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Psychiatric symptom versus neurocognitive correlates of diminished expressivity in schizophrenia and mood disorders

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ABSTRACT

Diminished expressivity is a poorly understood, but important construct for a range of mental diseases. In the present study, we employed computerized acoustic analysis of natural speech to understand diminished expressivity in patients with schizophrenia and mood disorders. We were interested in the degree to which speech characteristics tapping alogia (i.e., average pause duration) and blunted affect (i.e., prosody computed from fundamental frequency and intensity) reflected psychiatric symptoms (i.e., depression, anxiety, paranoia and bizarre behavior) versus neurocognitive deficits. Twenty-six subjects with schizophrenia and 22 subjects with mood disorders provided speech samples in response to a variety of laboratory stimuli and completed neuropsychological batteries assessing a range of abilities. For both the schizophrenia and mood disorder groups, attentional coding deficits were significantly correlated with increased pause time (at large effect size levels) and, for the schizophrenia group only, reduced prosody (also at a large effect size level). For the mood disorder but not the schizophrenia group, increased average pause time was also significantly associated with neurocognitive deficits on a range of other tests (medium to large effect size levels). Psychiatric symptoms were not significantly associated with speech characteristics for either group (generally, negligible effect sizes). These results suggest that there is a link between expressivity and neurocognitive dysfunctions for both patients with schizophrenia and mood disorders. Implications and future research directions are discussed.

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1. Introduction

A reduction in expressive behaviors, which include symptoms such as blunted affect, motor retardation and alogia, manifests across a range of severe mental illnesses. Of note, clinically-rated expressive deficits have been found to be similar in severity across patients with schizophrenia and mood disorders (Kulhara and Chadda, 1987; Galynker et al., 2000; Tremeau et al., 2005; Mueser et al., 2010). Despite these deficits reflecting important Research Domain Criteria (RDoC; Insel et al., 2010), and hence, being useful for improving diagnosis and understanding of clinical syndromes (Insel et al., 2010; Cohen et al., 2012a), our understanding of their nature is poor. A critical obstacle in this endeavor is a reliance on interviewer-based rating scales for measuring diminished expression (e.g., Andreasen, 1984). Data from these scales often cover wide temporal swaths, are relatively insensitive to change given their relatively few response options and ambiguous operational definitions, produce ordinal data that are inappropriate for parametric statistics and are imprecise for isolating specific behaviors from other negative traits/symptoms (Mueser et al., 1994; Alpert et al., 2002; Stahl and Buckley, 2007; Cohen et al., 2008). Thus, these scales have limited use for providing all but a gross understanding of how expressive deficits modulate within individuals, how they differ across individuals, and how they are broadly related to neurocognitive, functional, pathophysiological, genetic and other variables. Emerging computer-based technologies have allowed for assessment of natural behavior in individuals with severe mental illness that offer near perfect inter-rater reliability and greater sensitivity and specificity than clinical rating scales (Alpert et al., 2002; Cohen et al., 2008). The present project applied computerized acoustic analysis of natural speech to understand the underpinnings of expressive deficits in stable outpatients with severe mental illness.

Within schizophrenia, it has been proposed that negative symptoms can reflect a number of potential causes, including "psychiatric" sources such as depression, anxiety, bizarre behavior (e.g., catanoia) and paranoia. Thus, a patient's lack of communicative behavior may stem from being too depressed, socially anxious, disorganized or suspicious of others. Alternatively, it has been proposed that expressive deficits can reflect basic neurocognitive liabilities (Barch and Berenbaum, 1996; Berenbaum and Oltmanns, 1992; see also Cohen et al., 2012c for a more recent discussion). Generally speaking, effective expression is theorized to draw upon a range of mental resources, and taxing these resources limits their availability for expressive behavior. In patients with severe mental illness, these expressive deficits could be magnified

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relative to the nonpsychiatric population due to weakened cognitive stores more generally. Support for this theory has been found in that experimental increases in cognitive demands during speaking tasks lead to decreases in expressive behavior in individuals with schizophrenia-spectrum disorders/traits (Barch and Berenbaum, 1996; Cohen et al., 2012c). It is worth noting that patients with schizophrenia and mood disorders have shown similar levels of neurocognitive impairment across a range of domains (e.g., Šoštarič & Zalar, 2011; Cohen et al., 2012a) — thus raising questions about whether neurocognitive dysfunctions are similarly related to expressive deficits for both groups. Within these patient groups, individuals with negative symptoms (Cohen et al., 2007) and melancholic depression (Withall et al., 2009) tend to show greater neurocognitive deficits relative to other patients within their diagnostic categories. With this in mind, the primary aim of this study was to evaluate the hypothesis that diminished expressivity would be differentially associated with neurocognitive versus "psychiatric" (e.g., anxiety, depressive, bizarre behavior and paranoia symptoms) factors, and that the relationship between these variables would not differ for patients with schizophrenia versus mood disorders. A secondary aim of the project was to compare the contribution of a) neurocognitive tests primarily tapping attentional/working memory processes (i.e., processing speed, concentration, working memory) to b) neurocognitive domains that are less dependent on attentional processes, in terms of diminished expressivity.

2. Methods

2.1. Subjects

The subjects were recruited from an outpatient community mental health clinic. These subjects included 26 patients with Diagnostic & Statistical Manual of Mental Disorders 4th edition (DSM-IV; American Psychiatric Association, 1994) diagnosed schizophrenia and 22 patients with a history of DSM-IV major depressive episode without a history of schizophrenia-spectrum disorder. Diagnoses were made based on information obtained from the patients' medical records and from a structured clinical interview (SCID; First et al., 1996). Exclusion criteria included the following: a) Global Assessment of Functioning (American Psychiatric Association, 1994) rating below 30, indicating symptom levels that could interfere with participation in the study, b) documented evidence of mental retardation 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), 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. The patients received $40 for participation in this study. This study was approved by the appropriate Human Subject Review Boards and all the subjects offered informed consent prior to participating in the study. For further information on recruitment, see other published studies from this dataset (Cohen et al., 2012a, 2012b, 2012c).

2.2. Diagnostic and symptom ratings

The Brief Psychiatric Rating Scale (Lukoff et al., 1986) was used to characterize psychiatric symptoms. BPRS ratings were made using information obtained from medical records, the patients' treatment teams, self-report and behavioral observations made during the research interview. Individual subscales of anxiety, depression, suspiciousness and bizarre behavior, reflecting potential "psychiatric symptom" correlates of diminished expression (Kirkpatrick et al., 2001), were employed using scales from one to seven. Factor subscale scores reflecting positive (i.e., bizarre behavior, suspiciousness, unusual thought content, disorientation, and hallucinations items), negative (i.e., self-neglect, blunted affect, motor retardation, and emotional withdrawal items), and mania/excitement (i.e., motor hyperactivity, elevated mood, excitement, distractibility, hostility, and grandiosity items) symptoms (defined in Ventura et al., 2000) were also employed. Preliminary diagnoses and ratings were made by one of four doctoral level students who were trained to criterion (Intra-class Correlation Coefficient (ICC) values > .70). All research interviews were videotaped and diagnoses and ratings were reviewed during a monthly case conference meeting that was led by a licensed clinical psychologist with considerable diagnostic experience (Alex S. Cohen).

2.3. Speech samples

The subjects were asked to view and speak about affectively-valenced pictures from the International Affective Picture System (IAPS; Lang et al., 2005) in six separate, three-picture blocks grouped by emotional valence (good, bad and neutral) and arousal (high and low). Administrations, which employed different images, were performed twice — separated by a week epoch. The pictures were selected for their relative representation of their respective valence and arousal based on existing norms (Lang et al., 2005). Picture display was set at 20 s, and each speaking condition was exactly 60 s. Block order and picture order within each block were random. Blocks were separated by a 30-second interval during which the subjects were instructed to "relax and breathe deeply". While viewing the pictures, the subjects were asked to "discuss how the picture relates to them, what it means to them, what it reminds them of, and how it makes them feel". The subjects were encouraged to speak for the full recording time. Research assistants were not allowed to speak during the task, though hand gestures encouraging subjects to talk were permitted. In all, 720 s of speech was available for analysis for each subject.

2.4. Acoustic analysis

The Computerized assessment of Affect from Natural Speech protocol (Cohen et al., 2009, 2010), developed by our lab to assess vocal expression, was employed here. Speech was digitally recorded using headset microphones at a sampling rate of 44,100 kHz with 16-bit quantization. The digitized recordings were analyzed using PRAAT (Boersma and Weenink, 2006), a program that has been used extensively in acoustic analysis. The PRAAT system organizes sound files into "frames" for analysis which for the present study was set at a rate of 100 per second. During each of these frames, frequency and volume were quantified. Various MATLAB and Excel Macro functions were employed to compute our variables of interest from the PRAAT output. The variables examined in this study included the following: *average pause time* ($Pause_{\bar{x}}$) — computed as the average millisecond pause between utterances; *inflection* — computed as the standard deviation of the fundamental frequency, computed from the standard deviation scores within each utterance; *intensity* — computed as the mean volume across utterances, and *emphasis* — computed as the standard deviation of the volume, computed from the standard deviation scores within each utterance. The first symptom maps onto the construct of alogia whereas the others map onto blunted affect. The inflection, intensity and emphasis variables were converted to z-score format and summed to reduce the overall number of analyses. This variable is referred to as "prosody" in this paper. Note that all frequency values were log-transformed to control for nonlinear distributions. Increasing $Pause_{\bar{x}}$ and decreasing prosody values reflect increasing expressive deficits. For data reduction purposes, speech variables were aggregated across the various valence and arousal speaking conditions and across the two administrations. There were no significant changes in speech production as a function of group, time, valence or arousal using repeated measure × group ANOVAs after controlling for group differences in ethnicity. Data regarding temporal stability and group differences (as well as means and variability scores for these variables) are reported elsewhere (Cohen et al., 2012a).

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