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Latent semantic variables are associated with formal thought disorder and adaptive behavior in older inpatients with schizophrenia

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ABSTRACT

Introduction: Formal thought disorder is a hallmark feature of schizophrenia in which disorganized thoughts manifest as disordered speech. A dysfunctional semantic system and a disruption in executive functioning have been proposed as possible mechanisms for formal thought disorder and verbal fluency impairment. Traditional rating scales and neuropsychological test scores might not be sensitive enough to distinguish among types of semantic impairments. This has lead to the proposed used of a natural language processing technique, Latent Semantic Analysis (LSA), which offers improved semantic sensitivity.

Method: In this study, LSA, a computational, vector-based text analysis technique to examine the contribution of vector length, an LSA measure related to word unusualness and cosines between word vectors, an LSA measure of semantic coherence to semantic and phonological fluency, disconnectedness of speech, and adaptive functioning in 165 older inpatients with schizophrenia.

Results: In stepwise regressions word unusualness was significantly associated with semantic fluency and phonological fluency, disconnectedness in speech, and impaired functioning, even after considering the contribution of premorbid cognition, positive and negative symptoms, and demographic variables.

Conclusions: These findings support the utility of LSA in examining the contribution of coherence to thought disorder and the its relationship with daily functioning. Deficits in verbal fluency may be an expression of underlying disorganization in thought processes.

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1. Introduction

Formal thought disorder refers to a disorganization of thought that manifests in communication abnormalities. Disordered speech has long been recognized as one of the core features of schizophrenia (Bleuler, 1911; Kraepelin, 1919) occurring in 20–50% of patients with schizophrenia (Andreasen and Black, 2005; Breier and Berg, 2003). These symptoms are stable across the course of the disorder, are not simply a measurement artifact arising from psychotic symptoms (Harvey et al., 1990), and have been identified as predictors of poor functional outcome (Bowie and Harvey, 2008; Keefe et al., 1987).

Disordered speech may manifest in various forms, often classified as either "positive" or "negative" thought disorder. Positive thought disorder is characterized by disorganized or disconnected speech, such as loose associations between concepts evident in the switching of topics disjointedly, providing tangential responses, using nonsense words, or circumstantial speech patterns. Negative thought disorder is characterized by a reduction in the amount of elaboration, or overall verbal output. Typically, these subtypes are referred to as disconnected speech and verbal underproductivity, respectively. These subtypes are distinct from one another (Andreasen, 1979a; Harvey et al., 1992a,b), from positive and negative symptoms in recent-onset, neuroleptic-na've (John et al., 2003) and chronically ill (White et al., 1997) samples, and are differentially associated with social functioning competencies and behaviors (Bowie et al., 2011). Disordered speech is typically rated using instruments such as the Scale for the Assessment of Thought, Language, and Communication (TLC; Andreasen, 1979a,b), allowing for a clinical rating of a disordered thought phenomenon that manifests in conversational speech.

Various pathogenic neurocognitive mechanisms have been proposed to underlie disconnected speech wherein the two most prominent approaches are variants of executive dysfunction and impaired processing of semantic information and memory (Kerns and Berenbaum, 2002; Barrera et al., 2005; Stirling et al., 2006). Executive functioning is proposed to play a role in maintaining a topic of conversation, planning upcoming speech, and inhibition of inappropriate or unrelated discourse. Alternatively, disruption of semantic processing and memory may be due to a loss of stored information or impaired retrieval (Rapp and Caramazza, 1993), manifesting in difficulties retrieving correct words resulting in diffluent and nonsensical speech. There is currently no clear cognitive mechanism, though it stands to reason that it may involve a combination of semantic information processing and executive functioning (Kerns and Berenbaum, 2002; Doughty and Done, 2009).

One promising area utilizing disordered speech in understanding the role of thought disorder and cognition in schizophrenia is that of verbal fluency, specifically measures of semantic and phonological fluency. During these tasks participants are given a specific production rule, such as generating words that belong to a specific category for semantic fluency or words that begin with a specific letter for phonological fluency in a predetermined amount of time (Benton, 1968; Lezak, 1995). Verbal fluency tasks have been shown to be a sensitive indicator of general brain dysfunction (Lezak, 1995) and are thought to include semantic processing skills including controlled retrieval, semantic memory, and context processing (Docherty et al., 2011). Further, they are considered to place comparable demands on executive processing because of the requirements of efficient organization, self-monitoring of previous responses, and inhibition of inappropriate responses (Crawford and Henry, 2005; Ruff et al., 1997).

Previous research demonstrates that symptoms, and demographic characteristics such as level of education, premorbid ability, and chronological age (Crawford et al., 1992; Benton et al., 1994; Spreen and Strauss, 1998) play a role in the severity of thought disorder and verbal fluency deficits. Similar to other tests of cognitive functioning, performance on verbal fluency tasks is related to the presence of negative symptoms, but not positive symptoms (Howanitz et al., 2000; Kerns et al., 1999). Indeed, patients with more severe negative symptoms generate fewer words overall (Allen et al., 1993). In older samples, patients who have a more chronic course of illness demonstrate more impairments than younger patients (Harvey et al., 1997) and there is a pattern of longitudinal worsening in verbal productivity that is predicted by concurrent cognitive worsening (Bowie et al., 2005).

Disconnected speech has been found to be associated with production of fewer contextually-accurate semantic word clusters in a semantic fluency task (Kerns et al., 1999) and worse performance on a phonological fluency task (Aloia et al., 1998). Recently, Docherty et al. (2011) found that that there may be differential patterns of performance on verbal fluency tasks for individuals with alogia (i.e., underproductive speech) and formal thought disorder (i.e., disconnected speech). Specifically, disconnected speech was related to the proportion of semantically related words uttered in a phonological fluency task (Docherty et al., 2011). In studies comparing healthy older adults to younger adults, elderly participants generate fewer total words and fewer category switches on a semantic fluency task, and larger cluster sizes (i.e., greater number of semantically related words in a semantic cluster prior to shifting to a new semantic cluster) on a phonological fluency task (Troyer et al., 1997).

Examinations of factors associated with social and adaptive functioning in schizophrenia repeatedly reveal cognition as the most robust predictor (Green, 1996; Harvey et al., 1998). Specifically concerning verbal fluency, previous studies have found performance on verbal fluency tasks (measured by total number of words) to be correlated with impairments in functioning in individuals with schizophrenia (Green et al., 2000), a finding which holds even after accounting for negative symptoms (Jaeger et al., 2003), and is evident in geriatric patients (Bowie et al., 2004). Moreover, verbal fluency has been shown to be an important predictor of daily problem solving skills both in a testing setting (Keefe et al., 2006; Revheim et al., 2006) and in a real-world context (Rempfer et al., 2003).

While it is evident that performance on verbal fluency tasks is associated with severity of disconnected speech, it remains unclear how unique components of incoherent discourse specifically result in poor performance in these tasks, and the functional impact of underlying dysfunctional