Conceptual Sequencing and Disordered Speech in Schizophrenia

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Abstract

This study examined associations between impairments of attention, memory, and conceptual sequencing ability, and specific schizophrenia thought and language symptoms. Speech samples of stable schizophrenia outpatients were assessed for frequencies of six different types of communication failures. The classification of types of failures was based on hypothesized differences in underlying cognitive process. Frequencies of the four types of communication failures believed to involve language structural weaknesses all were significantly and fairly strongly related to conceptual sequencing ability. In addition, regression analyses indicated that each of these four types of communication failures was associated with a unique configuration of attentional, memorial, and conceptual sequencing processes. In contrast, the two types of communication disturbances not suggestive of language structural problems were not positively associated with any of the cognitive weaknesses assessed.

Keywords: Schizophrenia, thought disorder, language, working memory, attention, conceptual sequencing.

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The disturbances of thought and language manifest in the speech of people with schizophrenia have been the subject of much research and debate. Scholars over decades have examined data and generated models attempting to explain the nature and origins of these phenomena, and yet they have remained frustratingly opaque. One difficulty for researchers in this area has been the heterogeneity of these symptoms, in form and presumably also in underlying process (see Andreasen 1979; Andreasen and Grove 1986; Berenbaum and Barch 1995). For example, disordered speech in some few patients appears to involve a primary impairment in specifically linguistic processes, similar to that seen in the aphasias (Chaika 1974; Lecours 1995; Thomas and Leudar 1995). In schizophrenia patients as a group, interclausal complexity (Morice and Ingram 1982), hierarchical organization of clauses (Hoffman et al. 1986), and use of cohesive ties (Rochester and Martin 1979) are measurably affected. A lack of normal redundancy also has been noted in the speech of many patients (e.g., Manschreck et al. 1979), which has been hypothesized to originate, at least in part, from a lack of awareness in the speaker of the needs of the listener. Such "egocentricity" of speech may be associated with the more global deficits in interpersonal relatedness often observed in people with schizophrenia (Vigotsky 1934; Sullivan 1944; Harrow and Quinlan 1985). Finally, there is evidence that some of the more general cognitive impairments associated with the disorder, including deficits in facets of attention (Nuechterlein et al. 1986; Harvey et al. 1990; Docherty 1995), working memory (Docherty et al. 1996*c*; Barch and Berenbaum 1996; Sullivan et al. 1997), and conceptual capacity (e.g., Cameron 1944; Lovibond 1954; Blatt and Ritzler 1974; Johnston and Holzman 1979; McKenna 1995) may interfere with coherent language production. The present study was an examination of thought and language disturbances from a cognitive impairment perspective.

Results from studies looking for associations between cognitive test performance and language symptoms have been quite limited; effects have generally been weak, with few replications and no truly definitive findings. Part of the problem may be that thought and language disturbances have not generally been divided into distinct types based specifically on hypothesized differences in underlying cognitive process (but see Barch and Berenbaum 1996). Thus, the heterogeneity of the phenomena assessed in these studies may have obscured potential associations. The present study was an attempt to discriminate communication disturbances that involve inadequacies of language structure, in a broad sense of the term, from other

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types of communication failures associated with schizophrenia, and to elucidate some of the cognitive processes underlying this subset of disturbances. Structural disturbances are those involving organizational inadequacies—that is, problems in the relationships among the words and phrases in speech, as opposed to disturbances involving individual words or concepts.

In the realm of language structuring, investigators have hypothesized, among other things, that disordered speech in people with schizophrenia is the result of (1) an inability to generate a discourse plan (Frith and Allen 1988), (2) an inability to retain a discourse plan in working memory long enough to carry it out (Docherty et al. 1996*b*; Sullivan et al. 1997), (3) an inability to abstract and to organize thoughts according to subordinate and superordinate concepts (Cameron 1944; Hoffman et al. 1986), (4) an inability to separate figure from ground or to maintain set or context (McGhie and Chapman 1961; Harrow et al. 1983; Cohen and Servan-Schreiber 1992), and (5) an overactivity or idiosyncracy of associative networks (Rattan and Chapman 1973; Kwapil et al. 1990; Spitzer 1993).

Although these models differ from each other in important ways, they are also in some sense variations on a theme. A common element is an impairment in the capacity for conceptual sequencing. Conceptual sequencing is the controlled manipulation of simple concepts into sequences organized in accord with more complex concepts. Applied to speech, it is the process by which a speaker organizes simple concepts (words and phrases) into an appropriate sequence to express more complex concepts (the larger meanings of the utterance, the ideas being communicated). It involves more than simple temporal ordering, in that it requires ordering of subordinate concepts in the service of superordinate concepts. The construct of conceptual sequencing is consistent with the various models of schizophrenia cognitive deficit cited above, specifically as they relate to language structuring. However, it is more focused than some of the other constructs, it is comparatively simple, and it is directly measurable.

Conceptual sequencing is a relatively high-level cognitive function. If impairment in conceptual sequencing underlies the kinds of communication failures in schizophrenia that involve inadequacies of language structure, then the question arises as to whether deficits in lower level processes might underlie the impairment in conceptual sequencing ability. The types of disordered speech that suggest structuring difficulties could directly represent a primary deficit in the high-level cognitive function of conceptual sequencing. Alternatively, they could reflect a somewhat lower level deficit in the ability to structure simple sequences without the conceptual component. A third possibility is that they may result from impairment in still lower level attention and/or memory processes requisite for sequential organization. In the present study, conversational speech of schizophrenia patients was rated for frequencies of several different types of communication failures, only some of which were hypothesized to be related to weaknesses in the capacity for conceptual sequencing. The same patients also took tests assessing attention, immediate auditory memory, ability to organize simple sequences of given items, and ability to derive concepts and construct sequences using the concepts derived. The relative contribution of each of these cognitive functions to each type of communication failure was examined.

The types of communication disturbances rated are described in the Methods section (table 1). We hypothesized that conceptual sequencing difficulties would be associated with the types of communication failures involving inadequacies of language structure. These include references that are unclear as a result of a confusion, ambiguity, or absence of referents ("confused references," "ambiguous word meanings," and "missing information references" in the present study), as well as failures of meaning because of syntactic inadequacy ("grammatical unclarities"). Based on the findings of earlier studies on a separate sample of outpatients (Docherty et al. 1996*b*, 1996*c*), we expected that weaknesses of attention and immediate auditory memory also would contribute to the variance in these associations. Specifically, we hypothesized that failures of immediate memory would underlie the conceptual sequencing difficulties reflected in confused references, grammatical unclarities, and missing information references. Confused references and grammatical unclarities, as illustrated by the examples in table 1, appear to involve problems in remembering a discourse plan long enough to complete it. Further, speakers sometimes appear to make communication failures of these two types, and especially those involving grammatical failures, because by the time they reach the middle or end of an utterance they have forgotten exactly what they said in the first part of the utterance. We expected missing information references to be associated with poor memory performance for a different reason. This type of disturbance appears to involve an inability to differentiate in memory between information previously presented to the listener and information previously only thought about (see also Rochester and Martin 1979; Docherty et al. 1996*b*). We did not make specific hypotheses with respect to associations between attention and the language variables, or between organization/sequencing and the language variables. These cognitive functions were included in the study in order to test whether any of the hypothesized associations

Table 1. Communication failures rated by Communication Disturbances Index

Type of failure	Definition	Examples[1]
Confused reference	A reference for which there is more than one possible referent and the correct choice of referent is not obvious	(1) He stabbed the dude and I kicked *him.* I thought *he* punched *him.* I thought *he* was on the ground just acting like he was hurt.
		(2) The supervisor was so jealous because bosses liked *me* because I was a very good and hard worker, that *they* didn't like *that*...
Missing information reference	A reference to information not previously presented and not known by the listener	I designed the first rockets, and *the cars* and *the boats.* (There was no prior mention of any cars or boats.)
Ambiguous word meaning	A word or phrase with more than one definitional meaning, used in such a way that its intended meaning is uncertain	I'm all *natural* and I don't hang in crowds.
Grammatical unclarity	A phrase that is unclear in meaning due to violations of the structural rules of language	(1) *They had keeping* a babysitter that studied *but a Siamese cat* that had ringworm.
		(2) I was socializing with friends. Girlfriends and friends *the same as male.*
Vague reference	A word or phrase that is unclear because it lacks specificity	We had to go to court and other bad *things.*
Wrong word reference	An incorrect choice of word or phrase that renders the meaning uncertain	He was doing well in the beginning, but then he sort of *abused* his study habits.

[1]Communication failures are in italics.

between memory and communication failures might be a result of weaknesses in attention, and whether any of the associations between conceptual sequencing and communication failures might be a result of impairment of attention or of organization/sequencing processes.

In contrast to our predictions for the structural language variables, we did not expect conceptual sequencing to relate significantly to "vague references" or "wrong word references." These two types of failures of meaning both involve inadequate individual words or phrases within adequate linguistic structures. The context of the utterance is intact, and only the specific individual element is faulty. Because these types of unclarities do not appear to involve the same kind of structural sequencing problems, they served as control variables against which we tested the specificity of the associations between the cognitive and language variables in question.

Methods

Participants. Participants were 26 stable *DSM–IV* (American Psychiatric Association 1994) schizophrenia patients, ages 18 to 45, in treatment at a public sector outpatient clinic. The sample was drawn from participants in a large family study (see Docherty et al. 1999). The Schedule for Affective Disorders and Schizophrenia–Lifetime Version (SADS–L) interview, adapted slightly for use with *DSM–IV* criteria, was administered to all potential participants. The diagnostician was a clinical psychologist with research diagnostic experience who had attained acceptable levels of interrater reliability with another research group for the diagnosis of schizophrenia (κ = 0.88). Patients currently meeting *DSM–IV* criteria for substance abuse were excluded from the study, as were those whose histories suggested the possibility of organic dam-

age. The sample was 80 percent male; 80 percent of participants were Caucasian and 20 percent African-American. All participants were native English speakers. Their mean age was 32 (± 7); mean years of education was 13 (± 2); mean years of education of parents was 14 (± 3); mean duration of illness was 10 (± 6) years. Participants were considered clinically stable because they had been outpatients for at least 3 months and had not suffered acute exacerbations during that time period, according to patient and clinician report. All patients were functioning adequately in the community, although some were living in supervised housing situations. Mean current Global Assessment of Functioning score was 53 (± 11) (*DSM–III–R* scale) (American Psychiatric Association 1987). Current severities of hallucinations, unusual thought content, and conceptual disorganization as rated using the Brief Psychiatric Rating Scale (BPRS; see Procedures section) ranged from "absent" to "moderate/moderately severe," with means of "mild/moderate" for hallucinations, "very mild" for unusual thought content, and "very mild/mild" for conceptual disorganization. All patients were receiving antipsychotic medications at the time of assessment. Of these, 8 were using "traditional" neuroleptics, and 18 were using "atypical" antipsychotics (e.g., clozapine, risperidone). In addition, 9 participants were taking antiparkinsonian medications with substantial anticholinergic effects (cogentin, artane), 6 were taking mood stabilizers, and 12 were taking other medications, most often antidepressants or anxiolytics.

Procedures

Language ratings. *Speech samples:* Ten-minute conversational speech samples were collected from each participant. As in several of our earlier studies, participants were asked to describe some affectively negative events from their lives—that is, "bad memories" or "stressful times." The interviewer asked relevant, open-ended questions and made comments as needed to keep participants talking or to return them to the topic of negative events. We have previously found the frequency of patients' referential communication disturbances to be exacerbated in speech on affectively negative topics (Docherty et al. 1994*a* and 1994*b*; Docherty and Hebert 1997). We examined speech samples on affectively negative topics in this study because we wanted to look at speech containing relatively high levels of disorder; high levels of disorder would provide a greater range in the language ratings and thereby would make detection of significant correlations more likely. Speech samples were audiotaped and later carefully transcribed and proofread to ensure a high level of accuracy.

Communication disturbance ratings: The transcribed speech samples were rated using the Communication Disturbances Index (CDI). This measure is described more fully and validation data are provided in an earlier article (Docherty et al. 1996*a*). In that study, speech of schizophrenia inpatients was found to contain more frequent instances of each of the six types of communication failures assessed than speech of nonpsychiatric control participants. Total ratings using this measure have been demonstrated to be related to positive formal thought disorder as measured by Andreasen's thought, language, and communication scales (Andreasen 1979; Docherty and Hebert 1997); to Singer and Wynne's construct of communication deviance (Singer and Wynne 1965; Docherty et al. 1997); and to frequencies of unclear linguistic references as operationalized by Rochester and Martin (1979; Docherty et al. 1996*c*). The CDI focuses explicitly on failures of *communication* rather than on signs of underlying thought disorder or weaknesses of language structure as such. That is, it directly assesses failures in the transmission of meaning from speaker to listener. Both blatant and subtle instances of unclear meaning in a speech sample are identified. Each instance is classified as one of six different types. The CDI classification system was designed to discriminate among types of failures of meaning with apparently different cognitive origins. The types of failures rated are defined in table 1.

Instances are identified only by failures of meaning. Vague words, incorrect usage, syntactic errors, and so on are not counted unless they confuse or otherwise obscure the meaning of the utterance. Frequency of each type of disturbance is computed as number of instances in the speech sample divided by amount of speech. In the present study, scores were computed as instances per 100 words of speech. Speech samples were rated blind to participants' identities and other variables, by an individual who had attained acceptable levels of reliability with another rater on a set of 20 speech samples. Intraclass correlation (ICC), calculated using the method described by Bartko and Carpenter (1976), ranged from ICC = 0.77 to ICC = 0.93 for the individual categories; for total CDI ratings, ICC = 0.94.

Cognitive measures. *Attention:* A computerized visual continuous performance task (CPT) was administered to each participant. The version we used, which was developed by Keith Nuechterlein and colleagues, employs degraded (blurry) stimuli (Degraded Stimulus CPT, version 7.03; UCLA Clinical Research Center for the Study of Schizophrenia). This test approximates the CPT originally described by Nuechterlein et al. (1983). A quasi-random series of digits is flashed on a computer screen, at the rate of one per second, for 8 minutes. Participants are instructed to watch the screen and to respond by pushing a button every time the target digit (zero) appears. This version is believed to be more difficult than most, and partic-

ularly for schizophrenia patients, because the use of degraded stimuli imposes a relatively heavy information processing load, including a substantial burden on early perceptual discrimination and encoding (see Nuechterlein et al. 1994). It was important to use a measure that would capture high-load attentional deficits, because we wanted to see whether attentional impairment contributed to certain types of communication failures, and also whether impairment of immediate memory and conceptual sequencing ability contributed beyond the attentional measure. The test yields scores for hit rate, false alarm rate, sensitivity, and response bias. We used the sensitivity scores, which are derived from both hit rates and false alarm rates, as our measure of attention.

Immediate auditory memory: Immediate auditory memory was measured by a digit span test. The version used consists of eight audiotaped sequences of six digits each. After each sequence the tape is paused, and the participant repeats as many of the digits as he or she can remember, in the original sequence. Scores consist of the number of correct digits remembered, minus the number of incorrect digits and digits out of sequence. We did not include digits backward in this test, because we wanted a measure of immediate auditory memory for simple sequences without the higher level function of manipulation of the remembered information. We expected immediate auditory memory to be a factor particularly in confused references, missing information references, and grammatical unclarities based on the phenomenology of these types of disturbances and on some earlier findings that suggest that these disturbances may be associated with working memory impairment (Docherty et al. 1996*c*).

Organization/sequencing: The capacity for organization/sequencing was assessed by means of a trail making test (Trails B; Reitan and Davidson 1974), which requires the participant to draw a series of lines connecting 26 letters and numbers in alternating sequence. This test involves the organization of two preexisting, overlearned sequences (numerical and alphabetical), and as such is a measure of simple organization/sequencing of material. Efficient performance on this test depends in part on facets of working memory, in that it requires the maintenance of a two-step task set in memory while completing the procedure, and also the maintenance of an ongoing, orderly memory of one's own latest responses (see Levitt et al. 1995). Performance is measured by time to correct completion of the task. In the present study, scores were computed by subtracting time from zero, to change the direction of scores to conform with that of the other tests.

Conceptual sequencing: Our most complex cognitive task assessed the ability to conceptualize and to generate sequential items based on the concepts derived. The measure used for this purpose was the conceptualization subtest of the Shipley Institute of Living Scale (Shipley 1940). This test consists of 20 sequences of numbers, letters, or words. The participant is required to add to each given sequence by generating new sequential items. Simulated sample items (blanks to be completed by participant, one digit or letter per blank) might be:

(1) 9 8 7 6 5 _ _
(2) thin in clover over trout out blunder _ _ _ _ _
(3) down up under over out _ _

Each sequence is based on a different concept, with graduated levels of difficulty. Scores are computed as number of items correct, multiplied by 2.

Symptom ratings. The BPRS (Overall and Gorham 1962) was rated for each participant by one of two graduate student research assistants trained in the use of the scale, who were blind to participants' CDI ratings and cognitive test scores. The raters corated 30 percent of the participants and demonstrated acceptable levels of interrater reliability, ICC = 0.91 for total BPRS scores (for statistical method, see Bartko and Carpenter 1976).

Analysis. The analysis was done in three parts. First, correlations were computed among frequencies of the different types of communication disturbances. Second, correlations were computed between the cognitive test scores and frequencies of each type of communication disturbance. Differences in magnitudes of the correlations of conceptual sequencing scores with grammatical unclarities, confused references, missing information references, and ambiguous word meanings versus the correlations of conceptual sequencing with vague references and wrong word references were assessed for significance. Finally, the cognitive test variables were hierachically regressed on each of the structure-related types of disturbance to determine which types of cognitive weaknesses might have contributed to the production of each type of communication failure.

Results

Communication Disturbance Ratings. Means and standard deviations for each of the six types of communication disturbances are presented in table 2. Confused references, missing information references, ambiguous word meanings, and grammatical unclarities were significantly correlated with each other, suggesting some commonality of underlying process. Vague references and wrong word references were not associated with the other types of failures, supporting the idea that they have somewhat different underpinnings from the others. It should be noted that this pattern of relationships differed somewhat from those

Table 2. Communication disturbance ratings in stable schizophrenia outpatients

Type of disturbance	Mean (± SD)[1]
Confused reference	0.62 (± 0.56)
Missing information reference	0.46 (± 0.38)
Ambiguous word meaning	1.08 (± 0.49)
Grammatical unclarity	0.59 (± 0.36)
Vague reference	0.25 (± 0.36)
Wrong word reference	0.16 (± 0.27)

Note.—SD = standard deviation.

[1]These are instances per 100 words.

found in studies using affectively neutral or positive speech samples; in those speech samples, vague and wrong word references tended to be associated to some degree with the other types of disturbances (Docherty et al. 1996*a* and 1996*c*; Docherty et al. 1999). Correlations among the different types of disturbances are presented in table 3.

Cognitive Test Scores. Scores for the tests of attention, immediate memory, organization/sequencing, and conceptual sequencing are presented in table 4. Correlations among cognitive test scores are presented in table 5.

Medication Status and Cognitive Test Scores. To test for possible effects of medication on cognitive functioning, participants were divided several different ways based on medication status, and groups were compared on cognitive test scores and CDI ratings. There were no significant differences between those taking conventional and those taking atypical antipsychotics on any of the tests or language variables. There were also no differences between those taking mood stabilizers and those who were not, or between those taking antidepressants or anxiolytics and those who were not. There was one significant medication effect noted in the analyses comparing those who were taking antiparkinsonian medications with substantial anticholinergic effects versus those who were not. Those taking the anticholinergic medications performed more poorly on the test of immediate auditory memory ($M \pm SD = 0.95$ [± 0.08] vs. 0.82 [± 0.18], $t[25] = 2.6$, $p = 0.02$). This finding is consistent with prior evidence indicating that anticholinergics have a detrimental effect on memory functioning (Drachmann 1977; Frith 1984).

Correlations Between Communication Disturbances and Cognitive Test Scores. Correlations were computed between the cognitive test scores and frequencies of each type of communication disturbance. These correlations are presented in table 6. As predicted, high frequencies of grammatical unclarities, confused references, missing information references, and ambiguous word meanings in patients' speech were associated with poor performance on the test of conceptual sequencing. Three of these four types of disturbances were also significantly related to scores on the organization/sequencing test. Frequencies of confused references and grammatical unclarities were associated with performance on the test of immediate auditory memory, and frequencies of missing information references and ambiguous word meanings were significantly related to performance on the test of attention. Contrary to our expectations, missing information references had no association at all with scores on the test of immediate auditory memory. Vague references and wrong word references, the nonstructural types of disturbance, were not associated with any of the cognitive test scores.[1]

Analyses comparing the magnitudes of the correlations between conceptual sequencing scores and specific types of communication disturbances were computed using a test of significant differences between correlated correlations (Meng et al. 1992). Correlations between conceptual sequencing scores and frequencies of confused references, grammatical unclarities, missing information references, and ambiguous word meanings all were higher than correlations between conceptual sequencing scores and frequencies of vague references and wrong word references. Values ranged from $z = 3.47$, $p = 0.001$, to $z = 2.11$, $p = 0.04$, indicating that the differences in correlations were significant.

Frequencies of vague references and wrong word references were not significantly associated with scores on the conceptual sequencing test or with any of the other cognitive measures. This supports our hypothesis that impairments in the capacity for conceptual sequencing underlie certain specific types of communication failures and not others. However, vague references and wrong word references were also the two least frequently occurring types of failures, and as such associations would be

[1] The sample size was modest, and some types of disturbances did not occur with high frequencies. For the sake of caution, we also ran these analyses as Spearman rank-order correlations. Results were similar. The only notable difference was that the association between vague references and conceptual sequencing scores, which was in the *positive* direction, was significant at the 0.03 level ($p = 0.43$), indicating that individuals with better conceptual sequencing scores made somewhat more frequent vague references. While vague references are associated with pathology, in that they occur more frequently in the speech of schizophrenia patients than in the speech of nonpsychiatric controls (Docherty et al. 1996*a*), they may also require a level of conceptual capacity not present in a subset of schizophrenia patients. Thus it is possible that the communication failures in the speech of those patients who are able to conceptualize relatively well may include more frequent vague references, whereas those patients who are more concrete may make fewer vague references and more of the other types of referential failures.

Table 3. Correlations among communication disturbances in speech of stable schizophrenia outpatients[1]

	1	2	3	4	5	6
1. Confused reference	1.00					
2. Missing information reference	0.43*	1.00				
3. Ambiguous word meaning	0.65**	0.50**	1.00			
4. Grammatical unclarity	0.53**	0.40*	0.59**	1.00		
5. Vague reference	0.03	0.08	0.19	–0.10	1.00	
6. Wrong word reference	–0.04	–0.24	–0.20	–0.06	–0.26	1.00
7. Total communication disturbance	0.85**	0.67**	0.86**	0.70**	0.22	–0.04

[1] The table covers speech of stable schizophrenia outpatients (n = 26) on affectively negative topics.

* $p < 0.05$; ** $p < 0.01$

Table 4. Cognitive test scores

Cognitive function	Measure	Variable	M (± SD)
Attention	Degraded stimulus CPT	Sensitivity (A')	0.88 (± 0.12)
Immediate memory	Digit span	Correct rate	0.88 (± 0.16)
Organization/sequencing	Trail making test B	Time to completion	110 (± 78)
Conceptual sequencing	Sequence completion—Shipley	Total correct	22 (± 9)

Note.—CPT = continuous performance task; SD = standard deviation; Shipley = the Shipley Institute of Living Scale (Shipley 1940).

Table 5. Correlations among the cognitive measures (n = 26)

	1	2	3
1. Attention	1.00		
2. Immediate memory	–0.12	1.00	
3. Organization/sequencing	0.75**	0.17	1.00
4. Conceptual sequencing	0.39*	0.24	0.70**

* $p < 0.05$; ** $p < 0.01$

Table 6. Correlations between communication disturbances and cognitive measures

Language Disturbances	Sustained attention	Immediate memory	Organization/ sequencing	Conceptual sequencing
Structural				
Confused reference	–0.20	–0.46*	–0.28	–0.55***
Missing information reference	–0.42*	–0.02	–0.47*	–0.51**
Ambiguous word meaning	–0.58***	–0.21	–0.51**	–0.55***
Grammatical unclarity	–0.28	–0.58***	–0.44*	–0.55***
Nonstructural				
Vague reference	0.01	0.21	0.32	0.34
Wrong word reference	0.14	0.23	0.19	0.15

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$

more difficult to detect for them than for the other types of disturbances. Therefore, an additional analysis was conducted to further test the idea that the associations between structural language disturbances and conceptual sequencing reflect specific rather than generalized deficit effects. Global ratings of cognitive disorganization were assessed by means of the conceptual disorganization subscale of the BPRS. These global ratings were regressed out of each of the specific types of language ratings, and correlations with conceptual sequencing scores were recomputed. All of the structural language variables were still significantly associated with conceptual sequencing scores, even after removal of the global disorganization rating. These correlations are presented in table 7.

In order to look at the specificity of associations further, we also regressed Shipley vocabulary test scores out of the CDI ratings and reran the correlations between the language variables and conceptual sequencing scores. In this analysis we essentially removed the effects of differences among subjects in global verbal functioning. These correlations, which were similar but generally of lower magnitudes, are presented in table 7. Because conceptual sequencing is one element of global verbal functioning, and global verbal functioning was removed from these comparisons, these latter results probably underestimate the relationships between conceptual sequencing and the CDI language structural variables. However, they do demonstrate that the associations found previously are not based solely on level of global verbal functioning.

Regression Analyses. Hierarchical regression analyses were computed to determine the relative contributions of each of the cognitive functions tested to each of the four structural types of communication failure. The cognitive test scores were regressed on the language ratings in this order: attention, immediate auditory memory, organization/sequencing, and conceptual sequencing. We ordered the variables in this way so that the test reflecting the earliest and lowest level of processing was entered first, followed by tests reflecting increasingly higher level processes. We entered the variables in this order because we wanted to test for contributions of the lower level processes, and for contributions of the higher level processes beyond the effects of the lower level processes. Attention as measured involved both early perceptual processing and sustained attention. Both of these functions are prerequisites for effective immediate memory functioning; one cannot remember material that has not been perceived or to which one has not attended. Immediate memory, in turn, is necessary for organization/sequencing of material; one cannot organize and sequence material unless it is held in memory effectively. Finally, impairments in early perceptual processing, attention, immediate memory, and/or organization/sequencing ability would be expected to adversely affect conceptual sequencing capacity.

Results of the regressions are presented in table 8. The variables that contributed to confused references were immediate memory, and beyond that conceptual sequencing. For missing information references, only attention was a factor. Ambiguous word meanings were highly associated with attention and also with conceptual sequencing ability beyond the effects of attention. Grammatical unclarities were highly related to immediate memory, with a nonsignificant trend for an additional contribution from conceptual sequencing ability.

Anticholinergic Effects on the Associations. The medication analyses indicated that use of antiparkinsonian medications with substantial anticholinergic effects was

Table 7. Correlations between conceptual sequencing and communication disturbances[1]

	Conceptual Sequencing Scores	
Language Disturbances	**Conceptual disorganization ratings regressed out**	**Vocabulary test scores regressed out**
Structural		
Confused reference	–0.51**	–0.37
Missing information reference	–0.42*	–0.36
Ambiguous word meaning	–0.49**	–0.43*
Grammatical unclarity	–0.51**	–0.42*
Nonstructural		
Vague reference	0.32	0.34
Wrong word reference	0.14	0.15

[1] Correlations are after removal of (1) global disorganization scores or (2) vocabulary test scores.

* $p < 0.05$; ** $p < 0.01$

Table 8. Hierarchical regression of cognitive measures on structural language disturbances

Language Measures	Predictor Variables Entered: Step 1: Attention	Step 2: Immediate memory	Step 3: Organization/ sequencing	Step 4: Conceptual sequencing	Total
Confused reference					
F to enter	0.93	6.96**	0.01	10.04***	F(4,21) = 5.33***
R^2	0.04	0.28	0.28	0.53	Total adjusted R^2 = 0.43
Adjusted R^2	0.00	0.21	0.17	0.43	
Adjusted R^2 change	0.00	0.21	–0.04	0.26	
Missing information reference					
F to enter	4.64**	0.08	1.29	1.96	F(4,21) = 2.19
R^2	0.17	0.18	0.23	0.32	Total adjusted R^2 = 0.17
Adjusted R^2	0.14	0.10	0.11	0.17	
Adjusted R^2 change	0.14	–0.04	0.01	0.06	
Ambiguous word meaning					
F to enter	11.14***	2.88	0.01	6.16**	F(4,21) = 6.03***
R^2	0.34	0.42	0.42	0.56	Total adjusted R^2 = 0.47
Adjusted R^2	0.31	0.36	0.33	0.47	
Adjusted R^2 change	0.31	0.05	–0.03	0.14	
Grammatical unclarity					
F to enter	1.92	14.77***	0.38	3.53*	F(4,21) = 5.88***
R^2	0.08	0.46	0.47	0.55	Total adjusted R^2 = 0.46
Adjusted R^2	0.04	0.41	0.39	0.46	
Adjusted R^2 change	0.04	0.37	–0.02	0.07	

*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$

associated with poor performance on the immediate auditory memory test. Presumably, if the medications affected memory functioning, they would also affect memory-related language functioning, and overall associations would still hold. However, in the interests of conservatism, we computed subsidiary analyses in which we residualized the anticholinergic effect out of the memory test performance, and then reran the comparisons between memory performance and language. Correlations resembled those obtained previously. Memory test performance, with anticholinergic effects removed, correlated with confused references, $r = -0.41$, $p = 0.05$; missing information references, $r = -0.11$, *ns*; ambiguous word meanings, $r = -0.33$, *ns*; grammatical unclarities, $r = -0.55$, $p < 0.01$; vague references, $r = -0.02$, *ns*; and wrong word references, $r = 0.18$, *ns*. In the regression analyses, the regression of cognitive test performance on ambiguous word meanings showed a significant contribution from the memory variable as well as from the early perception/attention and conceptual sequencing measures. None of the other regressions were affected substantially by the removal of anticholinergic effects. It should be noted that when anticholinergic effects were residualized out of the language ratings as well as the memory test scores, association magnitudes tended to be intermediate between the original correlations and those computed with anticholinergic effects removed only from the memory scores.

Discussion

In summary, ratings of confused references, missing information references, ambiguous word meanings, and grammatical unclarities were correlated with each other, and not with ratings of the control language variables, vague references, and wrong word references. In addition, frequencies of the four structural types of disturbance were negatively associated with scores on the tasks assessing organization/sequencing and conceptual sequencing, while frequencies of the control nonstructural language variables were not. These findings support the idea that the structural types of failures in question have common origins to some extent, have largely different origins from

vague and wrong word references, and are associated with an impairment in the ability to conceptualize and organize information sequentially in accord with the concepts.

Both the ability to conceptualize and organize and the ability to structure speech were affected at a more basic level by deficits in attention and immediate memory. The results of the regression analyses indicated the following: Attention scores contributed significantly to the variance of missing information references and ambiguous word meanings, but not confused references or grammatical unclarities; immediate auditory memory performance contributed to the ratings of confused references and grammatical unclarities, but not to missing information references or ambiguous word meanings; and organization/sequencing scores did not contribute to any of the language variables beyond the effects of attention and immediate memory. Conceptual sequencing was still a factor in confused references and ambiguous word meanings but not in the other language variables, after removal of the effects of attention, memory, and organization/sequencing as measured here.

Confused References. As hypothesized, confused references were related to weaknesses in immediate auditory memory and also to impairment in conceptual sequencing. These associations support the idea that confused references involve an inability on the part of the speaker to construct an adequate discourse plan, which entails conceptual sequencing, and also to remember the plan and his or her own ongoing output in carrying out the plan.

Missing Information References. Missing information references were not very highly associated with the set of cognitive measures used here. Of the functions measured, only attention was a significant factor, and this was a fairly weak association. We had expected to find some involvement of immediate auditory memory, based partly on findings in an earlier study suggesting associations between an index of working memory impairment and the frequency of missing information references (Docherty et al. 1996*c*). We have previously hypothesized that missing information references involve an inability on the part of the speaker to remember what information he or she has previously presented (Docherty et al. 1996*b*, 1996*c*). Given the present findings, perhaps missing information references involve deficits in somewhat longer short-term memory processes than those measured by digit span forward. It is still possible that they may reflect a somewhat longer term reality monitoring deficit that leaves the individual unable to discriminate in memory between that which he or she has presented previously in speech and that which he or she has only thought (see also Rochester 1978; Harvey et al. 1988). This is a question for further study. Subjectively speaking, missing information references have a particularly schizophrenic tone; furthermore, in a previous outpatient sample they were the type of communication failure most characteristic of schizophrenia patients compared with both bipolar and nonpsychiatric control subjects (Docherty et al. 1996*c*). It will be important to examine other possible cognitive process correlates of this particular type of disturbance in future research.

Ambiguous Word Meanings. Ambiguous word meanings were strongly associated with both attention and conceptual sequencing impairment. This type of disturbance in particular may be akin to Singer and Wynne's (1965) construct of communication deviance. Communication deviance, which is conceptualized as reflective of an inability to share a focus of attention with another person, has also been found to be associated with attentional weaknesses (Singer 1978; Docherty 1993). Use of words and phrases with meanings ambiguous to the listener suggests a lack of ability to share a focus of attention with the listener. In addition, the use of words with ambiguous meanings suggests the possibility of weaknesses in concept boundaries, as discussed by Blatt and Wild (1976). Poorly defined concepts (words) presumably would be relatively unstable building blocks for the construction of speech. A weakness in concept definition would be likely to impair the capacity for ordering words and phrases to communicate larger concepts—that is, for conceptual sequencing. Thus, the use of ambiguous words could involve a basic difficulty with concept definition that then affects the structuring of language.

It also should be noted that the particular measure used to assess attention in the present study involved the discrimination of degraded stimuli, which places a heavy load on the processing of perceptual boundaries. A difficulty with boundary discrimination, both perceptual and conceptual, might account in part for the association between ambiguous word meanings and performance on the attentional task.

Grammatical Unclarities. Grammatical unclarities were related only to immediate auditory memory impairment; this association was strong, accounting for a substantial proportion of the variance. We have previously found grammatical unclarities to be associated with scores on a working memory index that combined measures of immediate auditory memory, maintenance of task set, and manipulation of information in immediate memory (Docherty et al. 1996*c*). The current analysis, in which these working memory processes were essentially examined separately, suggests that inability to retain information in auditory memory, as measured by digit span forward, was the main deficit underlying grammatical unclarities; maintenance of task set and manipulation and organization of information held in working memory, which are assessed by the trail making test, were not fac-

tors beyond the effects of impairment in immediate auditory memory. Of course, deficits in other realms of cognitive functioning that were not assessed in the present study might also underlie grammatical unclarities. However, their phenomenology, as illustrated by the examples in table 1, does suggest a primary involvement of immediate memory. The speakers who generated these examples may well have been unable to retain their intended meanings or their own speech in memory long enough to produce clear communications.

Frequencies of vague references and wrong word references were not significantly associated with any of the structure-related language variables, nor were they positively associated with any of the cognitive weaknesses assessed. This supports the idea that these two types of disturbances have different cognitive origins from the others. However, while these two types of failures were unrelated to the other types in these speech samples on affectively negative topics, they have been found to be somewhat associated with the other types of disturbances in affectively neutral and affectively positive speech samples (Docherty et al. 1996*a*, 1996*c*, 1999). These two types of disturbances have tended to be less affectively reactive than some of the others—that is, to be less markedly exacerbated in response to arousal of negative affect, suggesting again some difference in cognitive substrates. Interestingly, confused references and ambiguous word meanings, the two types of disturbance that were associated with conceptual sequencing even after removal of the effects of attention and immediate memory, were also the types of disturbance that have been most markedly exacerbated by negative affect in our studies of affective reactivity of speech (Docherty and Hebert 1997; Docherty et al. 1998). This suggests that the capacity for conceptual sequencing may be adversely affected in patients by arousal of negative affect. Vulnerability of this and perhaps other cognitive functions to negative affect could underlie the affective reactivity of thought and language disturbances found in schizophrenia (Docherty et al. 1994*a*, 1994*b*). This idea could be tested in future research by comparing associations between cognitive test performance and communication disturbances in affectively positive and affectively negative speech samples.

The sample in this study was modest in size, and some of the analyses were exploratory. Therefore the findings should be viewed with caution. In addition, conceptual sequencing, as we measured it, is complex. It requires the capacity to conceptualize, and also the capacity to construct sequences based on the concepts derived. The present study did not really discriminate between these two facets of conceptual sequencing. The associations between CDI variables and conceptual sequencing scores could have been the result of weaknesses in conceptual capacity alone, rather than of weaknesses in conceptual capacity and sequence construction. We did run a small post hoc analysis to test this possibility. We had Weschler Adult Intelligence Scale Similarities subtest (Wechsler, 1981) scores for many of the subjects, obtained in connection with a different study. The Similarities subtest is a simple measure of conceptualizing/abstracting. When Similarities scores were residualized out of conceptual sequencing scores, the associations between conceptual sequencing scores and all four of the language structural variables still remained significant, supporting the importance of the sequencing component. This question should be addressed more fully in future work.

The associations found in this study were unusually strong when compared with other findings in the literature on associations between cognitive functions and communication disturbances. Discriminating among types of thought and language symptoms based on hypotheses about their cognitive origins, and examining these types of disturbances individually, appears to be a useful strategy. In addition, orderly regression of cognitive variables on communication disturbances proved to be a revealing method of examining associations among functions in this study. Furthermore, the comparisons between correlates of different types of communication disturbances largely removed the problem of generalized deficit effects. The findings from this study support the idea that the types of disturbances defined by the CDI do have distinct cognitive underpinnings to some extent. The findings also provide some information as to the specific functions associated with four of the six types of disturbances. The strategies used in this study could be extended to other cognitive, psychophysiological, psychological, and brain structural variables that potentially contribute to specific types of thought, language, and communication symptoms.

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