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Intentional cognitive control impairments in schizophrenia: Generalized or specific?

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Abstract

Impairments in intentional—but not unintentional—inhibition have been found in schizophrenia, and are thought to contribute to the presence of psychotic symptoms. However, it was previously unknown whether this intentional cognitive control impairment extends to intentional resistance to interference—another form of cognitive control. The current study resolved this issue through administering two cognitive control measures: one with a high intentional resistance to interference demand and the other with a high unintentional inhibition demand, to schizophrenia ($n = 61$) and healthy control ($n = 34$) participants. Consistent with previous findings, schizophrenia participants' performance on the measures with a high unintentional inhibition demand was intact; however, they were impaired on the task with high intentional resistance to interference demands compared with controls. This latter finding suggests that *intentional* cognitive control impairments previously found in schizophrenia are not specific to inhibition, but instead are more general, including both processes requiring inhibition (as consistently reported in the literature) and resistance to interference (as found in the current study). (*JINS*, 2009, *15*, 982–989.)

Keywords: Schizophrenia, Cognitive control, Inhibition, Interference, Intentional, Unintentional

INTRODUCTION

Poor inhibitory control has been linked to the presence of aberrant cognitive experiences in schizophrenia, such as hallucinations, delusions, and thought disorder (Frith, 1979; Guillem, Rinaldi, Pampoulova, & Strip, 2008). While neurological studies of schizophrenia have consistently documented dysfunction of the prefrontal lobes (e.g., Kaladjian, Jeanningros, Azorin, Grimault, Anton, & Mazzola-Pomietto, 2007)—the neural regions largely responsible for most inhibitory-related processes (Koechlin, Ody, & Kouneiher, 2003)—cognitive studies of inhibition in schizophrenia have been less consistent in their findings (e.g., Donohoe et al., 2006; Yucel et al., 2002). Racsmany and colleagues (2008) recently found that schizophrenia participants were impaired on a directed forgetting task, but not on a retrieval practice task, said to measure intentional and unintentional executive control over memory, respectively. It is plausible that a similar intentional/unintentional distinction between impaired/intact processes in schizophrenia can be made for all inhibitory-related processes, explaining the inconsistency in findings on inhibition.

The term "inhibition" is often used as an umbrella term to cover a family of executive control processes which ultimately serve to prevent goal-irrelevant cognition, behavioral responses, and external stimuli from interrupting goal-directed thoughts and behaviors. One of the most cited and validated taxonomies of inhibitory-type processes was developed by Harnishfeger (1995). According to Harnishfeger, inhibitory processes are categorized by three dimensions: (1) *cognitive* (controlling mental processes) or *behavioral* (controlling impulses or motor responses); (2) *intentional* (the conscious and deliberate suppression of irrelevant or unwanted stimuli or responses) or *unintentional* (the automatic suppression of stimuli or responses, which occurs without conscious awareness); and (3) *inhibition* (the active suppression or expulsion of goal-irrelevant information that has already entered working memory) or *resistance to interference* (the gating mechanism that allows goal-relevant, but prevents simultaneously presented goal-irrelevant, information

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from entering working memory). Harnishfeger's (1995) three dimensions have been successfully used in cognitive studies in the fields of aging (e.g., Andrés, Guerrini, Phillips, & Perfect, 2008; Earles, Connor, Frieske, Park, Smith, & Zwahr, 1997; Salthouse, Atkinson, & Berish, 2003), frontal lobe damage (e.g., Stuss, Toth, Franchi, Alexander, Tipper, & Craik, 1999), Attention-Deficit Hyperactivity Disorder (ADHD; e.g., Nigg, Butler, Huang-Pollock, & Henderson, 2002), and Alzheimer disease (e.g., Amieva, Phillips, Della Sala, & Henry, 2004) to show specific inhibition deficits/decline in these populations. Further support for Harnishfeger's taxonomy comes from the developmental, experimental, and neurological literature. Of specific relevance to the current study is the *inhibition* versus *resistance to interference* distinction, and the *intentional* versus *unintentional* distinction. Evidence for the former of these distinctions comes from several sources: (1) neuro-imaging and cortical lesion studies have found some distinct neural regions involved in these two processes, namely activation of the left posterior region of the frontal lobe is specific to inhibition, while activation of the anterior cingulate is specific to interference control (e.g., McNab, Leroux, Strand, Thorell, Bergman, & Klingberg, 2008; Stuss et al., 1999); (2) rodent studies have found that norepinephrine is integral to interference—but not inhibitory—control (e.g., Arnsten, 1998); (3) studies have found differential involvement of working memory in the two forms of control (Kramer, Humphrey, Larish, Logan, & Strayer, 1994); (4) the development of interference control (but not inhibition) has been found to covary with an increase in memory capacity (cf. Harnishfeger, 1995); and (5) inhibition and interference control tasks have been shown to load on separate factors (Friedman & Miyake, 2004). The empirical support for the distinction between *intentional* and *unintentional* forms of cognitive control comes from the finding that unintentional forms of inhibition develop earlier (around age 5) than intentional forms of inhibition (around age 7; cf. Wilson & Kipp, 1998), and that selective cognitive control impairments based on this distinction have been documented in particular clinical populations (Amieva et al., 2004; Nigg et al., 2002).

This differentiation between inhibition-related processes may explain the discrepancy in empirical findings concerning "inhibition" in schizophrenia. By and large, evidence of reduced "inhibition" in schizophrenia has been reported in studies using tasks said to measure intentional cognitive inhibition (e.g., Racsmany et al., 2008; Salame & Danion, 2007; Waters, Badcock, Maybery, & Michie, 2003) and intentional behavioral/response inhibition (e.g., Badcock, Michie, Johnson, & Combrinck, 2002; Donohoe et al., 2006; Henik & Salo, 2004). However, schizophrenia studies have largely found inhibitory ability to be intact when using tasks said to measure unintentional cognitive inhibition (e.g., when using the Brown-Peterson [B-P] variant task; Fleming, Goldberg, Gold, & Weinberger, 1995; Randolph, Gold, Carpenter, Goldberg, & Weinberger, 1992) or unintentional resistance to distractor interference (e.g., Kopp & Rist, 1999; Yucel et al., 2002).

It has long been contended that difficulties in intentionally resisting interference from distracting stimuli ("intentional resistance to interference," according to Harnishfeger's inhibition taxonomy) are common to schizophrenia (Frith, 1979). However, validation of this proposal is limited because empirical support has largely come from studies using the Stroop paradigm, which has been argued to also measure behavioral response inhibition (because once the to-be-ignored color word enters working memory the participant must then suppress this response) and attention (Henik & Salo, 2004)—two executive processes known to be impaired in schizophrenia (Gooding, Braun, & Studer, 2006; Wykes, Reeder, & Corner, 2000). Thus, the overall pattern of "inhibition" findings reported above may reflect one of two possibilities: (1) individuals with schizophrenia have difficulties with all control processes that are intentional in nature (irrespective of whether they are cognitive or behavioral, and require inhibition or resistance to interference), but not with unintentional control processes; or (2) individuals with schizophrenia have specific intentional *inhibition* (cognitive and behavioral) impairments.

The aim of the current study was to investigate intentional resistance to interference (using the directed ignoring [DI] task) in schizophrenia to determine the specific nature of intentional cognitive control impairments in this disorder. The DI task requires participants to resist interference from a competing distractor (goal-irrelevant) story woven into a target (goal-relevant) story, thus requiring suppression, or "gating", of external stimuli prior to them entering working memory. The DI task has been shown to have good construct and discriminant validity (e.g., Earles et al., 1997; Lau, Christensen, Hawley, Gemar, & Segal, 2007; Paulik, Badcock, & Maybery, 2008;[1] Radvansky & Copeland, 2006; Salthouse et al., 2003). A commonly used task said to place a high demand on unintentional cognitive inhibition, the B-P task (Kane & Engle, 2000), was also administered to provide further support for the conjecture that unintentional control processes are intact in schizophrenia. The B-P task requires participants to automatically inhibit the intrusion of previously-relevant (currently-irrelevant) items to enable the correct recall of novel items belonging to the same category. The B-P task has also been shown to have good construct and discriminant validity (Friedman & Miyake, 2004; Paulik et al., 2008). State anxiety was also measured and controlled for, because studies have linked anxiety to impaired performance on intentional cognitive control measures, including the DI task (e.g., Amir, Coles, & Foa, 2002; Badcock, Waters, & Maybery, 2007; Hopko, Ashcraft, Gute, Ruggiero, & Lewis, 1998; Wood, Mathews, & Dalgleish, 2001), and anxiety levels are typically elevated in schizophrenia samples (Seedat, Fritelli, Oosthuizen, Emsley, & Stein, 2007).

[1] Although not reported in the publication, the DI and B-P task did not significantly correlate (Paulik et al., 2008).

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METHOD

Participants

Sixty-nine individuals meeting *International Classification of Diseases* (World Health Organization, 1993) criteria for schizophrenia ($n = 57$) or schizoaffective disorder ($n = 12$) were recruited through the Centre for Clinical Research in Neuropsychiatry (CCRN), Graylands Hospital and related out-patient clinics and hostels in Perth, Western Australia. Two schizophrenia participants were excluded because their psychiatrist-provided diagnosis was not confirmed at interview. Control participants were 39 healthy individuals who had participated in previous research at CCRN, and were initially recruited *via* a random telephone recruitment procedure. General inclusion criteria included fluency in English and being aged 18–60 years. General exclusion criteria included hospital admission for drug/alcohol rehabilitation within the past year; poor visual acuity; neurological disorders; serious head injury; a current diagnosis of ADHD, obsessive-compulsive disorder (OCD), or posttraumatic-stress disorder (PTSD);[2] and premorbid IQ (estimated from the National Adult Reading Test—2nd edition [NART]; Nelson & Willison, 1991) below 75. Control participants were also excluded if they had a personal or family history of psychosis. Based on these criteria, six schizophrenia participants and five control participants were excluded. Remaining participants were 12 females and 49 males in the schizophrenia group, and six females and 28 males in the control group. Of the schizophrenia participants, 88.5% were taking antipsychotic medications (69% atypicals only, 8% typicals only, and 11.5% typicals and atypicals) and 84% were outpatients at the time of testing.

MEASURES

Directed Ignoring (DI) Task

The DI task (Connelly, Hasher, & Zacks, 1991) is a simple story-reading task in which participants are required to read aloud only target text printed in italicized font (20-point Arial). Two main conditions are presented: in the distractor condition, participants are required to ignore (resist interference from) an unrelated story printed in regular (nonitalicized) font interwoven into the target story passage; whereas in the control condition, no distracting text is present. In this control condition, blank spaces matching the average length of a distracting text section were inserted into the passages to control visual scanning requirements. Blank spaces were used instead of a string of Xs (which has also been used as a control in the DI literature), because spaces eliminate any possible involvement of interference control when performing the control condition (a participant may find Xs distracting). There were two practice and 12 test stories. Target and distractor stories were matched on length (125 words), and sections of target and distractor text were 3–9 words in length. Two multiple-choice questions (each with four alternative answers) followed each story. For the distractor condition, each question had part of the distractor story's content as a plausible, but incorrect, response choice (a foil). Story order was counterbalanced across participants. There were two interference control indices: (1) the difference in reading time (RT) between control and distractor stories; and (2) for the distractor condition, the percentage of foils (of the total incorrect responses) chosen on the multiple-choice questions. Accuracy on the multiple-choice questions assessed text comprehension.

Brown-Peterson (B-P) Variant Task

This task assessed unintentional inhibition (Kane & Engle, 2000). In each of the three blocks presented, participants read aloud and attempted to recall three lists of words, each list being composed of 10 words presented serially (one word every 2 s) on a computer screen (see Paulik et al., 2008, for details). All lists within a block were composed of words from the same semantic category (four-footed animals, occupations, or fruits), and lists were matched for word length and frequency (Battig & Montague, 1969). After each list, a distractor task performed for 15 s required counting backward by twos from a number presented on the screen, at a pace set by auditory signals every 1500 ms. Participants were then asked to recall aloud as many words from the previous list as possible in any order in 20 s. To ensure that participants were not actively rehearsing items during the distractor task, participants with a counting accuracy rate of less than 70% were excluded. Four schizophrenia participants' results were excluded accordingly. This task requires the automatic inhibition of memory intrusions of previously learnt—but no longer relevant—items when recalling new items belonging to the same category (Solso, 1995). Hence, the cognitive overflow of (within block) previous list items—and thus the demand on inhibition—increases from list one (no overflow) to list three (maximum overflow). Inhibition was measured by the difference in recall accuracy (summated across blocks) between lists 1, 2, and 3—with poor unintentional inhibition indicated by a steep decline in recall across successive lists.

Clinical Interviews

Diagnosis for the schizophrenia group was confirmed using the Diagnostic Interview for Psychosis (DIP; Castle et al., 2006). The short version of the Mini International Neuropsychiatric Interview (Sheehan et al., 1997) was administered to control participants to screen for psychological disorders, including schizophrenia.

Additional Measures

Premorbid full-scale IQ was estimated from the NART (Nelson & Willison, 1991). The Digit Span subtest of the

[2] Studies have linked cognitive control deficits to ADHD, OCD, and PTSD (e.g., Amir et al., 2002; Badcock et al., 2007; Barkley, 1997); thus, participants with these diagnoses were excluded.

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Wechsler Adult Intelligence Scale—3rd edition (WAIS-III; Wechsler, 1997) measured working memory. The 7-item anxiety subscale of the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) measured state anxiety (score range 0–21).

Procedure

Ethics approval was obtained from the Perth North Metropolitan Area Mental Health Service Ethics Committee and the research was completed in accordance with the Helsinki Declaration. Signed consent was obtained from all participants. Testing took approximately 1.5 hr for controls and 2.5 hr for schizophrenia participants. Control participants were offered $20 and schizophrenia participants $25 for reimbursement of time/expenses.

RESULTS

Descriptive Statistics

One univariate outlier (a score more than 3 *SD*s from the respective group mean) was identified from the variables presented in Table 1 and subsequently deleted. As seen in Table 1, there was no significant difference between the control and schizophrenia participants on age; however, the latter group had significantly lower education, premorbid IQ and working memory, and a higher level of state anxiety. Consequently, in the following group comparisons, where significant effects were found, these variables were entered into the analyses separately as covariates to examine any possible confounding effects.

A chlorpromazine equivalent dosage score was calculated for each schizophrenia participant and correlated with all measures (British National Formulary, 1995; Woods, 2003). No significant correlations were found.

Schizophrenia and Control Group Comparisons

DI task performance

Seven schizophrenia participants did not complete the DI task. Three single data points (all from the control group) were identified as univariate outliers and subsequently deleted. Group means and *SDs* are presented in Table 2.

Reading time (RT)

Repeated measures analysis of variance (ANOVA) was used to compare the groups on their RTs on control and distractor stories. As expected, there was a significant Story main effect ($F(1,81) = 292.64$; $p < .05$; Partial Eta$^2 = .78$), with distractor story RTs longer than control story RTs. There was also a significant Group main effect ($F(1,81) = 33.48$; $p < .05$; Partial Eta$^2 = .29$), with schizophrenia participants' RTs longer than controls' RTs. Importantly, the Group × Story interaction was also significant ($F(1,81) = 15.68$; $p < .05$; Partial Eta$^2 = .16$). The amount of RT slowing to distractor stories compared with control stories was more pronounced for schizophrenia participants (see Table 2). The pattern of results remained the same when the additional measures were entered separately into the analysis as covariates.

Comprehension

A univariate ANOVA on the percentage of foil errors (of total errors) revealed there to be no significant group difference (see Table 2; $F(1,84) = 0.20$; $p > .05$; Partial Eta$^2 = .002$). It should be noted, however, that a floor effect may have masked group differences, because both control (total foils: mean = 0.70; *SD* = 0.77) and schizophrenia (total foils: mean = 1.58; *SD* = 1.47) participants made very few foils. A repeated measures ANOVA comparing the two groups on the percentage of correct responses on the comprehension questions for the control and distractor conditions, revealed a

Table 1. Group means, *SD*s, and *t* tests for the demographic characteristics and additional measures

	Controls ($n = 34$)		Schizophrenia ($n = 61$)		
	Mean	*SD*	Mean	*SD*	*t* tests
Age (yr)	41.35	11.85	38.00	10.01	1.46
Education[a] (yr)	12.56	1.99	11.40	1.88	2.77*
Length of illness (yr)	—	—	15.67	9.23	—
Age of illness onset (yr)	—	—	22.33	6.20	—
Chlorpromazine equivalent dosage (mg)	—	—	499.19	380.19	—
NART-IQ	109.65	8.80	98.18	10.49	5.38*
Digit Span scaled score	11.62	2.77	8.59	2.43	5.53*
HADS-Anxiety	4.21	3.07	8.77	4.43	5.33*
DIP positive symptoms[b]	—	—	3.64	2.46	—
DIP negative symptoms[c]	—	—	0.61	1.05	—

Note. NART-IQ = full-scale WAIS-III IQ estimated from the National Adult Reading Test; HADS = Hospital Anxiety and Depression Scale; DIP = Diagnostic Interview for Psychosis.
[a]Highest level of education completed (secondary and tertiary education only).
[b]Positive symptoms included hallucinations, delusions, positive formal thought disorder, and bizarre behavior (score range 0–17).
[c]Negative symptoms included restricted affect, blunted affect, rapport difficulties, thought blocking, poverty of speech, and restricted quantity of speech (score range, 0–6).
*$p < .05$.

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Table 2. Group means and *SD*s for the performance indices of the cognitive control tasks

	Controls[a]		Schizophrenia[b]	
	Mean	*SD*	Mean	*SD*
DI Control RT (s)	43.47	5.45	55.48	10.65
DI Distractor RT (s)	78.97	19.82	112.36	32.70
DI Control Correct Response[c]	87.50	9.37	83.92	9.45
DI Distractor Correct Response[c]	93.75	6.63	81.31	17.38
DI Foil Errors[d]	23.00	28.19	25.64	25.55
B-P List 1 Recall	5.99	1.29	4.58	1.28
B-P List 2 Recall	4.13	1.14	2.79	1.07
B-P List 3 Recall	3.26	1.19	1.92	0.91

Note. DI = Directed Ignoring task; B-P = Brown-Peterson variant task.
[a]$n = 34$.
[b]$n = 54$ for the DI task and 57 for the B-P task.
[c]Percentage of correct responses on comprehension questions.
[d]Percentage of foil errors of total incorrect responses on comprehension questions.

significant Group main effect ($F(1,81) = 15.76$; $p < .05$; Partial $Eta^2 = .16$), and a Story × Group interaction ($F(1,81) = 5.36$; $p < .05$; Partial $Eta^2 = .06$). *Post hoc t* tests revealed a non-significant group difference for accuracy on control stories, whereas control participants had significantly higher accuracy than the schizophrenia participants on distractor stories. The group main effect remained significant, while the interaction did not, when the additional variables were entered into the analysis separately as covariates.

B-P task performance

As expected, when a repeated measures ANOVA was conducted on correct list recall (lists 1 to 3), there was a significant List main effect ($F(2,178) = 291.50$; $p < .05$; Partial $Eta^2 = .78$), with *post hoc* tests showing that recall progressively decreased across lists. As reported in Table 2, the control participants had better recall overall than the schizophrenia participants ($F(1,89) = 42.60$; $p < .05$; Partial $Eta^2 = .32$). However, critically, the List × Group interaction was not significant ($F(2,178) = 0.054$; $p > .05$; Partial $Eta^2 = .001$). The pattern of results remained the same when the additional measures were entered into the analysis as covariates.

DISCUSSION

There is a large body of evidence linking schizophrenia to volitional executive deficits, whereas automatic processes appear to remain relatively intact (Merlotti, Piegari, & Galderisi, 2005; Racsmany et al., 2008; Zec, 1995). Inhibitory-related processes—theorized to contribute to the development and/or maintenance of psychotic symptoms (Frith, 1979)—seem to be no exception to this rule, with previous schizophrenia studies reporting intact unintentional inhibition and unintentional resistance to interference (e.g., Fleming et al., 1995; Kopp & Rist, 1999; Randolph et al., 1992), but impaired intentional inhibition (e.g., Badcock et al., 2002; Donohoe et al., 2006; Racsmany et al., 2008; Salame & Danion, 2007; Waters et al., 2003). However, up until now, whether these intentional control difficulties in schizophrenia were generalized (i.e., included both inhibition *and* resistance to interference) or specific (i.e., pertaining only to inhibition) remained unknown. This study aimed to clarify this issue.

Consistent with the premise that individuals with schizophrenia have generalized intentional control impairments, the schizophrenia group in the current study performed poorly on the task which places a high demand on intentional resistance to interference (the DI task): specifically, they took substantially longer to read passages that had embedded distractor text than did controls. Although the schizophrenia participants who completed the task did not appear to have difficulties understanding or following the task requirements (because they were able to slowly yet successfully perform the control condition), it cannot be ruled out that the schizophrenia participants had greater difficulty following the task requirements on the distractor condition, which is more cognitively taxing. However, it should be noted that the critical interaction on DI RTs could not be (statistically) explained by general cognitive decline or increased levels of anxiety, which one may expect if this alternative interpretation was correct. Contrary to the impaired intentional interference control hypothesis, schizophrenia participants did not make more foil errors than control participants. This suggests that, while schizophrenia patients have difficulties resisting interference from distractors, they may still be consciously aware that this information is not goal-relevant, and are able to decipher goal-relevant from goal-irrelevant information during recall. Consistent with this finding, previous research has found that clinical populations characterized by interference control deficits have not reliably been shown to produce higher foil errors than controls (e.g., Earles et al., 1997), for the likely reason that the intrusion of distractor information into working memory due to failed interference control does not dictate the failure to later distinguish distractor from target information once held in working memory (required for a foil error to occur). Subsequently, most recent DI studies only report reading times as an index of interference control (Radvansky & Copeland, 2006; Salthouse et al., 2003).

Text comprehension on the DI task was also examined. This analysis showed that the schizophrenia group made more comprehension errors on stories with included distractor words than stories without (relative to controls), but that this interaction effect was no longer significant once premorbid IQ, working memory, education, and anxiety were controlled for. This suggests that the schizophrenia participants had difficulties in synthesizing and/or remembering the content of the stories, and that this difficulty was more pronounced when the task carried a higher cognitive load due to reduced overall cognitive ability and higher levels of

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anxiety (which have been shown to exponentially impair cognitive ability with increased cognitive load; e.g., Wood et al., 2001).

As expected, recall on the B-P task decreased across successive lists for both groups, reflecting increased demand on unintentional inhibition through the build-up of category-specific proactive interference. Although the schizophrenia group had poorer recall than the control group overall (consistent with memory difficulties documented in schizophrenia; Merlotti et al., 2005), the decline in recall across lists was not amplified in the schizophrenia group, signifying intact unintentional cognitive inhibition. This provides further support for the conjecture that individuals with schizophrenia have difficulties with intentional, but not unintentional, control processes. Since similar patterns of findings using the DI and B-P task have been found in predisposed (unmedicated) individuals (Paulik, Badcock, & Maybery, 2007; Paulik et al., 2008), and intentional control difficulties have been previously linked to the genetic predisposition to schizophrenia (e.g., Ross, Harris, Olincy, Radant, Adler, & Freedman, 1998; Ross, Wagner, Heinlein, & Zerbe, 2008), it is unlikely that intentional control impairments in schizophrenia are due to medication, chronicity or hospitalization. In line with this, prospective studies have found that executive functions—and associated frontal–striatal activation—begin to decline before the onset of illness, with impairments increasing in severity further along the illness trajectory (e.g., Eastvold, Heaton, & Cadenhead, 2007; Morey, Inan, Mitchell, Perkins, Lieberman, & Belger, 2005). This suggests that intentional cognitive control impairments may represent a vulnerability or trait marker for schizophrenia, which may help in the assessment of individuals at ultra-high risk of psychosis.

The current study differentially examined inhibitory processes in schizophrenia using cognitive tasks which have been specifically designed and validated to measure distinct inhibitory constructs. A limitation of using previously developed and validated cognitive tasks was that we could not find two tasks that were matched on all additional task requirements. The B-P and DI tasks were chosen because they both require the participant to read to-be-remembered text aloud; however, the DI task requires more saccadic eye movements during the reading phase than the B-P task, and the tests of memory use a recognition paradigm in the DI task and a free-recall paradigm in the BP task. Thus, we cannot rule out that these task differences (and the neurological substrates involved) contributed to the group differences reported on these tasks, although this seems unlikely given that the schizophrenia group showed intact and impaired performance on different indices for both tasks. A different approach that may help to overcome these methodological limitations—which we recommend future studies use to extend the findings reported here—is to study these inhibitory dimensions using psychophysiological measures (for an example of using this approach to dissociate intentional and unintentional processes, see Carter, Robertson, Chaderjian, O'Shora-Celaya, & Nordahl, 1994).

Intentional resistance to interference permits an individual to select goal-relevant stimuli from the environment while ignoring goal-irrelevant stimuli. The breakdown of this process may contribute to the development or maintenance of several different symptoms and features of schizophrenia, including those present during the prodromal period. For instance, it may contribute to the development or maintenance of a selective processing bias for external stimuli that is thematically related to an individual's delusional beliefs (Frith, 1979). Likewise, disruption to the processing of goal-relevant cognitions caused by the intrusion of goal-irrelevant stimuli may contribute to thought blocking, thought perseveration, disorganized speech, and poor concentration, and may also impede important processes—such as reality monitoring and testing—thought to be involved in positive symptom formation (Garety, Kuipers, Fowler, Freeman, & Bebbington, 2001). Thus, it is possible that remediation of deficits in intentional resistance to interfere may reduce psychotic symptoms in schizophrenia: a speculation that warrants future clinical research.

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