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The effect of limited cognitive resources on communication disturbances in serious mental illness

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A R T I C L E I N F O

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A B S T R A C T

Semantically incoherent speech is a pernicious clinical feature of serious mental illness (SMI). The precise mechanisms underlying this deficit remain unclear. Prior studies have found that arousal of negative emotion exaggerates the severity of these communication disturbances; this has been coined "affective reactivity". Recent research suggests that "cognitive reactivity" may also occur, namely reflecting reduced "on-line" cognitive resources in SMI. We tested the hypothesis that communication disturbances manifest as a function of limited cognitive resources in SMI above and beyond that associated with state affectivity. We also investigated individual differences in symptoms, cognitive ability, and trait affect that may be related to cognitive reactivity. We compared individuals with SMI (n=52) to nonpsychiatric controls (n=27) on a behavioral-based coding of communication disturbances during separate baseline and experimentally-manipulated high cognitive-load dual tasks. Controlling for state affective reactivity, a significant interaction was observed such that communication disturbances decreased in the SMI group under high cognitive-load. Furthermore, a reduction in communication disturbances was related to lower trait and state positive affectivity in the SMI group. Contrary to our expectations, limited cognitive resources temporarily relieved language dysfunction. Implications, particularly with respect to interventions, are discussed.

1. Introduction

Language function is severely disrupted in individuals with serious mental illness (SMI). Of particular importance, individuals with SMI frequently produce language that is semantically incoherent, often leading to the discourse structure to be obfuscated (Elvevåg et al., 2007; Hoffman et al., 1986; Perlini et al., 2012; Rubino et al., 2011). Moreover, these communication disturbances are often stable over time, medication resistant, and linked to poor functional outcome (Bowie and Harvey, 2008; Kuperberg, 2011). Despite the wealth of empirical research into the ubiquity and burden of language dysfunction in SMI, the underlying mechanism of it remains a mystery. The present study leveraged behavioral language assessments to understand the cognitive mechanisms underlying communication disturbances in SMI.

Historically, investigators have measured language function using interview-based measures such as the Scale for Assessment of Thought, Language, and Communication (TLC; Andreasen, 1986). These measures have a number of drawbacks that contribute to limited understanding of language dysfunction in SMI. For example, clinical rating scales do not account for either the statistical properties or the structure of normal language, hence complicating definitions of "abnormal" language. Moreover, these measures employ ordinal based rating systems that are inappropriate for parametric statistics, produce data that are generally insensitive to change given the limited range of response options and ambiguous operational definitions, and are imprecise for isolating specific facets of language (Alpert et al., 2002; Cohen and Elvevåg, 2014; Elvevåg et al., 2016).

Given these limitations, there have been efforts to characterize language output in SMI in an objective and quantitative "behavioral-based" manner, particularly with respect to semantic expression. Behavior-based approaches are advantageous over clinical rating scales in that they quantify language disruptions using ratio scales and are not reliant on global clinical impressions. Of note, Docherty and colleagues developed the Communications Disturbances Index (CDI; Docherty et al., 1996) to systematically code for reference errors that make the discourse structure difficult to comprehend and has also been shown to be distinct from interview based measures of disorganized speech that assess for traditional speech symptoms (e.g., tangentiality, derailment, neologisms; Andreasen, 1986).

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As yet, behavioral based language assessments have had limited application for understanding the mechanisms underlying language dysfunction in SMI. Studies on the influence of emotional valence on discourse structure in patients have observed that patients produce more communication disturbances in their speech when discussing affectively negative versus positive and neutral topics (Burbridge and Barch, 2002; Docherty et al., 1994; Rubino et al., 2011). Emerging evidence also suggests that "cognitive resources", defined in terms of attentional, working memory, and related "on-line" resources (Plass et al., 2010), are also important for understanding language dysfunction in SMI (Cohen et al., 2014; Docherty, 2005; Melinder and Barch, 2003). Extensive research from a wide range of disciplines demonstrates that humans have a limited amount of cognitive resources at any given time, and allocating resources toward one task (e.g. remembering a phone number or name, operating a vehicle) limits the resources available for other tasks, for example, effective language function (e.g., Plass et al., 2010). Thus, it is reasonable to posit that communication disturbances manifest as a function of limited cognitive resources.

Three lines of research support this notion. First, a broad array of deficits in attention, working memory, concentration and other "on-line" abilities is exhibited in individuals with SMI, and these deficits appear to be similar across SMI boundaries (Mackin and Areán, 2009; Simonsen et al., 2011; Strauss et al., 2015). Second, a number of correlational studies have observed that cognitive deficits are associated with more language impairment in schizophrenia, depression, and mania using behavioral-based procedures/technologies (Becker et al., 2012; Docherty, 2005; Radanovic et al., 2013; Rosenstein et al., 2014). Third, investigators using experimental methods have found *cognitive reactivity* in speech, defined in terms of increased communication disturbances resulting from experimentally-manipulated cognitive load in healthy participants (Barch and Berenbaum, 1994; Kerns, 2007). While experimental studies have examined cognitive reactivity in patients, they have failed to include control groups (Barch and Berenbaum, 1996; Melinder and Barch, 2003) or a chronic SMI group (Minor et al., 2016); the present study addresses these limitations. Importantly, we previously evaluated the cognitive reactivity of negative speech symptoms (i.e., blunted vocal affect, alogia) using the same sample and task data as the current study (Cohen et al., 2014). Utilizing computationally-derived natural speech indices, we found that pause length abnormally increased as a function of increased cognitive load for patients with SMI (Cohen et al., 2014). The current study investigates the cognitive reactivity of communication disturbances in individuals with SMI and healthy controls utilizing behavioral-based measures of language production.

There is considerable variability in language dysfunction across individuals with SMI. Identifying individual differences that influences language function across patients may also yield understanding of the mechanisms underlying communication disturbances in SMI. The present study examined four candidate individual differences potentially related to cognitive reactivity: 1) cognitive ability; 2) state and trait affect; 3) positive symptoms; and 4) negative symptoms. It is particularly important to consider state affectivity when investigating language dysfunction in SMI. For example, arousal of negative emotions (e.g., discussing negatively valenced topics, attending to visually negative stimuli), dubbed *affective reactivity*, has exacerbated communication disturbances in both healthy (Docherty et al., 1998) and SMI (Burbridge and Barch, 2002; Rubino et al., 2011) samples. Similarly, Cohen and Docherty (2005) observed that arousal of positive emotions may also influence semantic coherence in a subset of a schizophrenia sample with more severe psychiatric symptomatology. To control for this potential alternate mechanism (i.e., high cognitive load may evoke negative or positive emotions in participants), we measured emotional lexical expression of negative and positive emotion in language production as our indirect measure of state affective reactivity (Pennebaker, 2001). This behavioral-based measure has been employed as an alternate method of assessing emotional experience in prior studies (Cohen et al., 2009; Minor et al., 2015; Najolia et al., 2011; St-Hilaire et al., 2008).

2. Methods

2.1. Participants

The patient group included 52 adults with Diagnostic and Statistical Manual of Mental Disorders 4th edition (American Psychiatric Association [APA], 1994) diagnosed schizophrenia (n=38), unipolar major depressive or bipolar disorder (n=14), recruited from an outpatient clinic. Diagnoses were made based on information obtained from the patients' medical records and from a structured clinical interview (SCID-IV; First et al., 1996). Patients were also recruited based on meeting federal criteria for having an SMI, defined in terms of adults (age 18 or older) who currently, or in the past year, meet criteria for a diagnosable mental, behavioral, or emotional disorder that results in functional impairment which substantially interferes with one more major life activities (i.e., per the ADAMHA Reorganization Act and Substance Abuse and Mental Health Services Administration) Exclusion criteria included the following: a) Global Assessment of Functioning (APA, 1994) rating below 30, indicating symptom levels that could interfere with participation in the study, b) documented evidence of intellectual disability from the medical records, c) current or historical DSM-IV diagnosis of alcohol or drug abuse suggestive of severe physiological symptoms (e.g., delirium tremens, repeated loss of consciousness), and d) history of significant head trauma (requiring overnight hospitalization). All patients were clinically stable at the time of testing and were receiving pharmacotherapy under the supervision of a multi-disciplinary team. Controls (n=27) were recruited from the community using the above exclusion criteria with the exception that they be free of current and past psychotic and affective disorders (per a SCID-IV interview). A more thorough description of our patient and control groups is detailed in our previous study (Cohen et al., 2014).

2.2. Speaking tasks

Subjects were seated in front of a computer monitor and asked to perform two separate 90-second speaking tasks involving discussion of affectively neutral topics (i.e., hobbies, foods, daily routines) during which participants were encouraged to speak as much as possible (Cohen et al., 2012, 2014). During a baseline, "low-load" narrative task, participants provided speech while passively watching symbols appear on the monitor. Six different visual symbols were presented at inter-stimulus intervals of 2000 ms. During a "high-load" narrative task, participants spoke while performing a one-back test. This task involved forced-choice responding (i.e., "match", "non-match") to stimuli when consecutively appearing visual symbols on a computer screen were identical. The visual stimuli and their presentation were identical across the two conditions. Four patients with a schizophrenia diagnoses were excluded from the present study for not responding during the cognitive task (accuracy < 10%). Participants underwent extensive training without the speech component to become familiar with the cognitive task (i.e., one-back). Feedback was offered during this practice. Order of task and speech topic was randomized. Previous studies have used similar windows of speaking durations (30-120s) to examine communication disturbances in healthy controls and in individuals with psychosis (Kerns, 2007; Minor et al., 2016).The following is an example of probe used to elicit speech: What kinds of hobbies do you have? You can discuss any hobby that you can think of, such as sports, walking, watching TV, or anything else you can think of.

2.3. Communication disturbances and cognitive reactivity

The tape-recorded interviews from the cognitive load tasks were