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Cognitive Correlates of Schizophrenia Signs and Symptoms: I. Verbal Communication Disturbances

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Abstract

We examined the relations between verbal communication disturbances and several hypothesized etiological factors in 47 schizophrenia spectrum individuals. Both alogia and disturbed discourse coherence were associated with poor planning abilities. Alogia and discourse coherence were differentially associated with performance on tasks measuring fluency, working memory, word finding abilities, and concentration/attention.

Keywords

alogia; formal thought disorder; planning; working memory; attention

1. Introduction

The signs and symptoms that comprise schizophrenia are remarkably diverse, ranging from pleasure deficits to hallucinations. Thus, it should probably not be surprising that schizophrenia has been posited to be associated with disturbances in a wide variety of brain regions and cognitive processes. For example, schizophrenia has been linked with disturbances in the left hemisphere (e.g., Flor-Henry, 1976), the right hemisphere (e.g., Cutting, 1990), the frontal lobes (e.g., Goldberg et al., 1987), attention (e.g., McGhie and Chapman, 1961), and memory (e.g., Saykin et al., 1991). The assumption upon which the present research is based is that although many cognitive disturbances may be associated with schizophrenia, and few if any cognitive disturbances may be specific to schizophrenia, the different signs and symptoms of schizophrenia are differentially associated with different cognitive disturbances. In other words, the heterogeneity of schizophrenia signs and symptoms might be explained by heterogeneity in cognitive disturbances.

Disturbances in verbal communication have long been considered a central feature of schizophrenia (e.g., Bleuler, 1911/1950; Kraepelin, 1919/1971). Verbal communication disturbances in schizophrenia are often divided into two types: (a) diminished verbal productivity, sometimes called alogia, which is associated with diminished syntactic complexity (e.g., Barch and Berenbaum, 1997); and (b) disturbances in the comprehensibility

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or coherence of speech (e.g., Berenbaum and Barch, 1995), sometimes called formal thought disorder (FTD).

A variety of different mechanisms have been proposed to explain the reduced quantity of speech in schizophrenia. Most of these proposed mechanisms involve executive processes that are associated with frontal lobe functioning. One possible explanation for poverty of speech that has been proposed is that it is due to a deficit in working memory (e.g., Barch and Berenbaum, 1994). A deficit in working memory might be expected to contribute to poverty of speech because in order to generate speech an individual may need to hold online several pieces of information, such as the topic of conversation and what they have already said. A second possibility, consistent with the results of Stolar et al. (1994), is that poverty of speech is due to a general fluency disturbance that is not limited to verbal communication. A third possibility is suggested by what is known about dynamic aphasia (sometimes referred to as transcortical motor aphasia; see Costello and Warrington (1989) for a discussion of the terminological variations). Dynamic aphasia, which arises from left hemisphere frontal lesions, is characterized by a severe reduction in speech production in the absence of any problems with language comprehension, reading, or naming. Costello and Warrington (1989) provided evidence suggesting that dynamic aphasia is caused by a disturbance in planning ability. Past research and theorizing on dynamic aphasia, along with the results of past research indicating that individuals with schizophrenia have a tendency to exhibit deficits in planning abilities, as measured using the Tower of London task (e.g., Morris et al., 1995; Kravariti et al., 2003), led us to hypothesize that reduced verbosity in schizophrenia is also influenced by a deficit in planning abilities. Another widely acknowledged hypothesis is that poverty of speech in schizophrenia is due to word finding difficulties (e.g., Alpert et al., 1994). Thus, one of the central goals of the present study was to examine which, if any, of these four cognitive processes (i.e., working memory, fluency, planning, and word finding) are associated with reduced quantity of speech in schizophrenia.

FTD, which encompasses at least two distinct types of speech production problems (disturbances in discourse coherence, such as derailments, and disturbances in fluency, such as neologisms; Berenbaum and Barch, 1995), has generally been presumed by most researchers to be due to one or more cognitive deficits (e.g., McGrath, 1991; Kerns and Berenbaum, 2002). In a meta-analytic review of the literature examining the relation between FTD and cognitive deficits, Kerns and Berenbaum (2002) provided strong evidence for impaired executive functioning playing a role in FTD. Thus, a second central goal of the present study was to examine which, if any, of three different cognitive processes associated with executive functioning (i.e., planning, working memory, and fluency) is associated with FTD. Planning abilities might be expected to be associated with FTD because the ability to generate a discourse plan is generally presumed by psycholinguists to be necessary for coherent language output (Levelt, 1989). Mixed support for this hypothesis was obtained by Barch and Berenbaum (1996), who found that performance on a discourse planning task (designed specifically for their study) was significantly associated with incompetent references ($r = .49$), was associated in the expected direction, albeit not significantly ($r = .13$), with the number of derailments and non-sequitur responses, and was not associated with neologisms/word-approximations or with tangential responses ($r = .01$ and $r = .01$). From a theoretical standpoint, one would expect difficulty holding information on line to be associated with difficulty generating coherent speech, since in order to produce coherent speech one must be able to hold on line the discourse plan one has generated. Consistent with such theorizing, past research has found that FTD is associated with deficits in working memory (Docherty et al., 1996; Barch and Berenbaum, 1997; Melinder and Barch, 2003). Since fluency is also considered an executive function, and executive functions are associated with FTD, one might therefore expect fluency to be associated with FTD. However, neither Barch et al. (1992) not Docherty et al. (1996) found

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evidence of performance on fluency tasks being associated with FTD among schizophrenia patients.

It has often been hypothesized that FTD is associated with cognitive processes that are specific to language production, though the evidence is at best mixed (Kerns and Berenbaum, 2002). If this is the case, one might expect FTD to be associated with word finding difficulties. In addition to examining executive processes and word finding abilities, we also examined attention/concentration (in the form of immediate auditory memory) and episodic memory. One reason to include measures of immediate auditory memory and episodic memory was to explore whether working memory specifically was associated with FTD or whether FTD was associated with all memory functions. A second reason to examine attention/concentration (immediate auditory memory) is that several previous studies have found associations between FTD and performance on non-distraction digit span tasks (e.g., Berenbaum and Barch, 1995; Docherty and Gordinier, 1999).

To summarize, the present study examined whether poverty of speech and FTD are associated with a variety of cognitive variables, all of which have been hypothesized to be associated with at least one of these two forms of verbal communication disturbance. We were especially interested in testing whether: (a) verbal communication disturbances are more strongly associated with some cognitive variables than with others (e.g., is FTD more strongly associated with working memory than with immediate auditory memory); and (b) are some cognitive variables more strongly associated with one form of verbal communication disturbance than with another (e.g., is working memory more strongly associated with FTD than with poverty of speech).

2. Method

2.1. Participants

The participants were 47 individuals with schizophrenia spectrum disorders (39 schizophrenia patients and 8 schizoaffective disorder patients). An additional 27 individuals with mood disorders (20 major depressive disorder patients and 7 bipolar disorder patients) were also assessed, but are not included in the analyses reported below since the primary goal of this study was to explore associations between schizophrenia symptoms and cognitive functioning. At the time of their participation in the study, all participants were receiving outpatient services from programs serving individuals with severe and persistent mental illness.

Psychiatric diagnoses were made using DSM-IV criteria following administration of the psychotic and mood disorders sections of the Structured Clinical Interview for the DSM-IV (First et al., 1998) and a review of clinical records. The interviews were conducted by an advanced graduate student in clinical psychology (LV). For the purpose of determining interrater reliability of the diagnoses, a second diagnostician (JG) sat in on the diagnostic interviews of a subset (N=16) of participants. Diagnostic interrater reliability was good; percentage agreement was 87.5% and kappa was .81. Final consensus diagnoses for all participants were made following consultation with the project's PI (HB). Information concerning sociodemographics, psychiatric history, and medication are presented in Table 1.

2.2. Measurements/Instruments

2.2.1. Verbal Communication Disturbances—To obtain speech samples for the purpose of obtaining extremely reliable, fine grained measures of verbal communication disturbances, we audiotaped participants during a structured interview in which they were asked a series of 26 questions such as “Could you tell me a little about yourself” and “What do you like to watch on TV.” The transcribed interviews were used to measure verbosity and syntactic complexity,

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and to rate FTD. Verbosity was measured simply as the number of words spoken. Following Barch and Berenbaum (1994), syntactic complexity was measured by computing the average number of dependent clauses per T-unit (Hunt, 1965); a T-unit is a single independent clause with all of its modifying subordinate clauses. For example, the T-unit "John, who lives in Chicago, likes baseball" has a single dependent clause, whereas the following pair of T-units do not have any dependent clauses: "John lives in Chicago. John like baseball."

FTD was measured using the Scale for the Assessment of Thought, Language, and Communication Disorders (TLC; Andreasen, 1979), as modified by Berenbaum, Oltmanns, and Gottesman (1985). We used the TLC to measure what Berenbaum and Barch (1995) described as disturbances in discourse coherence[1]. This was done by using the following TLC scales: nonsequitur responses, tangential responses, derailments, and losses of goal. Verbosity corrections were made following Berenbaum et al. (1985). TLC ratings were made by 5 undergraduate research assistants. A composite TLC disturbed discourse coherence score was computed by summing the standardized nonsequitur response, tangential response, derailment, and loss of goal scores. Interrater reliability of the TLC disturbance in discourse coherence score, measured using intraclass correlations (Shrout and Fleiss, 1979), treating the raters as random effects and the mean of the raters as the unit of reliability, was .87.

For the purpose of obtaining measures of FTD and verbosity that could be used to compare the present sample with others, both experimenters rated: (a) FTD using the conceptual disorganization scale of the Brief Psychiatric Rating Scale (BPRS; Lukoff et al., 1986); and (b) verbosity using the poverty of speech item from the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1983). Interrater reliability[2], measured using the intraclass correlation (Shrout and Fleiss, 1979), treating the raters as random effects and the mean of the raters as the unit of reliability, was .57 for conceptual disorganization and .35 for poverty of speech. Disagreements were resolved by consensus following discussion with the first author.

2.2.2. Cognitive Functioning

Planning and word finding: We used two of the psychological tests described by Lezak et al. (2004, p. 614) as being capable of providing information concerning planning abilities: (a) the Sentence Arrangement Test from the Wechsler Adult Intelligence Scale - Revised as a Neuropsychological Instrument (WAIS-R NI; Kaplan et al., 1991); and (b) the Picture Arrangement Test from the Wechsler Adult Intelligence Scale-Revised (WAIS-R; Wechsler, 1981). The Sentence Arrangement Test requires the participant to rearrange a set of words so that they form a sentence. The Picture Arrangement Test requires the participant to rearrange a set of pictures so that they tell a coherent story. Patients with dynamic aphasia have been found to perform extremely poorly on sentence arrangement tests (Costello and Warrington, 1989; Kartsounis et al., 1991). A composite arrangement test score was computed by summing standardized picture and sentence arrangement test scores.

Word finding ability was measured using the Boston Naming Test (Kaplan et al., 1983). Participants were shown pictures of 30 of the relatively most common objects (e.g., comb, pretzel) included in the full-length Boston Naming Test and were asked to name the object; scores are the number of objects named correctly.

[1]Disturbances in fluency, such as neologisms and word approximations, were also measured, but occurred quite infrequently in this sample, and will therefore not be discussed.

[2]Typically, interrater reliability is measured on the basis of two or more judges' degree of agreement concerning ratings based on the same observations or interview. In this case, the two judges observed the patients at different times, while engaging in slightly different activities. Thus, in this case, the intraclass correlation (ICC) is influenced by both interrater reliability and the degree to which the patients behaved differently at two different points in time, leading to a lower ICC than typically obtained.

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Planning and word finding abilities were also measured by examining between-clause and within-clause pauses, respectively. We measured both filled pauses (e.g., “um,” “uh”) and silent pauses, which we defined as any periods of silence lasting at least 250 milliseconds (ms). Silent pauses were identified with the use of Kay Elemetrics' Computerized Speech Lab (CSL #4300), which converts the analog voice recordings into digital output, which can then be listened to, filtered, displayed, and analyzed quantitatively. We distinguished between pauses that immediately preceded the first word of an independent clause, which we consider between-clause pauses, and pauses that occur elsewhere, which we consider within-clause pauses. Based on the work of Boomer (1965), between-clause pauses were presumed to be associated with planning, whereas within-clause pauses were presumed to be associated with word finding. The number of between-clause pauses was corrected for the number of independent clauses; the number of within-clause pauses was corrected for the total number of words spoken. As expected, the sum of within-clause pauses was significantly associated[3] with Boston Naming scores, r=0.40, P <0.01, but was not significantly associated with arrangement scores, r=0.16, *NS*; in contrast, the sum of between-clause pauses, excluding between-clause silent pauses of greater than 1000 ms, was significantly associated with arrangement scores, r=0.40, P <0.01, but was not significantly associated with Boston naming scores, r=0.22, *NS*.

Fluency: Fluency was measured using both verbal and design fluency tasks. There were four verbal fluency trials, lasting 90 seconds each. There were two trials in which words had to begin with a particular letter (S and A), and two trials in which words had to belong to a particular category (animals and colors). Because scores on all four trials were positively correlated, we used a single composite verbal fluency score computed by summing the standardized scores for each of the five trials. Participants also completed a design fluency test (Jones-Gotman and Milner, 1977) in which they were asked to create as many abstract, unnameable designs as possible. There were two design fluency trials, one in which participants had five minutes to draw as many designs as they wished without restrictions concerning the number of lines, and one in which they were given four minutes to draw designs using exactly four lines. Scores on the two trials were positively correlated, so a single composite design fluency score was computed by summing the standardized scores for the two trials. A total fluency score was computed by averaging across the verbal and design fluency scores, which were first standardized (i.e., converted into z-scores).

Episodic Memory: Episodic memory was measured using both verbal and non-verbal memory tasks. Verbal memory was measured using the Logical Memory subtest of the Wechsler Memory Scale-Revised (Wechsler, 1987). There were two trials, with participants asked to recall a different story for each trial. Scores on the two trials were positively correlated, so a single composite verbal memory score was computed by summing the standardized scores for the two trials. Nonverbal memory was measured using a face recognition task adapted from that employed by Banich et al. (1992). Participants were first be shown a series of 10 faces[4]. They were then shown 10 pairs of faces, and asked which of the two faces in each pair was in the original set they had been shown. A total episodic memory score was computed by averaging across the verbal and face memory scores, which were first standardized.

Working Memory: There were two working memory tasks: reading span and the modified A–X version of the continuous performance test (A–X CPT). In the reading span task (Daneman and Carpenter, 1980), participants read individual sentences typed on cards. On each trial, participants read a set of sentences and then attempted to recall the last word from

[3]Because the distributions of several variables were rather skewed, to avoid the possibility of correlations being overly influenced by participants with extreme scores, we report Spearman rank-order correlations throughout this paper.

[4]We used 10 faces, rather than the 16 used by Banich et al. (1992), to avoid obtaining floor effects. It should be pointed out that performance on this task could have been influenced by difficulties with face perception in addition to difficulties with episodic memory.

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each of the sentences. The task involved five trials at each set size, beginning with sets of two sentences. The end of the task occurred when a participant failed to recall any words on two consecutive trials or after completing trials with a set size of six. The dependent variable was the total number of words correctly recalled.

In the modified A–X CPT (Servan-Schreiber et al., 1996; Cohen et al., 1999), cue and probe letters were displayed successively on a computer screen. The target letter was the letter 'X' if it had been preceded by the letter 'A'. Participants used their right hand and were instructed to hit the left key of a response box for the target letter and the right key for all nontarget letters. Participants responded to both cue and probe letters. Cue and probe letters were displayed for 300 ms) each. The interstimulus interval between cue and probe was either 1000 ms (short-delay) or 5000 ms (long delay). The intertrial interval was 1000 ms. Participants completed the task in randomly alternating blocks of long and short delay trials, with 20 long and short delay trials within each block. Nontarget distraction letters could be any other letter of the alphabet except K. Tone feedback was given for correct and incorrect responses. The frequency of trials when 'A' and 'X' appeared in succession (A–X trials) was 70%. There were three other trials types; (1) a letter other than 'A' appeared with 'X' (B–X trials); (2) letter 'A' appeared along with a letter other than 'X' (A–Y trials); and (3) B–Y trials. The frequency of these other trial types was 10% each. The modified A–X CPT was developed so that the ability to maintain goal-relevant information would be particularly necessary in B–X trials (to override the prepotent response tendency of responding to 'X' as a target) and/or with long delays (Servan-Schreiber et al., 1996; Cohen et al., 1999). Barch et al. (1997), using the CPT-AX, found that activation of the dorsolateral prefrontal cortex was particularly sensitive to the length of the delay, with greater activation for long delay trials than for short delay trials. Thus, in the present study, we used d' (a signal detection measure of sensitivity) for long delay B–X trials as an index of working memory. To reduce the number of variables, a total working memory score was computed by averaging across the reading span and A–X CPT scores (which, as expected, were significantly correlated, $r=0.32$, $P<0.05$), which were first standardized.

Attention/Concentration: The Digits Forward subtest of the WAIS-R (Wechsler, 1981) was administered as a measure of attention/concentration. This task has also been described as a measure of immediate auditory memory (Docherty et al., 2000). The task involved two trials at each successive length of digits, beginning with 3 digits (e.g., 5-8-2). The task continued until the person had missed both trials at a particular digit length, or until the person completed the trials with a digit length of 9. The dependent variable was the number of correct trials, with a maximum score of 14.

2.3. Procedure

All participants were tested on the same day by the same two experimenters. One experimenter always administered the SCID and the arrangement tasks, whereas the other experimenter always administered the remaining cognitive measures as well as the interview used to measure disturbed discourse coherence, verbosity, and syntactic complexity. The research assistants who rated disturbed discourse coherence were blind to participants' scores on the cognitive measures. Thus, the three measures of verbal communication (i.e., disturbed discourse coherence, verbosity, and syntactic complexity) used to test this study's hypotheses should not have been influenced by knowledge of participants' scores on the cognitive measures.

3. Results

FTD scores, measured using the BPRS conceptual disorganization scale, ranged from one to five (M=2.1; SD=1.1). Poverty of speech scores, measured using the SANS, ranged from zero to four (M=0.6; SD=0.9). As expected, the discourse incoherence scores were significantly associated with the BPRS conceptual disorganization scores, r=0.46, P <0.01, and verbosity (number of words spoken) scores were significantly correlated with the SANS poverty of speech scores, r=0.51, P <0.01. All analyses reported throughout the remainder of the paper examined the verbosity and discourse coherence scores. Consistent with the results of past research (e.g., Barch and Berenbaum, 1997), in the present study, verbosity and syntactic complexity were significantly associated, r=0.42, P <0.01. Discourse incoherence was not significantly associated with either verbosity, r=0.05, *NS*, or with syntactic complexity, r=0.02, *NS*. Information concerning other symptoms can be found in the accompanying reports.

We first examined which, if any, verbal communication measures were associated with measures of planning and/or word finding. As can be seen in Table 2, all of the verbal communication scores tended to be associated with the planning scores, especially with the arrangement task scores. Specifically, diminished verbosity, diminished syntactic complexity, and higher levels of disturbed discourse coherence were associated with poorer planning abilities. In contrast, there was evidence of disturbed discourse coherence but not verbosity or syntactic complexity being associated with word finding ability, at least as measured by the Boston Naming Test. Differences in the magnitudes of correlations were compared using the formula recommended by Meng et al. (1992). Both verbosity and syntactic complexity were significantly more strongly correlated with arrangement task scores than with Boston Naming Test scores, z=2.03, P <0.05 and z=1.94, P <0.05, respectively. A related finding was a trend for performance on the Boston Naming Test to be more strongly associated with disturbed discourse coherence than with verbosity, z=1.40, P <0.09. In other words, whereas both disturbed discourse coherence and alogia were associated with poor planning abilities, they were differentially associated with Boston Naming performance, with disturbed discourse coherence but not alogia being associated with word finding difficulties.

We next examined which, if any, verbal communication measures were associated with the remaining cognitive measures. As can be seen in Table 3, verbosity and disturbed discourse coherence exhibited different patterns of associations with performance on the different cognitive tasks. Diminished verbosity was significantly associated with poorer performance on the fluency and digit span tasks, but not the episodic memory or working memory tasks. In contrast, disturbed discourse coherence exhibited the opposite pattern, with higher levels of disturbed discourse coherence significantly associated with poorer performance on the episodic memory and working memory tasks, but not the fluency or digit span tasks. Disturbed discourse coherence was significantly more strongly associated with working memory than with digit span performance, z=1.87, P<0.05. In contrast, there was a trend for diminished verbosity to be more strongly associated with digit span performance than with working memory, z=1.43, P<0.08. Working memory was significantly more strongly associated with disturbed discourse coherence than with diminished verbosity, z=2.06, P<0.05. Disturbed discourse coherence was significantly more strongly associated with working memory than with fluency, z=2.16, P<0.05. In contrast, diminished verbosity was significantly more strongly associated with fluency than with working memory, z=2.06, P<0.05. Thus, there was consistent evidence of disturbed discourse coherence and alogia being differentially associated with different cognitive factors.

4. Discussion

The results of this study are not consistent with the hypothesis that poverty of speech in schizophrenia is due to word finding difficulties (e.g., Alpert et al., 1994). Performance on the word finding task was not associated with verbosity, even though it was significantly associated with disturbed discourse coherence. In contrast, as hypothesized, diminished verbosity was associated with poor performance on the fluency and planning tasks. It was not the case that poverty of speech was associated with all executive processes, however; working memory,

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which was associated with disturbed discourse coherence, was not associated with diminished verbosity. We posit that: (a) the link between fluency and poverty of speech reflects a deficit in some schizophrenia patients' ability to generate ideas; (b) planning disturbances contribute to poverty of speech much as they have been hypothesized to contribute to dynamic aphasia (Costello and Warrington, 1989; Kartsounis et al., 1991), via the failure to plan discourse of any detail or complexity; and (c) working memory is not associated with poverty of speech because it may be the case that it is the level of detail and complexity of generating/planning discourse, rather than the ability to hold the discourse plan online, that contributes to poverty of speech. Interestingly, diminished verbosity was also significantly associated with poor performance on the digit span task. We posit that the capacity to attend to a conversation and to take in and immediately recall the information being presented by one's conversation partner is necessary to determine how to respond and to even begin developing a discourse plan. Of course, additional research is needed to rule out alternative explanations and to explicate the precise mechanisms that contribute to alogia in schizophrenia.

Consistent with the results of past research (Kerns and Berenbaum, 2002), the results of the present study suggest that disturbed discourse coherence is associated with disturbances in executive processes. Disturbed discourse coherence was consistently associated with disturbances in planning and working memory. In contrast, however, disturbed discourse coherence was not significantly associated with fluency performance, which is typically considered an executive process; in fact, disturbed discourse coherence was significantly more strongly associated with working memory than with fluency performance. The absence of an association between fluency performance and FTD is consistent with the results of past research (Barch et al., 1992; Docherty et al., 1996). Thus, while the present study provides evidence of disturbed discourse coherence being associated with some executive processes, it also provides strong evidence that not all executive processes play a role in the development of disturbed discourse coherence. We posit that: (a) planning abilities are associated with disturbed discourse coherence because the generation of a coherent discourse plan is almost certainly necessary for the generation of coherent speech; (b) working memory is associated with disturbed discourse coherence because the ability to hold a discourse plan online is probably necessary to produce coherent speech; and (c) fluency is not associated with disturbed discourse coherence because it is not central to the development or utilization of a coherent discourse plan. To further explicate the development of disturbances in discourse coherence, we recommend that future research continue to explore how different executive processes (ideally measured in multiple ways) are associated with the development and utilization of discourse plans. For example, it would be valuable to explore how several cognitive tasks that tap planning abilities (e.g., sentence arrangement, Tower of London), discourse planning, and disturbances in discourse coherence are all associated with each other.

Whereas verbosity was significantly associated with digit span performance, disturbed discourse coherence was not. This finding is inconsistent with the results of several previous studies that found associations between FTD and performance on non-distraction digit span tasks (e.g., Berenbaum and Barch, 1995; Docherty and Gordinier, 1999). Although the correlation between digit span performance and disturbed discourse coherence was not significant in the present study, it was in the expected direction. We posit that there are small to moderate associations between FTD and digit span performance, with the magnitude of the association being larger when: (a) executive processes are already being taxed at the time of speech elicitiation, such as when they are obtained under conditions of emotion evocation (e.g., Docherty and Gordinier, 1999); and/or (b) the executive functioning of the participants is particularly poor, such as among schizophrenia patients who are hospitalized and are more severely disturbed (e.g., Berenbaum and Barch, 1995); and/or (c) when FTD is measured more broadly (as opposed to focusing on disturbances in discourse coherence, as was done in the present study). Even if FTD is associated with digit span performance, the results of the present

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study suggest that disturbances in discourse coherence, and very possibly the broader construct of FTD, are more strongly associated with working memory performance than with attention/ concentration. We propose that working memory plays a greater role than does attention/ concentration (or immediate memory) in the etiology of disturbances in discourse coherence because the former (but not the latter) plays a central role in the ability to hold a discourse plan online, and we hypothesize that the failure to do so is one of the most important proximal causes of disturbances in discourse coherence.

Disturbances in working memory and planning are unlikely to be sufficient to account for the development of FTD or any of its facets, and thus it will be important for future research to delineate exactly how such disturbances contribute to FTD. In all likelihood, a combination of disturbances are needed to develop FTD. The results of the present study suggest an additional candidate to explore in future research. We found that disturbances in discourse coherence are associated with word finding abilities (as measured by the Boston Naming Test). The finding that disturbed discourse coherence was associated with word finding difficulties raises the possibility that deficits in cognitive processes that are specific to language production, coupled with other deficits (e.g., working memory), account for FTD in schizophrenia. Alternatively, the association between FTD and word finding abilities may not reflect anything about language-specific cognitive processes, but may instead reflect an association between FTD and disturbances in semantic processing (e.g., Goldberg et al., 1998; Kerns and Berenbaum, 2002; Leeson et al., 2005). Of course, there are additional cognitive processes that may play a role in the development of FTD, such as disturbances in conceptual sequencing (Docherty et al., 2000).

As expected, the vast majority of patients were receiving antipsychotic medication. Because patients were not randomly assigned to type or dosage of medication, this study cannot determine what role, if any, medication played in ameliorating or exacerbating patients' cognitive functioning or symptomatology (Blanchard and Neale, 1992). Since psychotropic medication affects brain functioning, and brain functioning affects cognitive functioning, and we hypothesize that cognitive functioning is a proximal cause of schizophrenia signs and symptoms, we would expect psychotropic medication to indirectly (via its effect on cognitive functioning) affect the signs and symptoms of schizophrenia that were the focus of this study. If it is the case that medication influences psychiatric signs and symptoms via its effect on the functions of the brain (which we presume to be mental processes, or cognitive functioning), then cognitive functioning can be considered to be closer in the causal chain leading to signs and symptoms than medication; as a result, it would be unlikely that medication effects would cause or exaggerate the associations between cognitive functioning and symptoms. In other words, just as medication intended to lower cholesterol levels would be unlikely to create an artifactual association between blocked arteries and heart attacks, medication intended to alter brain functioning would be unlikely to create an artifactual association between cognitive functioning and the signs and symptoms of schizophrenia. So, although the present study cannot tease apart the degree to which it is medications or other factors (e.g., neurodevelopmental disturbance) that contribute to cognitive functioning, the present study is capable of testing which facets of cognitive functioning are potential proximal causes of which symptoms.

One strength of the present study is that we measured most cognitive variables of interest (e.g., planning abilities, working memory) using two different measures. For example, working memory was assessed using both a reading span task and the A–X version of the CPT. Thus, we can be confident that our findings say something about cognitive processes and not just individual psychological tests. Another strength of the present study is that we measured two broad types of verbal communication impairment (i.e., both disturbed discourse coherence and alogia) and several different facets of cognitive functioning. Because we found that

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disturbances in discourse coherence and alogia were differentially associated with different cognitive factors (e.g., disturbed discourse coherence was more strongly associated with working memory than with digit span performance, whereas verbosity was more strongly associated with digit span performance than with working memory) we are able to rule out the possibility that our results merely reflect all forms of communication impairment being associated with all facets of cognitive functioning (i.e., a generalized deficit). Although the present study has not solved the puzzle of why individuals with schizophrenia often exhibit verbal communication disturbances, it has provided some important clues (e.g., the association between disturbed discourse coherence and working memory, and the association between alogia and planning) and has rendered less plausible several alternative explanations (e.g., that alogia is caused by word finding difficulties).

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Table 1

Sociodemographic, Psychiatric History, Symptomatology, and Medication Information

Age	
M	40.3
SD	9.1
Gender	
% Male	63.8
Race	
% African-American	17.0
% White	80.9
Education	
M	12.0
SD	1.6
Age First Hospitalized	
M	24.6
SD	8.2
Number Hospitalizations	
M	4.6
SD	4.7
Medications Taken	
% Mood Stabilizers	45.9
% Antidepressants	21.6
% Antiparkinsonian	54.1
% Antipsychotics	91.9
Antipsychotic Dosages (CPZ equivalents)	
M	576.7
SD	585.8

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Table 2

Associations Between Verbal Communication Variables and Planning and Word Finding Variables

	Diminished Verbosity	Diminished Syntactic Complexity	Disturbed Discourse Coherence
Planning			
Arrangement Task Total	−.35*	−.41**	−.51**
Between Clause Pauses	−.15	−.22	−.27t
Word Finding			
Boston Naming Test	−.04	−.12	−.34*
Within-Clause Pauses	−.10	−.02	.03

t *P* < 0.08

* *P* < 0.05

** *P* < 0.01 (2-tailed)

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Table 3

Associations Between Verbal Communication Variables and Remaining Cognitive Variables

Cognitive Variables	Diminished Verbosity	Diminished Syntactic Complexity	Disturbed Discourse Coherence
Fluency	−.39**	−.15	−.17
Episodic Memory	−.24	−.03	−.36*
Working Memory	−.07	.002	−.49**
Digit Span	−.33*	−.25†	−.17

† $P = 0.10$

* $P < 0.05$

** $P < 0.01$ (2-tailed)