



Patterns of evidence integration in schizophrenia and delusion

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ABSTRACT

Previous studies documented a bias against disconfirmatory evidence (BADE) in patients affected by schizophrenia spectrum disorders, with some discrepant findings on its relationship with delusions. In order to further investigate the patterns of evidence integration in schizophrenia and delusion, we recruited 40 deluded and non-deluded patients with schizophrenia and 40 healthy control subjects. Participants were administered the BADE test, which consisted of 30 delusion-neutral scenarios, each one progressively described by three subsequent disambiguating statements and providing four types of interpretation to rate for plausibility; at every additional evidence presentation, participants were asked to adjust their ratings. In contrast to previous works, patients displayed both a BADE and a bias against confirmatory evidence (BACE) relative to healthy subjects, as they reduced plausibility ratings on incorrect interpretations and increased plausibility ratings on correct interpretation significantly less over trial progress. Moreover, BACE and BADE measures showed to discriminate differentially control from schizophrenia participants and delusional from non-delusional patients.

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1. Introduction

Current cognitive models of psychosis propose multidimensional accounts for delusions formation, development and maintenance which try to integrate several interacting but independent factors: anomalies in perception, motivation, affect and cognition, meta-representation and beliefs system have been recognized to have a predisposing or precipitating role in delusion.

For example, Bentall and colleagues first showed the relation between a global, stable and externalizing attributional style (Kaney and Bentall, 1989) and delusions, as well as Frith explained persecutory and referential delusions as based upon a ToM (theory of mind) deficit, an impairment in inferring others' thoughts and intentions (Frith and Corcoran, 1996). Other models implicate emotion related processes: in the "threat anticipation model" paranoid patients over-estimate the likelihood of threatening events (Kaney et al., 1997).

While attributional and ToM account of psychosis focuses on specific delusional themes, theorizing about reasoning deficits applies to all kinds of delusions; this distinction is of some concern in studies

on schizophrenia, where many and different kinds of false beliefs are labeled as delusions (Frith, 1999; Langdon et al., 2010).

As to reasoning processes, in their pioneering work Garety and colleagues inscribed their account for delusion in the framework of Bayesian inference, predicting that in a probability judgment task "people with delusions would make more rapid and over-confident judgments than other clinical and non-clinical controls" (Garety and Freeman, 1999).

This reasoning style, characterized by the tendency toward early acceptance of hypotheses, has been consistently replicated in schizophrenia with the paradigmatic Beads task, in which it translates into "less draws to decision" (but not less "draws to certainty") and takes the name of Jumping To Conclusions bias (JTC). Rather than a general deficit in probabilistic reasoning, JTC has been described as a data-gathering bias that contributes to the lack of belief flexibility leading, in turn, to persistent delusional conviction and lower change potential (Garety et al., 2005). Patients seek less information to reach a decision rather than differ in certainty, that is to say they need less subjective probability to come to a conclusion.

Moritz, Woodward and co-workers set up a liberal acceptance (LA) account for JTC in schizophrenia, hypothesizing that patients rest their decisions on little evidence because of a lowered decision threshold. Using a paradigm that resembles the "who wants to be a millionaire" show (Moritz et al., 2006) and a

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paintings-to-title task (Moritz et al., 2009), in addition to a variant of the classic Beads task (Moritz et al., 2007), they proved that individuals with schizophrenia base decisions on lower subjective likelihood than controls. Importantly, in LA account, requiring less evidence to accept options does not necessarily implies a JTC (Moritz et al., 2007), which is expected when there are few alternatives mutually exclusive and one option stands out among others (low ambiguity). With more and less distinct alternatives (high ambiguity) LA account predicts a delay in taking a decision, since more options are considered.

The results of a recent meta-analysis (Fine et al., 2007) support a difference in the amount of evidence collected from deluded patients to reach a decision and confirm an hypothesis, difference which cannot be considered an epiphenomenon of schizophrenia. Their findings also suggest that when dealing with conflicting evidence, patients do not seem to “jump to new conclusion”. Two issues remained unsolved: (1) JTC paradigms failed to sort out how patients treat contradictory information once a belief has been accepted (that is to say: why delusion persists in the face of disconfirmatory evidence?); (2) JTC bias facilitates the hasty acceptance of the (delusional) hypothesis but a delusional thought must be present before JTC affects its development in delusion (that is to say: before investigation of confirmatory and disconfirmatory evidence, an hypothesis must be judged worthy of consideration; why patients consider seriously implausible hypotheses?).

Woodward et al. (2006b) introduced a new neuropsychological paradigm, aimed to investigate the possibility of a failure in integrating disconfirmatory evidence (bias against disconfirmatory evidence—BADE): if delusions are based on a confirmatory reasoning style, which discards disconfirmatory evidence, JTC could enlighten the mechanism of the former and BADE of the latter (issue 1). Furthermore, the BADE task was designed to allow exploration of LA of implausible interpretations also (issue 2).

In these studies, participants are presented with delusion-neutral sequences of pictures (Woodward et al., 2006b; Moritz and Woodward, 2006) or sentences (Woodward et al., 2007, 2008; Moritz et al., 2010) that progressively disambiguate a scenario, adding confirmatory or disconfirmatory evidence; for each scenario, different interpretations are provided to rate for plausibility and at every additional evidence presentation subjects are asked to adjust their ratings.

In the sentences version of the task, the interpretations have been designed to elicit different patterns of ratings across three informational levels and every scenario is presented with four types of possible interpretations: one true (initially not much plausible, becomes increasingly the most plausible), two lures (initially more plausible of the true, across levels become implausible; two variants: neutral lure and emotional lure) and one absurd (implausible at all stages).

For example, the first informational level of a scenario is represented by the statement “Jenny can’t fall asleep”. Interpretations given to rate for plausibility are: “Jenny is nervous about her exam the next day” (neutral lure), “Jenny is worried about her ill mother” (emotional lure), “Jenny is excited about Christmas morning” (true) and “Jenny loves her bed” (absurd). At the successive two stages of the trial a second and a third informative sentences are added: respectively, “Jenny can’t wait until it is finally morning” and “Jenny wonders how many presents she will find under the tree”. After each additional presentation, plausibility of each interpretation should be updated considering all evidence.

In Moritz, Woodward and co-authors works, the progressive upgrading and experimental manipulation of BADE paradigm from first to later researches makes quite hard the comparison between studies.

Time by time, the BADE task has been varied in stimuli (visual vs. verbal), ratings scale (Likert-type vs. continuous), nominal categories, number of trials, stages and interpretations, outcomes computation for bias indexes and indexes considered, analyses performed, assessment scale and criterion to discriminate deluded subjects from not deluded subjects; these changes could account for the discrepancies in findings obtained in different studies.

Therefore, we consider here for clarity only later works which made use of verbal stimuli although previous researches also provided evidence for a BADE, particularly accentuated in deluded patients, and a LA bias in schizophrenia (Moritz and Woodward, 2004; Woodward et al., 2006b; Moritz et al., 2006).

A study on a sample of first episode schizophrenia spectrum disorders vs. healthy controls (Woodward et al., 2006a), with 2 interpretations (true and lure) to rate, unspecified number of scenarios and 3 descriptions for each, showed a difference in BADE (computed as the decrease from sentence 1 to 3 in lure ratings) between controls and patients and, among these, between acutely delusional (4 or higher score on Positive and Negative Syndrome Scale (PANSS) delusion and paranoid ideation items) and non-delusional groups; no difference in BACE (first-to-third increase of plausibility in true ratings) was found.

In an exploratory principal component analysis (Woodward et al., 2007) a version of the test consisting in 30 scenarios with four interpretations and three levels, administered to a sample of schizotypal students, was employed. The BADE measures submitted to the factor analysis were all plausibility ratings for neutral and emotional lures; two independent factor emerged: Initial Belief (composed primarily of ratings at level 1 and partly of ratings at level 2) and Integration of Disconfirmatory Evidence (partly ratings after sentence 2 and primarily after 3). None of the six considered measures of BADE correlated with neuropsychological variables and Integration of Disconfirmatory Evidence was the only factor that correlated with delusional ideation.

The following research recruited patients with schizophrenia or schizoaffective disorders, obsessive-compulsive disorder and healthy controls (Woodward et al., 2008); the BADE task included 20 experimental and five filler scenarios, with some trial adapted from a prior version (2006b) and others newly developed. Scenarios were classified, by lure strength, in weak and strong, using ratings for true and lure interpretations provided by healthy subjects at the first sentence presentation. The dependent variables computed to index BADE and BACE were the means of ratings at sentence 2 and 3 subtracted from ratings at first for, respectively, lure and true items; the same was made for absurd items, even if a floor effect was expected. Score changes were covariated for initial plausibility ratings. In contrast with previous studies, analyses did not find differences in performance between delusional (three or higher score on PANSS delusion item) and non-delusional groups whereas, when pooled together, schizophrenia patients showed a BADE only in the strong lure condition. Schizophrenia vs. mixed-controls analysis revealed no BACE nor LA bias.

A second principal component analysis (Moritz et al., 2010) investigated the intercorrelations of cognitive biases, motivational factors, neuropsychological and psychopathological measures. Current version of the task implicated 24 scenarios with four interpretations and BADE index was the variable of interest, computed as ratings change for lures from sentence 1 to 3. Four independent components were identified among these “inflexibility” (BADE and need for closure). BADE correlated with pre-morbid intelligence but correlational analysis found no relation between inflexibility and neuropsychological or psychopathological variables.

The last research analyzing the relationship between the BADE and delusional ideation (Veckenstedt et al., 2011) compared

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