Speech Disorder in Schizophrenia: Review of the Literature and Exploration of Its Relation to the Uniquely Human Capacity for Language

by Lynn E. DeLisi

Abstract

The language capacity of modern humans is thought by some to be clearly distinct from that of nonhuman primates (Bickerton 1990). Crow (1997, 1998*a*) has proposed that a disturbance in the uniquely human aspects of language is central to the genetic etiology of schizophrenia. A review of the literature on language disorder in schizophrenia provides evidence for widespread deficits in comprehension, production, attention, and cerebral lateralization of language. We focused here on those anomalies that are uniquely human aspects of language. Bickerton's five distinctly human language devices were examined in patients with schizophrenia and their families by using a structured scoring format on oral soliloquies. The chronic patients showed reduced use of clausal embedding and used fewer words than first episode patients or well family members. The amount of sentence complexity was found to be familial and to cosegregate with schizophrenia within families. These data are consistent with previous literature and additionally show a familial component to these measures, thus suggesting that deficits in specifically human aspects of language may be related to the genetics of schizophrenia.

Keywords: Language, speech, evolution, genetics, families, relatives, schizophrenia.

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There has been much debate in linguistic literature about what constitutes specifically human aspects of language (reviewed in Hauser 1997) and whether there was an abrupt or gradual evolutionary transition in language abilities from nonhuman primates (early hominids) to *Homo sapiens* (Gardner and Gardner 1978; Bickerton 1990, 1995). Bickerton (1990) proposed five unique features of human language: (1) differences in the superficial order of constituents; (2) the use of null elements (e.g., "it"); (3) the use of a subcategorized argument structure for verbs; (4) mechanisms for the expansion of utterances; and (5) the use of grammatical items. These aspects of language must result from newly formed neuronal organization in the transition from early hominids to modern *Homo sapiens*. Genetic control of the development of these neuronal circuits responsible for language is thus likely. However, the genes responsible and the pathways that are specifically human are unknown.

The core phenomenologic characteristics of schizophrenia can be considered to stem from anomalous organization, retrieval, and communication of complex "thought" and language. Thus, it follows that schizophrenia is likely to be a uniquely human condition and that some deficits in the neural organization of language must exist in schizophrenia. Numerous aspects of both speech and its perception have been found to be deviant in studies of patients with schizophrenia (table 1). Crow has suggested that language deviance is the basis for the development of the nuclear symptoms of schizophrenia (Crow 1998*a*) and that "Schizophrenia is the price *Homo sapiens* pays for language" (Crow 1997). He further states that the development of cerebral structural asymmetries during hominid evolution is responsible for the uniquely human components of language (as discussed by Geschwind and Galaburda 1987 and Corballis 1991) and that these asymmetries are anomalous in schizophrenia (Crow 1998*b*). In support of this hypothesis, we previously have shown that reduced cerebral asymmetries are present early in the course of schizophrenia and that some components of asymmetry are inherited.

Other investigators ascribe a less central role to language and have focused on alternative explanations for language deviance in schizophrenia, such as dysfunctional executive control (frontal lobe; Chaika 1990; Morice 1995) or a deficit in either working or semantic memory,

Send reprint requests to Dr. L.E. DeLisi, Professor of Psychiatry, New York University School of Medicine, Millhauser Laboratories, 550 First Avenue, New York, NY 10016; e-mail: delisi76@aol.com.

Table 1. Selective review of literature on the language of patients with schizophrenia[1]

Study	Subjects	Function tested	Findings
I. Speech comprehension			
Condray et al. 1996	25 CSz males 11 control males	Comprehension of complex vs. simple sentences	Decreased comprehension associated with decreased working memory load; no difference in ability to perceive individual words
Condray et al. 1992, 1995	36 CSz males 41 brothers 18 control males	Comprehension; Luria-Nebraska Relational Concepts Scale	More errors in Sz and Sz spectrum subjects than in normal brothers or controls; not related to medication
Grove and Andreasen 1985	100 Sz subjects 50 controls	Syntax processing and perception; "embedded click" and "memory for gist tasks" tests	Sz subjects did worse on memory than on sentence processing; concludes that they have a memory deficit, not a perception deficit.
Faber et al. 1983	14 Sz subjects with TD (13 male) 13 aphasia subjects	Transcribed interviews subjectively rated	Sz pts showed fewer word-finding problems, better comprehension, and less poverty of speech, but more word approximations; some characteristics overlapped.
Faber and Reichstein 1981	24 Sz subjects (5 mania, 5 depr) 28 controls	Aphasia exam; naming tests; word repetition; auditory comprehension	Sz subjects with TD performed worse on all tests; language comprehension and repetition dysfunction in Sz subjects compared to others.
Miller and Phelan 1980	25 CSz subjects 25 controls	Comprehension of sentence acceptability	No difference between groups in ability to determine acceptability of sentence rules
Cheadle and Morgan 1972	65 Sz subjects 25 other pts 57 children 8–11 yrs	Understanding of common English expressions	Sz subjects failed to understand approximately 1/3 of all questions and were close to the level of 8–9-yr-old children.
II. Attention/interference			
Landre and Taylor 1995	21 Sz subjects (TD) 16 Sz subjects (no TD)	Porch index of communicative ability and other factors	Sz subjects with TD were more impaired than those without; reduced attention was best predictor of language dysfunction.
Spitzer et al. 1994	70 Sz subjects 44 controls	Semantic and phonological priming	Sz subjects with TD exhibited more intrusion from the priming.
Kwapil et al. 1990	21 Sz subjects 18 BP subjects 21 controls	Word recognition measure of semantic priming	Sz subjects exceeded both normal controls and BP subjects on facilitation (e.g., semantic priming heightened); BP subjects were not different from controls.
Grand et al. 1975	10 CSz subjects, all male	Stroop color word interference task followed by recorded unstructured interview; 4 dimensions of language scored; # of clauses and grammatically incomplete verbal units scored	Specific narrative language deficits were associated with interference but not with word-naming or color-encoding skills.

Study	Subjects	Function tested	Findings
III. Semantics			
Kareken et al 1996	29 Sz subjects 20 controls	California Verbal Learning Test to examine pro-active inhibition and semantic processing	Sz subjects have significantly less proactive inhibition and did not organize recall according to semantic category; pts had more phonemic errors than controls; results suggest that reduced semantic processing prevented proactive inhibition.
Goldfarb et al. 1994	29 left hemisphere stroke and tumor pts 26 CSz subjects	Semantic associations	Errors show similarities between Sz subjects and aphasia subjects.
Cutting and Murphy 1990	20 Ac Sz subjects 20 mania subjects 20 depr subjects	Semantics; denotative vs. connotative associations of words	Sz subjects had bias toward denotative associations.
Hoffman et al. 1985	24 Sz subjects 24 non-Sz psychiatric pts	Hunt Test requiring use of syntactic strategies to synthesize an extended text with a controlled set of inputs	More meaning misrepresentations of inputs among Sz subjects
Manschreck et al. 1980	10 Sz subjects 10 controls	Language samples in response to 2 pictures, spoken and written; cloze procedure used (deleting every 4th or 5th word); normal volunteers were asked to fill in missing word. Cloze score = % of words guessed right.	Written samples were not different between groups; oral samples distinguished Sz subjects from controls for the 5th deletion procedure and correlated with clinical formal TD.
Williams et al. 1976	40 Sz subjects 20 controls	Semantic response tests	Sz subjects differed; chronic subjects performed worse than Ac subjects.
Pavy et al. 1969	6 CSz subjects 9 Ac Sz subjects	100 words from written diaries analyzed for the type-token ratio	Chronicity associated with reduction in the total # of different words used
IV. Fluency			
Aloia et al. 1996	28 CSz subjects 32 controls	Spontaneously cluster exemplars from a specific category during a fluency task	Sz subjects showed less stable 2-dimensional organization of exemplars into subordinate clusters than controls, suggesting disorganized semantic networks.
Joyce et al. 1996	50 Sz subjects 25 controls	Verbal fluency, letter, and category	Category was superior to letter fluency in Sz subjects and category improved with cues; results suggest inefficient access to semantic stores.
Allen et al. 1993	20 CSz subjects 10 controls	Verbal fluency	Fewer words; reduced ability to retrieve words, lexicon intact
Chaika 1990; Chaika and Lambe 1989	14 Sz subjects 8 mania subjects	Speech in response to viewing a video story; cohesive ties counted	No differences between groups; Sz subjects more likely to use novel references and digression

Table 1. Selective review of literature on the language of patients with schizophrenia[1]—*Continued*

Study	Subjects	Function tested	Findings
Ragin and Oltmanns 1986	10 Sz subjects 11 mania subjects 11 schizoaffective subjects 10 controls	Interview speech samples; lexical ties per 15 clauses were counted between and within clauses.	No differences in between-clause lexical cohesion; Sz subjects showed fewer within-clause cohesions than the other pts or controls.
Allen and Allen 1985	10 Sz subjects with pos symptoms 9 Sz subjects with neg symptoms 9 controls	Speech produced in response to pictures	Organization within and between ideas was not different; however, pos speech-disordered Sz subjects omitted referents for noun phrases.
Wykes and Leff 1982	8 Sz subjects 4 mania subjects	Measurement of the # of structural link	Mania subjects had more links than Sz subjects.
Rausch et al. 1980	10 Sz "process" subjects 10 Sz "reactive" subjects 10 aphasia subjects 10 controls	Word-ordering tasks	Aphasia subjects had significantly longer time and errors in task than others; Sz subjects differed from normals only in # of errors rearranging sentences involving objects.
Rochester and Martin 1979; Rochester 1978	40 Sz subjects 20 controls	Speech samples; between-clause lexical ties	Reduced in Sz pts
Rutter 1979	10 Sz subjects 10 controls	Unstructured speech samples; psychology students asked to first place logical punctuation in each transcript and then reconstruct the transcriptions from cards of cutout sentences from each passage.	Passages from Sz subjects were significantly less connected than controls, but the sentences themselves were logically ordered.
Siegel et al. 1976	15 CSz subjects	Free speech	Pts with LT hospitalization had significantly greater paucity of speech, perseveration, repetition, and deviant verbalizations.
V. Complexity			
DeLisi et al. 1997	41 CSz subjects 26 controls	Sentence complexity from soliloquies	More morphological errors, less degree of embedding than controls
Thomas et al. 1996	First-onset pts, 45 with Sz, 14 with mania 18 controls	Written language; Hunt Test measuring complexity, errors in syntax, and semantics	No difference in written complexity; both patient groups made more errors, with increased complexity related to attention and working memory.
Thomas et al. 1993	First-onset pts, 38 with Sz, 11 with mania 16 controls	Oral interview transcripts; syntactic analysis	Less sentence complexity among Sz subjects

Study	Subjects	Function tested	Findings
Thomas et al. 1990	50 Ac Sz subjects 27 CSz subjects 50 controls	Oral interview transcripts	Chronic pts had less integrity, complexity, and fluency than Ac pts, but Ac pts performed worse than controls. Decreased complexity was related to neg symptoms and poor outcome.
Fraser et al. 1986	50 Sz subjects 51 mania subjects 50 controls	Free speech samples; syntactic complexity (embedding) and other structure analyzed on 1,000 words each.	Continuum of linguistic degeneration across the psychotic spectrum from controls; includes reduced complexity
Hoffman et al. 1986	29 Sz subjects 24 mania subjects 40 controls	Free speech samples; scored complexity and length of utterances	Mania subjects: shifts from one coherent structure to another; Sz subjects: deficient ability to construct discourse structure
Morice and McNichol 1985	17 Sz subjects 17 mania subjects 19 controls	Token test (measures comprehension of syntax) and free speech samples of 1,000 words	Token test not impaired in Sz or mania subjects; for Sz subjects only, there was a pos correlation between score on token test and depth of clausal embedding.
Morice and Ingram 1982	34 Sz subjects 11 mania subjects 18 controls	Free speech samples of 1,000 words; grammatical and syntax analyses; 98 variables, reflecting complexity, integrity, and fluency of speech; discriminant function analysis performed	Groups were distinguished by this analysis.
VI. Reference failures			
Docherty and Hebert 1997	29 Sz subjects	Free speech samples assessed for communication failures: overinclusive references, ambiguous word meanings, ambiguous references, and affective reactivity	Affective reactivity associated with the pos schizophrenic process.
Barch and Berenbaum 1996	39 CSz subjects No controls	Reference errors; discourse planning; neologisms; grammatical and phonological encoding	Reference errors and discourse planning correlated; neologisms and grammatical and phonological encoding correlated
Docherty et al. 1994*a*	30 Ac Sz subjects	Free speech samples; deviance in language scored in pos and neg affective conditions	Language on neg topics contained more disorder than on pos topics.
Docherty et al. 1994*b*	10 stable Sz subjects 18 unaffected parents 10 controls	Free speech samples; frequency of unclear linguistic references in pos and neg affective conditions	Sz subjects and parents scored worse than controls on pos situation; pts deteriorated on neg situation, parents and controls did not.
Harvey and Serper 1990	38 Sz subjects 30 mania subjects 25 controls	Measured serial recall and encoding, distractibility, pos and neg TD, and reference failures	Pos TD and reference failures among Sz subjects were best predicted by measures of distractibility.
Harvey and Brault 1986	22 Sz subjects 21 mania subjects	Scoring of unclear or ambiguous references	Pressure of speech accounted for reference failures in mania, while severity of derailment and poverty of speech were related to reference failures in Sz.
Kantorowitz and Cohen 1977	30 CSz subjects 15 controls	Structured task describing colored chips so that another person could identify them.	Poor communication accuracy in Sz subjects; failure to provide proper referents

Table 1. Selective review of literature on the language of patients with schizophrenia[1]—*Continued*

Study	Subjects	Function tested	Findings
Smith 1970	12 Sz males with TD 10 controls	Referent task: speaker must provide clues to hearer about referent word	Sz subjects performed significantly worse than controls.
Cohen and Camhi 1967	18 speaker-listener pairs (Sz–control; Sz–Sz; Control–control)	Referent task: speaker provides clues to listener to distinguish referent from nonreferent items	Sz speakers performed significantly worse than controls, while Sz listeners did not.
VII. Grammar			
Siegel et al. 1976	15 CSz subjects	Free speech	Pts with LT hospitalization had significantly greater paucity of speech, perseveration, repetition, and deviant verbalization.
VIII. Language lateralization			
Weisbrod et al. 1998	24 Sz subjects (no TD) 16 Sz subjects (with TD) 38 controls	Semantic associations and priming both hemispheres separately	Pts with TD showed indirect semantic priming in left hemisphere, enhanced spread of semantic associations in TD, and disorganization of the functional asymmetry of semantic processing.
Manoach 1994	29 Sz subjects 42 BP subjects 25 controls	Degree of manual superiority assessed	Atypical handedness was associated with language dysfunction in Sz.
IX. Miscellaneous			
Barr et al. 1989	15 CSz subjects No controls	Verbal perseverations	Higher verbal perseverative errors than published norms
Kinney et al. 1985	Adoptees 20 Sz subjects 26 control	Soliloquies; scores on social alienation and personal disorganization scales	High scores
Halpern and McCartin-Clark 1984	61 CSz subjects 61 aphasia subjects	Tested for impairment in 10 language categories	Aphasia subjects more impaired in writing dictated words, naming, syntax, and auditory retention; Sz subjects more impaired in relevance
Siegel et al. 1976	15 CSz subjects	Free speech	Pts with LT hospitalization had more paucity of speech, repetition, perseveration, and deviant verbalization
Gottschalk et al. 1961	152 CSz subjects 28 males 124 females	Verbal samples recorded and transcribed; disorganization and social alienation scored.	Paucity of speech was an indicator of severity of illness.

Note.—# = number; Ac = acute; BP = bipolar; CSz = chronic schizophrenia; depr = depression; LT = long-term; neg = negative; pos = positive; pts = patients; Sz = schizophrenia; TD = thought disorder.

[1] Studies using only standard neuropsychological tests were omitted, as were studies only clinically assessing "formal thought disorder," studies of the speech of children with schizophrenia, and studies in languages other than English. Not all publications from the same researcher and topic are presented. In these cases the publication with the largest sample size was selected. All studies were mixed-sex participants and controls matched to patients unless otherwise noted. In general, more males participated than females.

or both (Grove and Andreasen 1985; Mortimer et al. 1995).

The present report consists of two parts: (1) a review of the extensive past literature on language in schizophrenia to determine whether consistent patterns emerge; and (2) an extension of our previous results (DeLisi et al. 1997; Shedlack et al. 1997) to a new group of first episode patients with schizophrenia and families with a high density of schizophrenia. In this new study, a structured method for soliciting verbal production from each subject is used and scored. The data are then used to test the hypotheses (1) that uniquely human aspects of language are deviant in individuals with schizophrenia, (2) that the deviance is familial, (3) that it is associated with the inheritance of schizophrenia within families, and (4) that reduced cerebral dominance is associated with these language anomalies.

Methods

Literature Review. A comprehensive computer search of the literature was performed using Paperchase, a Web variant of Medline. The search items were "language," "schizophrenia," "speech," "syntax," and "semantics." Studies of children with schizophrenia, studies using only standard neuropsychological testing, studies only clinically assessing "formal thought disorder," and studies published in a language other than English were excluded. When multiple publications from the same researcher using overlapping samples were found, only the publication with the largest sample size was selected for inclusion. A total of 57 journal articles or books dating back to 1959 were reviewed and are included in table 1. The following topic areas were covered: speech comprehension, attention and interference, semantics, fluency, complexity, reference failures (i.e., when the speaker incorrectly infers that what he or she is referring to has been clearly stated), grammar, lateralization of language, and miscellaneous other aspects (e.g., disorganization and social alienation).

Schizophrenia Study

Subjects. Twenty-nine patients with *DSM–IV* chronic schizophrenia (22 males, 7 females; mean age 33.8 ± 8 years), 9 first episode schizophreniform or subchronic cases (6 males and 3 females; mean age 23.4 ± 5 years), and 12 controls (7 males and 5 females; mean age 32.6 ± 7 years) consented to be audiotaped for the following study. The patients with chronic schizophrenia were ill a mean of 12.4 ± 8 years and the first episode patients, a mean of 1.2 ± 2.0 years (time from first appearance of psychotic symptoms). The controls were solicited from the community as previously selected for other studies (DeLisi et al. 1991) on the basis that they were the same sex, age, and social class of consecutively obtained first episode patients. Thus the 12 controls were matched to 12 patients, 9 of whom satisfied *DSM–IV* criteria for schizophreniform or subchronic schizophrenic illness and 3 chronic schizophrenia at the time of a first hospital admission. All controls were interviewed using a structured format (Schedule for Affective Disorders and Schizophrenia–Lifetime [SADS–L]; modified from Spitzer and Endicott 1978) and anyone with an Axis I or II psychiatric disorder was eliminated prior to the study.

Eleven families with two or more ill siblings with schizophrenia also participated in the present study. These were local New York families drawn from a larger cohort of national U.S. families recruited for molecular genetic linkage studies (see Garner et al. 1996 and Shaw et al. 1998 for cohort details). In two of these families, one of the ill siblings refused to participate. Thus the families were composed of 20 subjects with chronic schizophrenia or schizoaffective disorder and 13 nonpsychotic members (two sisters, seven mothers, and four fathers; mean age 58.9 ± 16 years). Of the 13, one mother had a past episode of an acute psychosis (not otherwise specified), two fathers had paranoid personality disorder, two sisters had recurrent major depression, and one mother had a past history of panic disorder; the remainder had no major diagnosis.

All individuals with schizophrenia were medicated at the time of this study. The subjects with schizophrenia and those members of the family study with schizophrenia were all on conventional antipsychotic medications, with the exception of three chronic patients and the nine first episode patients, all of whom were participating in a double-blind haloperidol versus risperidone research protocol.

Family members were interviewed using the Diagnostic Interview for Genetic Studies (Nurnberger et al. 1994). The interviews, information from family members, and medical records were used to determine diagnoses. Diagnoses for all individuals studied were made using *DSM–IV* (APA 1994) criteria by two independent diagnosticians and any disputes settled by consensus in the presence of a third trained clinical professional. All individuals performing diagnoses previously underwent diagnostic reliability studies to maintain a kappa statistic above 0.90. None of the nonpsychotic family members had an Axis I diagnosis.

Study Design. Oral soliloquies were recorded and later transcribed as described below. An examiner asked subjects to use their imagination and describe what is occurring in each of seven pictures taken from the Thematic Apperception Test (Murray 1971). The seven pictures are as follows:

Picture 1 is a person of ambiguous gender lying on a bed or couch, with a man bending over the figure, one arm on the figure's left leg, the other arm raised over the reclining person's head.

Picture 2 is a woman lying on a bed face up, right arm hanging to the floor. She appears naked from the waist up. A man is standing facing away from her with his right arm covering his face. He is dressed and wearing a tie.

Picture 3 is a woman opening a door into a room with a wall bookcase, flowers, and a lamp on a table. Shadows and light mark this picture.

Picture 4 is a boy sitting in a dark doorway of a wooden building.

Picture 5 is a woman holding a person by his or her head at the bottom of a staircase.

Picture 6 is a boy sitting with his hands holding up his head and looking down at a violin on a table.

Picture 7 is scenery consisting of a tree with a rowboat underneath. A river is nearby.

The same individual recorded all subjects in this study. Pictures were presented to subjects in the same order. Subjects were given as much time as they needed to interpret each picture. The following are examples of a portion of a soliloquy from each of two patients with schizophrenia (dots indicate pauses):

> (One subject responding to picture 1) "I'm afraid to say something lewd but it could connotate that be a grandfather coming in to touch his precious grand pre-post pubescent granddaughter...and yet he has sorta of a halo around him...so it could be an angel...or maybe I am saying that because there was a chance I was sexually abused which I have been exploring in the last year or two...the innocent part of me says its an angel visiting the virgin Mary and the other part of me says its incest the beginning of an incestual relationship that has been going on for a while and he's not nervous...so I'm a little upset looking at that one"
>
> (Another subject responding to picture 2) "It looks like he is tired...he wants to go to bed...he's tired...I guess he has his hand over his face like he is really tired and he is aggravated he could be aggravated...he is just getting up out of bed putting his clothes on...getting out of bed getting something to drink or something...he could be getting up to go to work in the morning you know...his wife or his girlfriend is sleeping or maybe the wife died or something...he probably is going to go to work"

In addition, subjects were asked to describe what they do in the morning to get ready for an appointment, from waking up to arrival at the destination (a sample of verbal sequential ordering of events). This ability is used as a measure suggested by E. Chaika (personal communication, August 1997) to test intactness of executive control over language production. Cerebral dominance as determined by handedness was assessed by a hand use questionnaire (Annett 1967) and by a relative hand-skill test (Tapley and Bryden 1985). The latter is performed by each hand separately placing dots in circles as fast as possible in 20 seconds. The test is performed first by the right hand and then by the left. The number completed with the right hand is compared with those completed by the left as a ratio of right over left. These tests were incorporated in order to examine the relationship of cerebral dominance to language disorder.

Data Analysis. The tapes were transcribed by an experienced transcriber without punctuation but with pauses indicated. These were then rechecked for accuracy by the original recorder. All soliloquies were coded by the researcher, who recorded them with subject identifiers removed. The author, who did not have knowledge of patient, family, or control status, then analyzed transcribed recordings. A structured score sheet (figure 1) was used to analyze each soliloquy recording and included a total word count. An assessment of syntax was based on Bickerton's five unique characteristics of human language: (1) order (number of awkward sentences and number with incorrect word order; the examiner judged correctness of word order for all sentences); (2) number of null elements (use of dummy words, such as "it," that do not refer to objects); (3) number of sentences missing arguments for verbs; (4) mechanisms for expansion (number of conjoined and number of embedded clauses in the entire soliloquy); and (5) number of grammatical mistakes. Semantic deviance was scored by counting the number of misused words and the number of neologisms. All items were scored per the total number of words with the exception of order and missing arguments, which were adjusted for number of assumed sentences. Miscellaneous items, such as appropriateness of overall content, logical order to sequential task, and amount of detail in this task, were also graded as either yes/no or appropriate/inappropriate (1 or 2).

All analyses were performed using the Statistical Package for Social Sciences, version 9.1, for Windows 95. For quantitative variables, two separate analyses of variance (ANOVAs) were performed: one for the first episode cases compared to chronic patients and controls and covarying age, with sex and diagnosis as independent variables; and the second for the 11 families only, with sex, diagnosis, and family membership as independent variables, covarying for age. Family membership was coded 1–11 corresponding to each family (on average three individuals per family). In the variables in which

Figure 1. Contents of structured score sheet for evaluation of soliloquies

Subject Code #

Date:

SOLILOQUY ANALYSIS:

Total # Words:
Total # Sentences:

SYNTAX:	TOTAL #:
I. Order:	
Overall awkwardness of sentence:	_____
Incorrect order:	_____
II. # of Null Elements:	
(e.g., use of dummy subject "it")	_____
III. Arguments of Verbs:	
(# sentences missing arguments)	_____
IV. Mechanisms for Expansion:	
Noun Phrases:	_____
Conjoined clauses:	_____
Embedded clauses:	_____
V. Grammatical Items:	
Ratio of grammatical to lexical items:	_____
Grammatical mistakes:	_____
SEMANTICS:	
I. Misuse of words:	_____
II. Neologisms:	_____

OTHER:
(e.g., adequacy of content and order of sequential task; appropriateness of content of verbal responses)

types of words were counted, the total number of words was covaried. For categorical variables, both chi-square analyses and ANOVAs were used. Because the number of families was small and thus the numbers of individuals in each cell of the three-way analysis small, two further sets of analyses were performed to supplement these data: (1) in order to examine the familial effect, without regard for diagnosis, a two-way ANOVA was performed with sex and family group as the factors and age as a covariate; and (2) without regard for family membership, a two-way ANOVA was performed with sex and diagnosis as factors, covarying for age (and where appropriate for total number of words and presumed sentences). A third analysis was performed comparing all family members with schizophrenia to their healthy relatives and controls.

Results

Literature Review. As can be seen in table 1, several aspects of language comprehension and production have been found to be abnormal in patients with chronic schizophrenia compared to patients with bipolar psychosis, their nonpsychotic siblings, or controls: comprehension, attention, semantic organization, fluency, complexity, reference failures, paucity of speech, and language lateralization. Almost all studies focused on only one aspect of language and neglected others in the same individuals. Thus, whether patients with language disorder, or a subgroup of patients, have all the anomalies listed in table 1, or whether some patients have one abnormality while others have another, cannot be ascertained from the literature to date. A literature bias must also be recognized in that studies failing to find similar differences between patients and controls tend not to be published, whereas positive ones are more often reported.

Nevertheless, some patterns do emerge. The studies of speech comprehension seem to attribute reduced comprehension to deficient working memory (e.g., Grove and Andreasen 1985; Condray et al. 1996). On the other hand, deficits found in semantic processing (e.g., Kareken et al. 1996), fluency (e.g., Rochester and Martin 1979), and complexity (e.g., Thomas et al. 1996) are interesting because they may have a relationship to the cerebral organization of language. Reference failures, while shown to be frequent in patients with schizophrenia, may have more to do with distractibility than with primarily verbal organization. Very little was found about grammatical disturbance in schizophrenia and it could not be separated from general paucity of speech as characteristic of poor prognosis patients. At least one study has shown that the degree of language dysfunction was associated with atypical handedness (Manoach 1994). However, none of the studies reviewed addressed whether any of these traits are familial or related to the heritability of schizophrenia.

The literature suggests a lack of concentration on the unique features of human language with the exception of mechanisms for expansion, which are clearly associated with the degree of fluency and complexity of speech. Regardless of the aspect of speech studied, taken as a whole these studies point to the value of free speech samples for examining several components of language in patients with schizophrenia. When specifically devised tests are used, their relevance to overall language production is uncertain. Thus the following study of schizophrenia uses a standardized but free speech sample and concentrates on specific characteristics of human language in the analysis.

Schizophrenia Study

Unrelated Subjects With Schizophrenia versus Controls. As presented in table 2, there was a significant difference between all patients and controls for the number of words ($F = 3.2$, $p < 0.05$) and for the number of

Table 2. Patients versus controls (tests of between-subject effects)[1,2]

Variable	1st episode patients (n = 9)	Chronic patients (n = 29)	Controls (n = 12)	F(Dx) (df = 2,49)	$p <$
Age (yrs)	23.4 ± 5	33.8 ± 8	32.6 ± 7		
# words	594 ± 406	530 ± 267	862 ± 514	3.21	0.05
# awkward sentences	2.7 ± 3	3.3 ± 4	1.8 ± 1	0.44	0.65
# incorrect order	0.3 ± 0.7	0.3 ± 0.9	0	1.06	0.36
# null elements	6.8 ± 5	6.2 ± 4	11.0 ± 8	0.46	0.64
# grammatical mistakes	1.8 ± 2	1.3 ± 2	0.9 ± 1	1.50	0.24
# missing arguments	2.0 ± 2	1.1 ± 2	0.9 ± 1	0.31	0.73
# conjoined clauses	29.9 ± 24	20.2 ± 16	45.8 ± 27	5.92	0.005
Covarying # words				2.60	0.085
# embedded clauses	6.9 ± 7	5.6 ± 5	12.2 ± 12	2.68	0.08
Covarying # words				0.07	0.93
Misuse of words	0.44 ± 0.5	0.38 ± 0.6	0.17 ± 0.4	0.54	0.59
Neologisms	0	0.10 ± 0.6	0	0.30	0.75
Poor overall content	11%	41%	0	3.32	0.05
Vagueness	33%	28%	0	2.11	0.13
Sentences lacking connectivity	22%	14%	0	0.95	0.39
Incomplete sentences	44%	38%	8%	1.09	0.35
Numerous false starts	22%	35%	25%	0.80	0.46
Sequential task					
Poor content	20%	46%	9%	1.44	0.25
Poor order	20%	50%	18%	1.43	0.25
Handedness (% R)	80%	84%	100%	0.67	0.51
Hand-skill (R – L)/0.5(R + L)	1.3 ± 0.3	1.3 ± 0.4	1.3 ± 0.3	0.33	0.73

Note.—# = number of; Dx = diagnosis; L = left-handed; R = right-handed; SD = standard deviation.

[1] Mean ± SD or percent of whole.

[2] There were significant sex and sex-by-diagnosis effects. F(sex): # embedded clauses/# words, F = 4.77, $p < 0.034$, males > females. F(sex × Dx): # embedded clauses/# words, F = 3.94, $p < 0.027$, where female chronic patients had more embedded clauses than male patients, but male controls had more than female controls.

conjoined clauses (F = 5.9, $p < 0.005$), the latter becoming a trend when controlled for number of words (F = 2.7, $p < 0.085$). The number of embedded clauses only had a trend for significance without controlling for the number of words (F = 2.7, $p < 0.08$), and with the number of words controlled there were no differences (F = 0.07, $p < 0.93$). However, in post hoc analyses (Tukey-HSD), it was found that these variables were significantly reduced in the chronic patients when compared with controls, but not in first episode patients. Chronic patients have significantly fewer conjoined clauses ($p < 0.002$), fewer embedded clauses ($p < 0.04$), and fewer words ($p < 0.03$). First episode patients in general scored between chronic patients and controls, not reaching significance in comparison to either. There were no sex-by-diagnosis effects.

Using Spearman's nonparametric correlations, poor content (limited number of items mentioned) in the sequential task was inversely correlated with both the number of conjoined clauses ($r = -0.47$, $p < 0.000$) and the number of embedded clauses ($r = -0.52$, $p < 0.000$); however, neither were significantly correlated with the appropriateness of the sequential order of items.

Chi-square analyses for the independent indicator variables overall (presence or absence of vagueness, logical ordering, incomplete sentences, false starts, as well as order of and poor content of the sequential task) were performed using the expected amounts for the total group. Both first episode and chronic patients had significantly more vagueness to their speech ($\chi^2 = 4.7$, $p = 0.03$ and $\chi^2 = 4.1$, $p = 0.04$, respectively) and incomplete sentences ($\chi^2 = 3.7$, $p = 0.055$ and $\chi^2 = 3.6$, $p = 0.058$) than controls. However, only the chronic patients showed a higher frequency of overall inappropriate content ($\chi^2 = 7.0$, $p = 0.008$) and poor content to the sequential task ($\chi^2 = 4.7$, $p = 0.03$).

Neither hand skill nor handedness were correlated with any language variables, except that the degree of asymmetric hand skill (right > left) was positively correlated with the ability to order events appropriately in the sequential task ($r = 0.55$, $p < 0.000$). Age of onset was correlated with the number of embedded clauses ($r = 0.35$, $p < 03$; $r = 0.32$, $p < 0.05$ when controlled for number of words); however, it was not correlated with number of conjoined clauses.

Table 3. Analysis of families dense with schizophrenia[1]

	Males		Females		Family Diagnosis (df = 10,32)		Family Diagnosis (df = 1,32)	
Dependent variables	**Ill relatives**	**Well relatives**	**Ill relatives**	**Well relatives**	**F**	**$p <$**	**F**	**$p <$**
# words	527 ± 299	588 ± 201	499 ± 226	785 ± 558	1.59	0.26	0.740	0.42
# awkward sentences	4.7 ± 5	1.3 ± 2	1.0 ± 1	3.6 ± 6	1.18	0.42	0.150	0.71
# incorrect order	0.5 ± 1	0.3 ± 0.5	0.0	0.0	0.70	0.71	0.310	0.59
# null elements	5.5 ± 4	4.0 ± 5	7.0 ± 5	10.3 ± 12	8.62	0.005	0.040	0.84[2]
# grammatical mistakes	1.2 ± 1	0.8 ± 0.5	1.3 ± 0.6	0.9 ± 1	1.13	0.45	0.220	0.66
# missing arguments	1.4 ± 3	0.0	1.0 ± 2	0.9 ± 2	0.18	0.99	0.060	0.82
# conjoined clauses	19.7 ± 19	23.8 ± 18	22.0 ± 16	38.6 ± 36	3.76	1.66	0.960	0.03
Per # words	0.03 ± 0.02	0.04 ± 0.01	0.04 ± 0.01	0.05 ± 0.02	0.04	0.26	1.030	0.34
# embedded clauses	5.24 ± 7	7.3 ± 2	5.0 ± 5	8.7 ± 8	5.71	0.01	0.002	0.97
Per # words	0.008 ± 0.006	0.013 ± 0.004	0.009 ± 0.01	0.010 ± 0.007	5.10	0.02	1.280	0.30[2]
Misuse of words	0.53 ± 0.7	0.25 ± 0.5	0.33 ± 0.6	0.11 ± 0.3	0.87	0.59	3.170	0.12
Poor overall content	47%	25%	0%	0%	0.97	0.53	0.200	0.66
Vagueness	35%	0%	0%	22%	0.75	0.67	1.220	0.30
Sentences lacking connectivity	18%	0%	33%	22%	1.53	0.28	0.230	0.65
Incomplete sentences	41%	25%	33%	0	5.54	0.01	0.130	0.73
Numerous false starts	41%	0	33%	11%	0.83	0.61	0.530	0.49
Sequential task								
Poor content	60%	25%	33%	25%	5.92	0.01	0.120	0.74
Logical	60%	50%	0	50%	0.34	0.93	0.620	0.46
Handedness (% R)	80%	100%	66%	100%	1.43	0.33	0.003	0.96
Handskill (R – L)/0.5(R + L)	1.3 ± 0.5	1.3 ± 0.2	1.3 ± 0.2	1.3 ± 0.2	0.44	0.89	0.200	0.67

Note.—# = number of; L = left-handed; R = right-handed.

[1] Analysis of 11 families with two siblings diagnosed with schizophrenia. Three-way ANOVA was performed with sex, diagnosis (schizophrenia or schizoaffective disorder vs. no psychosis), and family group as factors with age as a covariate. Mean ± SD or percent of whole.

[2] A significant family-by-diagnosis effect covarying for total number of words was present for embedded clauses (F = 5.87, p = 0.02) and for number of null elements (F = 8.74, $p <$ 0.007).

Family Analyses. In the three-way ANOVA examining family membership, diagnosis, and sex (table 3), there was a significant familial effect for the number of embedded clauses when controlled for the number of words ($F = 5.1$, $p < 0.02$), the number of incomplete sentences ($F = 5.5$, $p < 0.01$), and poor content of the sequential task ($F = 5.9$, $p < 0.01$). A family-by-diagnosis interaction per number of words was present for embedded clauses ($F = 5.9$, $p < 0.02$) and per number of null elements ($F = 8.7$, $p < 0.007$).

In the two-way analysis with family membership and sex as factors, significant familial effects were observed for the number of null elements ($F = 2.7$, $p < 0.05$), number of conjoined clauses ($F = 7.1$, $p < 0.001$), number of embedded clauses ($F = 3.5$, $p < 0.02$), poor content of the sequential task ($F = 3.4$, $p < 0.02$), and number of incomplete sentences ($F = 8.0$, $p < 0.000$). There was also a sex by family interaction for number of null elements ($F = 4.8$, $p < 0.009$), number of conjoined clauses ($F = 6.3$, $p < 0.003$), number of embedded clauses ($F = 3.3$, $p < 0.03$), and number of incomplete sentences ($F = 6.5$, $p < 0.002$). In general, within these families with a high density of schizophrenia, females had more null elements in their speech than males and more conjoined and embedded clauses than males; males had more incomplete sentences than females.

The analysis comparing family members with schizophrenia, their healthy relatives, and controls without regard to family membership revealed differences in the number of conjoined clauses (only when not controlled for number of words: $F = 3.8$, $p < 0.03$, with the relatives having schizophrenia showing significant difference from controls [$p < 0.02$] and the well relatives not differing from controls) and in poor sequential task content ($F = 3.5$, $p < 0.04$, relatives with schizophrenia again showing significant difference from controls [$p < 0.01$], but not nonpsychotic relatives). There was a trend for a difference in only the number of embedded clauses ($F = 2.0$, $p < 0.15$, present only for the ill [$p < 0.06$] and not for the nonpsychotic relatives).

Discussion

The extensive literature analyzing the speech of patients with schizophrenia was searched for any evidence of unique characteristics that appear consistently across studies (table 1). No one aspect of speech appeared deviant; however, several observations emerged, the majority of which could be attributed to an underlying disturbance in either working memory or attention, or both, rather than in the ability to use the uniquely human tools of language correctly. For example, Thomas et al. (1996) have shown that when given a writing task, patients with schizophrenia wrote with as much complexity as controls, yet their speech, which depends on working memory and attention for focused fluent production, was less complex than that of controls (Thomas et al. 1990). Thus, Thomas and colleagues suggest that linguistic abilities are normal in schizophrenia (as seen in writing), but that quick retrieval (as in speech) is problematic. Similarly, Manshreck et al. (1980) showed that the correct use of words (their retrieval from long-term memory) was deficient in the speech of patients with schizophrenia but not in their writing. In addition, the connection between words in long-term memory storage, as suggested by the counting of cohesive ties (Rochester and Martin 1979), may be anomalous. Thus, quick retrieval of words from long-term memory when speaking may also be an underlying difficulty in schizophrenia.

The studies on increased reference failures in schizophrenia could indicate working memory problems whereby the speaker does not realize that the "hearer" does not recognize the referent. Failure to comprehend the sentence structure of speakers, particularly as it becomes more complex, is another indication that working memory capacity may be reduced.

However, neither working memory nor its ties to long-term memory storage and attention are clearly uniquely human, except that they may be suggested to operate at a quantitatively higher capacity in *Homo sapiens* than in nonhuman primates. Whether the deficits in language seen in the previous studies and our present one are due to primary cognitive defects cannot be discerned because the overall IQ of each subject was not measured and controlled for in the analyses. Future studies will need to examine the relationship of specific language measures to other measures of cognition.

Despite the controversial nature of the theoretical basis for the present study, we attempted to examine whether those "uniquely" human tools of language as described by Bickerton (1990) could be determined by the analysis of structured oral soliloquies to be specifically deviant in schizophrenia. While the number of subjects was small, a characteristic reduction in sentence complexity (reduced conjoined and embedded clauses) was observed in patients with chronic schizophrenia. They used fewer words overall, more inappropriate content, and less connectivity between sentences than controls did. These data are consistent with previous reports of reduced sentence complexity in chronic schizophrenia and were also correlated with age at onset—the earlier the onset, the less complex the sentence structure (Morice and Ingram 1983; Thomas and Leudar 1995).

In addition, familial basis for clausal expansion is suggested from the family analyses in our present study; clausal embedding in particular appeared to be familial and also to segregate with schizophrenia within families. Overall, the nonpsychotic relatives of individuals with

schizophrenia did not appear to have language production that differs from controls; the familial deviance was occurring only in those family members with schizophrenia. It is of interest that of Bickerton's five unique aspects of language, mechanisms for expansion (clausal embedding) were reduced, but the use of null elements, ordering of sentence constituents, grammatical deficiencies, and appropriate use of arguments for verbs were not different for patients and controls.

An interesting sex effect also emerged and is not surprising, given the several sex differences in the clinical and biological expression of schizophrenia (reviewed in DeLisi et al. 1989). In the present study, whereas male controls had significantly more sentence complexity than females, the reverse was true for schizophrenia (i.e., chronic male patients had significantly fewer embedded clauses than females). These sex differences could be seen as consistent with Crow's hypothesis that the underlying genetic basis for psychosis is located on the sex chromosomes (Crow 1997, 1998*b*; DeLisi and Crow 1989), but nevertheless the results should be interpreted with caution given the small number of males and females studied.

The additional aspect of Crow's hypothesis (1997), that anomalous cerebral lateralization underlies language deficits, was also tested. Although the degree of handedness or relative hand skill was unrelated to clausal embedding, asymmetric hand-skill was significantly correlated with the ability to order events appropriately in a sequential task ($r = 0.55$, $p < 0.000$).

In attempts to associate the defects in language that were observed with an alternative underlying mechanism, we examined their relationship to executive functioning as measured by being able to construct a sequential task orally. The ability to perform this task adequately was not correlated with the degree of clausal embedding (i.e., complexity). However, this was only a superficial look at complex executive control over language production.

The lack in the present study of detectable language abnormalities at the time of the first episode suggests progressive development after the onset of illness or heterogeneity in outcome after only one episode of psychosis (DeLisi 1997, 1999). The reduction of significance when controlled for total number of words used may mean that chronic patients with schizophrenia simply use fewer words than controls but that their mechanisms for expansion are intact.

In summary, patients with chronic schizophrenia have less verbal production than controls, and they appear to have reduced use of expansive mechanisms, which was shown in the present study to be familial and related to illness within families. Overall, this and other studies provide some evidence that some uniquely human qualities of language underlie the core deficits of schizophrenia. However, further exploration in larger groups of individuals is warranted. It is presently difficult to say what the significance of reduced numbers of words implies. Do subjects with schizophrenia speak less yet have an intact capacity for uniquely human expansive mechanisms, or do they produce fewer words because their capacity for expansion is less?

This was an extensive review of the literature and a preliminary study with a relatively small number of families. It was an initial attempt to explore the hypothesis that some uniquely human deviations of language are related to anomalous cerebral dominance and the inheritance of schizophrenia. Further extension of this work to the evaluation of a greater number of subjects and their families will hopefully clarify the significance of these results.

References

Allen, H.A., and Allen, D.S. Positive symptoms and the organization within and between ideas in schizophrenic speech. *Psychological Medicine,* 15:71–80, 1985.

Allen, H.A.; Liddle, P.F.; and Frith, C.D. Negative features, retrieval processes and verbal fluency in schizophrenia. *British Journal of Psychiatry,* 163:769–775, 1993.

Aloia, M.S.; Gourovitch, M.L.; Weinberger, D.R.; and Goldberg, T.E. An investigation of semantic space in patients with schizophrenia. *Journal of the International Neuropsychological Society,* 2:267–273, 1996.

American Psychiatric Association. *DSM–IV: Diagnostic and Statistical Manual of Mental Disorders.* 4th ed. Washington, DC: APA, 1994.

Annett, M. The binomial distribution of right, mixed, and left handedness. *Quarterly Journal of Experimental Psychology,* 19:327–333, 1967.

Barch, D.M., and Berenbaum, H. Language production and thought disorder in schizophrenia. *Journal of Abnormal Psychology,* 105:81–88, 1996.

Barr, W.B.; Bilder, R.M.; Goldberg, E.; Kaplan, E.; and Mukherjee, S. The neuropsychology of schizophrenic speech. *Journal of Communication Disorders,* 22:327–349, 1989.

Bickerton, D. *Language and Species.* Chicago, IL: University of Chicago Press, 1990.

Bickerton, D. *Language and Human Behavior.* Seattle, WA: University of Washington Press, 1995.

Chaika, E., and Lambe, R.A. Cohesion in schizophrenic narratives, revisited. *Journal of Communication Disorders,* 22:407–421, 1989.

Chaika, E.O. *Understanding Psychotic Speech.* Springfield, IL: Charles C. Thomas, 1990.

Cheadle, J., and Morgan, R. Does the chronic psychiatric patient understand plain English? *British Journal of Psychiatry,* 120:553–560, 1972.

Cohen, B.D., and Camhi, J. Schizophrenia performance in a word-communication task. *Journal of Abnormal Psychology,* 72:240–246, 1967.

Condray, R.; Steinhauer, S.R.; and Goldstein, G. Language comprehension in schizophrenics and their brothers. *Biological Psychiatry,* 32:790–802, 1992.

Condray, R.; Steinhauer, S.R.; van Kammen, D.P.; and Kasparek, A. Working memory capacity predicts language comprehension in schizophrenic patients. *Schizophrenia Research,* 20:1–13, 1996.

Condray, R.; van Kammen, D.P.; Steinhauer, S.R.; Kasparek, A.; and Yao, J.K. Language comprehension in schizophrenia: Trait or state indicator? *Biological Psychiatry,* 38:287–296, 1995.

Corballis, M.C. *The Lopsided Ape: Evolution of the Generative Mind.* Oxford: Oxford University Press, 1991.

Crow, T.J. Is schizophrenia the price that *Homo sapiens* pays for language? *Schizophrenia Research,* 28:127–141, 1997.

Crow, T.J. Nuclear schizophrenia symptoms as a window on the relationship between thought and speech. *British Journal of Psychiatry,* 173:303–309, 1998*a*.

Crow, T.J. Sexual selection, timing and the descent of man: A theory of the genetic origins of language. *Current Psychology of Cognition,* 17:1079–1114, 1998*b*.

Cutting, J., and Murphy, D. Preference for denotative as opposed to connotative meanings in schizophrenics. *Brain and Language,* 39:459–468, 1990.

Davis, K.L.; Buchsbaum, M.S.; Shihabuddin, L.; Spiegel-Cohen, J.; Metzger, M.; Frecska, E.; Keefe, R.S.; and Powchik, P. Ventricular enlargement in poor-outcome schizophrenia. *Biological Psychiatry,* 43:783–793, 1998.

DeLisi, L.E. Is schizophrenia a lifetime disorder of brain plasticity, growth and aging? *Schizophrenia Research,* 23:119–129, 1997.

DeLisi, L.E. Defining the course of brain structural change and plasticity in schizophrenia. *Psychiatry Research Neuroimaging,* 92:1–9, 1999.

DeLisi, L.E.; Boccio, A.M.; Riordan, H.; Hoff, A.L.; Dorfman, A.; McClelland, J.; Kushner, M.; Van Eyl, O.; and Oden, N. Familial thyroid disease and delayed language development in first admission patients with schizophrenia. *Psychiatry Research,* 38:39–50, 1991.

DeLisi, L.E., and Crow, T.J. Evidence for a sex chromosome locus for schizophrenia. *Schizophrenia Bulletin,* 15(3):431–440, 1989.

DeLisi, L.E.; Dauphinais, D.; and Hauser, P. Gender differences in the brain: Are they relevant to the pathogenesis of schizophrenia? *Comprehensive Psychiatry,* 30:197–207, 1989.

DeLisi, L.E.; Sakuma, M.; Kushner, M.; Finer, D.L.; Hoff, A.L.; and Crow, T.J. Anomalous cerebral asymmetry and language processing in schizophrenia. *Schizophrenia Bulletin,* 23(2): 255–271, 1997.

Docherty, N.M.; Evans, I.M.; Sledge, W.H.; Seibyl, J.P.; and Krystal, J.H. Affective reactivity of language in schizophrenia. *Journal of Nervous and Mental Disease,* 182:98–102, 1994*a*.

Docherty, N.M., and Hebert, A.S. Comparative affective reactivity of different types of communication disturbances in schizophrenia. *Journal of Abnormal Psychology,* 106:325–330, 1997.

Docherty, N.M.; Sledge, W.H.; and Wexler, B.E. Affective reactivity of language in stable schizophrenic outpatients and their parents. *Journal of Nervous and Mental Disease,* 182:313–318, 1994*b*.

Faber, R.; Abrams, R.; Taylor, M.A.; Kasprison, A.; Morris, C.; and Weisz, R. Comparison of schizophrenic patients with formal thought disorder and neurologically impaired patients with aphasia. *American Journal of Psychiatry,* 140:1348–1351, 1983.

Faber, R., and Reichstein, M.B. Language dysfunction in schizophrenia. *British Journal of Psychiatry,* 139:519–522, 1981.

Fraser, W.I.; King, K.M.; Thomas, P.; and Kendell, R.E. The diagnosis of schizophrenia by language analysis. *British Journal of Psychiatry,* 148:275–278, 1986.

Gardner, R.A., and Gardner, B.T. Comparative psychology and language acquisition. *Annals of the New York Academy of Science,* 309:37–76, 1978.

Garner, C.; Kelly, M.; Cardon, L.; Joslyn, G.; Carey, A.; LeDuc, C.; Lichter, J.; Harris, T.; Loftus, J.; Shields, G.; Comazzi, M.; Vita, A.; Smith, A.M.; Dann, J.; Crow, T.J.; and DeLisi, L.E. Linkage analyses of schizophrenia to chromosome 6p24-p22: An attempt to replicate. *Neuropsychiatric Genetics,* 67:595–610, 1996.

Geschwind, N., and Galaburda, A.M. *Cerebral Lateralization.* Cambridge, MA: MIT Press, 1987.

Goldfarb, R.; Eisenson, J.; Stocker, B.; and DeSanti, S. Communicative responsibility and semantic task in aphasia and "schizophasia." *Perceptual and Motor Skills,* 79:1027–1039, 1994.

Gottschalk, L.A.; Glesner, G.C.; Magliocco, B.; and D'Zmura, T.L. Further studies on the speech patterns of schizophrenic patients. *Journal of Nervous and Mental Disease,* 132:101–113, 1961.

Grand, S.; Steingart, I.; Freedman, N.; and Buchwald, C. Organization of language behavior and cognitive perform-

ance in chronic schizophrenia. *Journal of Abnormal Psychology,* 84:621–628, 1975.

Grove, W.M., and Andreasen, N.C. Language and thinking in psychosis: Is there an input abnormality? *Archives of General Psychiatry,* 42:26–32, 1985.

Halpern, H., and McCartin-Clark, M. Differential language characteristics in adult aphasic and schizophrenic subjects. *Journal of Communication Disorders,* 17:289–307, 1984.

Harvey, P.D., and Brault, J. Speech performance in mania and schizophrenia: The association of positive and negative thought disorders and reference failures. *Journal of Communication Disorders,* 19:161–173, 1986.

Harvey, P.D., and Serper, M.R. Linguistic and cognitive failures in schizophrenia: A multivariate analysis. *Journal of Nervous and Mental Disease,* 178:487–493, 1990.

Hauser, M.D. Language evolution: Linguists take a look. In: Hauser, M.D., ed. *The Evolution of Communication.* Cambridge, MA: MIT Press, 1997. pp. 30–50.

Hoffman, R.E.; Hoggben, G.L.; Smith, H.; and Calhoun, W.F. Message disruptions during syntactic processing in schizophrenia. *Journal of Communication Disorders,* 18:183–202, 1985.

Hoffman, R.E.; Stopek, S.; and Andreasen, N.C. A comparative study of manic vs. schizophrenic speech disorganization. *Archives of General Psychiatry,* 43:831–838, 1986.

Joyce, E.M.; Collinson, S.L.; and Crichton, P. Verbal fluency in schizophrenia: Relationship with executive function, semantic memory and clinical alogia. *Psychological Medicine,* 26:39–49, 1996.

Kantorowitz, D.A., and Cohen, B.D. Referent communication in chronic schizophrenia. *Journal of Abnormal Psychology,* 86:1–9, 1977.

Kareken, D.A.; Moberg, P.J.; and Gur, R.C. Proactive inhibition and semantic organization: Relationship with memory in patients with schizophrenia. *Journal of the International Neuropsychological Society,* 2:486–493, 1996.

Kinney, D.K.; Jacobsen, B.; Bechgaard, B.; Jansson, L.; Faber, B.; Kasell, E.; and Uliana, R.L. Content analysis of speech of schizophrenic and control adoptees and their relatives: Preliminary results. *Social Science and Medicine,* 21:589–593, 1985.

Kwapil, T.R.; Hegley, D.C.; Chapman, L.J.; and Chapman, J.P. Facilitation of word recognition by semantic priming in schizophrenia. *Journal of Abnormal Psychology,* 99:215–221, 1990.

Landre, N.A., and Taylor, M.A. Formal thought disorder in schizophrenia: Linguistic, attentional, and intellectual correlates. *Journal of Nervous and Mental Disease,* 183:673–680, 1995.

Manoach, D.S. Handedness is related to formal thought disorder and language dysfunction in schizophrenia. *Journal of Clinical and Experimental Neuropsychology,* 16:2–14, 1994.

Manschreck, T.C.; Maher, B.A.; and Rucklos, M.E. Cloze procedure and written language in schizophrenia. *Language and Speech,* 23:323–328, 1980.

Miller, W.K., and Phelan, J.G. Comparison of adult schizophrenics with matched normal native speakers of English as to "acceptability" of English sentences. *Journal of Psycholinguistic Research,* 9:579–593, 1980.

Morice, R. Language impairments and executive dysfunction in schizophrenia. In: Sims, A., ed. *Speech and Language Disorders in Psychiatry.* London, U.K.: Gaskell Press, 1995. pp. 57–69.

Morice, R., and McNicol, D. The comprehension and production of complex syntax in schizophrenia. *Cortex,* 21:567–580, 1985.

Morice, R.D., and Ingram, J.C. Language complexity and age of onset of schizophrenia. *Psychiatry Research,* 9:233–242, 1983.

Morice, R.D., and Ingram, J.C.L. Language analysis in schizophrenia: Diagnostic implications. *Australian and New Zealand Journal of Psychiatry,* 16:11–21, 1982.

Mortimer, A.; Corridan, B.; Rudge, S.; Kho, K.; Kelly, F.; Bristow, M.; and Hodges, J. Thought, speech and language disorder and semantic memory in schizophrenia. In: Sims, A., ed. *Speech and Language Disorders in Psychiatry.* London, U.K.: Gaskell Press, 1995. pp. 70–80.

Murray, H.A. *Thematic Apperception Test.* Cambridge, MA: Harvard University Press, 1971.

Nurnberger, J.I.; Blehar, M.C.; Kaufman, C.A.; York-Cooler, C.; Simpson, S.G.; Harkavy-Friedman, J.; Severe, J.B.; Malaspina, D.; and Reich, T. Diagnostic interview for genetic studies: Rationale, unique features and training. *Archives of General Psychiatry,* 51:849–862, 1994.

Pavy, D.; Grinspoon, L.; and Shader, R.I. Word frequency measures of verbal disorders in schizophrenia. *Disorders of the Nervous System,* 30:553–556, 1969.

Ragin, A.B., and Oltmanns, T.F. Lexical cohesion and formal thought disorder during and after psychotic episodes. *Journal of Abnormal Psychology,* 95:181–183, 1986.

Rausch, M.A.; Prescott, T.E.; and DeWolfe, A.S. Schizophrenia and aphasic language: Discriminable or not? *Journal of Consulting and Clinical Psychology,* 48:63–70, 1980.

Rochester, S.R. Are language disorders in acute schizophrenia actually information processing problems? *Journal of Psychiatric Research,* 14:275–283, 1978.

Rochester, S.R., and Martin, J.R. *Crazy Talk: A Study of the Discourse of Schizophrenic Speakers.* New York, NY: Plenum Press, 1979.

Rutter, D.R. The reconstruction of schizophrenic speech. *British Journal of Psychiatry,* 134:356–359, 1979.

Shaw, S.H.; Kelly, M.; Smith, A.B.; Shields, G.; Hopkins, P.J.; Loftus, J.; Laval, S.H.; Vita, A.; De Hert, M.; Cardon, L.R.; Crow, T.J.; Sherrington, R.; and DeLisi, L.E. A genome-wide search for schizophrenia susceptibility genes. *American Journal of Medical Genetics (Neuropsychiatric Genetics),* 81:364–376, 1998.

Shedlack, K.; Lee, G.; Sakuma, M.; Xie, S.-H.; Kushner, M.; Pepple, J.; Finer, D.L.; Hoff, A.L.; and DeLisi, L.E. Language processing and memory in ill and well siblings from multiplex families affected with schizophrenia. *Schizophrenia Research,* 25:43–52, 1997.

Siegel, A.; Harrow, M.; Reilly, F.E.; and Tucker, G.J. Loose associations and disordered speech patterns in chronic schizophrenia. *Journal of Nervous and Mental Disease,* 162:105–112, 1976.

Smith, E.E. Associative and editing processes in schizophrenic communication. *Journal of Abnormal Psychology,* 75:182–186, 1970.

Spitzer, M.; Weisker, I.; Winter, M.; Maier, S.; Hermle, L.; and Maher, B.A. Semantic and phonological priming in schizophrenia. *Journal of Abnormal Psychology,* 103:485–494, 1994.

Spitzer, R.L., and Endicott, J. *Schedule for Affective Disorders and Schizophrenia—Lifetime Version.* 3rd ed. New York, NY: New York Psychiatric Institute, 1977.

Tapley, S., and Bryden, M. A group test for the assessment of performance between the hands. *Neuropsychologia,* 23:215–221, 1985.

Thomas, P.; Kearney, G.; Napier, E.; Ellis, E.; Leudar, I.; and Johnston, M. Speech and language in first onset psychosis: Differences between people with schizophrenia, mania, and controls. *British Journal of Psychiatry,* 168(3):337–343, 1996.

Thomas, P.; King, K.; Fraser, W.I.; and Kendell, R.E. Linguistic performance in schizophrenia: A comparison of acute and chronic patients. *British Journal of Psychiatry,* 156:204–210, 1990.

Thomas, P., and Leudar, I. Syntactic processing and communication disorder in first-onset schizophrenia. In: Sims, A., ed. *Speech and Language Disorders in Psychiatry.* London, U.K.: Gaskell Press, 1995. pp. 96–112.

Thomas, P.; Leudar, I.; Newby, D.; and Johnston, M. Syntactic processing and written language output in first onset psychosis. *Journal of Communication Disorders,* 26:209–230, 1993.

Weisbrod, M.; Maier, S.; Harig, S.; Himmelsbach, U.; and Spitzer, M. Lateralized semantic and indirect semantic priming effects in people with schizophrenia. *British Journal of Psychiatry,* 172:142–146, 1998.

Williams, R.M.; Hemsley, D.R.; and Denning-Duke, C. Language behaviour in acute and chronic schizophrenia. *British Journal of Social and Clinical Psychology,* 15:73–83, 1976.

Wykes, T., and Leff, J. Disordered speech: Differences between manics and schizophrenics. *Brain and Language,* 15:117–124, 1982.

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The Author

Lynn E. DeLisi, M.D., is Professor of Psychiatry, New York University, New York, NY.