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Evidence of disturbances of deep levels of semantic cohesion within personal narratives in schizophrenia

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ABSTRACT

Since initial conceptualizations, schizophrenia has been thought to involve core disturbances in the ability to form complex, integrated ideas. Although this has been studied in terms of formal thought disorder, the level of involvement of altered latent semantic structure is less clear. To explore this question, we compared the personal narratives of adults with schizophrenia ($n = 200$) to those produced by an HIV+ sample ($n = 55$) using selected indices from Coh-Metrix. Coh-Metrix is a software system designed to compute various language usage statistics from transcribed written and spoken language documents. It differs from many other frequency-based systems in that Coh-Metrix measures a wide range of language processes, ranging from basic descriptors (e.g., total words) to indices assessing more sophisticated processes within sentences, between sentences, and across paragraphs (e.g., deep cohesion). Consistent with predictions, the narratives in schizophrenia exhibited less cohesion even after controlling for age and education. Specifically, the schizophrenia group spoke fewer words, demonstrated less connection between ideas and clauses, provided fewer causal/intentional markers, and displayed lower levels of deep cohesion. A classification model using only Coh-Metrix indices found language markers correctly classified participants in nearly three-fourths of cases. These findings suggest a particular pattern of difficulties cohesively connecting thoughts about oneself and the world results in a perceived lack of coherence in schizophrenia. These results are consistent with Bleuler's model of schizophrenia and offer a novel way to understand and measure alterations in thought and speech over time.

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1. Introduction

In his conceptualization of schizophrenia, Bleuler (1911/1950) suggested that people with the disorder shared a core set of features which include disruptions in associative processes. These disruptions compromised a person's ability to form coherent, complex ideas about the self and the world. With a reduced capacity to link related ideas together, Bleuler suggested that previously integrated ideas collapsed into disorganized fragments of experience. These disorganized fragments could no longer form the basis for goal directed activity. He wrote: "It appears as if the pathways of association and inhibition, established by experience, had lost their meaning and significance" (p. 350).

In the century since Bleuler, interest has persisted in disturbances of thought and language. For decades, researchers have investigated formal thought disorder—a set of symptoms reflecting disrupted thought

(Kuperberg et al., 2006; Ragin and Oltmanns, 1986) that typically manifest through speech disturbances (Andreasen, 1979; Docherty, 2012; Hoffman et al., 1986). Speech disturbances occur at multiple levels of language, ranging from basic components (e.g., word) to the more complex threads described by Bleuler. They typically include heightened instances of utterances which are incoherent, ideosyncratic, or fail to present ideas in a logical sequence. These disturbances have been observed across the schizophrenia-spectrum, including: schizotypy (Minor and Cohen, 2010; Minor and Cohen, 2012); clinical high risk for psychosis (Bearden et al., 2011; Perkins et al., 2015); early-stage psychosis (Minor et al., 2016); and prolonged schizophrenia (Docherty, 2012; Docherty et al., 2013; de Sousa et al., 2016). In schizophrenia, speech disturbances appear to be trait-like, treatment-resistant, and linked to poor clinical outcomes (Bowie and Harvey, 2008; Docherty, 2012; Holshausen et al., 2014).

Typically, speech disturbances have been assessed using either clinician-rated (e.g., Thought Disorder Index; Johnston and Holzman, 1979) or hand-scoring instruments (e.g., Communication Disturbances Index; Docherty et al., 1996). However, one disadvantage of these approaches

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is they are unable to quickly differentiate speech disturbances at multiple levels of language. Following recent advances, computational assessments have emerged as a scalable alternative with the potential to illustrate the different stages where disturbances in language occur (Bedi et al., 2015; Cohen and Elvevag, 2014; Elvevag et al., 2007; Fineberg et al., 2016; Minor et al., 2015). These methods hold promise for showing how speech is compromised in schizophrenia across words, phrases, sentences, paragraphs, and full conversations. This is important because evidence exists in early and later phases of schizophrenia that people construct representations of themselves and others that tend to be less integrated and complex (Lysaker and Dimaggio, 2014), but it is unclear whether this occurs at basic linguistic levels or reflects higher order disturbances.

To examine whether we could detect disturbances across basic and higher order levels of language, we analyzed cohesion within speech samples of persons with schizophrenia using the Coh-Metrix 3.0, a software system designed to compute cohesion and coherence metrics in transcribed written and spoken language documents (McNamara et al., 2014). Coh-Metrix contains over 100 language indices across 11 categories, ranging from basic descriptors of language (e.g., total spoken words) to complex indices that measure the structure of language within and across sentences (e.g., deep cohesion). Given assertions that difficulties building integrated representations of self and others is a hallmark of schizophrenia, we were interested in indices that measured language at separate levels. Specifically, we tested four types of indices: 1) Basic descriptors, which provided frequency-based counts of speech; 2) Connectives, or words which link ideas and clauses together within a sentence; 3) Situational models, or discourse markers which reflect the structures that allow the meaning of mental states and actions of persons in the text to be grasped within the flow of the narrative; and 4) Deep cohesion, which assess the presence of linguistic structures that allow for a more coherent and deeper understanding of the text (Graesser et al., 2003; McNamara et al., 2014; see Table 1 for more information on specific indices).

In most studies, speech between people with schizophrenia is compared to speech produced by healthy adults. However, persons with

schizophrenia experience sociopolitical forms of adversity—including stigma, demoralization, and social alienation—at a greater rate than healthy adults. This adversity likely influences how those with schizophrenia think and talk about their lives in ways that may extend beyond their illness (Ehrlich-Ben Or et al., 2013). Thus, we chose to analyze the speech of adults with HIV + as our comparison group, as these individuals may be subject to similar adverse experiences and demoralization (Logie and Gadalla, 2009; Varni et al., 2012). In this study, we tested two primary hypotheses. First, we expected the speech of people with schizophrenia to show signs of disturbances across all four types of indices when compared to the HIV + group. Second, we hypothesized that the Coh-Metrix would show utility for classifying people to the schizophrenia or HIV + group based solely on the speech produced within their narrative. This study has the potential to demonstrate the specific levels where speech differs in schizophrenia and establish if a novel computerized assessment can categorize people into diagnostic groups based on their speech.

2. Methods

2.1. Participants

Participants were 200 adults with SCID confirmed diagnoses of schizophrenia or schizoaffective disorder and 55 adults with a diagnosis of HIV + (see Table 2). Exclusion criteria included inpatient hospitalization or changes in medication being prescribed within the last month, active substance dependence or a chart diagnosis of intellectual disability. Participants were also excluded if they had comorbid diagnoses of schizophrenia and HIV +. All assessments were performed for the schizophrenia group as part of a baseline evaluation for a larger study testing the effects of cognitive behavioral therapy. Assessments for the HIV + group were performed as part of a protocol examining the effects of social cognitive and metacognitive deficits on wellness and outcome in non-psychiatric medical conditions.

2.2. Instruments

2.2.1. Indiana Psychiatric Illness Interview (IPII; Lysaker et al., 2002)

Speech for this study was collected using the IPII, a semi-structured interview originally designed to measure subjective experience in serious mental illness. Interviews were conducted by trained research assistants and generally lasted 30–60 min. These interviews were audio taped and later transcribed with identifying information removed. The IPII asks participants to tell their life story and how mental illness has affected different facets of their life. It differs from other symptom-based psychiatric interviews in that it does not ask about the presence or absence of specific symptoms. Instead, it focuses on one's experience of mental health challenges. For the HIV + group, the IPII was modified

Table 1
Descriptions of Coh-Metrix indices used in this study.

Index	What index measures
Descriptive	
Total words	Total number of words spoken by subject in clinical interview
Unique words	Total number of unique words spoken by subject in clinical interview
Unique-total word ratio	Unique words (i.e., type) divided by total words (i.e., token)
Connectives	
Causal	Connects ideas and clauses using causal words (e.g., because)
Logical	Connects two or more ideas using a logical operator (e.g., and)
Contrastive	Connects ideas using contrastive words (e.g., although)
Temporal	Connects ideas and clauses using temporal words (e.g., first)
Additive	Connects ideas and clauses using additive words (e.g., moreover)
Situational models	
Causal content	Total causal particles (e.g., because) and causal verbs (e.g., impact)
Intentional content	Total intentional particles (e.g., by) and intentional verbs (e.g., contact)
Causal cohesion	Ratio of causal particles to causal verbs
Intentional cohesion	Ratio of intentional particles to intentional verbs
Multidimensional	
Deep cohesion	Presence of causal/logical links to help others develop understanding

Notes. Further information on all Coh-Metrix 3.0. indices available in McNamara et al. (2014).

Table 2
Demographic and diagnostic data for schizophrenia ($n = 200$) and HIV + groups ($n = 55$).

Demographic	Schizophrenia		HIV +	
	Mean	SD	Mean	SD
Age	47.08	10.48	48.97	11.06
Education	12.58	1.98	13.51	2.21
Male (%)	87.50		89.09	
Race				
African-American (%)	55.55		56.36	
Caucasian (%)	43.00		40.00	
Other (%)	1.50		3.64	
Diagnosis				
Schizophrenia (%)	66.00		N/A	
Schizoaffective Disorder (%)	34.00		N/A	

Notes. N/A: not applicable.

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