Assessing Perspective Taking in Schizophrenia Using Relational Frame Theory

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Running Head: Deictic relational responding, Perspective-Taking, RFT, Schizophrenia, Theory of mind

ABSTRACT

Relational Frame Theory (RFT) explains perspective-taking performance in terms of deictic relational responding, which has been empirically examined in a number of studies employing both adults and children. Following this view, the current study aims at assessing deictic relational responding in people with schizophrenia, a population for whom there is evidence of a deficit in mental states attribution. A perspective-taking task and a mental states attribution task were employed with a sample of 15 patients diagnosed with schizophrenia and 15 age-matched controls. Results revealed poorer performance of participants with schizophrenia in responding in accordance with deictic frames at the highest levels of relational complexity (i.e., reversed and double reversed perspective-taking), while no difference appeared between the two groups on simple perspective-taking. In addition, a significant deficit emerged on the mental states attribution task. Group effects remained significant after controlling for IQ. Furthermore, performance in complex deictic responding was a strong predictor of accuracy on the mental states attribution task in both groups, thus supporting the RFT approach to Theory of Mind. These findings suggest the relevance of conceptualizing mental states attribution in terms of relational responding for the understanding and remediation of deficits linked to schizophrenia.

A relational frame analysis of perspective-taking

Over the past three decades, perspective-taking has constituted one of the main topics of research in psychology due to the likely involvement of such ability in social cognition. Undeniably, this field has been dominated by the cognitive approach which has produced models as numerous as contradictory. Indeed, while a consensus exists regarding the developmental stages of perspective-taking (Howlin, Baron-Cohen, & Hadwin, 1999), controversy still remains over the question of its functioning in normal subjects as well as in people suffering from pathologies linked to impairments in social cognition (e.g., autism spectrum disorder and schizophrenia). On the other hand, only a few behavior analysts have offered a functional account of such questions (see Spradlin & Bradly, 2008). Although it might be argued that the aim of behavior analysis is not necessarily to propose an account for concepts constructed into cognitive approaches, researchers working under the rubric of Relational Frame Theory (RFT) have claimed that complex verbal activities, such as social cognition, have long been neglected because little was known about certain crucial behavioral processes involved in these type of activities (see Hayes, Barnes-Holmes, & Roche, 2001).

At the core of RFT lies the principle that verbal behavior is a specific class of generalized operant that corresponds to the ability of responding to a stimulus in relation to another stimulus on the basis of properties defined by social community (arbitrarily applicable relational responding -AARR-). For instance, if an individual picks a soccer ball when asked to choose the biggest object among a range of different sports balls (such as a tennis ball and a golf ball), his/her behavior is based on non-arbitrary properties of the stimuli (the fact that the golf ball *is smaller* than the tennis ball is not established by social community and this relation of comparison cannot be transformed by means of verbal behavior). On the contrary, if the same individual is now asked to select which ball is used in a team sport, s/he will pick

the soccer ball once again but this time, according to arbitrary properties of the stimuli (in this context, the soccer ball and the two other balls are compared according to the kind of sport in which they are employed: team sport as *opposed to* individual sport, which is established by the social community).

Studies conducted under the rubric of RFT have shown that derived learning processes demonstrated in non-arbitrary relations (see Sidman, 1994) apply to AARR. That is, directly training the individual from our previous example to relate two stimuli (e.g. by telling him/her that a basketball *is the same as* a soccer ball, in terms of their use in team sports) entails that s/he may then respond to the soccer ball *in relation to* the basket ball (a soccer ball *is the same as* a basket ball) and *in relation to* the tennis ball (a basket ball *is the opposite* of a tennis ball) without having been trained directly to do so. This individual is said to "derive" his/her relational responses: s/he produces responses that have not been trained directly. According to RFT, these limited but powerful mechanisms of derivation allow humans to learn and establish relations between stimuli or relations in infinite ways, thus accounting for complex verbal activities such as story telling or understanding of metaphors and analogies (Barnes-Holmes & Barnes-Holmes, 2002; Stewart, Barnes-Holmes, Hayes, & Lipkens, 2001).

In addition to relational responding of coordination and opposition, a variety of other forms of relational responding have given rise to a functional analysis (Hayes et al., 2001b). These include relational responding of 'distinction' (Roche & Barnes, 1996), 'comparison' (e.g., more than, less than; see e.g., Dymond & Barnes, 1995; O' Hora, Roche, Barnes-Holmes, & Smeets, 2002), 'hierarchy' (Griffee & Dougher, 2002) 'analogy' (Barnes, Hegarty & Smeets, 1997; Lipkens & Hayes, 2009; Stewart, Barnes-Holmes, & Roche, 2004) 'temporality' (O' Hora et al., 2002; O'Hora, Barnes-Holmes, Roche, & Smeets, 2004) and 'perspective', usually called deictic relational responding (McHugh, Barnes-Holmes, & Barnes-Holmes, 2004). According to RFT, deictic relational responses are a family of

relational responses that appear to be critical for the development of perspective-taking skills. Indeed, it is the perspective that defines the nature of the relation shared by two stimuli in this case, according to interpersonal, spatial, and temporal dimensions. Every time one interacts with another person, s/he is speaking from I/HERE/NOW to someone who is YOU/THERE/THEN. While the physical properties of the context are always changing, the verbal relations between I and YOU, HERE and THERE, and NOW and THEN remain constant (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001).

Because deictic relational responding cannot be based on formal dimensions in the environment, it is very likely that these repertoires of relational responding are learned through interactions providing opportunities to talk about one's perspective in relation to the perspective of others (Hayes, 1984). For instance, when responding to a question such as "*What did you do in class this afternoon?*", a child is required to speak from his/her own perspective (I) and to adopt simple perspectives according to spatial (in class-THERE) and temporal (this afternoon-THEN) dimensions. More complex questions necessitate changing perspective in situations involving one, or all, of the three deictic relations. Consider an example of self-comment a child might produce in a Hide-and-Seek game: "*If I were my brother, where would I choose to hide?*". This time, the verbal activity of the child consists of reversing the I-YOU relation when predicting his/her brother's behavior (ex. "*I would hide behind the tree*").

The RFT view on perspective-taking skills has led to a series of studies that have aimed to assess deictic relational responding across different age groups (McHugh et al., 2004; McHugh, Barnes-Holmes, Barnes-Holmes, & Stewart, 2006; McHugh, Barnes-Holmes, Barnes-Holmes, Stewart, & Dymond, 2007) or among children with high functioning autism spectrum disorder (Rehfeldt, Dillen, Ziomek, & Kowalchuk, 2007), and at training skills when they are found to be absent or impaired (Barnes-Holmes, Barnes-Holmes, & McHugh,

2004; Heagle & Rehfeldt, 2006; Rehfeldt et al., 2007; Weil, Hayes, & Capurro, 2007). In one such study by McHugh et al. (2004), deictic relational responding was assessed across participants from five different age groups (from early childhood to adulthood). Participants in this study were required to respond in accordance with the three deictic frames and across three levels of relational complexity. In the first level, participants were required to adopt a simple perspective. They were presented with a question such as "*If I have a green brick and you have a red brick. Which brick do you have? Which brick do I have?*". In this situation, the conditional frame (IF-THEN) defines the functions associated with I and YOU and no derivation is required from the participant, that is, the correct answer necessitates responses that are identical to the arrangement specified in the instructions. In the second level, participants were required to reverse deictic relations (i.e., changing perspective) in tasks such as "*I have a green brick and you have a red brick. If I were you and you were me, which brick would I have? Which brick would you have?*". In this situation, a transformation of functions occurs via the conditional If THEN frame across the deictic I-YOU relation, such that now I have a red brick and you have a green brick. For the third level, participants are required to reverse two deictic relations at the same time. For instance, participants were asked "*Yesterday I was sitting there on a blue chair and today, I am sitting here on a black chair. If here was there and there was here and if now was then and then was now, where would I be sitting now? Where would I have been sitting then?*". In this situation, the conditional frame operates two successive transformations of functions over the frames of HERE-THERE and NOW-THEN thus leading the participant to be sitting back on the initial chair. Results from this study demonstrated that the early childhood group (3-5 year-olds) was the least accurate across trial-types. In general, participants' accuracy decreased as a function of relational complexity (i.e., from simple to double reversed perspective-taking). Additionally, all

participants produced fewest errors on trial-types involving the frame of I-YOU and most when the frame of NOW-THEN was involved.

Deictic relational responding and mental states attribution

Findings from the McHugh et al. (2004) study are of particular interest as they provide a functional analytic framework in which to study the understanding of other minds, a topic largely dominated by cognitive psychology under the rubric of "Theory of Mind" (ToM)[1]. ToM refers to the ability to attribute beliefs, intentions or emotions (i.e., mental states) to the self or to others in order to predict or explain their behavior (Premack & Woodruff, 1978). According to Barnes-Holmes, McHugh, and Barnes-Holmes (2004), this competency can be conceptualized in terms of deictic relational responding, that is, in order to identify private events one needs to adopt the perspective of others or of him/herself in different situations (time or place). For instance, in a well-known ToM task (Baron-Cohen, Leslie, & Frith, 1985) a participant is told a story about two characters, Sally and Anne, who are playing in a room. Sally puts a ball in a basket and leaves the room. In her absence, Anne moves the ball from the basket to a box. The participant is then asked "*When Sally will come back, where will she look first to find the ball?*". Following the RFT view on ToM, the participant predicts accurately that Sally will look in the basket by reversing the I-YOU relation (i.e., adopting her perspective) as follows: "*If I were Sally, I would not know that Anne has moved the ball and then I would look in the basket first*". Considering that developmental research has shown that competencies on this type of task increases crucially during the fifth year (Wellman, Cross, & Watson, 2001), results gathered by McHugh and her colleagues appear consistent with the RFT approach to mental states attribution.

[1] Although it would go beyond the scope of the current study to present it in detail, it should be mentioned that alternative behavior analytic accounts for perspective-taking and mental states attribution have been proposed outside RFT (see Dube, MacDonald, Mansfield, Holcomb, & Ahern -2004-; Schlinger -in press-; Spradlin & Brady -2008-).

In a more recent study, Villatte, Monestès, McHugh, Freixa i Baqué, and Loas (2008) observed that performance on McHugh et al.'s protocol predicted accuracy on another traditional ToM task consisting of attributing intentions behind indirect speech (modelled on the "Hinting Task" designed by Corcoran, Mercer, & Frith, 1995). In this task, the participant is read short interactions between two characters and must guess what they really want to say. For example, one of the items presents a character, Paul, who has to go to an interview and is running late. While he is cleaning his shoes, he says to his wife Jane: "*I want to wear that blue shirt, but it's very creased*." The participant is then asked: "*What does Paul really mean when he says this?*". According to RFT, in order to infer the intention of the character, the participant must change perspective, that is, derive deictic relations as follows: "*If I were that character (I-You) in that particular place (Here-There) and at that moment (Now-Then), I would intend to…*". In line with this view, results from Villatte et al.'s study showed that performance on trial-types of the perspective-taking protocol involving at least one inversion of a deictic relation were significantly associated with accuracy on attribution of intentions tasks.

Impairments in mental states attribution in schizophrenia

Mental states attribution has been the subject of numerous studies in the field of psychopathology. In particular, people with schizophrenia spectrum disorders suffer from deficits in a variety of ToM tasks such as those presented in the previous section (see Brüne, 2005a for a review and Sprong, Schorthorst, Vos, Hox, & Van Helgeland, 2007 for a meta-analysis). These difficulties appear not only in experimental tasks but also in everyday life through failures in communication. For instance, people with schizophrenia poorly understand irony and metaphors since it often requires inferring the intention of the speaker (Langdon, Davies, & Coltheart, 2002; Mo, Su, Chan, & Liu, 2008). More generally, impairments in

mental states attribution are linked to a deficit in social functioning, which constitutes one of the most dramatic features of this illness (Bora, Eryavuz, Kayahan, Sungu, & Veznedaroglu, 2006; Brüne, 2005b; Brüne, 2006; Roncone et al., 2002; Schenkel, Spaulding, & Silverstein, 2005). According to Hyronemus, Penn, Corrigan, and Martin (1998), inaccurate social perception persists during remission phases and causes failures in social integration, which, in turn, contribute to the re-emergence of psychotic symptoms.

At a theoretical level, main models proposed to account for poor ToM of people with schizophrenia are based on cognitive neuropsychology and postulate dysfunctions in the meta-representational monitoring system (Frith, 1992) or in the integration of contextual information (Hardy-Baylé, Sarfati, & Passerieux, 2003). However, other authors have rather considered that difficulties in perspective-taking skills constitute the core element of mental states attribution deficits in schizophrenia spectrum disorders (Langdon & Coltheart, 2001; Langdon, Coltheart, Ward, & Catts, 2001). In these studies, individuals with schizophrenia or with a schizotypal personality showed less accurate performance than controls in a visual perspective-taking task, which in addition was correlated with ToM tasks. In a subsequent study, Schiffman et al. (2004) observed that children who later developed a schizophrenia spectrum disorder presented lower scores on a perspective-taking task than children who did not develop any mental illness. Such findings seem in accordance with RFT view on ToM since it suggest that deficits in perspective-taking skills constitute a feature of schizophrenia, which might have a critical impact on the development of difficulties in mental states attribution. However, as far as we know, no study has ever showed a direct link in schizophrenia between perspective-taking and attribution of intentions (which constitutes the most studied ToM competency in schizophrenia spectrum disorders -see Brüne, 2005a; Sprong et al., 2007-). In addition, although findings from Villatte et al. (2008) already suggested the implication of deictic relational responding in attribution of intentions in a non

clinical population, this finding needs to be replicated in a clinical population in which ToM impairments are a common feature.

Thus, the current study aims to assess deictic relational responding in a population of participants diagnosed with schizophrenia using the McHugh et al. deictic protocol (2004). According to the RFT account of ToM, we predict that participants diagnosed with schizophrenia, whose impairments in mental states attribution are well established, will present a deficit in reversing deictic relations. Additionally, we predict that accuracy in reversing deictic relations will be a predictor of performance on a task consisting of attributing the intentions of others (using a task modelled on the Hinting Task) in participants with schizophrenia as well as in controls. If these predictions are correct, this will support the assumption that deictic relational responding is involved in attribution of intentions. Assessing deictic relational responding in people with schizophrenia will also provide a pattern of performance that might give important indications for building new remediation procedures for ToM impairments in this illness.

METHOD

Participants[2]

The study was approved by the local ethics committee (CCPPRB de Picardie) and all participants provided informed consent. Patients were recruited from the University-Psychiatric Hospital Ph. Pinel of Amiens and controls from personal acquaintances of the experimenters. Participants did not receive any payment for participation.

Experimental group: 15 patients (8 males and 7 females) diagnosed with schizophrenia according to ICD-10 (World Health Organization, 1992). Ages ranged from 22 to 53 years

[2] The participants were the same as those who took part in another study involving deictic relational responding (in preparation). However, the presentation order of the two protocols was counterbalanced.

(mean 33.3 years; SD: 8.4). Mean duration of illness: 5.13 (SD: 4.8). Mean age of onset of the disease was at 28.1 (5.5). Most patients were treated with conventional or atypical neuroleptics.

Control group: 15 healthy participants (8 males and 7 females). Ages ranged from 20 to 63 years (mean 30.08 years; SD: 11.2); there was no significant difference in age between the experimental and the control group: $t(28)= 0.68$; $p>.5$.

Exclusion criteria for all participants: any brain injury, age below 18 or above 65, and French as a second language.

Exclusion criteria for control participants: any history of psychiatric illness.

Measures

Although ToM impairments in schizophrenia generally remain significant after controlling for effects of IQ, intellectual competencies impacted on ToM performance in several studies (see Sprong et al., 2007). Thus, IQ of all the participants was estimated in the current study using Raven's Progressive Matrices (Raven, 1960) and analyses of co-variance were conducted with IQ as the co-variate (as reported in the results section). The mean IQ was 99.13 (SD: 12.4) for the experimental group and 110.07 (SD: 10.78) for the control group.

Setting and equipment

For the task 2, an E-Prime® (version 1.1) program was compiled in order to present a reduced version of the protocol designed by McHugh et al. (2004) to the participants on a Personal Computer with a 660 MHz processor, a 15-inch color monitor and a numeric pad. All trials in the program were presented in French (black letters, font 26).

Procedure

The two experimental tasks and Raven's Progressive Matrices were presented individually with the entire protocol lasting approximately 60 minutes. The presentation order of the tasks and Raven's test was counterbalanced.

Task 1 (ToM): The ToM task was modelled on the "Hinting Task" of Corcoran et al. (1995), one of the most widely employed tasks in the assessment of ToM impairments in schizophrenia. This task contains 20 short scenes read randomly to the participant. Each scene involves an interaction between two characters in an everyday life situation and the participant must guess what they really want to say. A complementary cue was also provided to the participants after their first answer.

For example:

"Stephanie says to her friend Nicole: 'I can't afford the repairs of my car. Could you lend me some money?' Nicole answers: 'I have to have my car repaired too'.

Question 1: *What does Nicole really mean when she says this?*

Cue: *Nicole says: 'And unfortunately, it will cost me a lot'.*

Question 2: *What does Nicole want Stephanie to understand?"*

Correct response: Nicole wants to say that she can not lend any money to Stephanie.

Each scene was evaluated from 0 to 3 points (2 points for a correct first answer and 1 point for a correct second answer). Participants' responses were evaluated independently by three different blind experimenters (for each response, points were allocated based on agreement of the majority of the experimenters).

As in the Corcoran et al. (1995) task, a cue and a second question was added to each scenario in order to avoid high failure rates from participants who found the task difficult (in

order to avoid a floor effect). But in contrast to the original task, the complementary cue was provided across all tasks (even after a correct first answer) in order not to influence participants' answers during the experiment. Participants were informed at the beginning of the task that they would receive an additional cue each time, irrespective of their response to the first question. This procedure was employed in order not to provide any feedback during the task and hence to allow a more accurate assessment of participants' spontaneous responses.

Task 2 (deictic relational responding):

The task included a set of 42 trials. Trials differed based on the deictic relation they tested for (I-YOU, HERE-THERE or NOW-THEN) and the level of relational complexity (simple, reversed and double reversed relations) involved. These combinations were presented across eight trial-types (see appendix for full protocol).

The first three trial-types corresponded to 8 trials of simple relations: 2 I-YOU, 2 HERE-THERE and 4 NOW-THEN. The NOW-THEN trial-type differs from the other two simple trials because, although the relational frame of I-YOU is present, it does not involve responding to I and YOU simultaneously. This procedural modification is necessary because in the frame of NOW-THEN, the target relations become unspecified when I and YOU relations are combined. For example, in "*Yesterday I was watching television, today you are reading*", what I am doing today and what YOU did yesterday is not specified. Thus, simple NOW-THEN was presented with I and with YOU separately. An example of simple trial was as follows: "*I have a red brick and you have a green brick. Which brick do I have?*" The participant had the choice between responding either "1: *Red brick*" or "2: *Green brick*" by means of pressing either of the two activated keys relevant to the task (keys 4 and 6 of the numeric pad covered by stickers with "1" and "2", respectively -other keys were covered by

blank stickers-).Then the second question appeared (“*Which brick do you have?*”), the introduction remaining on screen, and the participant had to choose once again between *“Red brick”* and *“Green brick”*

There were 20 reversed trials with three trial-types: 6 I-YOU, 6 HERE-THERE and 8 NOW-THEN (4 involving I and 4 involving YOU). Finally, there were 14 double reversed trials with two trial-types: 6 I-YOU/HERE-THERE and 8 HERE-THERE/NOW-THEN (4 involving I and 4 involving YOU). The presentation of reversed and double reversed trials and the procedure employed to respond to both questions of each trial was the same as for simple trials.

Both accuracy rates and response times were recorded (with longer response times predicted to reflect poorer performance). The recording was conducted as follows: once the participant had read the first statement (example: “*I have a red brick and you have a green brick. If I was you and you were me*,”), s/he had to press the key “Enter”. Then, the question and the two allowable responses appeared on screen (example: “*Which brick would you have?*”. Green brick/Red brick). Response times were recorded between the participant pressing “Enter” after having read the first statement and his/her response by pressing one of the two activated keys. No feedback was given after the participant’s response. The trials were presented randomly.

RESULTS

ToM task

The mean rate of accuracy for both groups was collated. The mean accuracy rate for the control group was 0.92 (0.90 for the first question and 0.94 for the second) whereas it was only 0.70 for the patient group (0.63 for the first question and 0.77 for the second). These data

were analysed using an independent *t* test and revealed that the difference between the two groups was significant ($t(28)=-5.12$; $p=.01$). In order to determine whether this difference in performance was due to a difference in IQ between the two groups an ANCOVA was conducted with IQ as the co-variate. The effect of group remained significant ($F(1, 27)=7.95$; $p<.01$) and the effect of IQ was not significant ($F(1, 27)=1.33$; $p>.28$). These results show that the difference between the two groups was independent of IQ. The mean rate of amelioration (a correct second answer after an incorrect first one) was 0.56 for the experimental participants and 0.62 for the controls[3]. This difference was not significant ($t(25)=-0.54$, $p=.59$), indicating that participants from both groups benefited equally from additional cues to correct their mistakes. However, caution should be taken regarding this result since only 30 errors were produced on a first question in the control group (*vs*. 111 in the group of patients). In addition, only 12 participants produced at least one error on a first question in the control group, whereas all participants of the experimental group did. To summarise, patients were unable to correctly infer 30% of the characters' intentions, thus demonstrating poorer accuracy than controls. However, they seemed to be able to improve their performance after receiving an additional cue as often as controls.

Deictic relational responding task

Accuracy

The percentage of accuracy was calculated for each participant. These results were then grouped by participant-type and trial-type and are presented in Figure 1. The data indicated that, across the whole sample of participants, the rate of accuracy decreased as a function of relational complexity. The rate of accuracy was similar in both groups for the simple trials. Patients produced clearly more errors than controls on all reversed trial-types

[3] None of the participants produced any error on a second question after a correct response to the first one.

and on double reversed I-YOU/HERE-THERE while almost the same rate of accuracy was observed for the two groups on double reversed HERE-THERE/NOW-THEN.

INSERT FIGURE 1 ABOUT HERE

A 2 x 8 mixed repeated measures multivariate analyses of variance (MANOVA) with the type of group (patients *versus* controls) as the between subject variable and trial-type as the within subject variable and with accuracy and response times as the two dependent variables was employed. The main effect of group was significant (Wilk's $F(2, 27)= 8.71$, $p=.001$). There was a significant main effect of trial-type ($F(14, 15)= 14.93$, $p=.000$). The interaction between group and trial-type was not significant ($F(14, 15)= 1.74$, $p=.15$), indicating that the two groups were similarly affected by the type of perspective-taking tested across both dependent variables.

Univariate analysis of the mean rates of accuracy revealed a significant main effect of group (Wilk's $F(1,28)= 18.18$, $p=.000$), trial-type ($F(7,196)=17.68$, $p=.000$) and a significant interaction between group and trial-type ($F(7,196) = 3.32$, $p<.01$), indicating that there was a difference between the two groups on accuracy as a function of the type of perspective-taking tested. An ANCOVA was conducted with IQ as a co-variate. Though the effect of IQ approached significance ($F(1, 27)=2.4$; $p=.053$), the effect of group remained significant ($F(1, 27)=3.2$; $p=.02$). Thus, IQ alone could not account for poorer accuracy of the patients.

Planned comparisons were conducted between the two groups and across the eight trial-types (using Bonferroni corrections to control for Type I errors). These tests revealed no significant difference on any simple trial-types (all values of $t < 1$). Patients were significantly less accurate than controls on reversed I-YOU (t (28) = -5.25, $p=.000$) and reversed NOW-THEN (t (28) = -4.47, $p=.000$); there was a similar trend that approached significance on

reversed HERE-THERE (t (28) = -2.87, p=.09). The difference between the two groups did not reach significance on double reversed trial-types, (I-YOU/HERE-THERE: t (28) = -2.71, p=.14; HERE-THERE/NOW-THEN: t (28) = -0.5, p>.9). However, the difference was significant before Bonferroni correction on I-YOU/HERE-THERE. To summarise, patients produced more errors than controls on reversed perspective-taking trial-types.

Another series of planned comparisons was conducted to analyse the effect of relational complexity in both groups. Patients were significantly less accurate on reversed I-YOU than on simple I-YOU (t (14) = 5.58, p=.000), whereas controls were equally accurate on these two levels of complexity (t (14) = 0.43, p>.9). Patients were less accurate on reversed HERE-THERE than on simple HERE-THERE (t (14) = 5.78, p=.000); a similar significant difference appeared in controls but was no longer significant after the Bonferroni correction (t (14) = 2.5, p=.35). Finally, only patients were less accurate on reversed NOW-THEN than on simple NOW-THEN (t (14) = 8.91, p=.000 for patients and t (14) = 1.68, p>.9 for controls). These results indicate a general tendency for performance of patients to weaken as the complexity level of perspective-taking required increases. This pattern of responding was not the same in controls, who seemed only slightly affected by the inversion of the spatial deictic relation. No comparison was conducted between the reversed and the double reversed and between the simple and the double reversed trial-types because relational complexity and relation type cannot be separated in these trial types. For example, when comparing simple I-YOU with double reversed I-YOU/HERE-THERE trials, any effect that would emerge could be due to relational complexity (simple *versus* double reversed) or to the type of relation (I-YOU alone versus I-YOU combined with HERE-THERE).

Because accuracy rates of 0.5 in a two-response protocol can be interpreted as chance level responding, the proportion of each group's participants whose scores were over 0.67 was calculated. These results were then grouped by trial-type and are presented in Figure 2.

INSERT FIGURE 2 ABOUT HERE

These proportions were not significantly different between the two groups for simple trial-types (between 80% and 93% for all relations) but were superior in the control group for reversed I-YOU (80% for controls *versus* 27% for patients: $\chi^2(1)= 10.21$; $p<.01$), reversed HERE-THERE (47% *versus* 0%: $\chi^2(1)= 9.13$), and reversed NOW-THEN (80% versus 7%: $\chi^2(1)= 16.43$; $p<.001$). Moreover, the proportion of participants obtaining less than 67% on the three reversed trial-types was 73% in patients *versus* only 7% in controls ($\chi^2(1)= 13.89$; $p<.001$). On double reversed trial-types, though 53% of the controls obtained more than 0.67 accuracy on I-YOU/HERE-THERE relations *versus* only 20% for patients and 47% *versus* 27% on HERE-THERE/NOW-THEN relations, these differences were not statistically significant (respectively, $\chi^2(1)= 3.59$; $p>.4$ and $\chi^2(1)= 1.29$; $p>.9$). However, the proportion of participants who scored under 0.67 both on I-YOU/HERE-THERE and HERE-THERE/NOW-THEN was three times less in the control group (20% *versus* 60% for the experimental group ($\chi^2(1)= 5$; $p=.17$ -this difference was significant before correction-). To summarise, these results are consistent with the previous analyse of variance. Patients produced more errors than controls on reversed perspective-taking. Similar trends emerged on double reversed trial-types, but these differences did not reach significance.

Response latencies[4]

Response latencies results are presented in Figure 3. These data indicate that the response latencies of the two groups were very close across all trial-types. In general, the response latencies increased as a function of relational complexity.

[4] Response latencies that exceeded two SD's above the mean were removed from statistical analyses. However, the exclusion of these data had no effect on the statistical analyses.

INSERT FIGURE 3 ABOUT HERE

Univariate analysis of response latencies revealed no significant effect of the type of group (Wilk's (1, 28) = 0.66; p=.42), a significant main effect of trial-type (F(7, 196)= 34.5; p=.000), and a significant interaction between the type of group and trial-type (F(7, 196) = 2.63; p=.01), indicating that the trial-type differently affected the two groups of participants' response latencies. An ANCOVA with IQ as co-variate revealed no significant effect of IQ (F= 2.07, p=.1).

Planned comparisons were conducted between the two groups and across the levels of relational complexity (using Bonferroni corrections). These analyses revealed no significant difference between the two groups; however, controls were faster than patients on simple HERE-THERE trials before correction, thus explaining the emergence of an interaction between the type of group and the type of trial with the ANOVA conducted earlier. Analyses concerning relational complexity showed that all participants were faster on simple than on reversed trial-types (patients: simple I-YOU/reversed I-YOU, t (14) = 4.64, p<.001; simple HERE-THERE/reversed HERE-THERE, t (14) = 2.91, p=.14 -significant before correction-, simple NOW-THEN/reversed NOW-THEN, t (14) = 4.95, p=.001. Controls: simple I-YOU/reversed I-YOU, t (14) = 5.19, p=.001; simple HERE-THERE/reversed HERE-THERE, t (14) =5.45, p<.001; simple NOW-THEN/reversed NOW-THEN, t (14) = 5.04, p=.001).

In addition to response latencies, the time spent on screens presenting the first statement of each item (ex: "*I have a red brick and you have a green brick. If I were you and you were me*:") was calculated in order to examine if the two groups required a different amount of time to read this instruction. In line with the variation of the first statement length across the different trial-types, univariate analysis of these results revealed a significant main

effect of trial-type (F(7,196)=10.15, p=.000), no significant effect of the type of group (1,28)=1.73, p>.2) and no significant interaction between the type of group and trial-type (F(7,196)=0.38, p>.9), indicating that the two groups did not differ in the amount of time they spent reading the first statement of the trials.

Links between ToM and deictic relational responding performances

A series of correlation analyses were conducted between performances on ToM and perspective-taking tasks (using Bonferroni corrections) with the purpose of examining the overlap between deictic relational responding and attribution of intentions. The trial-types were regrouped as a function of relational complexity to reduce multiple testing effects on Type I error. In the experimental group, ToM performance was moderately associated with accuracy on reversed (r = .49) and double reversed trial-types (r = .52), but weakly with simple trial-types (r = .29); however, none of these coefficients reached significance after correction. In the control group, associations between ToM and complex perspective-taking were stronger (reversed: r = .64, p=.05; double reversed: r = .6, p=.1). No association emerged between ToM and simple perspective-taking (r = -.04, p>.9). In order to examine the prediction that reversing deictic relations is required to infer the intentions of others, a linear regression analysis was carried out with ToM performance as dependent variable and mean accuracy on all trial-types involving changing perspective (i.e., reversed and double reversed trial-types) as independent variables. The model was significant and explained 44% of the variance (p<.01) in the experimental group and 41% in the control group (p=.01), thus indicating that accuracy in reversing deictic relations was a strong predictor for ToM performance.

DISCUSSION

The results from the current study indicate a clear deficit in the ability of reversing deictic relations in our sample of participants diagnosed with schizophrenia. These participants produced significantly more errors than controls when they were required to change perspective according to all deictic relations (i.e., personal, spatial, and temporal relations). A difference between the two groups appeared also on double reversed perspective-taking but, interestingly, did not reach significance in spite of the fact that a higher level of relational complexity was involved. While participants from McHugh et al. (2004) and Villatte et al. (2008) did obtain lower scores on double-reversed relations (thus supporting the prediction that a more complex relational activity is required at that level), a paradoxical effect analogous to which appeared in the current research has been observed by Rehfeldt et al. (2007). In this study, 66% of the participants diagnosed with high functioning autism spectrum disorder performed better on double-reversed than on reversed perspective-taking and the difference between experimental and control participants was significant only on reversed ones. Similarly, Weil et al. (2007) reported that certain young children from their training study acquired more slowly reversed than double reversed relations. In both cases, the authors hypothesised that participants presenting this contradictory pattern of response might not respond relationally at that level. Indeed, if a participant is unable to change perspective at all, s/he might stick with the first statement of the question (e.g. "*Yesterday I was sitting there on the blue chair and today, I am sitting here on the black chair*") and respond accurately. However, it is important to note that a difference did appear between the two groups of the current study on double-reversed relations (notably, the proportion of participants scoring not better than chance on double reversed relations was two times greater in patients than in controls). Thus, it is likely that the effect would reach significance with a larger sample of participants.

Contrary to the prediction that longer latencies in reversing deictic relations would reflect impairments of patients on complex perspective-taking, there was no difference between the two groups in their response latencies. Villatte et al. (2008) reported comparable results in participants with a high level of social anhedonia and concluded that response times might not constitute a dependent variable as discriminative as the rate of accuracy for non-clinical populations. Data from the current research suggest that this might be the case even with clinical populations. However, such findings weaken the inherent assumption of studies conducted in psychosis, that accuracy differences observed between group mean scores may have been a by product of neuroleptic treatment rather than participants clinical condition *per se*.

Results concerning the response times and the amount of time spent on the first statement screens also suggest that memory deficits do not account for poorer performance of the patients on the most complex trial-types. That is, one could argue that memory impairments, which have been repeatedly reported in schizophrenia (Heinrich & Zakzanis, 1998) could have impaired the patient groups performance on the reversed and double reversed trial-types due to the length of the trials. This however, is unlikely to be the case as the introduction of the items remained on screen, at all times, when participants were responding, allowing participants to read it as many times as they required. Additionally, no difference was found between the two groups on the time spent reading the trial introduction or in responding to the questions. Therefore, any influence of memory impairments on task performance is rather unlikely.

Conducting an assessment of deictic relational responding in a sample of individuals diagnosed with schizophrenia was driven mostly by the existence of a deficit in mental states attribution in this population. Results from the ToM task of the current study were consistent with the abundant literature in the area (see Brüne, 2005a; Sprong et al., 2007): specifically,

patients demonstrated poorer performance than controls in attributing the intentions of the characters. Although these data *per se* do not shed any new light on ToM impairments, carrying out a traditional ToM task was necessary first to ensure that patients from our sample presented such difficulties and then to test the RFT prediction regarding an involvement of deictic relational responding in mental states attribution. In line with that view, we observed that patients demonstrated difficulties in both tasks and that performance on tasks involving changing perspective significantly predicted accuracy on the Hinting Task in patients as well as controls. Although caution must be taken in making the assumption that deictic responding actually underpins ToM ability as the analysis was a correlation analysis[5], the results are at least strongly compatible with the view that inferring the intentions of others consists of deriving complex deictic relations.

One way to further explore the involvement of deictic responding in mental states attribution is to conduct training studies employing traditional ToM tasks as a post-test. To date, only one study of that kind has been conducted. Weil et al. (2007) used traditional false-belief tasks as a pre and post test during training sessions on perspective-taking with young children. Weil and his colleagues observed an improvement in ToM performance from the pre-test to the post-test. These results not only support the influence of deictic responding on ToM skills but also indicate that training these specific repertoires of relational responses is an efficient approach to the remediation of mental states attribution.

Considering the positive results from other training studies carried out with normal developing children (Barnes-Holmes et al., 2004) or children with autism spectrum disorder (Heagle & Rehfeldt, 2006; Rehfeldt et al., 2007), the current results suggest the utility of applying similar procedures with people suffering from schizophrenia. Indeed, even though

[5] The possibility that neuroleptic treatment might have handicapped certain patients on both tasks, hence inflating the correlation between them should be also considered. However, the coefficient of correlation observed in the non-clinical control group was also relatively high (as in Villatte et al., 2008), which, once again, weakens the assumption that medication biased the results of the current study.

this study consisted of an assessment rather than a functional analysis, data gathered regarding performance of the patients indicate that applied behavior analysis based on derived relational responding (see Rehfeldt & Barnes-Holmes, 2009) might help to remediate impairments in mental states attribution in this population. However, as the efficacy of training deictic responding to enhance accuracy in inferring intentions has not been demonstrated yet, remediation programs of that type should also include tasks like the Hinting Task as pre- and post-tests. In a recent research, Vilardaga, Levin, Waltz, and Hayes (2008) followed a new approach to develop empathy towards minority groups. These authors employed deictic prompts in association with short scenarios that involved descriptions of characters belonging to ethnic minorities. Similarly, it should be examined if instructions that encouraged participants to change perspective after hearing hinting stories might help them to identify the intentions of the characters (e.g. "*Imagine you were this character… Imagine you were in that place and at that moment…*"). However, since individuals with schizophrenia from the current study showed important difficulties in reversing deictic relations, this step might be feasible only after reaching a mastery criterion in deictic training.

Finally, it should be noted that the current study, although demonstrating deictic relational responding impairments independent of IQ in people with schizophrenia, cannot entirely exclude the possibility that these individuals suffer from a more general deficit in derived relational responding. In order to address this prediction, supplementary research should assess other types of relational responding with different degrees of complexity in this population. If difficulties appear in relational responding in general, then deictic responding might reflect only a particular case of the verbal disorders encountered by this population. Actually, one of the main models of ToM impairments in schizophrenia (Hardy-Baylé, 1994) has made such predictions, though not formulated in the terms of RFT. In this view, disorganized thought disorders underlie deficits in attributing intentions, thus only individuals

presenting a syndrome of thought and language disorganization show difficulties in ToM. Indeed, several studies using the Thought, Language, and Communication scale (Andreasen, 1979) to distinguish between disorganized and non-disorganized patients supported this prediction (Brunet, Sarfati, & Hardy-Baylé, 2003; Sarfati & Hardy-Baylé, 1999; Sarfati, Hardy-Baylé, Brunet, & Widlöcher, 1999; Sarfati, Hardy-Baylé, Nadel, Chevalier, & Widlöcher, 1997). Therefore, future research on deictic responding in schizophrenia might examine first if disorganized patients alone suffer from deficits in deictic relational responding and subsequently whether these patients are impaired in relational responding in general or more specifically in deictic relational responding.

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Appendix: Full perspective-taking protocol

SIMPLE TRIALS

Simple I-YOU:

I have a red brick and you have a green brick.
Which brick do I have? Which brick do YOU have?

I have a green brick and you have a red brick.
Which brick do YOU have? Which brick do I have?

Simple HERE-THERE:

I am sitting here on the blue chair and you are sitting there on the black chair.
Where am I sitting? Where are YOU sitting?

I am sitting here on the black chair and you are sitting there on the blue chair.
Where are YOU sitting? Where am I sitting?

Simple NOW-THEN:

Yesterday I was watching television, today I am reading.
What am I doing now? What was I doing then?

Yesterday I was reading, today I am watching television.
What was I doing then? What am I doing now?

Yesterday you were reading, today you are watching television.
What are YOU doing now? What were YOU doing then?

Yesterday you were watching television, today you are reading.
What were YOU doing then? What are YOU doing now?

REVERSED RELATIONS

Reversed I-YOU:

I have a red brick and you have a green brick. If I was you and you were me.
Which brick would I have? Which brick would YOU have?

I have a green brick and you have a red brick. If I was you and you were me
Which brick would YOU have? Which brick would I have?

I have a red brick and you have a green brick. If I was you and you were me.
Which brick would YOU have? Which brick would I have?

I have a green brick and you have a red brick. If I was you and you were me
Which brick would I have? Which brick would YOU have?

I am sitting here on the black chair and you are sitting there on the blue chair. If I was you and you were me.
Where would YOU be sitting? Where would I be sitting?

I am sitting here on the black chair and you are sitting there on the blue chair. If I was you and you were me.
Where would I be sitting? Where would YOU be sitting?

Reversed HERE-THERE:

I am sitting here on the blue chair and you are sitting there on the black chair. If here was there and there was here.
Where would YOU be sitting? Where would I be sitting?

I am sitting here on the blue chair and you are sitting there on the black chair. If here was there and there was here.
Where would I be sitting? Where would YOU be sitting?

Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If here was there and there was here.
Where would I be sitting now? Where would I be sitting then?

Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If here was there and there was here.
Where would I be sitting then? Where would I be sitting now?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If here was there and there was here.
Where would you be sitting now? Where would you be sitting then?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If here was there and there was here.
Where were you sitting then? Where would you be sitting now?

Reversed NOW-THEN:

Yesterday I was watching television, today I am reading. If now was then and then was now.
What would I be doing then? What would I be doing now?

Yesterday I was watching television, today I am reading. If now was then and then was now.
What would I be doing now? What would I be doing then?

Yesterday you were watching television, today you are reading. If now was then and then was now.
What would you be doing then? What would you be doing now?

Yesterday you were watching television, today you are reading. If now was then and then was now.
What would you be doing now? What would you be doing then?

Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If now was then and then was now.
Where would I be sitting now? Where would I be sitting then?

Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If now was then and then was now.

Where would I be sitting then? Where would I be sitting now?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If now was then and then was now.
Where would you be sitting then? Where would you be sitting now?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If now was then and then was now.
Where would you be sitting now? Where would you be sitting then?

DOUBLE REVERSED RELATIONS

I-YOU/HERE-THERE:
I am sitting here on the blue chair and you are sitting there on the black chair. If I was you and you were me and if here was there and there was here.
Where would I be sitting? Where would YOU be sitting?

I am sitting here on the blue chair and you are sitting there on the black chair. If I was you and you were me and if here was there and there was here.
Where would I be sitting? Where would YOU be sitting?

I am sitting here on the black chair and you are sitting there on the blue chair. If I was you and you were me and if here was there and there was here.
Where would I be sitting? Where would YOU be sitting?

I am sitting here on the blue chair and you are sitting there on the black chair. If I was you and you were me and if here was there and there was here.
Where would YOU be sitting? Where would I be sitting?

I am sitting here on the black chair and you are sitting there on the blue chair. If I was you and you were me and if here was there and there was here.
Where would YOU be sitting? Where would I be sitting?

I am sitting here on the black chair and you are sitting there on the blue chair. If I was you and you were me and if here was there and there was here.
Where would YOU be sitting? Where would I be sitting?

HERE-THERE/NOW-THEN:
Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If here was there and there was here and if now was then and then was now.
Where would I be sitting then? Where would I be sitting now?

Yesterday I was sitting there on the blue chair, today I am sitting here on the black chair. If here was there and there was here and if now was then and then was now.
Where would I be sitting now? Where would I be sitting then?

Yesterday I was sitting there on the black chair, today I am sitting here on the blue chair. If here was there and there was here and if now was then and then was now.
Where would I be sitting then? Where would I be sitting now?

Yesterday I was sitting there on the black chair, today I am sitting here on the blue chair. If here was there and there was here and if now was then and then was now.
Where would I be sitting now? Where would I be sitting then?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If here was there and there was here and if now was then and then was now.
Where would you be sitting then? Where would you be sitting now?

Yesterday you were sitting there on the blue chair, today you are sitting here on the black chair. If here was there and there was here and if now was then and then was now.
Where would be you sitting now? Where would you be sitting then?

Yesterday you were sitting there on the black chair, today you are sitting here on the blue chair. If here was there and there was here and if now was then and then was now.
Where would you be sitting then? Where would you be sitting now?

Yesterday you were sitting there on the black chair, today you are sitting here on the blue chair. If here was there and there was here and if now was then and then was now.
Where would you be sitting now? Where would you be sitting then?

FIGURE 1

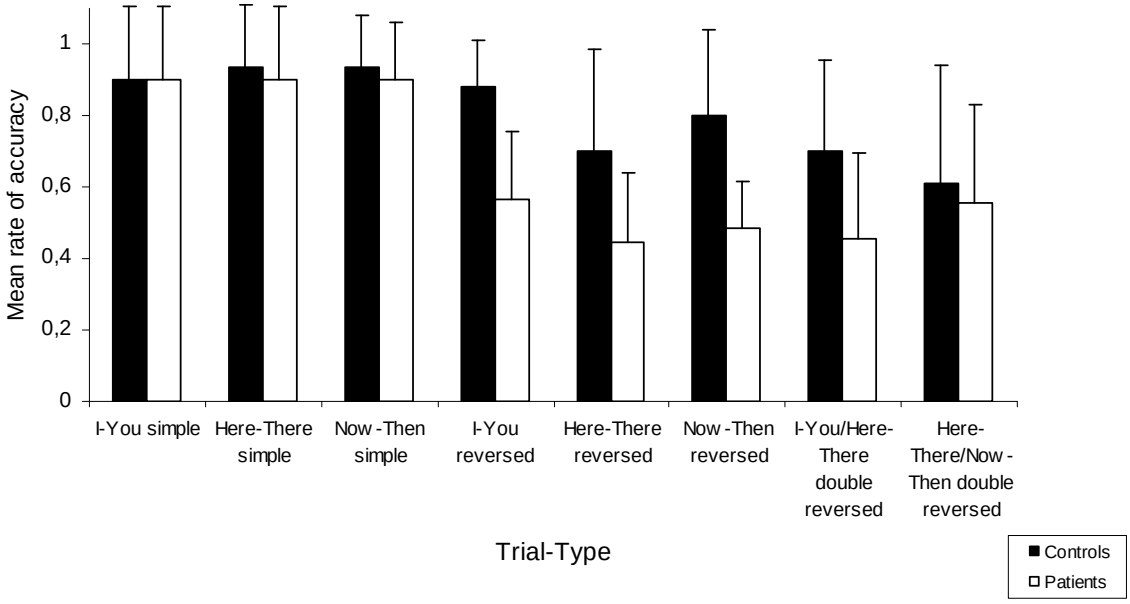
Mean rate of accuracy
1
0,8
0,6
0,4
0,2
0
I-You simple
Here-There simple
Now-Then simple
I-You reversed
Here-There reversed
Now-Then reversed
I-You/Here-There double reversed
Here-There/Now-Then double reversed
Trial-Type
Controls
Patients

FIGURE 2

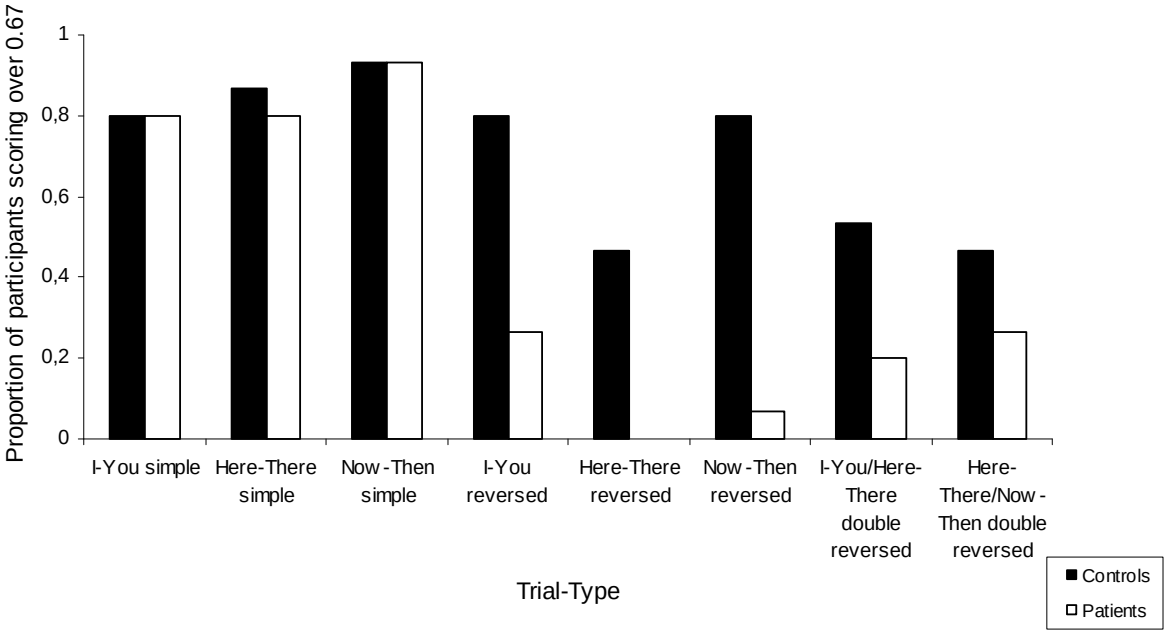
Proportion of participants scoring over 0.67
1
0,8
0,6
0,4
0,2
0
I-You simple
Here-There simple
Now-Then simple
I-You reversed
Here-There reversed
Now-Then reversed
I-You/Here-There double reversed
Here-There/Now-Then double reversed
Trial-Type
Controls
Patients

FIGURE 3

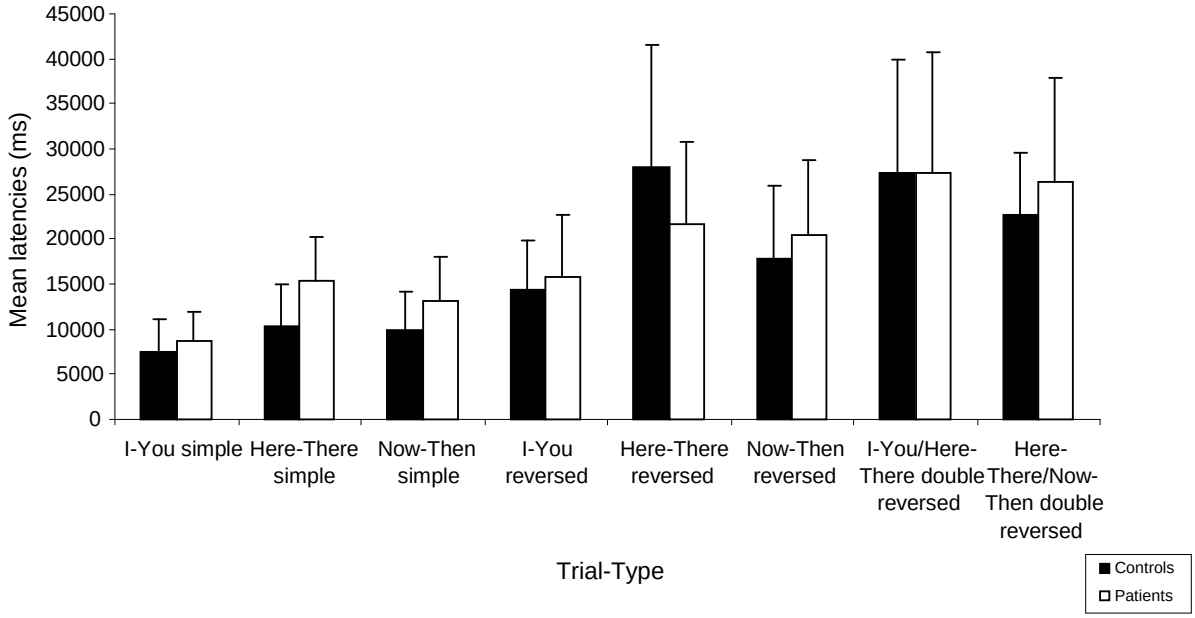
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
Mean latencies (ms)
I-You simple
Here-There simple
Now-Then simple
I-You reversed
Here-There reversed
Now-Then reversed
I-You/Here-There double reversed
Here-There/Now-Then double reversed
Trial-Type
Controls
Patients

FIGURE CAPTIONS

Figure 1

Accuracy (proportion correct) for experimental and control participants on the eight trial-types of the deictic relational responding task

Figure 2

Proportion of patients and controls scoring over 0.67 on the eight trial-types of the deictic relational responding task

Figure 3

Response times (ms) for experimental and control participants on the eight trial-types of the deictic relational responding task