Impoverished Counterfactual Thinking is Associated with Schizophrenia

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COUNTERFACTUAL thoughts are mental representations of alternatives to past events. Recent research has shown counterfactual thinking to be a pervasive cognitive process in normal populations and has linked it to effective problem-solving and decision-making. The present research demonstrates that counterfactual thinking is impaired in schizophrenia patients relative to normal control subjects; this impairment was evident using measures of counterfactual thoughts as well as counterfactual-derived inferences. Furthermore, this impoverished counterfactual thinking partly mediated impaired social functioning experienced by schizophrenia patients. Given the convergence of neuropsychological evidence showing counterfactual deficits in frontal lobe patients and the documented frontal deficits in schizophrenia patients, future studies investigating a specific relationship between counterfactual thinking and frontal lobe function in schizophrenia patients would be a logical next step in this line of research.

Counterfactual thinking refers to the generation of alternatives to past factual events, and it appears to be a pervasive feature of normal cognition (Roese 1997). Counterfactual thoughts, as defined here (as well as elsewhere; see Roese 1997), are thoughts that posit an alternative action that could have been taken during a past event. People regularly muse on what might have been, that is, on how specific events might have turned out differently had they taken some alternative action. Although such thoughts can heighten distress (Davis and Lehman 1995), they also play a key role in conceptual learning, decision-making, social functioning, and performance improvement (Roese and Olson 1997). Specifically, counterfactual thoughts illuminate causal relations (e.g., "If only she had studied harder, she would have passed"), thereby suggesting future courses of action that might be strategically deployed to facilitate success (e.g., "She should study harder next time"). Moreover, counterfactual thinking is activated to a greater extent by negative

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This research was supported by National Institute of Mental Health FIRST grant MH55578 awarded to Neal Roese, and by grants awarded to Sohee Park from the National Alliance for Research in Schizophrenia and Depression the Scottish Rite Schizophrenia Research Program. The authors thank Galen Bodenhausen and Marcia Grabowecky for commenting on an early draft and Ginger Pennington for collecting the pilot CIT data. The authors also thank Andy Moore for help with data collection, and Michelle Pagel, and Karen Madda for subject recruitment.

emotions than by positive emotions, again suggesting that these thoughts are strategically functional in guiding individuals through problematic social situations (Roese and Hur 1997).

Although counterfactual thinking is a pervasive feature of normal cognition, there have only been a few studies that have investigated the link between psychopathology and counterfactual thinking. These studies have centered almost exclusively on depression, with the general conclusion that unchecked, long-term counterfactual rumination exacerbates negative affect and contributes to depression (Markman and Weary 1998; Roese and Olson 1993, 1997). This line of research in depressed populations shows the detrimental effects of excessive counterfactual thinking. However, given that an optimal range of counterfactual thinking has been linked to effective problem solving in normal populations (Roese 1997), one might expect certain clinical populations to show detrimental effects resulting from a deficiency of counterfactual thoughts. In light of specific patterns of cognitive dysfunction in schizophrenia patients, we believed this population would be at risk for a deficit in counterfactual thought.

To date there are no studies investigating the relationship of counterfactual thinking and schizophrenia. Despite the dearth of research in this area, several lines of evidence suggest that counterfactual thinking may be impoverished in schizophrenia patients. Primarily, neuropsychological theory and research links social decision making (Damasio 1994) and counterfactual thinking in particular (Knight and Grabowecky 1995) to frontal lobe function. Researchers have documented problems in schizophrenia patients in social decision-making (Bellack, Sayers, Mueser, and Bennett 1994; Frith 1992) and frontal lobe function (Goldman-Rakic 1996; Velligan and Bow-Thomas 1999). This combination of social dysfunction and hypofrontality led us to explore the possibility that schizophrenia patients would have deficits in counterfactual thinking.

In general, prefrontal cortex damage produces a syndrome of deficits with social dysfunction (Damasio 1994), cognitive reasoning (Waltz et al. 1999), and perseveration (Lezak 1995) as cardinal features. Of particular note is the frontal lobe patient's apparent insensitivity to long-term affective consequences of current decisions (Bechara, Damasio, Damasio, and Anderson 1994; Tucker, Luu, and Pribram 1995).

Knight and Grabowecky (1995) posit that part of what causes this social dysfunction and poor decision making in frontal lobe lesion patients is a deficit in counterfactual thinking. They argue convincingly that counterfactual thinking requires the process of *simulation*, "the ability and process of generating internal models of external reality" (p. 1358), and *reality checking*, the process that allows for the comparison between internally generated alternatives (the counterfactual scenario) and the real scenario. Failure of simulation results in being "stimulus bound" (Luria 1966), that is, being stuck in the immediate, present environment and the stimuli found there. It also leads to the tendency to perseverate, to continue to perform, with a certain strategy even though it has been shown to be no longer beneficial. One reason that frontal lobe patients may perseverate is their inability to generate new alternatives to the present environment and situation.

Knight and Grabowecky (1995) go on to outline an intriguing neurological case study of a man with dorsolateral prefrontal cortex damage in which the "most marked behavior was a complete absence of counterfactual expressions" (p. 1367). This lack of counterfactual generation was particularly apparent in certain negative situations that would typically inspire counterfactual responses in normal participants, such as career failures (a once promising law career) and the sudden death of his mother. When asked to discuss these situations, he had no evidence of counterfactual thoughts (e.g., "If only I had spent more time with my mother before she died" or "If only I had taken the bar exam right after law school"). He did not seem to consider alternative scenarios at all.

Although there have been numerous case studies illustrating that frontal lobe dam-

age results in poor social functioning (see Damasio 1994), little is known about the process by which the breakdown in social function occurs. One reason for this may be the lack of prefrontal measures that assess executive skills for social information, especially in a social context. Although there are few standardized tests of prefrontal social skills, one standardized frontal lobe measure, the Wisconsin Card Sort Task, has been shown to be related to social functioning in schizophrenia patients (Lysaker, Bell, and Beam-Goulet 1995).

The Wisconsin Card Sort Task is one of the most common measures of frontal lobe function, and it is particularly sensitive to perseveration (Boone 1999; Crider 1997; Lezak 1995). In this task, subjects have to sort four cards on the basis of color, form, or number. They are given "yes/no" feedback as to whether they sorted the cards correctly. The sorting criteria, however, changes at seemingly random intervals and the subject has to come up with the new sorting procedure on their own. Thus the task requires that subjects generate hypotheses as to why the old strategy failed and what the new sorting strategy might be. Patients with frontal lobe damage have difficulties "shifting sets," or changing their criteria, and instead tend to perseverate on the previous strategy despite repeated failures. It appeared to us that counterfactual thinking may be a construct in social cognition that requires the same skill in real life as the Wisconsin Card Sort Task does in the laboratory, that is, the ability to generate alternative actions that may effect a different outcome to a given situation.

Growing evidence implicates poor performance on the Wisconsin Card Sort Task as well as prefrontal abnormalities in schizophrenia patients (Goldman-Rakic 1996; Weinberger 1988). Specific deficits that have been linked to prefrontal dysfunction in schizophrenia patients include perseveration, poor planning, difficulty generating novel ideas, and impaired self-monitoring and reality-checking (Crider 1997; Goldman-Rakic 1996; Seidman, Oscar-Berman,Kalinowski, and Ajilore 1995; Velligen and Bow-Thomas 1999). The tendency of schizophrenia patients to perseverate has been demonstrated so frequently in cognitive tasks (for a review, see Crider 1997) that researchers in the field have speculated that schizophrenia patients would perseverate in aspects of social cognition as well (Penn, Corrigan, Bentall, Racenstein, and Newman 1997). Thus, it seems quite likely that the process facilitating the generation of new hypotheses on the Wisconsin Card Sort Task may be the same process required for counterfactual thinking in real life situations. Given that prefrontal lobe dysfunction and the failure to generate new hypotheses in tests of executive function are associated with schizophrenia, a convergence of impaired counterfactual thinking coupled with impaired psychosocial functioning might be detectable in these patients.

To summarize, our goal in this research was to document a general impairment of counterfactual thinking among patients with schizophrenia relative to nonpsychiatric participants control. Moreover, we expected that this deficit in counterfactual thinking should operate above and beyond that of the general cognitive dysfunction associated with schizophrenia. We also expected that impairment in counterfactual thinking would be related to global social dysfunction. We used two measures of counterfactual thinking: a direct measure of participants' ability to generate counterfactual thoughts derived from their own recent past; and a measure of the resultant inferences and insights that emerge from successful manipulation of counterfactual ideas.

METHOD

Participants

Fourteen schizophrenia patients were recruited from a residential mental health care facility. Patients were individually diagnosed by trained clinical psychology graduate students and a licensed clinical psychologist using a semi-structured clinical interview (Schedule

for Affective Disorders and Schizophrenia [SADS] Interview—Lifetime Version). Patients with a history of substance abuse, head injury, or co-morbid Axis I disorder were excluded. Twelve normal control participants were recruited from the support staff of the same facility. Participants with a history of mental illness, substance abuse, neurological disorder, or head injury were excluded. There was no significant difference in education between the schizophrenia patients (M = 11.7 years) and the controls (M = 13.3 years), $F(1, 24) = 2.60$, $p > .10$. Schizophrenia patients tended to be older(M = 39.2) than the controls (M = 29.9), $F(1, 24) = 8.87$, $p < .05$. There were 11 males and 3 females in the schizophrenia group, and 5 males and 8 females in the control group. Each schizophrenia patient was under direct psychiatric care and was taking antipsychotic medication at the time of testing.

Measures and Procedure

All participants completed a battery of tests that included two counterfactual measures, two measures of cognitive ability, and one measure of social competence. The first counterfactual measure focused on frequency of counterfactual thinking in response to a personal, real-life event. Participants were first asked to recall a negative personal event in the past year; they were given three minutes to consider this event in detail. Negative events as opposed to positive events were used because past research has shown that spontaneous counterfactual thinking is more likely for such events (Roese and Hur 1997). Participants were then asked explicitly if, as they recalled their personal life event, they had any thoughts of how things might have gone differently—thoughts of "if only" or "what if." Responses were tape-recorded and the number of discrete counterfactual thoughts were tabulated. Counterfactual thoughts were defined as any thought that offered a different alternative action that might have been taken in that situation. This direct solicitation of counterfactual thinking based on retrospective self-report has been widely used in research among normal populations (Roese and Olson 1997).

The second counterfactual measure centered on inferences resulting from counterfactual thinking and was designed specifically for this research. The counterfactual inference test (CIT) was based on past research showing that affective and judgmental reactions regarding social events are influenced by counterfactual thinking but, more specifically, that outcomes preceded by unusual rather than typical actions heighten counterfactual thinking (Kahneman and Tversky 1982) and that events that seem "almost" (either spatially or temporally) to have occurred also heighten counterfactual thinking (Kahneman and Varey 1990). In essence, the CIT is an adaptation of experimental materials from this previous research, simplified into four forced-choice questions. For each one, events experienced by two individuals are presented, and three response options are given. The two individuals experience similar outcomes, but the circumstances between them differ such that one should think "if only" to a greater extent than the other. These items appear in Table 1.

Based on previous research, the typical/normative responses of undergraduate participants would be 1a, 2b, 3b, and 4a. These items were prepared so as to counterbalance across four additional variables. First, the more regretful individual is described either first (items 1 and 3) or second (items 2 and 4). Second, gender of target individuals is varied (female for items 1 and 2; male for items 3 and 4). Third, the ordering of the two individuals matches the ordering of the response options for items 1 and 2 but mismatches them on items 3 and 4. And fourth, items 1 and 3 center on the pattern that greater counterfactual thinking occurs for events that nearly happened than for events that did not (item 1 is spatial, item 3 is temporal), whereas items 2 and 4 center on the pattern that greater counterfactual thinking occurs for unusual rather than normal events. In addition, the target questions vary to reflect different higher order inferences: item 1 centers on general affective

TABLE 1
Counterfactual Inference Test (CIT): Pilot Findings

1. Janet is attacked by a mugger only 10 feet from her house. Susan is attacked by a mugger a mile from her house. Who is more upset by the mugging?
   a) Janet (37, 86%)
   b) Susan (0, 0%)
   c) Same/Cant' tell (6, 14%)
2. Ann gets sick after eating at a restaurant she often visits. Sarah gets sick after eating at a restaurant she has never visited before. Who regrets their choice of restaurant more?
   a) Ann (3, 7%)
   b) Sara (38, 88%)
   c) Same/Can't tell (2.5%)
3. Jack misses his train by 5 minutes. Ed misses his train more than an hour. Who spends more time thinking about the missed train?
   a) Ed (3, 7%)
   b) Jack (39, 91%)
   c) Same/Can't tell (1, 2%)
4. John gets into a car accident while driving on his usual way home. Bob gets into a car accident while trying a new way home. Who thinks more about how his accident could have been avoided?
   a) Bob (38, 88%)
   b) John (2, 5%)
   c) Same/Can't tell (3, 7%)

Note. Included here are the wording of the CIT along with validating data collected from a pilot sample of undergraduate students. In parentheses is the number of participants who selected the particular option, followed by the proportion of all 43 participants who selected that option.

evaluation ("upset"), item 2 on regret, item 3 on rumination, and item 4 on judgments of avoidance/prevention.[1]

The CIT was pilot-tested among a sample of 43 Northwestern University undergraduates to ensure that it could reproduce the pattern of findings documented in previous research. As can be seen in Table 1, the CIT was indeed successful in replicating that pattern. Pilot participants more often selected the target counterfactual response (overall, 88.4%) than either of the other two responses (4.7% and 7.0%). In Chi square tests performed on each item, this pattern was significant, $\chi^2(2) = 55.0, 58.7, 63.8, 58.7$, all $ps < .0001$. The CIT was scored by tabulating the number of counterfactual target items selected by participants on each item, which results in a score ranging between 0 and 4, with greater values indicating inferences that more closely match the normative pattern. The mean CIT score from the pilot data was 3.53. If responses to the CIT were selected randomly, the expected score would be 1.32 (1 in 3 chance multiplied by 4 items); the pilot mean reliably exceeded this value, $t(42) = 24.5$, $p < .001$.

The WAIS-R (vocabulary and digit-span subtests) was used as a measure of general cognitive ability. The FAS Verbal Fluency Test (Lezak 1995) was used as a measure of verbal production. These control measures were used to confirm that dysfunction in counterfactual thinking was not simply reducible to global deficits in cognition or poverty of speech. Finally, the Zigler social competence scale was calculated using a demographics questionnaire that each participant completed upon initially entering the lab. Four variables (education, marital status, occupation, and employment history) were given a value of 0, 1, or 2 depending on the level of functioning achieved (Zigler and Levine 1981). For example, marital status was rated a 0 for never been married; 1 for divorced, separated, or remarried; and 2 for a single, continuous marriage. The measure was designed specifically to measure premorbid social competence in schizophrenia patients and has also been used to measure current social functioning. The original measure also included age to use developmental maturity at illness onset as a predictor variable for outcome (Zigler and Levine 1981); because age

[1]The four items of the CIT were adapted directly from published research. Item 1 was adapted from Miller and McFarland (1986, Study 2). Item 2 was adapted from Macrae (1992). Item 3 was adapted from the Mr. Crane/Mr. Tees scenario presented in Kahneman and Tversky (1982, p. 203). Item 4 was adapted from the Mr. Jones scenario also presented in Kahneman and Tversky (1982, p. 204).

was not a pertinent aspect of the study, it was not included as a variable. The measures of cognitive ability and social functioning were collected in a single testing session. The measures of counterfactual thinking were collected during a separate testing session several weeks later.

RESULTS

Counterfactual Thinking

Overall, schizophrenia was associated with impairment in counterfactual thinking relative to controls. Patients with schizophrenia were less likely to mention counterfactual thoughts in response to direct solicitation ($M = 1.00$) than were control participants ($M = 2.08$), $F(1, 24) = 9.56$, $p = .005$. In addition, counterfactual-derived inferences were reliably different between these two groups, as assessed by scores on the CIT, $F(1, 24) = 7.91$, $p = .01$. Patients with schizophrenia evidenced lower CIT scores ($M = 1.29$) than did control participants ($M = 2.33$). Interestingly, the schizophrenia CIT scores were almost exactly what would be expected if the test options were selected at random (i.e., $M = 1.32$), $t(13) = .11$, $p = .91$. Control CIT scores, on the other hand, were reliably higher than this chance value, $t(11) = 5.39$, $p < .001$. These results indicate that impairment both in counterfactual thinking and in counterfactual-derived inferences are associated with schizophrenia. The two measures of counterfactual thinking were significantly correlated $r(26) = .443$, $p < .05$. Means appear in Table 2.

General Cognitive Ability

The two groups of participants did not differ on the WAIS-R measure of vocabulary ($F[1, 24] = 1.62$, $p = .22$), on the WAIS-R digit span test ($F[1, 24] = 1.20$, $p = .29$), or on the FAS test of verbal fluency ($F[1, 24] = .10$, $p = .76$). These results suggest that impoverished counterfactual thinking in schizophrenia patients cannot be explained by a generalized cognitive deficit owing to the illness. Moreover, reduced counterfactual thinking is not simply the result of a general reduction in verbal fluency.[2]

Social Competence

The groups differed on the Zigler scale of social competence, $F(1, 24) = 29.0$, $p < .001$, such that patients with schizophrenia scored lower ($M = 1.86$) than did controls ($M = 5.75$). These means also appear in Table 2.

Counterfactual thinking was correlated with social functioning as measured by the Zigler scale. That is, both the counterfactual solicitation scores and the CIT scores correlated reliably with the Zigler scores, $rs(24) = .53, .51$, both $ps < .01$. We then tested whether the group difference in social functioning was mediated by variation in counterfactual thinking, as assessed by the CIT (see Kenny, Kashy, and Bolger 1998). The relation between the dummy-coded schizophrenia versus control variable and the CIT score was reliable ($\beta = .498$, $p < .05$), as was the relation between the CIT and the Zigler scores ($\beta = .511$, $p < .05$). The relation between the dummy-coded schizophrenia versus control variable and the Zigler score was also reliable ($\beta = .713$, $p < .05$), but the strength of this relation was reduced when CIT scores were held constant ($\beta = .627$). This reduction in effect size was reliable, $Z = 1.97$, $p < .05$.[3] We also tested whether the group difference in social functioning was mediated by the number of counterfactual thoughts generated (the Counterfactual Solicitation score) (Kenny et al. 1998). The relation between the dummy-coded schizophrenia versus control variable and the

[2] Word fluency has also been shown to be associated with frontal lobe function (Milner 1964). Although this may appear to contradict our theoretical position of counterfactuals being mediated by the frontal lobes, the exact mechanisms mediating word fluency is still not clear, and it is possible that counterfactuals and word fluency are mediated by different aspects of frontal lobe function. Most importantly we felt it necessary to control for verbal fluency in our task.

[3] This test statistic was suggested by Kenny et al. (1998, p. 260).

TABLE 2
Counterfactual Thinking, Cognitive Ability, and Social Functioning in Schizophrenia and Control Participants

Measure	Schizophrenia	Control
Counterfactural Solicitation	1.00 (.82)	2.08 (.95)
Counterfactual Inference Test	1.29 (1.14)	2.33 (.65)
WAIS-R Vocabulary	8.14 (3.63)	6.40 (2.76)
WAIS-R Digit Span	7.64 (2.13)	8.77 (3.17)
FAS	35.5 (15.7)	37.2 (11.5)
Zigler Social Functioning	1.86 (1.23)	5.23 (2.13)
n	14	12

Note. Value is the mean, value in parenthesis is the standard deviation.

Counterfactual Solicitation score was reliable ($\beta = .534, p < .05$), as was the relation between the Counterfactual Solicitation and the Zigler scores ($\beta = .534$, $p < .05$). The relation between the dummy-coded schizophrenia versus control variable and the Zigler score was reliable (as above) ($\beta = .713$, $p < .05$), but the strength of this relation was reduced when Counterfactual Solicitation scores were held constant ($\beta = .592$). This reduction in effect size was reliable, $Z = 2.13$, $p < .05$.[3] These findings are consistent with our hypothesis that the impairment in counterfactual thinking associated with schizophrenia at least partly contributes to deterioration in psychosocial functioning.

Given that we had differences in the age and sex distributions between the two groups, we ran the regression analysis adding age and gender as predictor variables. These analyses show that the counterfactual solicitation score ($F(3, 24) = 3.1$, $p < .05$) and the Counterfactual Inference Test ($F(3, 24) = 3.3$, $p < .05$) were significantly correlated with social competence even when controlling for age and sex.

DISCUSSION

This research demonstrated that schizophrenia patients have impoverished counterfactual thinking when compared to normal control participants. Schizophrenia patients reported fewer counterfactual thoughts based on personal experiences than did control participants. Also, such patients were less adept at drawing counterfactual-derived inferences about hypothetical social events than were control participants. These impairments in counterfactual thinking did not appear to be the result of general cognitive or verbal ability, as the schizophrenia and control participants were not significantly different on these variables. Counterfactual thinking was, however, reliably related to general social functioning. More specifically, the effect of schizophrenia (vs. control participants) on social functioning was mediated in part by counterfactual thinking. This finding is compatible with recent depictions of counterfactual thinking as a functional thought process that contributes to effective psychosocial function (Roese and Olson 1997) and suggests that impairment of counterfactual thinking is associated with deficits in psychosocial functioning.

Though neuropsychological studies of front lobe patients (e.g., Knight and Grabowecky 1995) indicate hypofrontality as a possible causal factor in this deficit of counterfactual thinking, given the complexity of schizophrenia, there are several other possible explanations to consider. First, a central feature of schizophrenia is formal thought disorder in which reasoning is incoherent and arbitrarily chained (Holzman, Solovay, and Shenton 1985; Marengo, Harrow, and Edell 1993). In addition to the presence of formal

thought disorder, an absence of self-insight affects patients with schizophrenia, which in turn is associated with impairment of psychosocial function (Amador et al. 1994; David 1991). A key aspect of counterfactual thinking centers on reality monitoring, that is, the ability to discriminate and draw inferences from a direct comparison between hypothetical events and actual events. An additional feature of thought disorder may well be impairment in the process by which a conceptual separation between counterfactuality and factuality is preserved. Given the previously established link between counterfactuals and psychosocial functioning demonstrated within normal populations (Roese 1994), the utilization of inferences derived from counterfactuals may thus relate to the psychosocial impairment suffered by patients with schizophrenia. In other words, this perspective suggests that when counterfactuals are constructed by those with schizophrenia, these thought yield no inferential benefits because the cognitive tools by which those subsequent inferences are drawn are defective.

Another reason that schizophrenia patients show deficits in counterfactual thinking may be a faulty link between affect and cognition. Negative affect directly induces counterfactual thinking, and such an effect is functional to the extent that negative affect implicitly signals to the individual a problematic state of affairs, and that counterfactuals yield insights that facilitate social functioning (Roese and Olson 1997). These aspects of counterfactual thinking are also supported by Damasio's (1994) idea that proper decision making is facilitated by the infusion of appropriate affect. Schizophrenia patients can show either flat or inappropriate affect (American Psychological Association, 1994). Both of these symptom features could result in a dysregulation of counterfactual thinking. Further research can address both of these possible influences by correlating aspects of counterfactual thinking with specific symptoms.

Nonetheless, although there are many different possible causal explanations, this initial study provides preliminary evidence that the process underlying this specific aspect of social cognition is faulty in schizophrenia patients as compared to normal control participants and that this may have an effect on social functioning. Counterfactual thinking has been documented as a nearly ubiquitous feature of mental life, one that has multifaceted implications for affect, coping, judgments of blame, and expectations for the future (for a review, see Roese 1997). Moreover, this literature indicates that counterfactual thinking may have positive, functional benefits on decision making and performance (Roese 1994). In addition, the neuropsychological literature has documented frontal lobe and schizophrenia patients who make poor decisions in their daily lives, have difficulty shifting sets and generating new alternatives on tests of executive function (Braff et al. 1991; Crider 1997; Velligan and Bow-Thomas 1999), and have various problems with community and social functioning (for a review, see Green 1998).

It is our theoretical position that the tendency to perseverate in laboratory tests of frontal lobe function, such as the Wisconsin Card Sort Task, may be part of the same underlying process as the demonstrated impoverishment in counterfactual thinking, that is, failing to generate an alternative action—being locked into a single, specific mode of operation that is repeatedly ineffective. In addition, as would fit with our findings, performance on the Wisconsin Card Sort Task has been shown to be a reliable predictor of community functioning (Lysaker et al. 1995).

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Several limitations to the current study can be addressed in future research. The methodology of this study required participants to recall a negative life event and then recount the thoughts they had at the time. It is possible that schizophrenia patients had counterfactual thoughts at the time of the event but did not recount them during the interview. This can be addressed in future research by creating situations in the laboratory that would be likely to generate counterfac-

tual thoughts. Secondly, the Zigler Scale is a global measure of social functioning and might better represent premorbid status than current functioning. A more comprehensive, current measure would provide a more accurate assessment of the relationship between counterfactual thinking and social functioning.

Recent research in cognition of schizophrenia has focused on the idea that many cognitive deficits observed in experimental paradigms are the result of a general cognitive deficit (Heinrichs and Zakzanis 1998). Though there was no significant difference in estimated IQ between controls and schizophrenia subjects, future studies can employ more rigorous control measures to show a differential deficit (Chapman and Chapman 1978) in counterfactual thinking. Furthermore, although our control group did not differ from the schizophrenia group in education, estimated IQ, or verbal fluency, they did differ in age and gender. There are no documented age or gender related differences in counterfactual thinking, and these variables did not have significant influence in our study. Future investigations, however, should try to equate these variables. In addition, the present study was small in scale, testing only 14 patients and 12 normal control participants. Though the findings are indicative of an interesting association between counterfactual thinking and social functioning, future studies will need to be conducted before it is clear whether these findings can be generalized to a larger population of patients.

Finally, although the theoretical foundations of the study were inspired by the similarity of frontal lobe tasks and counterfactual thinking, we did not test frontal lobe function in this experiment. Elaboration and validation of this idea could be achieved by specifically investigating the relationship between frontal lobe function and counterfactual thinking. Means of investigation could include correlating perseveration scores on the Wisconsin Card Sort Task and measures of counterfactual thinking and/or using neuroimaging techniques to monitor brain activity of subjects engaged in counterfactual thought.

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