

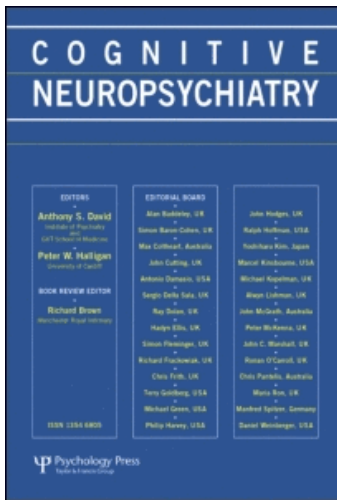
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Belief inflexibility in schizophrenia

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Background. Previous studies using delusion-neutral material have demonstrated that patients with schizophrenia, particularly those with delusions, display a bias against disconfirmatory evidence (BADE). In the current study we investigated the moderating impact of belief strength on this effect.

Methods. Thirty-three schizophrenia patients, 18 patients with obsessive compulsive disorder, and 25 healthy control participants, were consecutively presented with delusion-neutral statements that provided increasingly detailed information about a scenario. They were asked to re-rate the plausibility of four descriptions of the scenario. The correct (“true”) interpretation appeared poor on the first statement and then increasingly gained plausibility, whereas “lure” interpretations appeared plausible initially to varying degrees, but became implausible once all information was presented.

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Results. Schizophrenia patients displayed a BADE for strong beliefs, in that they were biased against revising their ratings of lure items in light of new disconfirming evidence compared to the mixed control group. However, like controls, patients with schizophrenia were willing to revise weak beliefs.

Conclusion. This confirms that schizophrenia patients are generally impaired in their ability to integrate disconfirmatory evidence, even for material that does not touch on delusional themes. This response pattern was more pronounced for strong beliefs, and this may contribute to the fixation of false ideas (i.e., delusions).

Delusions are consensually defined as fixed false beliefs not amenable to contrary evidence, and are hallmark symptoms of schizophrenia spectrum disorders. First-person accounts describing the eventual dismissal of a delusion often involve years of noting and recording evidence that disconfirms the delusion.

The belief stayed fixed until I researched and found sceptical debunking counter-arguments and disconfirming evidence. . . . If I tended to rebelieve a delusion, I decided I hadn't argued and investigated enough. It can take years to dismiss a belief altogether. (Chapman, 2002, p. 551).

Although it was initially proposed that delusional ideation cannot be explained by a pathology of reasoning (Maher, 1988), recent work has revealed a number of aberrations in logical thinking and data gathering in schizophrenia patients with current or past delusional ideas (for reviews see Bell, Halligan, & Ellis, 2006; Blackwood, Howard, Bentall, & Murray, 2001; Garety & Freeman, 1999). In our recent work along these lines, using delusional neutral material (i.e., test stimuli not associated with delusional beliefs), we observed a bias against disconfirmatory evidence (BADE) in schizophrenia (Moritz & Woodward, 2006b; Woodward, Moritz, & Chen, 2006; Woodward, Moritz, Cuttler, & Whitman, 2006). This was found to be more pronounced in delusional patients in some studies (Woodward, Moritz, Cuttler, & Whitman, 2006), and may reflect a vulnerability factor, as it was found both in first episode patients (Woodward, Moritz, & Chen, 2006), and was associated with delusional ideation in schizotypy (Buchy, Woodward, & Liotti, 2007; Woodward, Buchy, Moritz, & Liotti, 2007).

In previous studies, participants were presented scenarios, and were asked to rate the plausibility of each of four written interpretations of these scenarios. Some of the interpretations were designed to lure subjects into a belief about the scenario, but this belief became implausible when additional information was presented. Relative to control subjects, nondelusional schizophrenia patients, and particularly delusional schizophrenia patients, showed an unwillingness to change their endorsement of lures when confronted with disconfirmatory evidence. In contrast, no group differences

were observed in rating changes in response to confirmatory evidence. In other words, schizophrenia patients were less willing to “let go” of their previously endorsed interpretations of a scenario. However, on these same scenarios, schizophrenia patients were *not* impaired in their ability to integrate *confirmatory* evidence into their plausibility ratings.

In the original studies, scenarios with weak lures were dropped in order to promote a more stable measurement of integration of disconfirmatory evidence (e.g., Woodward, Moritz, Cuttler, & Whitman, 2006). In the current study we increased the number of scenarios to allow comparison of scenarios with weak lures to those with strong lures, as a BADE in schizophrenia may be more pronounced with strong lures.

In the current BADE version, statement scenarios were used instead of pictures, reducing administration time, and thereby allowing more items to be presented, and increasing reliability. The scenarios were categorised on the basis of lure strength, and this variable was assessed alongside the originally investigated measures of integration of disconfirmatory and confirmatory evidence. In order to ensure that preexisting initial beliefs about the neutral scenarios did not lead to group differences in integrating disconfirmatory evidence, initial plausibility ratings were used as covariates for all analyses of change scores.

Importantly, we included a psychiatric and a healthy control group for additional confirmation that the BADE is characteristic of schizophrenia patients and does not generalise to other psychiatric populations. The psychiatric control group was comprised of people with obsessive-compulsive disorder (OCD). Although obsessive beliefs (preoccupation that one is responsible for a catastrophe) sometimes resemble delusional ideation, the cognitive systems underlying obsessions are probably distinct from that underlying delusions: People with OCD typically have insight into the problematic nature of these beliefs, are doubtful about their worries, and do not display the strong conviction associated with true delusions. Therefore, as in past work (Moritz & Woodward, 2006a), we expected the OCD group to perform similarly to the healthy controls on the BADE task.

METHODS

Participants

Participants were 33 patients with a diagnosis of schizophrenia or schizoaffective disorder (18 were acutely delusional), 18 psychiatric control patients (obsessive-compulsive disorder; OCD), and 25 healthy control participants. Diagnoses were confirmed through the Mini International Neuropsychiatric Interview (MINI; Sheehan et al., 1998).

Schizophrenia and schizoaffective patients were recruited from an acute psychosis ward and an outpatient clinic specialised for psychosis and personality disorder from the University Medical Center, Hospital for Psychiatry and Psychotherapy in Hamburg (Germany). Psychopathology was assessed with the Positive and Negative Symptoms Scale (PANSS; Kay, Opler, & Lindenmayer, 1989) by a trained psychologist. Schizophrenia patients were classified as displaying paranoid delusions at the time of testing if they scored 3 or higher on the Delusions item (Item 1 on the positive subscale) of the PANSS. All schizophrenia patients were medicated with atypical antipsychotic medication at the time of testing. Schizophrenia patients with severe substance abuse, any form of documented or suspected brain damage/disease, and any additional Axis I diagnosis were excluded (however, depression did not warrant exclusion).

Eighteen OCD patients served as psychiatric controls. OCD patients displaying any psychotic symptoms were excluded from the study. The Yale-Brown Obsessive-Compulsive Scale (Y-BOCS; Goodman et al., 1989) mean total score was 24.71 ($SD = 6.83$, min: 13, max: 40). We applied the Hamburg Obsession/Compulsion Inventory (HOCl -S; Klepsch, Zaworka, Hand, Lünenschloss & Jauernig, 1991) scale to determine OCD subtypes. Most of the patients were checkers ($n = 10$) and washers ($n = 5$ washers, 4 of these also displayed checking). Seven patients did not fulfil criteria for a subtype according to HOCl norms. OCD patients with severe substance abuse, any form of documented or suspected brain damage/disease, and any additional Axis I diagnoses were excluded (however, comorbid anxiety disorders and depression did not warrant exclusion in line with prior studies in the field).

The healthy control participants were drawn from the general population via advertisement and word of mouth, and were screened for a history of traumatic brain injury, past or present epilepsy or encephalitis, and for any major Axis I psychiatric disorder via the semistructured MINI interview.

BADE task

The BADE task consisted of 25 scenarios with 20 experimental scenarios (BADE) and 5 filler scenarios. Each experimental scenario (trial) consisted of three successive statements, each providing additional information that further disambiguated the scenario. Along with the first statement, four interpretations appeared that had to be rated for plausibility. On the subsequent two statement presentations, participants were encouraged to adjust their ratings if this was warranted by the new pieces of information. It was emphasised that each of the four interpretations should be rated

independently, and that none or many of the interpretations may provide a particularly good fit to the scenario.

For each BADE scenario, the following four interpretations were prepared: one *true interpretation* (eventual solution; on the first stage this interpretation was thought to be either less or equally plausible than the lure interpretations), one *absurd interpretation* (interpretations that were implausible across all stages), and two *lure interpretations* (interpretations that were deemed plausible for the first statement, but became implausible with accumulating evidence). To give an example, the first statement for one BADE trial was “Heike is very thin”. This was presented along with the following interpretations: (1) “Heike is a model” (lure); (2) “Heike is suffering from an eating disorder” (lure); (3) “Heike has lost her false teeth” (absurd); and (4) “Heike is homeless” (true). Following this, a second statement was presented: “Heike has had a hard life”. Finally, the statement “Heike does not even have a home” was presented, providing strong disconfirmatory evidence against both lure interpretations, and strong confirmatory evidence for the true interpretation. After the presentation of each new statement, participants were asked if they would like to revise their original ratings based on the new information.

The BADE trials were either newly developed or adapted from a prior BADE experiment (Woodward, Moritz, & Chen, 2006). For the five filler trials, one or two true options were accurate on the first trial, and this did not change over all trials. The sole purpose of the filler trials was to provide variation in the pattern of responding, so that the BADE pattern did not become too obvious. Ratings from filler trials were dropped from subsequent analyses.

Each participant was individually tested in a quiet room. Two practice trials were provided prior to the experiment to familiarise participants with the task set-up. All statements were presented using Microsoft Internet Explorer 6.0 in 12 point Times New Roman font. Plausibility ratings were achieved by using a mouse to move a slider along a scale of 1 to 10. Each interpretation was associated with its own rating scale, and directly below each rating scale was the numbers 0 to 10, with the labels “Poor”, “Possible”, “Good”, and “Excellent” situated directly below the numbers 0, 3.5, 6.5, and 9.5, respectively. In addition, the point along the rating scale that was currently selected by the mouse was displayed in a box to the immediate right of the rating scale. Trial order and positions of the four response alternatives were randomly determined. The total duration of the experiment session was approximately 35 min.

In order to investigate the impact of lure strength, blind to group differences items were categorised according to the lure strength for that trial; that is to say, items for which lure plausibility was initially rated significantly higher than interpretations that turned out to be true were

considered strong lure trials. Assignments of trials as weak or strong lure trials were initially based on ratings made by the healthy control group, and this separation was confirmed by analyses involving all groups. Paired-sample *t*-tests between ratings of true and lure interpretations after Statement 1 were used to classify scenarios by lure strength, with $p < .05$ (two-tailed) used as the cutoff for significance. A significant difference for any of these comparisons warranted inclusion of the scenario in the strong lure category. This selection process resulted in 8 scenarios classified as strong lure trials, and 12 scenarios classified as weak lure trials.

For the BADE task, the dependent measures were calculated using change scores. Specifically, in accordance with recent methodology based on factor analysis of the BADE lure types (Woodward et al., 2007), the change scores were computed by averaging together the ratings following Sentences 2 and 3, and subtracting that from the ratings following Sentence 1. The BADE and BACE (Bias Against Confirmatory Evidence) measures were computed by following this procedure for lure and true items, respectively. To extend the analysis to all items, the same computations were made for absurd items, although the change on these items was expected to be relatively small due to floor effects.

A reluctance to integrate disconfirmatory evidence, and an enhanced willingness to integrate confirmatory evidence, may be natural consequences of holding a strong belief (Hemsley, 1988, p. 118; Jonas, Schulz-Hardt, Frey, & Thelen, 2001; Nickerson, 1998). In order to control for the potential impact of the initial belief on changes in that belief, and in accordance with past work (Woodward, Moritz, & Chen, 2006; Woodward, Moritz, Cuttler, & Whitman, 2006), the corresponding initial plausibility ratings were used as covariates for all analyses of BADE and BACE change scores. That is to say, when computing the BADE, the initial ratings for lure items were used as covariates, and when computing the BACE, initial ratings for the true interpretations were used as covariates.

A fundamental assumption underlying the application of ANCOVA is homogeneity of regression coefficients (Pedhazur, 1982, p. 497). The process of adjustment for the covariate involves correcting the dependent variable for variance attributable to the covariates, with the essential point being that a single regression weight (for each covariate) is applied to all groups. The homogeneity of regression coefficients assumption states that the covariate has a uniform relationship with the dependent variable in all groups. This can be statistically tested using the method described by Pedhazur (1982, pp. 516–517), which involves testing that the interaction between the covariate and the grouping variable does not account for significant variance over and above that accounted for by the main effects of those variables. We found that the homogeneity of regression coefficients assumption was met for all analyses reported below.

RESULTS

Demographics for all groups are listed in Table 1. As mentioned earlier, the dependent measures were calculated using change scores. In particular, change scores were computed by averaging together the ratings for Sentences 2 and 3, and subtracting that from the ratings for Sentence 1. The BADE and BACE measures were computed by following this procedure for lure and true items, respectively.

Preliminary analyses of all dependent measures (BADE and BACE) demonstrated, as expected, no differences in performance between the healthy and psychiatric control groups (all $ps > .3$), and no significant interactions (all $ps > .7$) of this grouping factor with lure strength (strong lure vs. weak lure). There were also no differences in performance between the delusional and nondelusional schizophrenia groups (all $ps > .3$), and no significant interactions of this grouping factor with lure strength (all $ps > .3$). Therefore, to maximise power for the main analyses of interest, the healthy and psychiatric control groups were collapsed for all analyses reported below, as were the delusional and nondelusional patient groups, resulting in a two-group comparison (schizophrenia vs. mixed controls) for testing the main hypotheses of interest. Statistical two-group comparisons of the demographic variables resulted in an absence of significant differences (all $ps > .2$). A 2×2 mixed model ANOVA on all lure item ratings following Sentence 1, with lure strength (strong lure vs. weak lure) as the within-subject factor, and group (schizophrenia patients vs. mixed controls) as the between-subjects factor, demonstrated a highly significant effect of lure strength, $F(1, 74) = 63.87, p < .001$, that did not interact with group, $F(1, 74) = 0.95, p = .33$, confirming that the

TABLE 1
Sociodemographic characteristics of the samples, along with statistical comparisons

Variable	Healthy ($n=25$)	Schizophrenia ($n=33$)	OCD ($n=18$)	Statistics
Gender (male/female)	8/17	18/15	7/11	$\chi^2(1) = 3.14, p > .2$
Age in years	33.72 (11.03)	37.12 (11.50)	37.78 (10.77)	$F(2, 73) = 0.91, ns$
Education in years	11.68 (1.75)	11.55 (1.70)	10.53 (1.62)	$F(2, 73) = 2.67, ns$
Subjects on antipsychotics (atypical/typical/ combined)	—	29/3/1	—	—
PANSS total	—	62.21 (15.74)	—	—
Yale-Brown Obsessive- Compulsive Scale	—	—	24.71 (6.83)	—
Previous hospitalisations	—	3.38 (2.68)	2.78 (2.98)	$t(48) = 0.73, p > .4$
Premorbid intelligence (IQ)	113.32 (12.86)	104.64 (12.31)	110.17 (14.69)	$F(2, 73) = 3.26, p = .04, H > S$

lure strength manipulation was valid for both groups, and did not differ between the groups.

The BADE and BACE change scores were analysed separately with 2×2 mixed model ANCOVAs, with lure strength (strong lure vs. weak lure) as the within-subject factor, and group (schizophrenia patients vs. mixed controls) as the between-subjects factor. For BADE scores on lure items, the effect of group and the Group \times Lure strength interaction was significant, $F(1, 70) = 5.69, p < .05, F(1, 70) = 5.41, p < .05$, respectively. The significant interaction was due to the group difference being pronounced for the high lure strength items, $F(1, 70) = 9.54, p < .01$, but not for the low lure strength items $F(1, 70) = 1.82, p = .18$, suggesting that schizophrenia patients were willing to change ratings for weak lures, but not for strong lures, relative to controls. In contrast, for BACE scores on true items, the effect of group and the Group \times Lure strength interaction were not significant, $F(1, 72) = 0.33, p = .57, F(1, 72) = 3.46, p = .07$, respectively. For BADE scores on absurd items, the effect of group and the Group \times Lure strength interaction were not

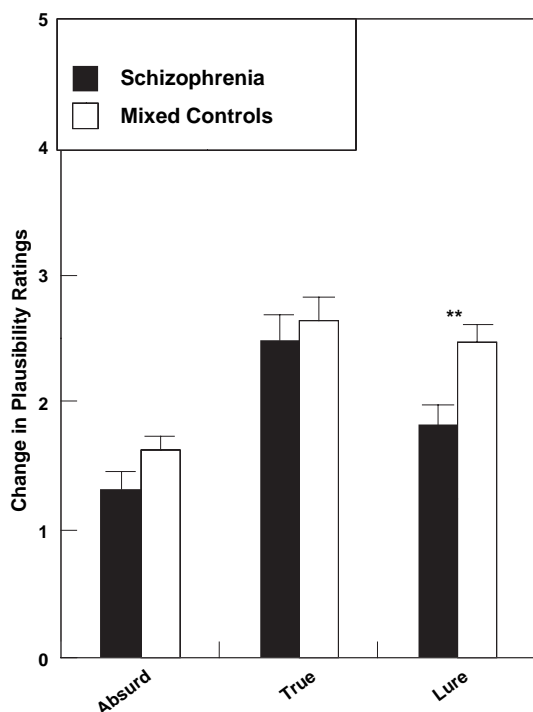


Figure 1. Mean changes in plausibility ratings for absurd, true, and lure items (strong lure trials only), plotted as a function of group. ** $p < .01$. Means are adjusted for covariates. The sign has been reversed for computations based on “true” interpretations.

significant, $F(1, 72) = 3.48, p = .07$, $F(1, 72) = 0.03, p = .88$, respectively. The covariate-adjusted means are presented in Figure 1 for high lure strength trials, as a function of group and interpretation type.

DISCUSSION

The results of the current study suggest that, relative to controls, patients with schizophrenia were less able to integrate evidence disconfirming *strongly* held beliefs. In other words, patients were more unwilling to change a strong belief compared to the mixed control group, but did not differ with respect to their willingness to change a weak belief. As this group difference emerged using delusion-neutral material, this suggests that although the groups were similar on their level of *initial* strong belief, schizophrenia patients were less willing to revise those strongly held beliefs than the control group. Therefore, the BADE cannot be explained as “normal” resistance to giving up preferred theories, but instead provides evidence for a reasoning bias in schizophrenia involving a failure in integrating disconfirmatory (but not confirmatory) evidence when strong preferences exist. This may contribute to the maintenance of false beliefs, because when beliefs become as strongly held as delusions, this BADE effect may be intensively magnified, possibly contributing to the pathological conviction that is associated with delusions, as opposed to those that characterise everyday strong opinions.

In the current study a BADE was not increased for the delusional patient group. This is in contrast to two other studies that found that BADE was associated with delusions (Woodward, Moritz, & Chen, 2006; Woodward, Moritz, Cuttler, & Whitman, 2006). One reason for this discrepancy may be the use of different symptom rating scales in the two studies. In the original study we used the Signs and Symptoms of Psychotic Illness rating scale (SSPI; Liddle, Ngan, Duffield, Kho, & Warren, 2002), which puts more emphasis on the role of insight and conviction when rating delusions relative to the PANSS. It is possible that the BADE effect is more pronounced for patients with strong conviction in their delusions, highlighting the importance of rating scales that index conviction, such as the PSYRATS (Haddock, McCarron, Tarrier, & Faragher, 1999). Another important question that is yet to be investigated is whether or not insight of illness is underpinned by a BADE, as the presence of delusions overlaps with absence of insight in schizophrenia (Buchy, Torres, Liddle, & Woodward, 2008).

The absence of a difference between the healthy control groups and the OCD patients suggest that the BADE is not a manifestation of psychiatric illness per se. There is recent evidence that patients with OCD are as flexible as controls on tasks that require belief flexibility. In a study conducted by Moritz and Pohl (2006), OCD patients were asked to rate the incidence

probability of certain classes of events that were OCD related as well as unrelated. Thereafter, they were provided with the correct probabilities, and then 2 hours later were required to recall their initial estimates. Both healthy and OCD participants integrated the intervening information to a comparable degree (i.e., both showed a hindsight bias).

Previous work shows that both delusional and nondelusional patients with schizophrenia are hasty in their decision making (Dudley & Over, 2003), making them prone to errors, and that they display a liberal acceptance (LA) of even unlikely scenarios (Moritz & Woodward, 2004). While these reasoning biases may cause nondelusional patients to give undue credence to false ideas, perpetuation of these false beliefs, possibly in part due to a BADE, may block the path back to healthy reality testing, and delusions may evolve, possibly in concert with other biases (e.g., self-esteem, need for closure). Future longitudinal investigations will be required in order to understand how cognitive biases such as JTC, LA, and BADE interact and combine with other cognitive biases and/or neuropsychological deficits to eventually culminate into delusional beliefs. In view of cumulative evidence for cognitive biases in schizophrenia, we have recently developed a metacognitive training programme (Moritz, Woodward, & Metacognition Study Group, 2007) which, among other cognitive distortions such as JTC and LA, introduces belief inflexibility as a thinking style that is part of psychosis and schizophrenia. Patients are confronted with tasks similar to those developed for the present and prior studies, and experience, as a group, the advantages of incorporating new evidence into beliefs.

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