Recognition and Repair of communicative failures: The interaction between theory of mind and cognitive complexity in schizophrenic patients

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Abstract

The aim of the present research is to perform a detailed and empirical investigation of schizophrenia patients' deficits in recognizing and recovering a communicative failure. In particular, this paper investigates the role of theory of mind (ToM) and of the complexity of the mental representations involved in explaining patients' deficits in recognizing and recovering different kinds of communicative failures, i.e. failure of the expressive act, failure of communicative meaning and failure of the communicative effect. Twenty-two patients with schizophrenia and an equal number of healthy controls took part in the experiment. The experimental protocol consisted of videotaped stories in which two agents interact, showing a communicative failure; the participants were asked to recognize and repair the observed failure. Some classical ToM tests (Sally and Ann, Modified Smarties and a selection of six Strange Stories) were also administered. Our results revealed a deficit in patients, when compared with healthy controls, in recognizing and recovering communicative failures. Furthermore, focusing on schizophrenia patients' performance *per se*, we observed a trend with regard to the increasing difficulty of understanding and recognizing different kinds of communicative failures, i.e. failure of expression act, failure of communicative meaning, and failure of the communicative effect.

Keywords: cognitive pragmatics, communication, inferences, mental representation, mindreading.

1. INTRODUCTION

The impaired use of language for communicative purposes is considered a common deficit in patients with schizophrenia, despite the complexity of their pathology, whose distinctive symptoms vary from delusions and hallucinations to catatonic behavior and affectivity problems. Starting from a review of the research on language in schizophrenia, Frith and Allen (1988) observed that patients' syntactic and semantic abilities were intact, whereas they showed deficits in a more complex use of language. Frith (1992) concluded that the typical language deficit of patients with schizophrenia principally concerns pragmatics, i.e. the communicative use of language in a certain context. In particular, it has been found that schizophrenia patients perform poorly in the comprehension of pragmatic tasks – such as indirect speech acts (Corcoran, Mercer & Frith, 1995), irony and metaphors (Drury, Robinson & Birchwood, 1998; Langdon, Coltheart, Ward & Catts, 2002; Langdon, Davies, & Coltheart, 2002) – and more generally exhibit a high degree of inadequacy in their pragmatic abilities (Meilijson, Kasher & Elizur, 2004).

Frith (1992) was the first author to propose that the communicative deficit of patients with schizophrenia could be explained on the basis of their principal deficit in theory of mind. ToM is the ability to ascribe mental states to oneself and to other people, and to use such knowledge to interpret one's own as well as other people's behaviors (Premack & Woodruff, 1978). Several empirical studies have shown that ToM is impaired in such patients (for a recent meta-analysis, see Bora, Yücel & Pantelis, 2009).

More recently, a series of structured and detailed studies by Lysaker et al. describe and explain schizophrenia patients' symptomatology on the basis of their metacognitive deficit (Lysaker, Dimaggio, Buck, Carcione & Nicolò, 2007; Lysaker et al., 2008; see also Brüne, Dimaggio and Lysaker, 2011, for a review). The term "metacognition" includes and expands the concept of theory of mind, referring, in addition to the more basic mindreading ability, to a person's ability to use such knowledge in order to solve problems and interpersonal conflicts and to master subjective suffering (Lysaker et al., 2005).

In line with the relevant literature, we expect patients with schizophrenia to perform worse compared to healthy controls in theory of mind tasks.

Several authors have highlighted the role of theory of mind in human communication (Sperber & Wilson, 2002; Happé & Loth, 2002; Tirassa, Bosco & Colle, 2006); a capacity to mind-read needs to have been developed and retained intact in order to comprehend a partner's communicative intention.

To the best of our knowledge, only one study (Vallana et al., 2007) has investigated the role of theory of mind and of the representational complexity involved in explaining schizophrenia patients' communicative deficits in understanding different pragmatic phenomena, i.e. indirect speech acts, irony and deceit. The term "representational complexity" refers to the content of a mental process underlying a person's comprehension of the communicative meaning of a pragmatic phenomenon (Bucciarelli, Colle & Bara, 2003; Angeleri, Bosco, Zettin, Sacco, Colle & Bara, 2008; Bosco & Bucciarelli, 2008). Vallana et al. (2007) found that although ToM appears to be correlated with such tasks, it alone cannot explain the increasing difficulty experienced by patients in solving them. In fact, the increment of representational complexity involved was found to be the factor that better explained the schizophrenia patients' increasing difficulty in solving such tasks. However, communicative failure was not taken into account in this study.

The aim of the present study is to provide a detailed investigation of schizophrenia patients' ability to handle an essential albeit somewhat neglected phenomenon in the pragmatic domain: communicative failure. In a previous study, Bosco, Bucciarelli & Bara (2006) proposed and empirically validated an original taxonomy (based on the representational complexity involved) of the different kinds of failure that may occur in communicative interaction: failure of the expressive act, failure of the actor's meaning, and failure of the communicative effect.

In the present study, we wish to investigate the roles played by theory of mind and the representational complexity in explaining the schizophrenia patients' deficit in recognizing and repairing these different kinds of communicative failures. In our view, the theory of mind and the complexity of the mental representations both contribute, at different levels of analysis, to explaining the communicative deficit in schizophrenia patients.

In particular, we hypothesize that the theory of mind deficit explains schizophrenia patients' poorer performance in recognizing and repairing a communicative failure, when compared with healthy controls. Thus we propose that

the theory of mind is the factor explaining the different performance between patients and controls.

Furthermore, focusing on schizophrenia patients' performance *per se*, we claim that the increasing representational complexity involved (see the next paragraph) explains patients' progressive difficulty in solving different kinds of failures, i.e. failure of expression act, failure of communicative meaning, and failure of communicative effect. Thus we propose that the represenational complexity is the factor explaining the different performance on the various tasks among patients with schizophrenia. To the best of our knowledge, no other study has investigated the role of these cognitive factors in the recognition and repair of a communicative factor in patients with schizophrenia.

The paper is organized as follows: in the next section, we will review the literature on communicative failure and theory of mind, after which we present the taxonomy of different kinds of failures (Bosco et al., 2006) based on the theory of Cognitive Pragmatics (Airenti, Bara & Colombetti, 1993a, 1993b; Bara, 2010), and finally we will describe our research and its results.

1.1 Communicative failure and theory of mind

Feldman and Kalmar (1996) were, to our knowledge, the first authors to highlight the role played by theory of mind in repairing a communicative failure. The authors suggest that when a person repairs a communicative failure, he/she usually adapts his/her strategy in order to take his/her interlocutor's perspective into account. This means that a person repairing a failure tries to imagine why his/her communicative intention was not understood or his/her request not accepted by his/her partner. The cognitive component underlying such ability is the theory of mind.

In line with this hypothesis, children with autism and Asperger syndrome or high-functioning autism – conditions which have been claimed to be associated with an impaired ToM (Baron-Cohen, Leslie and Frith, 1985) – appear to experience communication failures (see Keen, 2003) and communicative errors (Loukusa et al., 2007) more frequently than their typically developing peers, although Volden's (2004) study of the problem yielded ambiguous results. On the one hand, children with autism spectrum disorder (ASD) performed similarly to controls in responding to requests for

clarification; they used more flexible and increasingly complex repair strategies according to whether they had received a neutral request, a request for clarification, or a semi-structured prompt ('Tell me in another way') from an interlocutor. On the other hand, ASD children also produced a greater number of inappropriate replies than the controls.

Also, in children with schizophrenia, a less frequent use has been noted of self-initiated repair strategies like repetition, revision and fillers than in normally developed children (Caplan, Guthrie and Komo, 1996). In adults suffering from the same disorder, a tendency to attempt to self-repair their messages inadequately during a referential communication task has also been reported (Leudar, Thomas & Johnston, 1992). Docherty (2005) used the Communicative Disturbances Index (Docherty, DeRosa & Andreasen, 1996) to measure different kinds of failure during a natural conversation in a group of adult patients with schizophrenia, finding that these patients experienced more difficulty than the controls.

In line with such results, Salvatore et al. (2007; 2008) described at phenomenological level the use of understanding mental states to solve pragmatic communicative problems, arguing that persons with schizophrenia withdraw from social relationships due an inability to understand others' intentions on a pragmatic level.

In the light of all this data, we conclude that ToM plays a role in the ability to repair a communicative failure.

Furthermore, we propose that the theory of mind plays a role not only in the ability to repair a communicative failure but also in the ability to recognize it. Indeed, in order to recognize a failure, a person has to realize that he/she failed to modify his/her partner's mental state in the desired way. Thus we hypothesize that:

Considering their theory of mind deficit, patients with schizophrenia perform worse, compared to healthy controls, in recognizing and repairing a failure in a communication act.

Focusing now on schizophrenia patients' performance *per se*, we also expect that theory of mind alone cannot explain the differences within patients' performance that we expect to find among the different sorts of recognition and recovery of communicative failures that we will investigate, i.e. failure of expression act, failure of the speaker's meaning and failure of communicative effect. We suggest, as we will

see in detail in the next section, that the representational complexity involved in such different tasks explains the differences within schizophrenia patients' performance.

2. A TAXONOMY OF COMMUNICATIVE FAILURES BASED ON THE REPRESENATIONAL COMPLEXITY

2.1 Cognitive pragmatics theory

Bosco et al. (2006) proposed a taxonomy of the different kinds of failure that may occur in communicative interaction, distinguishing between failure of the expressive act, failure of the actor's meaning[1], and failure of the communicative effect. This taxonomy is based on Cognitive Pragmatics (Bara, 2010), a theory of the mental processes underlying the comprehension and production of communication acts.

According to this theory, the meaning of any communication act can only be fully understood when the behavioral game of which the move is a part has been clearly identified. A behavioral game is a shared stereotyped pattern of interaction: each participant in a dialogue interprets the communication acts of the interlocutor on a basis he/she assumes to be shared with the latter.

Different moves can be part of the same behavior game. Here, the actor may use different moves to suggest playing the game. Consider the game [LEND-CAR].

Angela might ask her brother Bob to lend her his car by saying:

[1] Please lend me your car.

[2] Would you lend me your car?

[3] My car has broken down; I can't go out for dinner.

[4] I feel down because I haven't got a car for this evening...

A further assumption that we derive from the theory is that the same move may have different linguistic formulations. Consider for example the following formulation of [2]:

[2a] Would you lend me your car?

[2b] Please lend me your car.

[1] Since the theory holds for both linguistic and extralinguistic communication, we use the terms "actor" and "partner" instead of "speaker" and "hearer".

[2c] Lend me your car.

At the same time, the same move might be part of different behavior games. For example, [4] is consistent with the game [LEND-CAR] as well as with the game [GIVE A RIDE].

When people communicate, their basic aim is to achieve an effect on their partner, that is to say, they wish to make their partner carry out some action, or to modify their partner's mental states, or simply to share a certain mental state. The following sequence outlines the steps in the comprehension/generation process of a communication act that the agents have to take:

Expression act: the partner recognizes what the actor communicated, starting from the expression act.

Actor's meaning: the partner comprehends and reconstructs the actor's communicative intentions, i.e. what A implies or presupposes.

Communicative effect: the partner attributes private mental states (e.g. beliefs) to the actor.

Reaction and Response: the partner produces the intentions that he/she will communicate in his/her response, and he/she then produces an overt communicative response.

The theoretical assumption deriving from the theory of Cognitive Pragmatics that underlies our hypothesis is that the increasing complexity of the mental representations involved in the recognition or production of a pragmatic phenomenon is the factor determining the difficulty of such a task.

2.1.1 Recognition of a failure in a communication act

On the basis of the comprehension/generation process illustrated above, Bosco et al. (2006) proposed, and empirically validated, a taxonomy of the different sorts of communicative failure that may occur, in terms of the representational complexity underlying their recognition. Based on our theoretical framework, Cognitive Pragmatics theory (Bara, 2010), our crucial assumption is that comprehending the communicative meaning of any kind of utterance corresponds to detecting which is the behavioral game intended by the actor; each participant in a dialogue interprets the communication acts of the interlocutors on the grounds of what he/she assumes to be shared between them. Bucciarelli, Colle & Bara (2003) claim that a specific factor

may hamper the comprehension of a communicative act: whether there is inconsistency between actors' and partners' mental representations of the move/game played during the comunicative interaction. The actor can consider his/her act to be successful when the partner adopts the actor's goal and the actor detects no inconsistency between his/her own representation of the move/game and that entertained by the partner. The presence (or otherwise) and the type of any inconsistency determine the representational complexity involved in recognizing each kind of failure. The representational complexity increases in two dimensions: the presence of inconsistencies, and the level where the inconsistencies occur. An inconsistency at the move level is simpler than an inconsistecy at the game level (see Table 1).

From our theoretical perspective, the meaning of a communicative interaction is constructed by the actor and partner together, thus both interlocutors are co-responsible for communicative failure, and it is possible to analyze such a process from both perspectives: however, in the present paper we will focus on describing the recognition and recovery of a communicative failure from the actor's perspective.

Failure of the expression act: this occurs in the first phase of the comprehension process, and consists in the actor's recognition of the partner's failure to comprehend the expressive value of the utterance. In this case, there is an inconsistency between the move bid by the actor and the move attributed to him/her. As the expression act is the starting point for the partner to understand the actor's communicative intention, a failure at this stage stops the comprehension process.

Failure of the actor's meaning: this occurs in the second phase of the comprehension process; it consists in the actor's recognition that his/her partner has failed to comprehend the behavior game that he/she bid. In this case, the partner correctly comprehends the expression act through which the communication act is realized, but does not relate the move to the behavior game bid by the actor. A communication act is only fully understood when the game of which it constitutes a move is identified. Thus the partner's recognition of the expression act is a necessary (but not sufficient) starting point for understanding the actor's communicative intention. The same utterance can trigger different communicative intentions; it is only by recognizing the behavior game bid by the actor that the partner is able to comprehend the former's communicative intention. With failure of the actor's

meaning, there is an inconsistency between the game of which the partner's move forms part and the game that the actor is bidding through his/her move. This mismatch relates to the game implied by the move, rather than the direct move as made by the agent (compare the case of failure of the expression act). The recognition of the failure of the actor's meaning involves the detection of such a discrepancy concerning the representations of the game being played. For this reason, we hypothesize that failure of the actor's meaning is harder to detect than failure of the expressive act.

Failure of the communicative effect: this occurs in the final phase of the comprehension process of a communication act; it does not involve detecting any inconsistency. The partner understands both the expression act and the actor's meaning, but does not modify his/her mental state in the way the actor desires, while the actor realizes that his/her counterpart refuses to adhere to the actor's goal. Here the partner explicitly and overtly refuses to participate in the game proposed by the actor; for this reason, failure of the communicative effect is the simplest failure for the actor to recognize.

In summary, we hypothesize that an actor's difficulty in recognizing a failure is a matter of degree and depends on the increasing complexity of the mental representations underlying it, in particular:

Patients with schizophrenia will exhibit the following trend of difficulty in recognizing a communicative failure, from the simplest to the most complex: recognition of the failure of the communicative effect, recognition of the failure of the expression act, and recognition of the failure of the actor's meaning.

2.1.2 Failure repair

The repair of a communicative failure is a new attempt by the actor to modify his/her partner's mental state in the desired way: clearly, the repair strategy will depend on the kind of failure that has occurred.

A valid strategy is defined in terms of the likelihood of modifying the partner's mental state in the way intended by the actor. Naturally, the mere adoption of a strategy does not guarantee a successful outcome: whether to accept the actor's proposal is up to the partner. An actor has many ways of repairing a communicative failure; Bosco et al. (2006) showed (with normally developed children) that the underlying representational complexity is predictive of the relative difficulty of

implementing such strategies.

Our assumption is that, in recovering a failure, patients with schizophrenia will experience more difficulty with strategies involving increasing representational complexity. We present the strategies in Table 2.

Repairing the failure of the expression act: *the simplest strategy is just to repeat the move as previously enacted, i.e. using the same formulation.*

Consider the following example:

[5] Bob is sitting on the terrace reading a book. His sister Angela is sitting nearby:

Angela*: '*Bob could you please lend me your car this evening?'

A motorbike runs along the road below, making a lot of noise.

Bob: 'What did you say?'

In this case, Angela may repeat her request, 'Could you please lend me your car this evening', making the same move as before and keeping the proposed behavior game the same. A precondition for this strategy is to get rid of the noise that caused the communicative failure. For example, in [5] if the noise continues to drown out her voice, Angela must either wait until the noise stops or speak louder.

Repairing the failure of the actor's meaning: the simplest strategy is to reformulate the communication act by choosing a different utterance. As mentioned above, the same move can be expressed through different formulations. Consider the following case of misunderstanding of the actor's meaning:

[6] *Bob meets his sister Angela in the supermarket; she wants to ask him to lend her his car.*

Angela: 'Bob, my car has broken down.'

Bob: 'I know a very good mechanic.'

The simplest form of repair in this case is to rephrase the move by using a different utterance to clarify the actor's communicative intention. For example, Angela could say: 'Please Bob, lend me your car.'

Repairing the failure of communicative effect: the simplest strategy for the actor is to choose another move, one which better fits the game previously bid. For example, the actor may choose a move that is more acceptable or attractive to the partner, or propose an alternative game in order to realize her goal. For example, Angela could suggest a kind of deal with Bob:

[7] Angela: 'If you lend me your car, I'll give you a ticket for next Friday's concert!'

In general, strategies with greater representational complexity may be adopted to recover a failure for which a strategy with less representational complexity would suffice (the other way round is not possible). For instance, in the case of failure of the communicative effect in [9], it is impossible for the actor to modify the partner's mental state just by repeating the same move (note that we are considering the simplest possible solution, here).

In summary, the increasing complexity of the mental representations involved in the different failures augment the inferential difficulty involved in repairing it. Thus, repairing the failure of the expression act merely requires the failed move to be repeated, and nothing has to be changed in the move's formulation. Repairing failure of the actor's meaning requires that the move be performed using a different communication act. Repairing a failure of the communicative effect is more complex than either of the other repairs, because the actor has to take into account the private motivations of his/her partner. In this case, the partner has actually understood the bid by the actor's move, but refuses to play the game. Thus we hypothesize that:

Patients with schizophrenia will show the following increasing trend of difficulty in repairing a communicative failure, from the simplest to the most complex: repairing the failure of expression act, repairing the failure of actor's meaning, and repairing the failure of communicative effect.

3. METHODS

3.1 Participants

Twenty-two individuals with a diagnosis of schizophrenia according to the DSM-IV (APA, 1994) helped us to collect the present data. Eighteen participants were outpatients of the San Gerardo Hospital, Monza (at the Psychosocial Center in Besana Brianza), and four participants were from the "Crisis welcome center" in Collegno. All participants were native speakers of Italian. None was floridly psychotic at the time of administration of the experimental material, and all were in the chronic phase of their illness. The DSM-IV sub-types were distributed thus: paranoid (13 subjects), undifferentiated (3 subjects), disorganized (3 subjects) and residual (3 subjects). The subjects were receiving medication: 7 received typical medicine

(haloperidol and methotrimeprazine, a.k.a. levomepromazine), 13 atypical (clozapine, quetiapine, risperidone and olanzapine) and 2 both typical and atypical. The mean onset of illness was at 25.86 years (standard deviation – SD = 6.18) and the mean duration of illness was 13.73 years (SD = 6.47). The inclusion criterion for schizophrenic subjects was IQ > 70, evaluated with the WAIS-R two/three weeks before the administration of the experimental pragmatic protocol and the ToM tasks; patients' mean IQ was 87 (SD = 13).

The symptomatology of the schizophrenic subjects at the time of testing was investigated with the Positive and Negative Syndrome Scale (PANSS: Kay, Fiszbein, & Opler, 1987). This consists of 30 items subdivided into three scales: one for positive symptoms (7 items), one for negative symptoms (7 items) and a general psychopathology scale (16 items); each item is assessed on a 7-point scale ranging from "absent" (1) to "extremely serious" (7). The subjects' mean scores were: Negative symptoms 22.18 (SD = 8.84), Positive symptoms 16.27 (SD = 5.37) and General symptoms 39.68 (SD = 13.4). A control group of healthy individuals was also included in the study. The two groups were matched for sex (schizophrenic subjects: 9 females, 13 males; controls: 9 females, 13 males), age (schizophrenic subjects: mean = 39.45, SD = 11.88; controls: mean = 41.09, SD = 11.69), and years of formal education (schizophrenic subjects: mean = 10.55, SD = 3.45; controls: mean = 11.18 SD = 3).

The exclusion criteria for both schizophrenic subjects and controls included an anamnesis of neurological or neuropsychological disease, leucotomy, head injury, and substance or alcohol abuse (both defined as per DSM-IV).

4.2. Material

The experimental pragmatic protocol was developed by Bosco et al. (2006). It consisted of videotaped stories (each lasting 10-15s) comprising a controlled number of words[2] (range: 7 ± 2), in which two agents interact communicatively. In particular, 12 of the stories involve a single communicative exchange where an actor makes a request and the partner does not comply (a failure), against four stories involving a successful communication (the control tasks, i.e. a simple standard communication

[2] The number was controlled based on the original material in Italian; in the English translation, it was subject to change.

act)[3]. Of the twelve failures, four are due to failure of the actor's meaning, four to failure of the expression act, and four to failure of the communicative effect.

In addition, the following ToM tests were administered to both the schizophrenia patients and the controls. The ToM tests were randomly presented to half of the participants before the presentation of the communicative failure tasks, and to half of the participants after the presentation of the communicative failure tasks.

Sally and Ann (Baron-Cohen, Leslie & Frith, 1985). The experimenter, holding a doll called Sally and another called Ann, says: ''Sally places her ball in the basket and leaves the scene. Ann moves the ball from the basket to the box". While speaking, the experimenter acts out the corresponding gestures and then asks the subject: "When Sally comes back, where will she think her ball is?"

Modified Smarties (cigarettes). This is a modified version (Pickup & Frith, 2001) of the original Smarties task (Perner, Leekam & Wimmer, 1987). The experimenter shows the subject a packet of cigarettes and asks: "What is inside this?" Of course, the subject answers: "Cigarettes". The experimenter then opens the pack, shows that it contains pencils instead, closes it again and asks: "When the nurse enters, what will she think is inside?"

Strange Stories (Happé, Brownell & Winner, 1999). We presented a selection of six Strange Stories, excluding those requiring comprehension of communication acts like metaphors and irony. We did not use the stories concerning irony and metaphor because they exemplified phenomena pertaining to the same communicative/pragmatic domain as the communicative failures that we investigated. A possible correlation between the comprehension of stories concerning irony and metaphor and our tasks concerning a communicative failure, could be simply explained by the fact that they are all tasks involving communicative/pragmatic phenomena. The following story is an example of the task we administered: "A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know that the man is a burglar; he just wants to tell him that he has dropped his glove. But when the policeman shouts out to the burglar, 'Hey, you! Stop', the burglar turns round, sees the policeman and gives himself up. He puts his hands up and admits that he did the

[3] We expect to find no difference between schizophrenia patients and controls in such tasks.

break-in at the local shop." The subject is asked: ''Why did the burglar do that?" A correct interpretation of the situation requires the subject to assess the burglar's mental state and to realize that he misunderstood the policeman's intention, which was to return the glove.

The tasks were presented in two different random orders; the participant groups were balanced for age and gender. Each session lasted about 20 minutes and was audio-recorded.

4.3 Procedure

The experimenter showed the subjects the videotaped stories one at a time; at the end of each story, she asked the participant (i) whether the actor achieved her communicative intent (recognition task), and (ii) to try to recover the failure (recovery task) – for a description of the experimental tasks and the questions posed to the subjects, see Appendix A.

When empirically investigating failure comprehension, one cannot rely on the protagonists of a failed communicative interaction as experimental subjects; it would be meaningless to create an experimental setting in which the subjects are invited to misunderstand, to not comprehend, or to reject a particular communicative act, while at the same time being requested to explain the reasons underlying this failure.

On the other hand, studies in which persons are observed directly provide an effective way of focusing exclusively on the repair of a communicative failure. In this case, the only failure-recognition measure is that the actor effects some kind of repair: the empirical evidence about recognition clashes de facto with possible evidence obtained about repair.

Our goal in this research was to obtain two different measures referring to the same person: one regarding the subject's comprehension of the failure and one regarding the subject's ability to implement a repair. To resolve the methodological impasse alluded to above, we created an experimental task that consistently allowed participants to adopt the actor's perspective in the recognition task and to recover the failure directly themselves. As regards the recovery task, the participant becomes a virtual actor in the communicative interaction.

As for the recognition task, it is important to note that the actor declares his/her communicative intention beforehand: the experimental subject thus clearly

understands the actor's communicative intention in proffering the utterance.

The participants in the experiment can construct mental representations equivalent to those of the protagonists in the observed communicative interaction; in this way, they are able to assume the actor's perspective in answering the experimenter's questions.

We acknowledge that a laboratory setting always involves a certain amount of artifice as compared to a natural investigation, but for the specific goals of this research, the experimental method we adopted is the only feasible way to test both recognition and repair.

At the end of the experiment, two independent judges who had not been informed of its aim or the participant's identity (patients vs. controls) listened to the audiotapes; their task was to evaluate the participants' ability to recognize and recover a particular failure. They coded "0" the answers they considered incorrect and "1" the answers they considered correct (see Appendix B for examples of correct and incorrect answers). The inter-rater agreement between judges was very high (Cohen's $K = .97$; $p < .0001$). For the final score, the judges discussed any responses on which they had not initially agreed, until they reached full consensus.

The two judges also scored the ToM tests, following the relevant criteria available in the literature, assigning "0" to each incorrect answer and "1" to each correct one.

5. RESULTS

5.1 Overview

The control subjects' performance exhibited a ceiling effect. Accordingly, we performed non-parametric analyses to compare performance between patients and controls in order to verify our hypothesis concerning patients' poorer performance compared to the controls on all the failure-recognition/recovery and ToM tasks investigated (see paragraph 5.2).

However, while the controls showed a severe ceiling effect, patients with schizophrenia showed less marked deviations from normality. Thus we performed an arcsine transformation on data concerning patients' performance on each failure-

recognition/recovery task (i.e. failure of expression act, failure of actor's meaning, and failure of communicative effect) and on (overall) theory of mind tasks, so as to reduce the ceiling effect and normalize the distribution. We thus focused on the patients' group *per se* and were able to perform ANOVA analyses while satisfying the required assumptions. We carried out these ANOVA analyses in order to investigate our hypotheses concerning the existence of a trend of increasing difficulty in the recognition (see paragraph 5.3) and recovery (see paragraph 5.4) of different kinds of failures.

Still focusing on schizophrenia patients' performance, we conducted a regression analysis (on normalized data) between performance on ToM tasks and performance in recognizing and recovering the various kinds of failure, in order to establish the role of ToM in explaining the different difficulty patients experienced in solving these different kinds of pragmatic task (see paragraph 5.5).

We then conducted regression analyses between PANSS and performance on ToM tasks, on one hand, and communicative failures, on the other, in order to establish whether the patients' symptomatology differently correlates with the patients' deficit in mindreading and pragmatic ability (see paragraph 5.6).

Finally, for exploratory purposes, we conducted a regression analysis between each kind of communicative failure recognition and recovery (always on normalized data) and duration of illness, years of education and IQ, in order to rule out any role for such variables in explaining patients' performance (see paragraph 5.7).

5.2 Theory of mind, recognition and recovery of failures: patients vs. controls

First of all, we verified if a difference in performance on ToM tasks exists between schizophrenia patients and the controls. The mean percentage of correct answers given by schizophrenia patients on ToM tasks (Sally and Ann, Cigarettes, and Strange Stories) was 64.2 (s.d. = 25.96); the mean percentage of correct answers given by schizophrenia patients on ToM tasks was 99.43 (s.d. = 2.67). In line with our hypothesis, the patients' performance was worse than that of the controls (Mann–Whitney: $z = - 5.28$; $p < .001$).

Figure 1 shows the mean percentages of correct answers given by schizophrenia patients and control subjects for the recognition of successful communication tasks (control tasks) and for recognition of a communicative failure. First of all, we verified

that patients with schizophrenia did not differ from control subjects in the recognition of control tasks (i.e. an example of successful communication consisting of a simple standard communication act). There was no significant difference between patients and control subjects (Mann–Whitney: z =-1.43; p .15; see Figure 1).

Also, as predicted, patients with schizophrenia performed significantly worse than control subjects in the recognition tasks: recognition of failure of expression act (Mann–Whitney: z = -3.12; p = .002), and recognition of failure of actor's meaning (Mann–Whitney: z = -4.58; p < .001); the only exception was the recognition of communicative effect, where no significant difference emerged between patients and control subjects (Mann–Whitney: z = -1.43; p = .15; see Figure 1). This lack of difference is not surprising, since the recognition of failure of communicative effect is the simplest task to solve, and a ceiling effect can also be seen in patients' performance.

Figure 2 shows the mean percentages of correct answers that schizophrenia patients and control subjects gave to the repair of a communicative failure task.

As predicted, patients with schizophrenia performed significantly worse than control subjects in all the recovery tasks: recovery of failure of expression act (Mann–Whitney: z = -3.62; p < .001), recovery of failure of actor's meaning (Mann–Whitney: z = -4.87; p = < .001), and recovery of failure of communicative effect (Mann–Whitney: z- 4.17; p <.001).

5.3 Recognition of communicative failure: schizophrenia patients' performance

Focusing on schizophrenia patients, we then conducted an ANOVA analysis – on normalized data – with one within-subjects factor (type of recognition of failure, with three levels: communicative effect, expression act and actor meaning) in order to investigate the within-patients difference in performance in recognizing different kinds of failure (see Figure 1). This analysis revealed a main effect of the type of recognition of failure ($F_{(2, 42)}$ = 22.39; p < .001; η^2 = .21; see Figure 1). We introduced a linear contrast which revealed a linear decrease in scores depending on the type of recognition investigated ($F_{(1, 21)}$ = 11.62, p = .003): as predicted, recognition of failure of communicative effect is simplest to understand, followed by recognition of failure of expression act, and finally recognition of failure of actor meaning (the most complex task). In particular, a series of post-hoc comparisons between the pairs of

phenomena investigated showed that, for patients with schizophrenia, recognition of failure of communicative effect is easier than recognition of expression act (Bonferroni correction: $p < .005$) and that recognition of the expression act is easier than recognition of failure of actor's meaning (T-test: $t = 6.31$; $p < .008$).

5.4 Repair of a communicative failure: schizophrenia patients

In order to investigate the within-patients difference in performance for the repair of different kinds of failure, we then conducted an ANOVA analysis – on normalized data – with one within-subjects factor (type of repair, with three levels: communicative effect, expression act and actor meaning) (see Figure 2). The analysis revealed a main effect of the type of repair of failure ($F_{(2, 42)} = 6.02$; $p = .005$; $\eta^2 = .22$). We introduced a linear contrast, which, contrary to our expectation, did NOT reveal a linear decrease in scores depending on the type of repair investigated ($F_{(1, 42)} = .16$; $p = .69$). However, a series of post-hoc comparisons between the pairs of phenomena investigated showed that, as expected, patients found it easier to repair the failure of the expression act than to repair the failure of the actor's meaning; contrary to our expectation, patients did not find it easier to repair the failure of the actor's meaning than to repair the failure of the communicative effect

(Bonferroni correction: $p = .06$).

5.5 Relation between Theory of mind and communicative failure in schizophrenia patients' performance

We conducted a series of regression analyses in order to rule out the possibility that the theory of mind – and not the represenational complexity, as we proposed – might be the factor explaining the increasing trend of difficulty in the recognition and repair of a communicative failure that we observed in schizophrenia patients' performance.

Despite the small number of patients in our experimental group ($N = 22$), we found a significant relationship between the performance in the ToM tasks (considered overall) and the recognition of communicative effect and the recognition of expression act. By contrast, we did not find any correlation between the ToM task and the recognition of the actor's meaning (see Table 3), which is the more complex

task to solve for patients with schizophrenia. If ToM were the principal factor explaining the increasing difficulty in recognition for schizophrenia patients the different tasks analyzed, we would expect a significant correlation between schizophrenia patients' performance in ToM tasks and that in the most complex task to solve, i.e. the recognition of the actor's meaning.

As regards the repair of a communicative failure, again despite the small number of patients in our experimental group, we found a significant correlation between the theory of mind tasks (considered overall) and the repair of expression act and actor's meaning, but not with the repair of communicative effect. Analyzing the significant correlation found for the two tasks in more detail, we observed that the R^2 did not increase in line with the increasing trend of difficulty exhibited by schizophrenia patients in solving such tasks (see Table 3). The R^2 value indicates how much variance is explained by a certain variable. If ToM were the factor that best explained the difference in difficulty between the tasks, then we should expect the value for the repair of actor meaning to be higher, which is harder to solve for patients with schizophrenia in comparison to the repair of the expressive act. By contrast, we found that the higher value of R^2 corresponds to the expressive act that is NOT the more difficult failure to repair.

5.6 Correlation between PANSS, ToM and communicative failures

With the previous analyses, we established that the ToM deficit in schizophrenia patients, even if unable to explain their increasing trend of difficulty in solving the failure tasks, is still correlated to such tasks , albeit to a different extent. We conducted an exploratory regression analysis and found that negative symptoms (regression: $F = 6.56$, $p = .018$) correlate with ToM but positive symptoms (regression: $F = .05$, p .83) do not (taking all tasks into consideration).

Furthermore, we investigated whether a specific kind of recognition and repair of communicative failure that we investigated correlates with negative vs. positive symptoms. We found that negative symptoms correlated with each kind of recognition of communicative failure and with the repair of expression act, but not with the repair of communicative effect or with the repair of actor's meaning (see Tables 2 and 3). We found that positive symptoms correlated neither with any kind of recognition nor with any kind of repair of failure task. We did not find any correlation between the

general symptom severity (measured by PANSS) exhibited by the patients and their performance on each recognition and repair of communicative failure task.

5.7 Correlation between duration of illness, years of education and communicative failure

Finally, we investigated whether a correlation exists between the duration of schizophrenia patients' illness and their performance on each recognition and repair of communicative failure task, but found none (see Tables 4 and 5).

We continued with an exploratory investigation into whether the patients' IQ and their years of education correlated with their performance on each recognition and repair of communicative failure task. As regards recognition of a communicative failure, we found a significant correlation between patient IQ and the recognition of the expression act (see Table 4). However, the recognition of the expression act is not the most difficult task to solve, thus IQ cannot be the best factor in explaining patient performance. In terms of the recovery of a failed communicative act, we found a significant correlation between IQ and the repair of failure expression act and between IQ and the repair of failure of actor's meaning (see Table 5). However, another R^2 analysis in this case did not show an increase in this value in line with the patient's greater difficulty in solving the more difficult task, i.e. the repair of actor's meaning ($R^2 = .263$), vs. the repair of the expression act ($R^2 = .277$). We can thus reject the hypothesis of IQ being the factor that explains the increasing trend of difficulty in repairing a communicative failure that we observed.

6. DISCUSSION AND CONCLUSION

This study has investigated the role that the theory of mind and the represenational complexity involved play in schizophrenia patients' performance in recognizing and repairing a communicative failure. To the best of our knowledge, this is the first such study conducted with schizophrenia patients. We proposed that a theory of mind deficit explains schizophrenia patients' poor performance in the recognition and repair of communicative failure tasks, when compared with controls. However, an investigation of schizophrenia patients' performance *per se* shows that the theory of mind deficit is not sufficient to explain the observed differences in

performance. We now propose that the increasing complexity of the mental representations involved is the factor explaining schizophrenia patients' progressive difficulty in recognizing and repairing the different sorts of communicative failures we investigated, namely: failure of expressive act, failure of actor meaning and failure of communicative effect.

In line with the current literature (Doody et al., 1998; Langdon et al., 2002; Mazza et al., 2001), we found that patients with schizophrenia perform worse than healthy controls in solving theory of mind tasks.

In line with our prediction, we found that patients with schizophrenia perform worse than healthy controls both in recognition and in repair of each of the kinds of communicative failures that we investigated. Such results are in line with the relevant literature (Caplan et al., 1996; Leudar et al., 1992; Docherty, 2005). Our results are also in line with recent studies (Lysaker et al. 2005; Lysaker, Dimaggio, Buck, Carcione & Nicolò, 2007; Lysaker et al. 2008; see also Brüne, Dimaggio and Lysaker 2011 for a review) showing that patients with schizophrenia suffer from an articulated metacognitive deficit, concerning various kinds of sub-component, such as self-reflectivity, empathy and mastery, and that such deficits cause the patients' poor social functioning. In particular, Lysaker et al. (2010a) focused on the concept of metacognitive mastery – i.e. the use of mentalistic knowledge to solve problems, cope with stressors and symptoms, and promote adaptation (see Carcione et al. 2010) – and they showed that, in persons with schizophrenia, poor mastery predicts poor social functioning.

We also proposed that the schizophrenia patients' ToM deficit explains their difficulty in recognizing and repairing a communicative failure when compared with healthy controls. In order to recognize a failure, a person has to realize that he/she failed to modify his/her partner's mental state in the desired way. Similarly, when a person repairs a communicative failure, he/she usually adapts his/her repair strategy in order to take his/her interlocutor's perspective into account.

Focusing on schizophrenia patients' performance per se, and considering patients' ability to recognize failures, our results confirm the predicted trend, based on the representational complexity involved; from the simplest to the most difficult patients found it easier to recognize the failure of communicative effect than the failure of expression act, and they found it easier to recognize the failure of the

expression act than the failure of the actor's meaning.

As regards repairing the failure of communication act, we found that, in line with our prediction, the repair of the expression act is easier than repair of the actor's meaning. Contrary to our expectation, however, the repair of failure of the actor's meaning is not easier than the repair of the communicative effect. An analytical examination of the schizophrenia patients' answers shows that, with failure of communicative effect, they often use a behavioral and stereotyped exchange strategy. Consider task (6) in Appendix A, for example. In the video, the child asking for the toy has a ball in his hand. A frequent answer given by the patients is that the child could give the ball to his friend to obtain the car. Given the simple kind of interaction proposed in the experimental tasks, such a repair is a suitable method of obtaining the desired goal. It is possible that patients had developed a stereotyped routine to solve their everyday communicative difficulties but that, in more sophisticated interactions, such simple strategies would not suffice to modify their partner's mental state or behavior in the desired direction.

We also analyzed whether this different trend of difficulties in the recognition and repair of the different kinds of communicative failure that we examined was better attributable to the schizophrenia patients' ToM deficit, instead of, as we proposed, to the complexity of the mental representations involved.

Although our experimental group had few participants, we found a significant relationship between performance in the ToM tasks and the recognition of the communicative effect and the recognition of expression act, but not between the ToM tasks and the recognition of the actor's meaning, which was the more complex task to solve for patients with schizophrenia. If ToM were the principal factor in explaining schizophrenia patients' increasing difficulty in recognizing the different tasks we analyzed, we would expect to see a significant relationship between their performance in ToM tasks and that in the most complex task to solve, i.e. the recognition of the actor's meaning – yet we found no such relationship.

As regards the repair of a communication act, we found a significant relationship between the theory of mind tasks and the repair of the expression act and actor meaning, but not the repair of communicative effect. However, from a more detailed analysis of the correlation found to be significant for the two tasks – repair of expression act and repair of actor's meaning – we observed that the R^2 did not

increase in line with the increasing trend of difficulty experienced by schizophrenia patients. The R^2 value indicates how much variance is explained by a certain variable. If theory of mind were the factor that best explained the difference in difficulty between the tasks, then we would expect the highest value to be for the repair of actor's meaning, which is more complex for schizophrenia patients to solve than the repair of the failure of expressive act. By contrast, the repair of the expressive act has the higher R^2 value. Furthermore, if ToM were the factor that best explained the difference in difficulty between the tasks, it would be difficult to explain why ToM correlates with the repair of the actor's meaning and not with the repair of the communicative effect, since patients with schizophrenia perform equally in the two tasks.

In summary, our experimental sample did not provide us any empirical evidence that ToM is the factor that best explains the increasing trend in difficulty shown by patients with schizophrenia in recognizing and recovering the different communicative failures investigated. In our view, the increasing representational complexity provides a more convincing theoretical explanation for this result.

For exploratory purposes, we conducted a regression analysis between negative and positive symptoms (both measured by PANSS) and patients' performance in ToM tasks; we found that negative symptoms correlate with ToM tasks but positive symptoms do not. This result is in line with Langdon, Coltheart, Ward & Catts (2001), who argued that the patients with predominant negative symptoms are those in whom ToM is impaired most severely, and also with Lysaker et al. (2005), who found that emotional withdrawal, a negative symptom, correlated with patients' mindreading deficit.

We continued with an exploratory investigation into whether a relationship exists between negative symptoms or positive symptoms and the recognition and repair of communicative failures. We found that negative symptoms correlate with each kind of recognition of communicative failure and with the repair of expression act, but not with the repair of communicative effect or with the repair of actor meaning (see Tables 4 and 5). We found that positive symptoms correlated neither with any kind of recognition nor with any kind of repair of failure task. We did not find any correlation between the general symptom severity (measured by PANSS) exhibited by the patients and their performance on each of the recognition and repair

of communicative failure tasks investigated. Taken overall, such results suggest that patients with prevailing negative symptoms (vs. prevailing positive symptoms) are those whose ToM and ability to recognize and recover a communicative failure are impaired most severely.

Considering these results in the round, we suggest that the patients' difficulty in managing communicative failure can be considered a mediating factor between the patients' poor theory of mind, on the one hand, and poor social functioning/negative symptoms, on the other (see Brüne, Dimaggio and Lysaker, 2011). Our results are consistent with the suggestion of Salvatore et al. (2008) that a reason for a person with schizophrenia withdrawing from a social relationship could be his/her inability to pragmatically understand another person's communicative intention.

Finally, in order to rule out the possibility that patient IQ or education are the factors explaining their increasing recognition and repair difficulties in the tasks used, we investigated whether such factors correlated with their performance on each pragmatic task. The only correlations we found were a significant correlation between IQ and the repair of expression act and between IQ and the repair of actor's meaning. However, another R^2 in this case did not find an increase of such value in line with the patient's greater difficulty in solving the most complex task, i.e. in repair of actor's meaning vs. the repair of the expression act. Thus we can conclude that neither IQ nor level of education is the factor explaining the difference in difficulty experienced by patients in solving such tasks.

A limitation in the present study is its not having considered the multi-component nature of ToM (Bosco et al., 2006; Bell, Langdon R., Siegart R., & Ellis P.M., 2010; Ziv, Leiser & Levine, 2011). In particular, we did not take account of the distinction between first-person ToM (Nichols & Stich, 2002) or self-reflection (see Dimaggio et al., 2008; 2009), i.e. the ability to reflect on one's own mental states, and third-person ToM, i.e. the ability to comprehend another person's mental states. Studies show that these two ToM components could be damaged with different degrees of severity in patients with schizophrenia (Bosco et al, 2006; Lysaker et al. 2010). We suggest that further research should specifically investigate, at both theoretical and empirical levels, the possible specific role of third-person ToM in recognizing a communicative failure and that of self-reflection, or first-person ToM, in recovery such a failure.

However, to the best of our knowledge, our research is the first in-depth, systematic investigation into schizophrenic patient's capacity to recognize and recover different sorts of communicative failures; it has two main clinical implications.

First communication is the expressive means through which it is possible to realize any form of clinical treatment, both psychotherapeutic and rehabilitative. This is why an in-depth understanding is required of the theoretical reasons causing communicative failure, to assist in developing an efficient communicative process and to help patients avoid and recover communicative failures in their everyday interactions.

Second, our study highlights the importance of considering all the contributory factors in order to explain communicative deficits in schizophrenia. In particular, our results show the role played by the representational complexity underlying the ability to recognize and repair different kinds of communicative failures, in addition to the ToM: this cognitive factor helps to explain the variation in the communicative ability of patients with schizophrenia.

Treatments, insofar as they are devised to improve communicative abilities in schizophrenia patients, are principally focused on increasing ToM ability (e.g. Kayser, Sarfati Besche, & Hardy-Baylé, 2006). In the light of our results, which clarify the importance of representational complexity in explaining the pragmatic deficit of patients with schizophrenia, we hope that researchers and therapists will also take such factor into consideration in their rehabilitative programs.

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Appendix A

Experimental protocol

We provide an example of each kind of failure investigated more an example of control task. We also provide the questions that the experimenter posed to the subjects and some example of correct and wrong subject's answers.

FAILURE OF THE EXPRESSION ACT

(1) *Marco is sitting at the table, he is reading a book and listening to music, the volume is loud. There is a bottle on the table, Luca comes in and says*:

Luca: 'Marco, please give me the bottle'

The song ends and Marco does not give Luca the bottle. Luca looks at Marco questioningly.

(2) *Paolo is sitting at the table, on the table there is a big packet and a cap*[4]*. Giovanna comes in and says:*

Giovanna: 'Paolo, please give me the packet'

Paolo: 'All right, here's your cap'

Paolo gives Anna the cap.

FAILURE OF THE ACTOR'S MEANING

(3) *Maria has got two identical dolls and says:*

Maria: ' When Sara comes I'll give her one of these'.

Then Sara comes in.

Maria: 'Sara have you got a doll like this?'

Sara: 'Why do you ask?'

(4) Carlo is sitting on the sofa and talking to himself:

Carlo: 'When Franco comes I'm going ask him to cook me some pasta'

Franco arrives and Carlo says:

Carlo: 'How about some pasta?'

Carlo 'Yes, make a lot because I'm hungry'.

[4] In Italian the words 'pacchetto' (packet) and 'berretto' (cap) sound similar.

Carlo looks at Franco disappointedly.

FAILURE OF THE COMMUNICATIVE EFFECT

(5) Marino has some candy and his friend Giuseppe asks him:

Giuseppe: 'Will you give me a candy?'

Marino: 'No, I won't'.

(6) *Nicola is playing with some toy cars, Stefano is sitting near him and has a ball.*

Stefano: 'May I play with the toy cars?

Nicola: 'No! I'm playing with them now!'

Stefano: 'Please, let me play with them a little bit!'

Nicola: 'Stop it, they're mine and you can't play with them'.

QUESTION TO THE SUBJECTS

At the end of each videotaped interaction the experimenter asked the subject:

C1: In your opinion, has [name of partner] understood/done[5] what [name of actor] asked (for/to do) or not[6]?

If the subject recognizes the failure, the experimenter asks:

RI: 'What might [name of actor] say or do now to obtain what she/he wants?'

If subject the DOES NOT RECOGNIZES the communicative failure the experimenter asks:

RII[7]: 'What might [name of actor] say or do now?'

[5] In case of Failure of the expressive act and the actor's meaning the experimenter asked if the partner has understood what the actor said. In case of Failure of the communicative effect, such a question is inappropriate because the crucial point is not the partner's understanding of the actor's question, but his denial. Thus the experimenter asked if the partner has done what the actor wante

[6] In Italian there is no difference between "to ask" (for information) and "to ask" (for something to be done); both are expressed by the same verb *chiedere*.

[7] This question was made to verify whether a participant, despite he failed the recognition task, was able to repair it.

CONTROL TASK: EXAMPLE OF SUCCESSFUL COMMUNICATION

(7) *Alberto has got a box of cookies, Giulia enters the scene*.

Giulia: 'Alberto will you give me a cookie please?'

Alberto: 'No, I'm really hungry and I only have a few

Giulia: 'If you give me a cookie I'll give you a candy'

Giulia shows him the candy.

Alberto: 'Right here's the cookie.'

Alberto gives Giulia a cookie.

Control questions to the subject:

C1: In your opinion, has [name of partner] understood what [name of actor] asked (for) or not?

If the subject answers yes, the experimenter asks

RI: 'What might [name of actor] say or do now?'

If the subject answers no, the experimenter asks:

RII[8]: 'Why didn't [name of partner] understand what [name of actor] asked (for)?

[8] This question was only asked to be sure that the subject did not give the wrong answer for the right reason.

APENDIX B

Exempla of correct and wrong answers

Recognition (Answer to question C1) for all tasks:

Correct answer: No

Wrong answer: yes

Repair (Answers to question RI and RII)

Task (1)

Some examples of correct answers: "He can repeat what he said", "He can say it again"

Some examples of wrong answers: "He can bring the bottle himself", "The friend doesn't want to be disturbed", "I don't know".

Task (2)

Some examples of correct answers: "He could repeat the question", "He has to say that he said packet and not cap".

Some examples of wrong answers: "He could bring the packet himself", "The packet is still on the table"

Task (3)

Some examples of correct answers: "She can say that she won't give her the doll"

Some examples of wrong answers: I don't know

Task (4)

Some examples of correct answers: "He hasn't understood, he has to cook pasta", "He can ask: will you make it please?"

Some examples of wrong answers: "He can say it again", "He can say that he is hungry", "I don't know".

Tasks (5)

Some examples of correct answers: "He can say that he is hungry", "He can say that if she gives him a candy he'll give her a biscuit"

Some examples of wrong answers: "He can ask him again", "He wont give him a candy", "I don't know".

Task (6)

Some examples of correct answers: "He can say that if he gives him the car he'll give him the ball"

Some examples of wrong answers: "He repeats what he said", "I don't know".

Task (7) (Control Task)

Some examples of correct answers: "She can say: thank you", ""She can say: I'll eat the others"

Some example of wrong answers: "I don't know"

Table 1.

Recognition of communicative failure: inconsistencies. The relative degree of representational complexity of failure recognition is indicated by '+' , adapted from Bosco et al. (2006)

Level of failure: recognition	**Inconsistencies**	**Representational complexity**
Communicative effect	No	+
Expression Act	Yes (move)	++
Actor's meaning	Yes (game)	+++

Table 2.

Repair of a communicative failure: repair strategies from the actor's perspective. The relative degree of representational complexity of failure recognition is indicated by '+' , adapted from Bosco et al. (2006)

Level of failure: recognition	**The simplest repair strategy**	**tational complexity**
Expression act	Repetition of failed move	+
Actor's meaning	Reformulation of failed move	++
Communicative effect	Change move or game that still realizes the desired goal	+++

Table 3

Regression analysis between ToM Tasks and Recognition and Repair of a communicative failure

	Theory of Mind				
Type of Recognition of communicative failure	R^2_{adj}	R^2	β	F	p
Communicative effect	.16	.20	.45	4,92	.038
Expression act	.36	.39	.62	12,96	.002
Speaker's meaning	.002	.05	.22	1,04	.32
	Theory of Mind				
Type of Repair of communicative failure	R^2_{adj}	R^2	β	F	p
Communicative effect	.06	.10	.82	2,24	.15
Expression act	.39	.41	.91	14,16	.001
Speaker's meaning	.24	.27	.52	7,51	.013

Table 4

Regression analysis between PANSS, duration of illness, IQ and years of education and the recognition of a communicative failure

	Recognition of communicative failure					
	Communicative effect		*Expression act*		*Speaker's meaning*	
	F	*p*	*F*	*p*	*F*	*p*
PANSS						
Negative symptoms	4.61	.044	20.15	<.0002	6.4	<.019
Positive symptoms	.004	n.s.	2.1	n.s.	1,17	n.s.
General Psychopathology	1.07	n.s.	2.44	n.s.	.03	n.s.
Duration of illness	.92	n.s.	.84	n.s.	.13	n.s.
IQ	2.05	.17	4.67	.043	.003	n.s.
Years of education	1.21	n.s.	3.10	n.s.	.13	n.s.

Table 5

Regression analysis between PANSS, duration of illness, IQ and years of education and the recognition of a communicative failure

	Repair of communicative failure					
	Communicative effect		*Expression sct*		*Speaker's meaning*	
	F	*p*	*F*	*p*	*F*	*p*
PANSS						
Negative symptoms	1.65	n.s.	10.85	.0004	3.37	n.s.
Positive symptoms	4.02	n.s.	.22	n.s	1.03	n.s.
General Psychopatology	.24	n.s.	.24	n.s.	.02	n.s
Duration of illness	2.33	n.s.	2.39	n.s.	.58	n.s.
IQ	.76	n.s.	7.76	.012	7.13	.015
Years of education	2.21	n.s.	2.10	n.s.	3.96	n.s.