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Computerized facial analysis for understanding constricted/blunted affect: Initial feasibility, reliability, and validity data

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ABSTRACT

Diminished expression is a diagnostic feature of a range of schizophrenia-spectrum disorders/conditions and is often unresponsive to treatment, is present across premorbid, first episode and various clinical states, and is considered a poor prognostic indicator. Surprisingly, little is known about diminished expression. The present study sought to address this issue by evaluating a commercially-available computerized facial analysis software for understanding diminished expressivity. We analyzed natural facial expression from a series of laboratory interaction tasks in 28 individuals with psychometric schizotypy — defined as the personality organization reflecting a putative genetic schizophrenia liability, and 26 matched controls. We evaluated (a) feasibility — defined in terms of the number of video frames recognized by the software, (b) reliability — defined in terms of correlations between facial expression variables across the three laboratory interactions, and (c) construct validity — defined in terms of relationships to clinical variables. For most subjects (~80%), approximately three-quarters of the video frames were analyzable by the software; however, a minority of the videos were essentially unreadable. The facial expression variables showed excellent reliability across interaction conditions. In terms of construct validity, facial expression variables were significantly related to a measure of psychoticism, tapping subjective cognitive concerns and "first-rank" schizophrenia symptoms, but were generally not different between groups. Facial expression variables were generally not significantly related to measures of depression, anxiety, paranoia or, surprisingly, self-reported negative schizotypy. While computerized facial analysis appears to be a reliable and promising method of understanding diminished expressivity across the schizophrenia-spectrum, some work remains. Implications are discussed.

1. Introduction

Many individuals with schizophrenia-spectrum disorders have blunted or constricted affect (American Psychiatric Association [APA], 2000) — expressive deficits that are generally intractable and, despite considerable empirical attention, are a mystery in terms of underlying pathophysiology. One major factor contributing to this dearth of understanding is that measurement of expressive deficits is, for the most part, dependent on symptom rating scales (e.g., Andreasen, 1984; Kirkpatrick et al., 1989, 2011; Horan et al., 2011; see also Kring and Sloan, 2007 for behavioral-based coding strategies). Data from symptom rating scales often cover wide temporal intervals (e.g., weeks, months, or years), are relatively insensitive to change given their comparatively 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 symptoms (Mueser et al., 1994; Alpert et al., 2002; Stahl and Buckley, 2007; Cohen et al., 2008). Although integral to schizophrenia research, these scales have limited use for providing all but a gross understanding of how expressive deficits vary within individuals, how they differ between individuals, and how they are broadly correlated to other clinical and pathophysiological phenomena. Emerging computer-based technologies have allowed for assessment of natural behavior with near perfect inter-rater reliability, greater sensitivity and specificity than clinical rating scales (Alpert et al., 2002; Cohen et al., 2008), and greater efficiency than behavior-based coding systems. Several programs are currently in development for measuring expressive deficits in schizophrenia-spectrum disorders (e.g., Alvino et al., 2007; Cohen et al., 2008, 2010a). The present study sought to compliment this endeavor by evaluating a commercially-available, computerized facial analysis software — advantageous in that this software is easily accessible to researchers, has dedicated customer service and technological support, and has full-time developers interested in expanding its application.

In this study, we employed facial analysis software to understand expression in individuals with schizotypy — defined as the personality organization reflecting the putatively genetic risk for schizophrenia-

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spectrum pathology. There are advantages for feasibility testing in this population, in that these individuals are generally high functioning and computer-literate, and thus more able to comply with laboratory procedures. Moreover, these individuals are, for the most part, unmedicated, cognitively intact, and show lower levels of comorbid (and thus, potentially complicating) substance abuse, depression, anxiety and other disorders. With these benefits in mind, we sought to evaluate whether output variables from the commercial software package (a) can meaningfully detect facial expressions in individuals with psychometrically-defined schizotypy and controls (i.e., feasibility), (b) show appreciable temporal stability across laboratory assessments (i.e., reliability), and (c) meaningfully relate to demographic and clinical features of schizotypy (i.e., construct validity).

2. Methods

2.1. Participants

Participants were college undergraduates approached by email to participate in an on-line survey and offered a chance to win monetary prizes ($N = 10{,}258$). The survey included a consent form, basic demographic questions, the Schizotypal Personality Questionnaire — Brief Revised (SPQ-BR; Cohen et al., 2010b), the Brief Symptom Inventory (Derogatis and Melisaratos, 1983), and the Chapman Infrequency Scale (Chapman and Chapman, 1983). Individuals endorsing more than three of 14 infrequency items were considered ineligible for the present study. The response rate was modest ($n = 2300$). This study was approved by the Louisiana State University Human Subject Review Board and all participants offered informed consent prior to completing the surveys. Individuals scoring in the 95th percentile on the gender determined means for the positive ($n = 64$), disorganization ($n = 36$), or negative ($n = 53$) subscale from the SPQ-BR were contacted about participating in a laboratory study. Fifty-three individuals were also recruited who had elevations on multiple SPQ-BR scales. Individuals scoring high on the negative subscale (defined as a sum of "constricted affect" and "no close friends" subscales; Cohen et al., 2010b) were considered for the study only if they (a) also showed elevations (defined as the 95th percentile or higher) on the positive or disorganization subscales, or (b) had a depression subscale score from the Brief Symptom Inventory (Derogatis and Melisaratos, 1983) below their gender determined mean. In this manner, we sought to reduce the chances of individuals who were depressed (but not schizotypal) being recruited for the study. Subjects were excluded if they endorsed a personal history of schizophrenia diagnosis. Of the 206 subjects eligible for the schizotypal group, 37 were recruited and completed the laboratory testing. Thirty-three control subjects, of a total possible 485, selected from participants scoring below the gender-determined means for each of the positive, disorganization, and negative SPQ-BR factors, were also recruited. The 50th percentile was selected based on our prior research that individuals scoring below this cut-off are highly unlikely to have a history of schizophrenia diagnosis, inpatient hospitalization, or psychiatric or psychological treatment more generally (Cohen and Najolia, 2011). Controls were excluded if they reported a family history or self-diagnosis of schizophrenia.

2.2. Traits and symptoms

Schizotypal traits were measured using the Brief-Revised version of the Schizotypal Personality Questionnaire (Cohen et al., 2010b). Reported in this manuscript are data for the superordinate cognitive-perceptual, negative, and disorganization factor scores. Clinical symptoms were measured using the BSI (Derogatis and Melisaratos, 1983) which taps a broad range of psychopathology during the past seven days. We were particularly interested in depression (i.e., "feeling no interest in things"), anxiety (i.e., "feeling tense or keyed up"), paranoia (i.e., "feeling that most people cannot be trusted"), and psychoticism (i.e., "the idea that someone else can control your thoughts", "the idea that something is wrong with your mind") scales from this instrument, as these scales would be expected to be related to either diminished facial expression or schizotypy more generally. The BSI has well-documented psychometric properties and has been used in hundreds of published, peer-reviewed studies to date.

2.3. Interaction task

Subjects were seated in front of a computer monitor and asked to discuss three separate 90-second autobiographical memories separately involving neutral, positive, and negative memories from their lives. Instructions, for example, for the positive condition were as follows:

> Tell me some stories about when you were feeling really good. Please get into telling this story as much as you can, and talk for about 90 s. Some things to talk about include:
>
> 1) Times you were really happy with someone.
> 2) Times when you accomplished something really special.
> 3) Times you were feeling at your best.

The research assistant was out of view of the subject while they were speaking in order to minimize effects due to experimenter characteristics (i.e., individual differences in sex, ethnicity). Subjects were asked to talk to the research assistants (while looking at the computer screen), though research assistants were not allowed to speak during the narrative task. The task was digitally recorded using a camera fixed to the top of the computer monitor. Consistent with the recommendations detailed in the software manual, the overhead lights were turned off and two LED light towers, located on either side of the subject's face, were illuminated. Video was continuously recorded during the various speaking conditions and was spliced by research assistants using video editing tools to ensure each recording was exactly 90 s long. Beyond discussing autobiographical memories, subjects were blind to the purpose of this task.

2.4. Computerized facial analysis

FaceReader version 4.0 (Noldus Information Technology, 2010), a commercially-available program developed by Noldus Information Technology, was used to measure facial expressions. FaceReader is an automated program that uses algorithms to evaluate, on a video frame-by-frame basis, facial images in terms of seven emotional states — happy, sad, angry, surprised, scared, disgusted, and "neutral". These variables reflect a measure of the magnitude of that emotion being shown from 0 (not at all) to 100 (perfect match). Additionally, FaceReader can measure movement in eye gazes, mouth movements, and head movements along X, Y, and Z axes. For the present study, each subject yielded approximately 6750 frames for analysis. It is important to note that each frame is not necessarily analyzable, as FaceReader requires recognition of key facial features in order to evaluate emotional valence and head movement. As such, the "percentage of frames recognized" is a key variable for evaluating whether the software can be applied to schizophrenia research using our laboratory methods. For the present study, we report data on neutral, positive, and negative valence (defined as a sum of sad, angry, scared, and disgusted category scores) and on variability in eye, mouth, and head movement (defined as the standard deviation of values for each of these categories). Note that the head movement variable reflected a sum of movements across X, Y, and Z axes. For further scientific applications of the FaceReader software, see Chentsova-Dutton and Tsai (2010) as well as Choliz and Fernandez-Abascal (2012). "Surprise" emotions were excluded from the present study, given their ambiguity with