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The intentionality bias in schizophrenia

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Abstract

The tendency to over-interpret events of daily life as resulting from voluntary or intentional actions is one of the key aspects of schizophrenia with persecutory delusions. Here, we ask whether this characteristic may emerge from the abnormal activity of a basic cognitive process found in healthy adults and children: the intentionality bias, which refers to the implicit and automatic inclination to interpret human actions as intentional (Rosset, 2008). In our experiment, patients with schizophrenia and healthy controls were shown sentences describing human actions in various linguistic contexts, and were asked to indicate whether the action was intentional or not. The results indicated that people with schizophrenia exhibited a striking bias to over attribute intentionality regardless of linguistic context, contrary to healthy controls who did not exhibit such a general intentionality bias. Moreover, this study provides some insight into the cognitive mechanisms underlying this bias: an inability to inhibit the automatic attribution of intentionality.

Keywords: intentionality bias, schizophrenia, inhibitory processes, Theory of Mind

1. Introduction

The tendency to interpret the events of daily life as intentional or voluntary is one the central elements of schizophrenia with persecutory delusions. This trait is depicted in representations of the disease in popular culture (as in the film *A Beautiful Mind*), and is regularly found in the discourse of patients who describe accidental or common events, such as a mistake on the telephone or the laughter of others, as involving extra (i.e. illusory) layers of intentionality. Deficits of people with schizophrenia in Theory of Mind are now well documented (Harrington et al., 2005; Sprong et al., 2007; Bora et al., 2009) and, in the relevant scientific literature, numerous studies have highlighted this impairment in tasks particularly targeting intention recognition (Sarfati et al., 1997a; Sarfati et al., 1997b; Sarfati and Hardy-Baylé, 1999; Brunet et al., 2003). Nevertheless, authors reported in some patients, notably those having paranoid symptoms, not a lack to ability to infer others' mental states, but an excessive attribution of intentions to others (Abu-Akel and Bailey, 2000; Montag et al., 2011). The origins of this over-attribution of intentionality remain poorly understood.

The present work asks whether this important characteristic of schizophrenia may emerge from the abnormal activity of a more basic cognitive process. In particular, we examine the possibility that a primitive bias to attribute intentionality. Corollaries of such a bias are found in young children, who promiscuously over-attribute purpose and function to non-living natural kinds (Kelemen, 1999; DiYanni and Kelemen, 2005) as well as in healthy adults who over-attribute intentionality under time pressure

(Rosset, 2008) or under alcohol intoxication (Bègue et al., 2010). This basic intentionality bias may be the root cause of this deficit in schizophrenia.

Rosset (2008) had healthy adults read simple sentences that were somewhat ambiguous with regards to their intentionality, or were even read as being prototypically unintentional (e.g. “He set the alarm off”). Upon reading the sentence, participants were asked to indicate whether or not the person acted intentionally. Rosset (2008) found that participants who were asked to respond quickly (compared to a condition in which they were given more time to think carefully about the sentence) displayed an “intentionality bias”, i.e. a bias to treat unintentional actions as being intentional. According to this intentionality bias hypothesis, when someone evaluates the behavior of an agent engaged in an action, an intentional interpretation is automatically activated. Only through the use of additional knowledge acquired over time with experience (e.g. understanding of social norms, and of behavior cues) is someone able to inhibit the intentional explanation to interpret the action as unintentional or accidental. Note that the existence of the purported intentionality bias hypothesis is nevertheless controversial and Hughes et al. (2012) by using the same material as Rosset (2008) did not replicate these data.

For the first time (to our knowledge) we adopt a similar methodology to ask how this basic bias may manifest in schizophrenia. We predicted that if schizophrenia includes a general over-firing of the mental mechanism for attributing intentionality, schizophrenics should function similarly to healthy adults under time pressure by showing a bias to treat actions that are frequently unintentional as having been carried out intentionally. This prediction was motivated in part by the well known observations mentioned at the beginning of the introduction and in part by the work of Bara et al. (2011), who proposed a potential mechanism that might underlie hyper-intentionality in schizophrenia: a lack of deactivation of the intentional detector. This hypothesis has received some indirect empirical support in studies by Frith (1979, 1992) who proposed that several behavioral symptoms as well as cognitive deficits in schizophrenia could be explained by a lack of inhibition. Thus here we additionally postulated that any overactive intentionality bias we might observe should be linked to a failure of inhibitory processes.

In order to ensure that ours was the strongest possible test, we modified the basic design from the Rosset study due to recent research showing that the intentionality bias is heavily influenced by the grammatical structure of the linguistic stimuli employed. Strickland et al. (2011) have shown that French speaking healthy adults show the intentionality bias under time pressure for verbs that take “avoir” (i.e.

“have”) as an auxiliary in the past tense but do not do so for verbs that take “être” (i.e. “to be”). Thus participants under duress of time pressure were more likely to falsely say that Jean acted intentionally in (1) than in (2) despite the fact that in the absence of time pressure, virtually all participants claimed that these sentences referred to accidents.

1. Jean a glissé. (John has slipped)
2. Jean est tombé. (Jean has (is) fell)

Here we were interested in investigating the fundamental Theory of Mind processes present in schizophrenia. However, given that with French-speaking populations, Strickland et al. found that the intentionality bias is so heavily modified by grammatical structure, it is important to test the full spectrum of relevant grammatical contexts in order to ask about the generality of the intentionality bias in schizophrenia. We therefore tested participants’ intuitions about the intentionality of both verb types. The central question is whether, even in conditions involving no time pressure, people with schizophrenia would display a general intentionality bias across a wide range of linguistic contexts.

2. Methods

2.1. Participants

Seventy-six native French-speaking volunteers participated in the study. Thirty-eight people meeting DSM-IV-TR criteria (American Psychiatric Association, 2000) for schizophrenia were recruited from Saint Jean de Dieu Hospital and Le Vinatier Hospital in Lyon (France). All schizophrenic patients received antipsychotic medication with a mean chlorpromazine equivalent dose (CPZ; Woods, 2003) of 329.78 mg per day (S.D. = 229.24). Thirty-eight healthy controls, with no history of psychiatric disorders and no first-degree relatives with psychotic illnesses were recruited from the general community. These participants were gathered from around Lyon, France. Subjects in all groups were aged between 18 and 65 years and control subjects were matched to subjects with schizophrenia on age, sex and years of

education. Individuals with a history of head injury, co-morbid psychiatric or neurological illness, substance abuse (tobacco excepted) or learning disabilities were excluded.

The investigation was carried out in accordance with the Declaration of Helsinki and was approved by the local Ethical Committee (CPP Lyon – Sud Est IV, n°11/030, AFSAPPS n° 2010-A01403-36). All subjects gave written informed consent.

2.2. Clinical evaluation

Each patient from Le Vinatier Hospital ($N=28$) was evaluated by an experienced psychiatrist with the French version (Lépine et al., 1989) of the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). We used the five-dimensional structure of the PANSS (Lançon et al., 1998) initially derived from the work of Kay and Sevy (1990) and completed by Lindenmayer et al. (1994). This five-factor model involves the selection of only 24 items that encompass five main components: positive, negative, excitation, depression and cognitive. We chose this dimensional structure because we were particularly interested by the following items: P4 “excitation” which involves an increased response to stimuli, G4 “tension” which implies physical manifestations of excitation, and G14 “poor impulse control”, which entails defective regulation and control of internal impulses. These items could be some of clinical markers of the deregulation of inhibitory processes and constitute the excitation dimension of the PANSS’ five-dimensional structure of Lançon et al. (1998).

The demographic and clinical characteristics of participant groups are shown in Table 1.

2.3. Task

The task was devised to test the ability of patients with schizophrenia compared with control subjects to decide as accurately as possible (without time pressure) if a character acted intentionally or unintentionally in an action described by a short sentence. A set of 72 sentences was constructed. We manipulated two main factors: (1) the intentionality of the action (intentional vs. unintentional), and (2) the grammatical structure of the sentence (“to have” (avoir) or “to be” (être) verbs). We therefore built four groups of 18 sentences: (1) “to be”/intentional, (2) “to have”/intentional, (3) “to be”/unintentional, and (4) “to have”/unintentional. Each sentence described a simple action or event carried out by a single character, and was built according to the same structure: (1) the character, identified by either a male or a female French name (François, Lise), or a type of profession or qualification (the engineer, the burglar, the singer), or a type of relationship using either the first person singular (my neighbour, my aunt) or the third person singular (her/his son, her/his employee). In each group of 18 sentences there were: 5 or 6 male names, 3 female names, 5 professions or qualification, 1 or 2 types of relationships using the first person singular and 2 using the third person singular; (2) a verb conjugated in the “past tense” (for half of the sentences we chose “to have” verbs and for the other half we used “to be” verbs), and finally (3) a circumstantial complement of time, space, or manner. We ensured that each group of 18 sentences contained the same number of positive, negative and neutral events.

Examples of sentences:

- (1) “to be”/intentional : “Charles est allé à l’enterrement” – “Charles (*is*) went to the funeral”
- (2) “to have”/intentional. “Le client a signé ce matin” - “The (*has*) client signed this morning”
- (3) “to be”/unintentional: “François est tombé sur la glace” – “François (*is*) fell on the ice”
- (4) “to have”/unintentional: “Marc a glissé sur la chaussée” – “Marc (*has*) slipped on the walkway”

To ensure that each sentence was clearly intentional or unintentional, a pilot study was carried out on a different group of healthy participants ($N=30$). In this study, participants made intentionality and emotional judgments about each of the sentences. The list of the 72 sentences used in the test was exclusively constituted by sentences for which the agreement was higher than 80% in the pilot study.

2.4. Experimental procedure

Sentences were presented on a computer screen in a random order with PsyScope software (Cohen et al., 1993). Each sentence was preceded by a screen, which allowed participants to take a break and which gave instructions concerning the task at hand, in order to reduce difficulties caused by working memory impairments in schizophrenia. The participant had to press a key to display the sentences. Then he/she had to indicate whether the person acted intentionally or unintentionally in the described action as correctly as possible (and without time pressure) by pressing one of two keys on the keyboard. In order to familiarize participants with the task, they also saw six practice sentences (3 intentional and 3 unintentional) before the experimental task itself.

3. Results

3.1. Between-group analyses

Patients with schizophrenia ($N=38$) and normal controls did not differ with respect to age ($t(1,74) = -1.43$; $P = 0.16$, n.s.), and sex distribution ($\chi^2(1,74) = 0.234$; $P = 0.63$, n.s.). Education level is marginally lower for patients compared to controls (Mann-Whitney- $U = 564$; $P = 0.10$).

We calculated and examined the proportion of intentional answers (this score represented each participant's propensity to respond that the person in the sentence acted intentionally) for both groups of subjects (controls vs. patients) depending on the intentionality (intentional vs. unintentional) and on the grammatical structure ("to have" or "to be" verbs). Because variance was not homogenous, we corrected the raw data by using an angular transformation of the form $X'_{ki} = 2\text{ArcSin}\sqrt{X_{ki}}$ in order to be able to perform the ANOVA.

The pattern of results highlighted the expected "overactive" intentionality bias in people with schizophrenia. Thus we observed a main effect of group ($F(1, 74) = 5.01$, $P = 0.028$) whereby the proportion of intentional answers of patients ($m=0.57$) was higher than that of controls ($m=0.52$). This bias is not explained by the marginally lower education level of people with schizophrenia, as verified by the result of the correlation analysis performed for this participant group between education level and

proportion of intentional answers ($r = 0.24$). As we would expect, the proportion of intentional answers was higher for intentional sentences ($m=0.86$) than for unintentional sentences ($m=0.23$), ($F(1, 74) = 603, P < 0.0001$). The interaction between sentence intention and participant group was also significant ($F(1, 74) = 52.9, P < 0.0001$). This indicates that the pattern of responses between the two populations was significantly different with regards to their attributions of intentionality depending on the sentence type.

Furthermore the difference between patients and controls was not influenced by grammatical structure. This was confirmed by the three-way ANOVA (intention \times group \times grammatical structure) which revealed that the second order interaction was not significant ($F(1, 74) = 0.26, P = 0.61$). This can be appreciated by looking at Table 2 below. As can be seen, for both the “to have” and “to be” verbs, schizophrenic patients were more likely to judge the action as being intentional. These differences were significantly different in both cases, as verified by two planned contrasts (t “to have” (1,74) = 3.02 ; $P = 0.0035$ and t “to be”(1,74) = 2.31 ; $P = 0.022$).

Taken together these findings suggest that there exists in schizophrenia a general “over-firing” of the mechanism responsible for the detection of intentionality. The notion of “over-firing” is quite broad in the sense that it refers to any level of activation which is above baseline (healthy) levels. Below we explore one potential mechanism that could account for such over-firing: lack of available inhibitory resources.

Finally, we did not find any difference between “to be” and “to have” verbs contrary to Strickland et al.’s results. It is relevant with the fact that our study does not involve time pressure, unlike theirs.

3.2. Analyses within the schizophrenia group

We performed a correlation analysis in order to account for the link between these results and specific symptoms of schizophrenia. We obtained PANSS scores for schizophrenic patients from Le Vinatier Hospital ($N=28$). First, we checked for the occurrence of the *intentionality bias* and the same pattern of results as the whole panel of patients with schizophrenia.

We measured correlations between the “intentionality score”, measures of psychopathology according to the five-dimensional structure of the PANSS (Lançon et al., 1998). A marginal correlation was found between the proportion of intentional responses and PANSS-Excitation ($r = 0.34$; $P = 0.077$). This correlation was not statistically significant but reflected a trend in favour of our assumption. No correlation between the intentionality score and others dimensions of the PANSS – negative ($r = 0.19$; $P = 0.33$), positive ($r = -0.02$; $P = 0.91$), depression ($r = -0.13$; $P = 0.50$) and cognitive ($r = -0.13$; $P = 0.52$) – has been highlighted. Then, we performed a correlation analysis between the proportion of intentional responses and individual PANSS items. Significant correlations were found between proportion of intentional answers and the following items: “poor impulse control” (G14) ($r = 0.54$; $P = 0.0031$), “excitement” (P4) ($r = 0.43$; $P = 0.022$). An interaction was also found for the PANSS-Excitation item “uncooperativeness” (G8), but this correlation was not significant according to the fixed detection threshold ($r = 0.36$; $P = 0.057$). Hence most items that correlated significantly with the proportion of intentional responses were part of the “excitation” dimension of the PANSS. Nevertheless, one item of the Cognitive-dimension of the five-factor structure of the PANSS, “conceptual disorganization” (P2) also correlated significantly with the proportion of responses “intentional” ($r = -0.41$; $P = 0.031$).

4. Discussion

The tendency to over-interpret the events of daily life as resulting from voluntary action is one of the key aspects of schizophrenia with persecutory delusions. The current study presents evidence that this tendency originates from the over-activation of a cognitively basic bias found in children and adults (Keleman, 1999; Rosset, 2008). Our principal finding is that people with schizophrenia exhibited a striking bias to over attribute intentionality in all type of syntactic constructions, contrary to healthy controls who did not exhibit such a general intentionality bias. Below we examine some further implications of this work.

4.1 Implications of this work on the understanding of Theory of Mind deficit in schizophrenia

There is considerable evidence that the understanding of others' intentions is impaired in schizophrenia (Sarfati et al., 1997a, 1997b; Sarfati and Hardy-Baylé, 1999; Langdon et al., 2002; Brunet et al., 2003). Our findings confirm this assumption by showing that patients with schizophrenia had more difficulty than healthy controls in detecting the intentional or unintentional nature of an action performed by a character described in short sentences. More precisely however, our findings revealed the *intentionality bias*: participants with schizophrenia had a general tendency to interpret actions as intentional. This is consistent with the existing literature suggesting that some patients with schizophrenia, notably those with paranoid symptoms may have a "hyper-theory of mind" (Abu-Akel, 1999) or an "overmentalizing" capacities (Frith, 2004), that is inferring mental states when none are obviously suggested. The assumption of a "hyper theory of mind" which is one of the central ideas developed by Abu-Akel and Bailey (2000) propose that not all psychiatric disorders associated with theory of mind impairment could be appropriately described in terms of diminished capacity to represent the mental states of self and other. For them, patients might have knowledge about other people's minds but use it in a biased way that could results in an overly simplistic or complex attribution of mental states to others (Abu-Akel, 1999; Abu-Akel and Bailey, 2000; Montag et al., 2011). Few studies have reported this assumption. For example, Blakemore et al. (2003) showed that people with persecution delusions reported excessive ascription of contingencies of two shapes than non-deluded

patients. In another study using the “triangle task”, Russell et al. (2006) demonstrated that individuals with schizophrenia, and notably with paranoid symptoms, had a tendency to use more mentalizing terms to describe a short animation displaying a random movement compared with controls. Similarly, Montag et al. (2011) highlighted that positive symptoms as delusions were associated with a tendency to make mistakes of Theory of Mind towards an overmentalizing bias. Finally, An et al. (2010) found that first episode schizophrenia patients and individuals at high risk for psychosis exhibited higher levels of perceived intentionality compared to healthy controls.

Our results contribute to this literature and propose that this characteristic of some people with schizophrenia could emerge from the abnormal activity of a basic cognitive process, a primitive bias to attribute intentionality. Moreover, the current study provides some insight into the mechanisms underlying this bias. According to Rosset (2008), people could inhibit the initial interpretative impulse and come to unintentional or accidental explanations with the contribution of additional knowledge; and indeed this may be the normal developmental trajectory. This knowledge implies the ability to understand beliefs, desires or intentions of others, or to be more conceptual, it involves Theory of Mind abilities. A tremendous amount of research has shown that people with schizophrenia are severely impaired in Theory of Mind (for reviews see Brüne, 2005; Harrington et al., 2005; Sprong et al., 2007; Bora et al., 2009). But we mentioned in the theoretical part of the present paper that the association of symptoms with Theory of Mind deficit in schizophrenia has been vague across many studies (Harrington et al., 2005; Abdel-Hamid et al., 2009). Yet, our results suggest that people with schizophrenia may not solely differ from healthy adults in the default level of activation of Theory of Mind, but they could differ from them in their inability to inhibit the automatic attribution of intentionality. Indeed, the correlation analysis highlighted an association between the proportion of “intentional” responses of patients with schizophrenia and the “excitation”-dimension of the PANSS. More precisely, at the level of specific items, strong associations were found between the tendency to respond “intentional” and the following items: “poor impulse control” (G14) and “excitement” (P4). These results could highlight a relationship between the intentionality bias and some difficulties in inhibitory processes.

In schizophrenia, deficits in inhibitory processes have been suggested since Frith’s pioneering work (1979). In line with this view, it seems that several symptoms that characterise schizophrenia could be conceptually related to dysfunctions of elementary cognitive mechanism of filtering that is inhibition. Indeed, several studies have reported impairment in inhibitory processes by focusing on several aspects of schizophrenia (Laplante et al., 1992). For example, some authors showed evidence for the fact that

severity of hallucinations in schizophrenia was linked to a failure in intentional inhibition (Waters et al., 2003; Soriano et al., 2009) and several research groups have reported impaired stop-signal response inhibition in individuals with schizophrenia spectrum disorders (cited in Hughes et al., 2012). Hence, our results suggest a link between inhibitory processes and another characteristic of schizophrenia: the ability to attribute intentionality.

Nevertheless, the results presented in this study have some limitations. First our two groups were not strictly matched on the level of intelligence. An accurate measure of IQ would have been more relevant to exclude the possibility that this component alone accounts for the intentionality bias. Nevertheless, our results are suggestive that intelligence differences are unlikely to account for increased attributions of intentionality given that educational level did not significantly correlate with intentional responses in the schizophrenic group. Secondly, the correlation analysis between the proportion of intentional responses of patients with schizophrenia and the excitation-dimension of the PANSS is only marginally significant. Moreover we chose this dimension because it could have a link with the lack of inhibition, which could be on the basis of the intentionality bias. To study this assumption, a specific test of inhibitory processes would have been more relevant. Thirdly, it would have been relevant to study results of our experiment in the light of other measures of intentionality, as the Ambiguous Intentions Hostility Questionnaire (AIHQ, Combs et al., 2007), and notably with ambiguous items of the scale, which seem to be related to paranoia.

4.2 Implications for the “intentionality bias” more generally

In addition to offering insight into the underlying mechanisms for attribution of intentionality in schizophrenia, these analyses potentially also provide insight into the mechanisms underlying any purported intentionality biases in healthy adults and children.

In general, exaggerated attributions of intentionality have typically been observed either under time pressure in healthy adults (Rosset, 2008) or in young children (Kelemen, 1999; Rosset and Rottman, 2014). Given the overlap in behavioural responses between schizophrenics, adults under time pressure and young children, this suggests that impaired inhibitory abilities may underlie any observed intentionality bias in all three populations. This intriguing possibility fits with what we already know

about inhibitory abilities from the healthy populations. It has been convincingly demonstrated in other experimental contexts that time pressure reduces self-regulatory abilities (Wegner and Erber, 1992). In previous studies demonstrating an increased intentionality bias under time pressure, healthy adults similarly may not have had ample access to the necessary resources required to inhibit an intentional interpretation of the behaviour in question. Along similar lines, we know that young children lack certain crucial resources required for self-regulation/inhibition (e.g. Mischel et al., 1989), and this could explain why, like healthy adults under time pressure and schizophrenic patients, they also exhibit a bias for intentional explanations.

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Highlights

- Origins of the over-attribution of intentionality in schizophrenic patients with persecutory delusions may emerge from a primitive bias to attribute intentionality
- The task is to decide if a character acted intentionally or unintentionally in an action described by a short sentence
- Results highlighted the expected “overactive” intentionality bias in people with schizophrenia
- This is consistent with the existing literature suggesting that some patients with schizophrenia, notably those with paranoid symptoms may infer mental states when none are obviously suggested
- Our results suggest that people with schizophrenia may not solely differ from healthy adults in the default level of activation of Theory of Mind, but they could differ from them in their inability to inhibit the automatic attribution of intentionality

Table 1Demographic and clinical data for healthy controls, and patients with schizophrenia
(means and standard deviations)

	Healthy Controls (N=38)	Patients (N=38)
Sex (M/F)	24/14	26/12
Age (Years;Months)	40;8 (±13;5)	37;0 (±7;10)
Education (years)	12.7 (±2.9)	11.6 (±2.4)
PANSS Negative	N/A	19.64* (±6.73)
PANSS Positive	N/A	15.61* (±6.38)
PANSS Excitation	N/A	9.25* (±4.08)
PANSS Depression	N/A	7.5* (±3.07)
PANSS Cognitive	N/A	7.61* (±2.92)
Chlopromazine equivalent dose (mg)	N/A	329.8 (±229.2)

* (N=28)

Table 2

Proportion of intentional answers for both groups of participants (patients with schizophrenia versus healthy controls) according to grammatical structure of sentences

"to have" verbs		"to be" verbs	
Patients with schizophrenia	Healthy controls	Patients with schizophrenia	Healthy controls
0.58	0.52	0.56	0.51

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