

Increased Hindsight Bias in Schizophrenia

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An underlying theme common to prominent theoretical accounts of cognition in schizophrenia is that information processing is disproportionately influenced by recently/currently encountered information relative to the influence of previously learned information. In this study, the authors tested this account by using the *hindsight bias* or *knew-it-all-along* (KIA) paradigm, which demonstrates that newly acquired knowledge influences recall of past events. In line with the account that patients with schizophrenia display a disproportionately strong influence of recently encountered information relative to the influence of previously learned information, patients displayed a KIA effect that was significantly greater than in controls. This result is discussed in the context of the cognitive underpinnings of the KIA effect and delusion formation.

Keywords: schizophrenia, hindsight bias, memory, delusions

The *knew-it-all-along* (KIA) or *hindsight bias* effect (e.g., Fischhoff, 1975, 1977) occurs when newly acquired knowledge biases recall of past events. One established method for experimentally eliciting this effect is to follow presentation of very difficult trivia questions (for which participants are forced to choose between two answers) with presentation of the correct answers in an ostensibly unrelated task. When asked to reproduce their initial trivia answers, participants' memories are biased toward the recently encountered (and correct) trivia answers.

The KIA effect depends on imperfect source memory. Self/other source memory failures are commonly reported in schizophrenia (Bentall, Baker, & Havers, 1991; Keefe, Arnold, Bayen, McEvoy, & Wilson, 2002; Woodward, Menon, Hu, & Keefe, in press), but failures to replicate call into question the reliability of this finding (Moritz & Woodward, 2006; Moritz, Woodward, & Chen, 2006). Although imperfect source memory is required to produce the KIA effect, the effect is increased if recently encountered information is given high weight relative to previously encountered information when a source memory failure occurs. A review of the schizophrenia literature suggests that a disproportionately strong influence of recently/currently processed information relative to the influence of previously learned information may be more important than source memory deficits for understanding schizophrenia. This is the main construct underlying the following major cognitive accounts of psychosis: (a) the weakening of the influence of stored memories of regularities of previous input on current perception (WISM) account of Hemsley (Gray, Feldon, Rawlins, Hemsley, & Smith, 1991; Hemsley, 1996), (b) the context-processing account of Cohen (Cohen, Barch, Carter, & Servan-Schreiber, 1999; Cohen & Servan-Schreiber, 1992), and (c) the jumping-to-conclusions account of Garety (Garety & Freeman, 1999; Garety, Hemsley, & Wessely, 1991). Specifically, both the WISM and context accounts propose disruption in activating stored information to integrate with current processing (Hemsley, 1996, p. 150; 2005, p. 50). Similarly, the jumping-to-conclusions account postulates that patients base strong judgments on currently available evidence. In this regard, all three accounts involve a disproportionately strong influence of recently/currently processed information relative to the influence of previously learned information.

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In line with this construct that is thought to underlie we hypothesized that in the KIA paradigm, newly acquired information would have an undue influence on recollection, producing a greater KIA effect for patients than for controls. Further, in accordance

with previous findings that patients with schizophrenia show greater confidence in incorrect responses (Moritz & Woodward, 2006; Moritz, Woodward, & Ruff, 2003), we expected that compared with controls, patients with schizophrenia would be more confident in their reproduction of their original answers when showing the KIA effect.

Method

Participants

Twenty-eight inpatients diagnosed with schizophrenia according to *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; American Psychiatric Association, 1994) criteria were recruited from Riverview Hospital and the Forensic Psychiatric Services Commission, Coquitlam, British Columbia, Canada. Twenty-nine control participants consisting primarily of Riverview Hospital staff were also recruited for the study. Table 1 provides a summary of the samples' sociodemographic characteristics. The groups of patients with schizophrenia and controls were matched on age and socioeconomic status (Hollingshead & Redlich, 1958). For 2 patients and 7 controls, English was their second language, but all read and spoke English proficiently and used English as their primary daily language. At the time of testing, all patients were receiving atypical antipsychotic medication (chlorpromazine equivalent dosage in milligrams: $M = 688.91$, $SD = 644.00$; Bezchlibnyk-Butler & Jeffries, 2000). Participants were excluded if their IQ was less than 70 or if they had a history of primary or acquired brain damage (e.g., stroke, encephalitis) or traumatic head injury (e.g., with a loss of consciousness for more than 10 min).

Materials

Psychopathology. Psychopathology was assessed with the Signs and Symptoms of Psychotic Illness rating scale (SSPI; Liddle, Ngan, Duffield, Kho, & Warren, 2002). The SSPI is a 20-item scale that can be completed after a 25–30-min semistructured interview containing 15 direct questions about symptoms. The severity of each item is rated on a scale ranging from 0 (*no pathology*) to 4 (*severe pathology*). The SSPI is criterion-referenced, providing anchor points for each of the five severity levels for each of

the 20 items. The syndrome scores for reality distortion, disorganization, and psychomotor poverty were summed from items selected on the basis of previous factor analyses of the SSPI (Woodward, Ruff, Thornton, Moritz, & Liddle, 2003; Woodward, Thornton, Ruff, Moritz, & Liddle, 2004).

KIA test. There were three phases to the KIA paradigm in the current study (see Figure 1). For the first phase, participants were required to provide answers to very difficult trivia questions, to which the correct answers were unlikely to be known (see Figure 2). This was followed by the second phase, a feedback session, during which participants were exposed to the correct answers to half of the trivia questions, under the guise of a speeded reading task (SRT). In the final phase, participants were reexposed to the difficult trivia questions and were instructed to ignore any feedback they were given and to attempt to remember how they responded the first time. As mentioned above, the KIA effect is characterized by a tendency for participants to gravitate toward the correct answers in the final phase, claiming that they initially gave the correct answers (i.e., that they knew it all along), in comparison with the control items for which they did not receive feedback.

For the first phase, Trivia Test 1, a set of 60 trivia questions was constructed from various sources (e.g., Nelson & Narens, 1980) and presented to participants in random order. Forty of the questions were critical items that were difficult to answer (e.g., "What do you call a baby echidna?"), whereas the other 20 questions were designed to be easier to answer and were included as filler items (e.g., "Which precious gem is red?"). There were two possible solutions provided with each question: the correct answer and a plausible foil (for the echidna item, "puggle" and "chuttle" were the answer options, with the former being correct). For the second phase, the feedback phase (introduced as an SRT), we constructed two feedback lists to counterbalance, between subjects, which critical items were given feedback and which were given no feedback. For this feedback phase, reworded trivia questions were constructed from half of the critical items. These reworded questions always contained the actual solution as the critical item (e.g., "For what animal is a baby called a puggle?"; solution: echidna). In addition, 7 new filler items were created for use in the feedback phase.

Procedure

Participants were tested individually on an IBM-compatible personal computer using Superlab 2.0 (Cedrus Corporation, San Pedro, CA). Participants were seated directly in front of the computer, with the experimenter off to the side. For the first phase, Trivia Test 1, the experimenter read the following instructions aloud to the participants:

You will be presented with a series of general-knowledge questions, each with two possible alternatives. One of the alternatives is the correct answer to the question. The two responses will be separated by a number scale ranging from 1 to 10. Your task is to read the question aloud and choose the number that you believe corresponds to the correct answer. You must select a number for every question, so you can guess if you do not know which alternative is the correct answer. Some of the general-knowledge questions are very difficult (i.e., people rarely know the correct answer), so do not be discouraged if you have a difficult time choosing the correct answer for some of the questions.

Participants were encouraged to respond after being prompted for an answer. They were instructed to vocalize their choice aloud, and the experimenter keyed in their responses. It was pointed out to participants that there was no midpoint on the number scale and that they always had to side with one of the answers. They were also told to use the number scale as an indicator of their response confidence, with numbers closer to the answers indicating a greater degree of confidence. Finally, they were instructed to try to use the full range of this scale, to avoid repetitively using only one point as their response. To ensure that participants fully

Table 1.

Sociodemographic Characteristics of the Samples

Characteristic	Controls ($n = 29$)		Patients with schizophrenia ($n = 28$)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (in years)	33.21	14.54	35.61	9.86
Education	14.29	2.24** ^a	11.64	2.42** ^a
IQ estimate	103.07	12.05** ^a	96.79	8.24** ^a
Socioeconomic status	31.54	14.77	36.15	13.77
Length of illness (in years)	—	—	15.12	8.47
Delusions	—	—	2.67	1.04
Hallucinations	—	—	1.48	1.67
Formal thought disorder	—	—	0.74	1.16
Flat affect	—	—	0.67	1.00
Poverty of speech	—	—	0.56	1.09
Underactivity	—	—	0.63	1.01

Note. Gender of samples: Controls = 17 women and 12 men; patients with Schizophrenia = 7 women and 21 men. Significance determined by the Pearson Chi-square test.

^a Significance determined by independent-groups *t* tests.

* $p < .05$. ** $p < .001$.

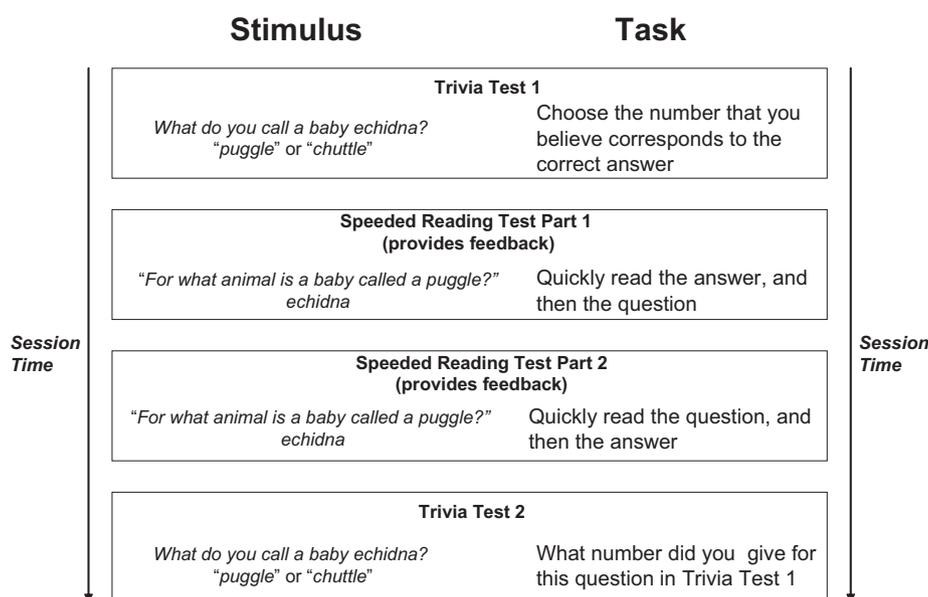


Figure 1. Overview of task with examples of stimuli and task requirements. Trivia Test 1 involved requiring participants to provide answers to very difficult trivia questions for which the correct answer was unlikely to be known. This was followed by two feedback sessions, during which participants were exposed to the correct answers for a portion of the questions, under the guise of a speeded reading task. The knew-it-all-along (KIA) task was completed by a second exposure to the difficult trivia questions, but this time the participants were asked to attempt to remember how they responded to these questions the first time. The KIA effect is characterized by a tendency for participants' claims of how they responded during Trivia Test 1 to gravitate toward the correct answers given as feedback (in comparison with the control items that did not receive feedback) because of the exposure to those correct answers during the feedback session.

understood how to use the number scale, the experimenter guided them in responding to two examples prior to starting Trivia Test 1.

The feedback phase occurred immediately after Trivia Test 1. In an attempt to make the nature of the feedback phase less transparent, participants were informed that they were going to complete a two-part SRT. Part 1 was called the study phase, and Part 2 was called the test phase. The feedback phase was disguised as an SRT because the trivia items themselves were quite memorable and the KIA effect could be obscured if the feedback was presented in a manner that allowed participants time to actively recall their Trivia Test 1 responses (i.e., if participants were given ample time to look at the correct answers presented with the trivia items). In the first part of the SRT, 27 trivia questions (20 reworded critical items and 7 new filler items) were presented. For each trial, the question was presented near the bottom of the screen, and the correct answer appeared above the question. Participants were told that their first task was to read the answer aloud into their clipped-on microphone (i.e., before even looking down at the question). As soon as the participants responded, the experimenter immediately advanced the screen with a keypress (the microphone was not actually recording response time), the answer disappeared, and participants were then required to read the question aloud. The experimenter explained to the participants that their goal was to associate (for the purpose of learning) the answer that they had just read aloud with its question, motivating them as follows: "The better you are at learning the answers to the questions in this study section, the faster your response time should be in the upcoming test." Prior to starting Part 1 of the SRT, participants were told that many of the trivia questions were similar to the questions from the preceding Trivia Test 1 but that none were the exact same questions from that test.

In Part 2 of the SRT, the 27 trivia questions from Part 1 of the SRT were presented again. Participants were instructed that on each trial a question

would appear near the top of the computer screen and that they were to read the question to themselves. They were told that once they had read the question they were to push a button (which caused the question to disappear), and the answer to the question would be presented in the center of the screen. Participants were instructed to say the answer as quickly as possible into the microphone. They were unaware that the microphone was not actually recording their response times. The experimenter emphasized to participants that their goal was to improve their reaction time (i.e., respond faster) as they moved through the 54 trials and, therefore, it was important for them to respond both accurately and quickly.

The final phase, Trivia Test 2, occurred immediately after Part 2 of the SRT. Participants were informed that they would be presented with some of the trivia questions from Trivia Test 1 (to reduce the length of the testing session, only the critical items were presented in Trivia Test 2) and that their task was to recall and state the same number that they had given to each question in Trivia Test 1. The experimenter stressed that the researchers were interested in whether participants could consistently select the same numbers that they had chosen in Trivia Test 1 and, therefore, that it was important for them to ignore the SRTs and concentrate on remembering the original number that they had given for each question in Trivia Test 1. After choosing their Trivia Test 1 response, participants were required to complete a confidence rating for their last response (i.e., how confident they were that the response they just gave was the same as the response they gave in Trivia Test 1) on a Likert scale ranging from 1 to 4, using the anchors of *positive*, *rather certain*, *rather uncertain*, or *guessing*.

Measures

The measure of the KIA effect used in the present study was how much closer (in rating scale units) the Trivia Test 2 responses were to the correct

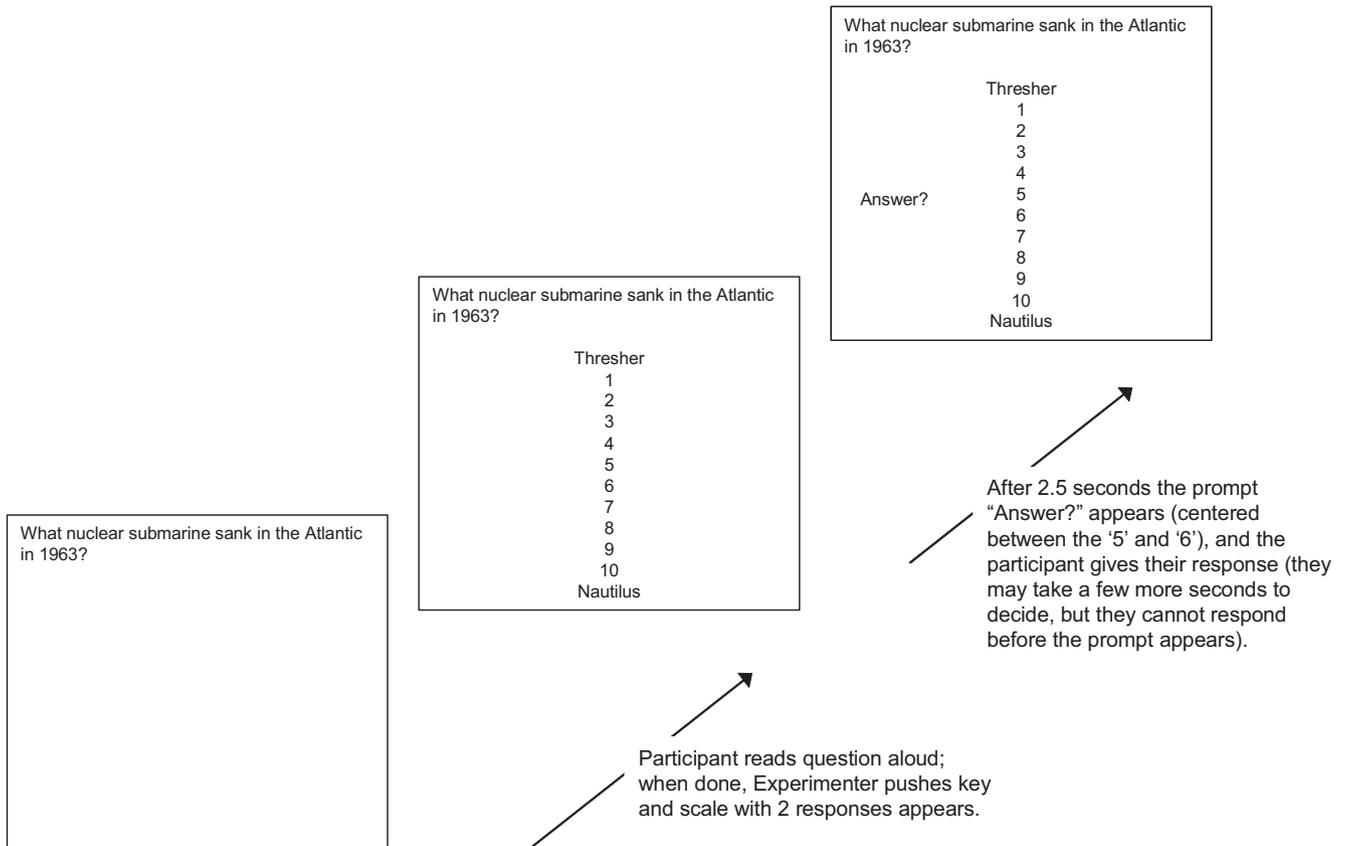


Figure 2. Screen display and procedural summary for an example Trivia Test 1 trial.

answers, compared with the Trivia Test 1 responses. Thus, the KIA measure was computed as the magnitude of change on the number scale toward the correct responses from Trivia Test 1 to Trivia Test 2. As detailed above, "feedback" refers to the trials in Trivia Tests 1 and 2 that were in the SRTs, whereas "no feedback" refers to the trials in Trivia Tests 1 and 2 that were not in the SRTs. Thus, the KIA measure (and its associated confidence) computed on no-feedback trials served as a control for the KIA measure (and its associated confidence) computed on feedback trials.

Results

The primary analyses consisted of 2×2 mixed-model analyses of variance (ANOVAs) with the experimental manipulation of interest (e.g., feedback vs. no feedback) as the within-subjects factor and group as the between-subjects factor. To distinguish between trait variables (i.e., impairments present for all people with schizophrenia regardless of symptom profile) and state variables (i.e., increased impairments for people with current delusions), we performed two sets of analyses with group defined in two different ways. To detect trait variables, we defined group as patients with schizophrenia versus healthy controls. To detect state variables, we repeated the same analyses only for patients with schizophrenia, with group defined as currently delusional patients versus currently nondelusional patients. Item 7 from the SSPI was used to quantify the presence or absence of delusions. A rating of 3 (definite delusions but the delusional beliefs do not have a perva-

sive influence on thinking or behavior) or 4 (definite delusions that have pervasive influence on thinking and/or influence observable behavior) warranted classification into the delusional group. For these "state variable" analyses, 1 patient was excluded due to the absence of symptom data. The remaining 27 patients were split into 18 currently delusional and 9 currently nondelusional patients. All 9 currently nondelusional patients had experienced delusions sometime in the past, as determined by a comprehensive chart review.

Acceptance of Trivia Answers

To provide a general picture of the degree of acceptance of trivia answers on critical items prior to feedback, we submitted Trivia Test 1 responses to a 2×2 mixed-model ANOVA with correctness (responded on the side of the scale with the correct answer vs. responded on the side of the scale with the incorrect answer) as a within-subjects factor and group (patients vs. controls) as a between-subjects factor. The dependent variable was the number of rating units (in terms of response given) toward the extreme of the response scale (ranged from 1 to 5). No effects involving the within-subjects factor were significant (all F s < 1.0 , all p s $> .35$), confirming that participants were not responding with more conviction on correct responses than on incorrect ones, suggesting that the correct responses were, in fact, not recognized by the participants. In contrast, the group effect was highly significant, $F(1,$

55) = 14.94, $p < .001$, $\eta^2 = .21$, such that patients tended to respond approximately three rating steps toward the extreme endpoints ($M = 3.06$, $SE = 0.16$), whereas controls tended to respond approximately two steps toward the extreme endpoints ($M = 2.22$, $SE = 0.15$). This result suggests that although neither group showed evidence of recognizing the correct answer (i.e., no significant effect of correctness), in general patients accepted their chosen option with more certainty. When the same analysis was carried out comparing delusional and nondelusional patients, no effects were significant (all F s ranged from 0.24 to 1.91, all p s $> .18$).

KIA Effect

The KIA effect was analyzed by way of a 2×2 mixed-model ANOVA with feedback (feedback vs. no feedback) as a within-subjects factor and group (patients vs. controls) as a between-subjects factor (see Figure 3). The dependent variable was the KIA measure, computed (as discussed above) as the magnitude of change on the number scale toward the correct response from Trivia Test 1 to Trivia Test 2. This analysis led to a significant interaction, $F(1, 55) = 5.36$, $p < .05$, $\eta^2 = .09$, with the magnitude of the KIA measure for patients being greater than that for controls ($M = 0.74$, $SE = 0.22$; $M = 0.19$, $SE = 0.09$, respectively). The magnitude of the KIA effect was significantly different from zero for both the patient and control groups, $t(27) = 3.36$, $p < .005$, $\eta^2 = .29$; $t(28) = 2.09$, $p < .05$, $\eta^2 = .13$, respectively.

To investigate the potential confounding influence of the demographic variables that differed between the groups (see Table 1), we computed correlation analyses for the control and patient groups separately. Pearson's correlation computations suggested that neither years of education ($r = -.20$, $p = .30$; $r = .14$, $p = .47$, respectively) nor estimated IQ ($r = .02$, $p = .94$; $r = -.24$, $p = .21$, respectively) was significantly associated with the KIA

measure, and t tests suggested that KIA magnitude did not differ between men and women for either group ($p = .38$ and $p = .09$, respectively). Therefore, these potential confounds were not investigated further.

When the KIA effect analysis was carried out comparing delusional and nondelusional patients, the Feedback \times Group interaction was not significant, $F(1, 25) = 0.24$, $p = .63$, $\eta^2 = .01$, indicating that the magnitude of the KIA effect did not differ between these groups. The magnitude of the KIA effect was significantly different from zero for both the delusional and nondelusional groups, $t(17) = 2.22$, $p < .05$, $\eta^2 = .22$; $t(8) = 4.16$, $p < .01$, $\eta^2 = .68$, respectively ($M = 0.71$, $SE = 1.36$; $M = 0.95$, $SE = 0.23$, respectively).

Confidence

The confidence ratings (i.e., 4-point scale indicating how confident the participants were that the Trivia Test 2 answer was the same as the Trivia Test 1 answer) were analyzed by way of a 2×2 mixed-model ANOVA with feedback (feedback vs. no feedback) as a within-subjects factor and group (patients vs. controls) as a between-subjects factor. This analysis was restricted to trials for which Trivia Test 2 answers were closer to the "correct trivia answer" than were the Trivia Test 1 answers (i.e., KIA trials). No significant main effects or interactions were observed (all F s < 0.60 , all p s $> .50$). When the same analysis was carried out comparing delusional and nondelusional patients, no effects were significant (all F s ranged from 0.16 to 0.52, all p s $> .48$).

Correlations With Syndrome Scores

For the patient group, neither the strength of conviction, nor the KIA effect, nor the confidence ratings were significantly correlated with any of the syndrome scores (Pearson's r s ranged from $-.33$ to $.13$, all p s $> .09$).

Discussion

In the current study, we used the KIA paradigm to test whether patients with schizophrenia would be disproportionately influenced by recently processed information relative to the influence of previously learned information. Participants were presented with a number of difficult trivia questions, and the correct answers were subsequently presented in a task that the participants were told involved speeded reading. Finally, participants were asked to reproduce their original answers to the trivia questions. For both groups, the "reproduced" responses were closer to the correct answers than were the original responses (this is the KIA effect). However, in line with predictions, the magnitude of the KIA effect in patients was significantly increased relative to controls.

An additional effect of interest was that, even prior to feedback, patients with schizophrenia tended to respond closer to the extreme endpoints than did controls. This result suggests that patients were more accepting of their chosen answer, despite the fact that the questions were designed such that the answer would rarely be known and, in fact, patients' (and controls') accuracy was very poor. This replicates previous findings that people with schizophrenia display a liberal acceptance bias in that they are more willing than controls to endorse implausible statements on the

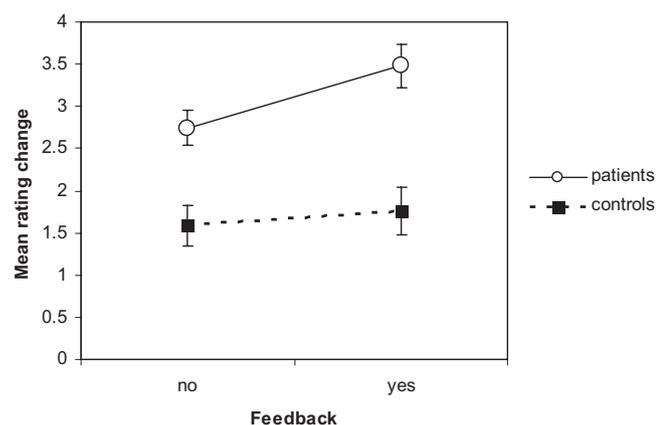


Figure 3. Mean knew-it-all-along (KIA) measure ($\pm SE$) presented as a function of group and feedback. The KIA measure was computed as the magnitude of change on the number scale toward the correct responses from Trivia Test 1 to Trivia Test 2. The term *feedback–yes* refers to the trials in Trivia Tests 1 and 2 that were in the speeded reading tasks (SRTs), whereas *feedback–no* refers to the trials in Trivia Tests 1 and 2 that were not in the SRTs. Thus, the KIA measure (and its associated confidence) computed on no-feedback trials served as a control for the KIA measure (and its associated confidence) computed on feedback trials.

basis of little evidence (Moritz & Woodward, 2004; Woodward, Moritz, Cuttler, & Whitman, in press) and display more confidence in unreliable information (Moritz & Woodward, 2002, 2006; Moritz, Woodward, Cuttler, Whitman, & Watson, 2004; Moritz et al., 2003).

To the extent that the hindsight bias assessed here correlates with the hindsight bias relevant to autobiographical memories (Ross, 1989), the current finding of an increased hindsight bias suggests that past "reality-based" memories (e.g., how one felt, what one thought, what one said and did) that may otherwise provide a correcting influence on distorted reality perception may not sufficiently moderate current experience. For example, a delusion that a patient's sister is plotting to keep the patient in the hospital could be countered by the past memory and experience that the sister has shown love and trust to the patient in the past. Liberal acceptance of the implausible paranoid scenario, combined with an absence of the correcting influence of past memories, may provide fertile ground for the development of delusions. Once these false interpretations have been accepted, they might be further strengthened through information collection guided by a confirmation bias (Freeman, Garety, Kuipers, Fowler, & Bebbington, 2002) or a bias against disconfirmatory evidence (Woodward, Moritz, & Chen, in press; Woodward, Moritz, Cuttler, & Whitman, in press), leading to a strongly maintained delusional belief. Thus, candidate trait variables such as liberal acceptance and the absence of the correcting influence of past memories may combine with proposed state variables, such as a bias against disconfirmatory evidence, to form and maintain the delusional belief systems that characterize schizophrenia.

The generality of the KIA effect as a trait variable for delusions could be tested by extending this paradigm to other aspects of the schizophrenia spectrum. For example, patients with schizotypal personality disorder would be expected to show an attenuated KIA effect relative to appropriate controls. An alternative approach for future research is the investigation of neurocognitive rehabilitation programs that involve metacognitive skill training (Moritz, Burlon, & Woodward, 2005). Patients could be made more aware of common cognitive biases and how to overcome them (e.g., past memories can provide a stabilizing influence over current perceptions of reality) and/or could be cautioned against trusting partial information. Similarly, patients with schizophrenia could be taught ways to confirm hypotheses in a more stringent manner (e.g., according to the scientific method). It is important for patients to understand the fallibility of human recollection in general and their own in particular. When information is not available, judgments should be made with caution, and additional evidence (e.g., "anchor" persons such as close relatives) should be consulted for confirmation.

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