; Sarfati et al. 2000; Pickup and Frith 2001; Roncone et al. 2002; Brüne 2003a, b; Frith 2004), but to some degree independent of cognitive functioning (Langdon et al. 2002, Brunet et al. 2003, Janssen et al. 2003, Linscott 2005), such that mentalising deficits in SSD are seen as selective, depending on the subtype of the disorder (Abdel-Hamid et al. 2009). It would therefore seem to be straightforward to examine the possible association of mentalising deficits with poor pragmatics in SSD; however, only a few studies have actually addressed this issue (De Decker and van de Craen 1987, Cocoran and Frith 1996, 2003, Mitchley et al. 1998, Abu-Akel 1999, Tenyi et al. 2002). For example, Langdon and colleagues (2002) observed that poor mentalising skills were linked to a compromised comprehension of ironical statements, but not to the understanding of metaphorical expressions (see also, Mitchley et al. 1998). In partial contrast, Brüne and Bodenstein (2005) found that the understanding of metaphors, at least in the form of proverbial expressions, critically depended on schizophrenia patients' mentalising abilities, which they believed was related to the fact that at least some proverbs (e.g., "a fox who wants to catch geese wags his tail") express hidden intentions (Brüne and Bodenstein 2005).

With regard to the encoding aspect, Abu-Akel

(1999) argued that violations of the Gricean maxims might be related to excessive mentalising, rather than to a mentalising deficit. An analysis of the conversation between patients with disorganised schizophrenia and their therapists revealed that the former incorrectly inferred that their therapists knew details about the patients' lives that the therapists actually could not know (Abu-Akel 1999). Clinically, such conversation appears "disorganised" reflecting formal thought disorder.

A couple of other studies have focussed on the relationship between neurocognition and pragmatic language comprehension. For example, Thoma and colleagues (2009) found that the application of pragmatic conversation maxims correlated with executive functioning in schizophrenia. Specifically, divided attention was related to proverb comprehension abilities, even when the effect of IQ was partialled out (Thoma et al. 2009). Other studies found evidence for an association of working memory, executive planning skills, set shifting and problem solving performance to proverb comprehension in schizophrenia (Sponheim et al. 2003, Kiang et al. 2007).

In spite of the evidence that pragmatic abilities in SSD are linked to mentalising skills and executive functioning, existing research has assessed these cognitive domains in isolation, that is, no studies have examined the ability to apply pragmatic maxims (encoding), the deciphering of metaphorical speech (decoding), mentalising and executive functioning in the same sample. In the present study, we therefore sought to examine pragmatic language use, proverb comprehension, mentalising skills, and executive functioning in patients with SSD. Based on Abu-Akel's (1999) work, we focused on the maxims of "quantity" and "relation", since these can be operationalised and quantified best in spontaneous speech. We predicted that violations of these maxims would be most strongly associated with impaired proverb understanding and mentalising deficits.

## Methods

### *Participants*

Forty-nine patients (25 women) with SSD, diagnosed according to DSM-IV criteria (American Psychiatric Association 2000), and 29 persons (19 women) from the general population as a non-psychiatric control group were examined. All subjects gave written informed consent after having received detailed information about the aim of the study. Twenty patients had paranoid schizophrenia, 8 disorganised schizophrenia, 4 patients had catatonic schizophrenia, 7 were classified as undifferentiated. One patient suffered from residual schizophrenia, 9 patients had schizoaffective disorder.

The mean age of the patient group was 37.3 ( $\pm 11.4$ ) years (28 – 68 years). The mean duration of illness was 9.2 ( $\pm 8.2$ ) years (0–33 years). All patients received second-generation antipsychotic drugs: The mean chlorpromazine equivalent dose (Woods 2003) was 671.2 mg (0 – 3333). Exclusion criteria were traumatic brain disorders, intellectual disability and substance dependence. The control group was recruited from the

general population. It included 19 female and 10 male subjects with a mean age of 37.0 ( $\pm 13.7$ ) years (19–65 years). They had never suffered from schizophrenia or any other psychiatric disorder. None of the subjects received medication or had first grade relatives with a psychotic disorder. **Table 1** shows the demographic variables of the patient and control groups.

## Neuropsychological measures

### *Assessment of Gricean maxims*

For the assessment of the Gricean maxims of quantity and relation we recorded a free description of six cartoon stories depicting cooperation between 2 characters, intentional deception of one character by another, and two stories combined showing 2 characters cooperating at the expense of a third. The narratives were analysed by two raters (BB and MB) for violations of the Gricean maxims of quantity and relation. For the assessment of quantity we counted the number of words within the descriptions, arguably a simplistic approach that however vague, allows an estimation of participants' ability to provide relevant but not unnecessary information. Concerning the maxim of relation we examined for the number of deviations from the topic. In case of divergent assessment between the two raters, a consensus was made after re-evaluating the audio-taped narrative.

### *Comprehension of metaphorical language*

The proverb-metaphor-test (Barth and Küfferle 2001) was used to examine the patients' level of concretistic thinking. The task comprises 14 proverbs, which are given in the form of a multiple-choice test. Subjects are asked to select the correct interpretation from 5 given alternatives. The test offers five types of answers to a proverbial saying: Type 1 (the correct

choice) is meaningful and abstract; type 2 is meaningful and partly concretistic; type 3 is meaningful and concretistic; type 4 is meaningless and concretistic; type 5 is meaningless and abstract.

### *Intelligence*

Verbal intelligence was assessed using the multiple-choice verbal comprehension test (MWT-B; Lehrl et al. 1995), practical intelligence was measured using the picture completion subtest taken from the Hamburg-Wechsler intelligence test for adults (HAWIE- R; Wechsler 1955/1982; Tewes 1991).

### *Executive functioning*

For the assessment of executive functioning as an indicator of cognitive flexibility, the Wisconsin Card Sorting Test was used in a simplified, computerised version (Heaton et al. 1993). Furthermore, planning abilities were analysed using the Zoo Map test of the Battery for the Assessment of the Dysexecutive Syndrome (BADS; Wilson et al. 1996).

### *Mentalising*

The ability to recognise mental states of other persons was evaluated using the same cartoons that were used for the free descriptions (Brüne 2003). This task has previously been used several times in patients with schizophrenia or SSD (e.g., Brüne et al. 2007).

In the version employed in this study, subjects were asked to sequence 6 cartoon stories, consisting of 4 pictures each. Two stories showing "physical" sequences of events were given as exercise. Ratings were adopted from Langdon et al. (1997). In addition, a mentalising questionnaire comprising 23 questions was given to the subjects in order to test the participants' ability to appreciate the mental states of the characters

**Table 1.** Demographic characteristics of patients with schizophrenia spectrum disorders (SSD) and the healthy control group

|                     | SSD           | Controls      | Significance |
|---------------------|---------------|---------------|--------------|
| N                   | 49            | 29            |              |
| F : M ratio         | 25:24         | 19:10         | P = .215     |
| mean age (in years) | 37.76 (18-68) | 37.00 (19-65) | P = .786     |
| duration of illness | 8.80 (0-33)   | --            |              |
| years of education  | 10.71 (6-13)  | 12.28 (8-13)  | P < .001     |

involved in the cartoon stories (Brüne 2003). The questions referred to the mental states of the characters of the picture stories according to different levels of complexity. For example, a so-called 'first order question' was: "What do you think (1) this person (pointing to the respective character) intends?" An example of a second order question was: "What do you think (1) this person believes (2) the other intends to do?" Overall, questions addressed the participants' ability to recognise cooperation, deception, to detect cheating and to comprehend true and false beliefs of the characters in the picture stories. The maximal score for the correct sorting of the cartoons was 36 points, for the questionnaire section it was 23 points. Thus, the maximal total score was 59 points.

### *Psychopathology*

For the evaluation of psychopathology the Positive and Negative Syndrome Scale (PANSS; Kay et al. 1987) was used.

### *Statistical analysis*

Statistical analysis was performed using SPSS Version 17.0 for Windows. Depending on normal distribution we used Student's t-test or non-parametrical Mann-Whitney U-tests. Correlative relationships were determined according to Pearson or Spearman. A linear regression was performed for the relationship between the maxim of "relation" and neurocognitive functioning.

## **Results**

### *Demographic variables*

No significant difference concerning age or sex distribution could be detected between patients with SSD and the healthy control group. The groups, however, differed with respect to the length of education (**Table 1**).

### *Gricean maxims*

Analyses of the Gricean maxims of quantity and relation showed significant differences between the patient group and the control group (for quantity: Mann-Whitney-U = 290.500,  $Z = -3.286$ ,  $P = .001$ ; for relation: Mann-Whitney-U = 305.000,  $Z = -2.948$ ,  $P = .003$ ). Patients used significantly fewer words to describe the stories and violated the maxim of relation more frequently by reporting unnecessary details or speculating about the content.

### *Comprehension of metaphorical language*

Patients with SSD had significantly greater difficulties to understand the metaphoric content of the proverbial material (Mann-Whitney-U = 185.00,  $Z = -5.392$ ,  $P < .001$ ). Patients chose the correct explanation

less often ( $7.61 \pm 4.58$ ) compared to controls (mean score  $13.00 \pm 2.41$ ).

### *Intelligence*

Significant differences between the groups were detected for both verbal and practical intelligence. A univariate ANOVA showed a significant difference between the two groups for verbal intelligence ( $F = 6.123$ ,  $df = 1$ ,  $P = .016$ ). Moreover, the non-parametrical Mann-Whitney test revealed a significant difference for the picture completion test in the HAWIE (Mann-Whitney-U = 379.500,  $Z = -3.146$ ,  $P = .002$ ).

### *Executive functioning*

With respect to executive functioning in the WCST the patient group showed a significantly higher rate both in errors ( $F = 14.456$ ,  $df = 1$ ,  $P < .001$ ) and number of perseverative errors (Mann-Whitney-U = 274.500,  $Z = -4.293$ ,  $P < .001$ ). Planning abilities as assessed using the zoo map task from the BADS were also significantly worse than those of the control group ( $F = 25.826$ ;  $df = 1$ ,  $P < .001$ ).

### *Mentalising*

In the mentalising test, the questionnaire section with a maximum of 23 points on the one hand, and the total score with a maximum of 59 points on the other, were computed. For both parameters the Mann-Whitney U Test showed a highly significant difference between the patients and the healthy subjects (questionnaire: Mann-Whitney-U = 336.0,  $Z = -3.944$ ,  $P < .001$ ; overall score: Mann-Whitney-U = 273.5,  $Z = -4.459$ ,  $P < .001$ ).

### *Psychopathology*

Concerning the evaluation of psychopathology by means of the PANSS, the patients with SSD exhibited a mean of 17.42 ( $SD \pm 5.02$ ) for positive symptomatology and a means of 20.17 ( $SD \pm 7.39$ ) for negative symptomatology. As expected, the comparison between patients and healthy subjects showed significant differences (PANSS pos: Mann-Whitney-U = 34.000,  $Z = -6.980$ ,  $P < .001$ ; PANSS neg: Mann-Whitney-U = 39.000,  $Z = -6.940$ ,  $P < .001$ ). The group differences are summarised in **Table 2**.

### *Specificity of group differences*

In order to explore whether the differences between patients with SSD and controls regarding the Gricean maxims of relation and quantity depended on neurocognitive functioning, we computed univariate ANOVAs using intelligence, proverb comprehension, mentalising performance and executive functions as co-variables. Although the application of ANOVA to non-normally distributed variables is not optimal, it is



**Table 2.** Characteristics of both groups concerning violations of Gricean maxims, intelligence, executive functioning, mentalising, proverb comprehension, and psychopathology

|                         | SSD                  | Controls             | Significance |
|-------------------------|----------------------|----------------------|--------------|
| Maxim of relation       | 2.10 ( $\pm$ 1.533)  | 1.05 ( $\pm$ 0.653)  | P = .003     |
| Maxim of quantity       | 1.81 ( $\pm$ 1.875)  | 0.36 ( $\pm$ 0.953)  | P = .001     |
| Verbal IQ               | 103.9 ( $\pm$ 13.21) | 111.6 ( $\pm$ 13.44) | P = .016     |
| IQ (HAWIE subtest)      | 11.2 ( $\pm$ 3.43)   | 13.6 ( $\pm$ 2.23)   | P = .002     |
| WCST errors             | 9.23 ( $\pm$ 4.65)   | 5.50 ( $\pm$ 3.00)   | P < .001     |
| WCST perseverations     | 3.30 ( $\pm$ 3.79)   | 0.89 ( $\pm$ 1.40)   | P < .001     |
| Zoo Map Test            | 0.21 ( $\pm$ 3.60)   | 4.54 ( $\pm$ 3.55)   | P < .001     |
| Mentalising quest.      | 18.98 ( $\pm$ 3.881) | 21.90 ( $\pm$ 1.398) | P < .001     |
| Mentalising total score | 47.08 ( $\pm$ 9.312) | 55.66 ( $\pm$ 3.528) | P < .001     |
| Proverb comprehension   | 7.61 ( $\pm$ 4.578)  | 13.00 ( $\pm$ 2.405) | P < .001     |
| PANSS positive          | 17.42 ( $\pm$ 5.02)  | 8.59 ( $\pm$ 1.45)   | P < .001     |
| PANSS negative          | 20.17 ( $\pm$ 7.39)  | 8.28 ( $\pm$ 1.87)   | P < .001     |
| PANSS general           | 35.27 ( $\pm$ 7.81)  | 19.38 ( $\pm$ 3.44)  | P < .001     |
| PANSS sum score         | 72.85 ( $\pm$ 16.24) | 36.28 ( $\pm$ 4.88)  | P < .001     |

HAWIE: Hamburg-Wechsler Intelligence Test; PANSS: Positive and Negative Syndrome Scale; WCST: Wisconsin Card Sorting Test; Mentalising quest.: Mentalising questionnaire.

nonetheless a robust method for an at least approximate determination of the influence of the given covariates.

For the maxim of relation, the group difference disappeared when controlling for executive planning skills, as measured using the Zoo Map test. Likewise, differences became non-significant when mentalising and proverb comprehension were co-varied out (all  $P > .05$ ). In contrast, the differences with regard to the maxim of relation remained when verbal IQ ( $F=4.756$ ;  $P=.033$ ) or the number of perseverative errors in the WCST ( $F=4.082$ ;  $P=.047$ ) were controlled for. Regarding the maxim of quantity, group differences remained significant when proverb comprehension ( $F=6.373$ ;  $P=.014$ ), the number of perseverative errors in

the WCST ( $F=5.778$ ;  $P=.019$ ) or verbal IQ ( $F=8.513$ ;  $P=.005$ ) were co-varied out.

### *Correlations within the patient group*

Concerning the violation of the Gricean maxim of relation, a significant correlation with the number of correctly interpreted proverbs could be found for the patient group ( $r=-.38$ ,  $P=.01$ ). Also, the number of violations of the Gricean maxim of relation correlated with the sequencing task ( $r=-.424$ ,  $P=.003$ ), the questionnaire of the mentalisation task ( $r=-.788$ ,  $P<.001$ ) and thus the total score of the mentalising task ( $r$

**Table 3.** Correlations (Spearman's rho shown in *italics*) between violations of the Gricean maxims of *Quantity and Relevance with mentalising, proverb comprehension, executive functioning and demographic data within the patient group*

|                          | Age at onset      | Dur. of illness   | Maxim of Quantity | Maxim of Relation | Mentalising       | Proverbs          | MWT IQ            | WCST□pers         | Zoo Map Test     | HAWIE picture completion | PANSS pos        | PANSS neg         | PANSS global      | PANSS sum        | CPZ             |
|--------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|--------------------------|------------------|-------------------|-------------------|------------------|-----------------|
| Age at onset             |                   | -.401**<br>(.005) | .057<br>(.703)    | -.002<br>(.991)   | -.253<br>(.087)   | -.021<br>(.893)   | -.221<br>(.132)   | .123<br>(.414)    | -.090<br>(.545)  | -.059<br>(.702)          | .066<br>(.660)   | -.333*<br>(.022)  | -.161<br>(.279)   | -.208<br>(.160)  | .236<br>(.123)  |
| Dur. of illness          | -.401**<br>(.005) |                   | -.065<br>(.666)   | .238<br>(.107)    | .034<br>(.818)    | -.205<br>(.177)   | .027<br>(.855)    | -.009<br>(.952)   | -.094<br>(.531)  | .031<br>(.841)           | .055<br>(.713)   | .113<br>(.450)    | .119<br>(.426)    | .125<br>(.401)   | -.175<br>(.256) |
| Maxim of Quantity        | .057<br>(.703)    | -.065<br>(.666)   |                   | .608**<br>(.000)  | -.372*<br>(.010)  | -.143<br>(.349)   | -.204<br>(.165)   | .195<br>(.193)    | -.275<br>(.061)  | -.261<br>(.084)          | .108<br>(.469)   | .192<br>(.195)    | .133<br>(.374)    | .299<br>(.121)   | .043<br>(.782)  |
| Maxim of Relation        | -.002<br>(.991)   | .238<br>(.107)    | .608**<br>(.000)  |                   | -.660**<br>(.000) | -.380*<br>(.010)  | -.461**<br>(.001) | .317*<br>(.032)   | -.320*<br>(.028) | -.481**<br>(.001)        | .096<br>(.521)   | .366*<br>(.011)   | .264<br>(.073)    | .353*<br>(.015)  | -.131<br>(.396) |
| Mentalising              | -.253<br>(.087)   | -.372*<br>(.010)  | -.372*<br>(.010)  | -.660**<br>(.000) |                   | .432**<br>(.003)  | .539**<br>(.000)  | -.579**<br>(.000) | .536**<br>(.000) | .592**<br>(.000)         | -.191<br>(.198)  | -.299*<br>(.041)  | -.288*<br>(.050)  | -.336*<br>(.021) | .088<br>(.564)  |
| Proverbs                 | -.021<br>(.893)   | -.205<br>(.177)   | -.143<br>(.349)   | -.380*<br>(.010)  | .432**<br>(.003)  |                   | .350*<br>(.017)   | -.294*<br>(.050)  | .221<br>(.145)   | .467**<br>(.002)         | -.309*<br>(.036) | -.154<br>(.307)   | -.382**<br>(.009) | -.348*<br>(.018) | .099<br>(.534)  |
| MWT IQ                   | .221<br>(.132)    | .027<br>(.855)    | -.204<br>(.165)   | -.461**<br>(.001) | .539**<br>(.000)  | .350*<br>(.017)   |                   | -.369*<br>(.011)  | .330*<br>(.022)  | .545**<br>(.000)         | -.057<br>(.698)  | -.440**<br>(.002) | -.144<br>(.328)   | -.291*<br>(.044) | -.219<br>(.149) |
| WCST□pers                | .123<br>(.414)    | -.009<br>(.952)   | .195<br>(.193)    | .317*<br>(.032)   | -.579**<br>(.000) | -.294*<br>(.050)  | -.369*<br>(.011)  |                   | .587**<br>(.000) | -.479**<br>(.001)        | -.013<br>(.929)  | .230<br>(.119)    | .166<br>(.264)    | .217<br>(.144)   | .053<br>(.736)  |
| Zoo Map Test             | -.090<br>(.545)   | -.094<br>(.531)   | -.094<br>(.531)   | -.320*<br>(.028)  | .536**<br>(.000)  | .221<br>(.145)    | .330*<br>(.022)   | -.587**<br>(.000) |                  | .247**<br>(.003)         | -.111<br>(.457)  | -.183<br>(.218)   | -.178<br>(.231)   | -.205<br>(.168)  | .023<br>(.883)  |
| HAWIE picture completion | -.059<br>(.702)   | .031<br>(.841)    | .031<br>(.841)    | -.481**<br>(.001) | .592**<br>(.000)  | .467**<br>(.002)  | .545**<br>(.000)  | -.479**<br>(.001) | .247**<br>(.003) |                          | -.083<br>(.589)  | -.135<br>(.378)   | -.081<br>(.598)   | -.123<br>(.420)  | .129<br>(.416)  |
| PANSS pos                | .066<br>(.660)    | .055<br>(.713)    | .055<br>(.713)    | .108<br>(.469)    | -.191<br>(.198)   | -.309*<br>(.036)  | -.057<br>(.698)   | -.013<br>(.929)   | -.111<br>(.457)  | -.083<br>(.589)          |                  | .081<br>(.585)    | .484**<br>(.000)  | .579**<br>(.000) | .094<br>(.544)  |
| PANSS neg                | -.333*<br>(.022)  | .113<br>(.450)    | .113<br>(.450)    | .192<br>(.195)    | -.299*<br>(.041)  | -.154<br>(.307)   | -.440**<br>(.002) | .230<br>(.119)    | -.183<br>(.218)  | -.135<br>(.378)          | .081<br>(.585)   |                   | .685**<br>(.000)  | .809**<br>(.000) | -.100<br>(.518) |
| PANSS global             | -.161<br>(.279)   | .119<br>(.426)    | .119<br>(.426)    | .264<br>(.073)    | -.288*<br>(.050)  | -.382**<br>(.009) | -.144<br>(.328)   | .166<br>(.264)    | -.178<br>(.231)  | -.081<br>(.598)          | .484**<br>(.000) | .685**<br>(.000)  |                   | .942**<br>(.000) | .012<br>(.937)  |
| PANSS sum                | -.208<br>(.160)   | .125<br>(.401)    | .125<br>(.401)    | .299<br>(.121)    | -.336*<br>(.021)  | -.348*<br>(.018)  | -.291*<br>(.044)  | .217<br>(.144)    | .023<br>(.883)   | .579**<br>(.000)         | -.123<br>(.420)  | .809**<br>(.000)  | .942**<br>(.000)  |                  | -.010<br>(.946) |
| CPZ                      | .236<br>(.123)    | -.175<br>(.256)   | .043<br>(.782)    | -.131<br>(.396)   | .088<br>(.564)    | .099<br>(.534)    | -.219<br>(.149)   | .053<br>(.736)    | .023<br>(.883)   | .129<br>(.416)           | .094<br>(.544)   | -.100<br>(.518)   | .012<br>(.937)    | -.010<br>(.946)  |                 |

CPZ: Chlorpromazine equivalents; HAWIE picture completion: Picture completion task taken from the Hamburg Wechsler Intelligence Test for Adults – revised version (Tewes, 1991); MWT IQ: IQ screening test (Lehrl et al., 1995); PANSS: Positive and Negative Syndrome Scale (KAY et al., 1987); Proverbs: Proverb comprehension; Zoo Map Test from the BADS (Wilson et al., 1996).

\* Correlation is significant at the .05 level (two-tailed)

\*\* Correlation is significant at the .01 level (two-tailed)

= -.660,  $P < .001$ ). Moreover, a significant correlation was found between the number of violations of relation and the PANSS negative score ( $r = .366$ ,  $P = .011$ ). In contrast, the maxim of quantity correlated weaker with the mentalising scores; the coefficient with the sequencing task was ( $r = -.256$ ,  $P = .082$ , n.s.), with the questionnaire section ( $r = -.349$ ,  $P = .015$ ), and with the total score ( $r = -.372$ ,  $p = .01$ ).

Additional correlation coefficients are summarised in Table 3.

Due to ceiling effects in the mentalisation task and in the proverb comprehension task we did not carry out correlational analyses for the healthy control group.

### Partial correlations

To control for IQ concerning the Gricean maxim of relation and the correct answers in the proverb test, we conducted partial correlations. Accordingly, when verbal IQ was controlled for, the correlation between the maxim of relation and proverb comprehension ( $r = -.221$ ,  $P = .149$ ) disappeared; however, the relationship between the maxim of relation and mentalising (total score) remained significant ( $r = -.549$ ,  $P < .001$ ). The robustness of this association could be confirmed by the inclusion of the two intelligence parameters and the variables related to executive functioning as covariates in a partial correlation ( $r = -.444$ ,  $P = .005$ ). While the correlative associations between mentalising and proverb comprehension persisted when verbal IQ executive functioning was controlled for, it disappeared when the picture completion task from the HAWIE was included ( $r = .225$ ,  $P = .180$ ). If one included school education as another control parameter in all correlations, the correlative associations remained significant (Gricean maxim of relation/mentalising:  $r = -.614$ ,  $P < .001$ ; Gricean maxim of relation/ proverb comprehension:  $r = -.309$ ,  $P = .043$ ; mentalisation/ proverb comprehension:  $r = .428$ ,  $P = .004$ ).

### Linear regression analysis to predict performance in the maxim of "relation"

To further analyse the influence of neurocognitive measures and mentalising skills on the maxim of relation in the patient group, we performed a stepwise linear regression analysis including IQ, the number of perseverative errors on the WCST, executive planning skills, proverb comprehension and the mentalising score into the equation. The full model was highly significant (corrected R-square .483,  $F = 40.190$ ,  $df = 1$ ,  $P < .001$ ). As predicted, the mentalising score was the only variable that was included to predict the maxim of "relation" ( $B = -.122$ ,  $\beta = -.704$ ,  $P < .001$ ). All other variables were excluded as non-significant predictors.

### Discussion

In the present study we investigated the relationship between pragmatic language skills – measured on the basis of the Gricean maxims of quantity and relation – and mentalising ability as well as

neurocognitive parameters and psychopathology in patients with SSD who were moderately severely ill at the time of testing. In line with predictions, we found significant differences between patients with SSD and healthy controls regarding the maxims of quantity and relation in free descriptions of social interactions. Although influenced by neurocognitive performance in complex ways, within the patient group the greatest association of violations of the maxims "relation" and "quantity" was found with impaired mentalising. This finding is in accordance with previous studies. For example, Abu-Akel (1999) was able to show in an extensive case study that patients with disorganised schizophrenia exhibited violations regarding the Gricean maxims in manifold ways. Specifically, patients incorrectly attributed knowledge to their interlocutors (therapists), which the therapists did not have. This over-attribution of mental states ("hyper-mentalising") disrupted conversation between patient and therapist, because it caused violations of the maxims of "quantity" and "relation" (Abu-Akel 1999). Similarly, Tenyi et al. (2002) found that schizophrenic patients were significantly less well able to recognise violations of the maxim of relation compared to a group of healthy control subjects. Corcoran and Frith (1996) arrived at the same conclusion, in particular with regard to patients with negative symptomatology. Associations of Gricean maxims with mentalising abilities in schizophrenia have also been reported in several other studies that converge to suggest that both encoding and decoding of language is severely compromised in schizophrenia, and that these difficulties to a great extent reside in deficits in mentalising (De Decker and van de Creen 1987; Cocoran and Frith 1996, 2003; Cocoran et al. 1997; Mitchley et al. 1998; Pickup and Frith 2001; Doody et al. 2002; Langdon et al. 2002; Tenyi et al. 2002; Hardy-Bayle et al. 2003; Keri et al. 2004; Mazza et al. 2001, 2008).

In the present study, differences between patients with SSD and controls persisted with respect to violations of the maxim of "relation", even when verbal IQ and cognitive flexibility were co-varied out; group differences disappeared, however, when executive planning skills and mentalising were considered. This finding corroborates previous accounts highlighting the importance of both mentalising and executive functioning for the ability to appreciate pragmatic language rules (Sponheim et al. 2003; Brüne and Bodenstein 2005; Kiang et al. 2007; Thoma et al. 2009). Moreover, within the patient group a significant correlation was found between the violation of "relation" and mentalising. Furthermore, in a linear regression analysis revealed that mentalising skills were the best (and only significant) predictor of the maxim of "relation" in the patient group. This suggests that – similar to what we have previously found with regard to mentalising in patients with SSD (Brüne et al. 2007) – that there is an intimate link of mentalising with executive planning that now seems to extend to patients' application of conversational maxims in story narratives. Our results therefore support the hypothesis put forth by Sperber and Wilson (2002), who postulated intact mentalising abilities as a precondition for the obedience to pragmatics, that is, one must be able to appreciate an interlocutor's mental state in order to

follow the cooperative rules of conversation.

Contrary to our hypothesis, we could not find a clear relationship between the violation of pragmatic rules of language and the comprehension of metaphorical speech in proverbial material. Although there was a correlation between these two variables within the patient group, this association was no longer detectable when intelligence and executive functioning were controlled. This suggests that encoding and decoding of speech are not that intimately linked. Rather, it seems that the ability to provide relevant information in free narratives (i.e. to follow the maxim of “relation”) does not necessarily mean that patients with SSD are able to extract the figurative meaning of speech as, for example, in proverbial expressions. This finding could be of potential clinical importance, because in clinical discourse, therapists may not take for granted that patients always grasp the meaning of a therapeutic intervention, even if they are capable of producing coherent speech in therapeutic interaction.

Taken together, the present investigation found a clear relationship between cognitive flexibility and the comprehension of metaphorical language, similar to what was shown in a recent study by Thoma et al. (2009). Moreover, similarly to a previous study (Brüne and Bodenstein 2005), we found an association between patients’ comprehension of metaphorical language and mentalising, which persisted after other cognitive parameters were statistically partialled out. Concerning psychopathological parameters, correlations between the violation of the maxim of “relation” and negative symptoms became evident, similar to Thoma et al.’s study (2009). No influence of antipsychotic medication on pragmatics was found.

The study has several shortcomings: First, the design of the study was perhaps not optimally suited for the assessment of Gricean maxims, since our investigation drew on free narratives of cartoon stories instead of real conversational conduct. In particular, the maxim of “quantity” was measured using a simplistic word-count, which at best approximates the goal to assess whether or not participants provided relevant information, and avoided irrelevant details. In any event, to the best of our knowledge the present study is, apart from Abu-Akel’s work (1999), the first that has focused on the association of the pragmatic rules of language with neurocognition, comprehension of metaphorical speech and mentalising.

## Conclusions

Our findings support the view that patients with SSD are compromised in their ability to apply the pragmatic maxims of conversation and that these problems may, in part, be related to patients’ impaired understanding of mental states. In clinical interaction, it is therefore advisable to disambiguate information as far as possible and to encourage patients to try to get to the bottom of verbal communication.

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