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Differential profiles in auditory social cognition deficits between adults with autism and schizophrenia spectrum disorders: A preliminary analysis

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ABSTRACT

Impairment in social cognition, including emotion recognition, has been extensively studied in both Autism Spectrum Disorders (ASD) and Schizophrenia (SZ). However, the relative patterns of deficit between disorders have been studied to a lesser degree. Here, we applied a social cognition battery incorporating both auditory (AER) and visual (VER) emotion recognition measures to a group of 19 high-functioning individuals with ASD relative to 92 individuals with SZ, and 73 healthy control adult participants. We examined group differences and correlates of basic auditory processing and processing speed. Individuals with SZ were impaired in both AER and VER while ASD individuals were impaired in VER only. In contrast to SZ participants, those with ASD showed intact basic auditory function. Our finding of a dissociation between AER and VER deficits in ASD relative to Sz support modality-specific theories of emotion recognition dysfunction. Future studies should focus on visual system-specific contributions to social cognitive impairment in ASD.

1. Introduction

Autism Spectrum Disorder (ASD) and schizophrenia (SZ) are complex neuropsychiatric disorders characterized by significant impairments in social cognition (Solomon et al., 2011). While natural history and symptom expression differentiate these disorders, overlap in risk genes and domains of functional impairment also exist (Crespi et al., 2010; Gilman et al., 2012; Rapoport et al., 2009; Watkins et al., 1988). Nevertheless, few studies have compared patterns of social cognition deficits across these two disorders, or have examined dissociations in impairment which may inform underlying pathophysiology.

Social cognition is the ability to process, store, and apply information about others. It includes a range of neural capabilities related to both visual (or facial) emotion recognition (VER) and auditory (or voice) emotion recognition (AER) (Sasson et al., 2011). Essential substrates for these processes include low level sensory regions that process cues such as face configuration or auditory tonal variation critical for conveying emotion, as well as higher order emotion regulatory regions of the brain such as limbic or prefrontal regions that play critical roles in maintaining representations of emotion precepts (Leppanen and Nelson, 2009).

Functional magnetic resonance imaging (fMRI) and human lesion studies demonstrate that VER processing involves a right-lateralized circuit including occipital face areas, fusiform and superior temporal gyri, somato sensory cortex, amygdala and both medial and dorsolateral prefrontal regions (Adolphs et al., 2002; Dal et al., 2013; Jehna et al., 2011; Philippi et al., 2009; Vuilleumier et al., 2004). Deficits in AER, notably in individuals with congenital and acquired amusia, support the relevance of bottom-up auditory impairments through changes in primary auditory cortex but also impairments in higher-order cortical regions (Sarkamo et al., 2009, 2010), often overlapping with areas

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responsible for VER.

Of the two emotion recognition domains, VER has been more extensively studied than AER in both ASD and SZ, using well-validated batteries such as the Penn Emotion Recognition Test (ER-40) (Gur et al., 2010), Reading the Mind in the Eyes test (Baron-Cohen et al., 2001), and the Ekman 60 Faces Test (Diehl-Schmid et al., 2007). Robust deficits have been observed in both schizophrenia and ASD, although the underlying neural mechanisms remain obscure (Bolte and Poustka, 2003; Eack et al., 2013; Kohler et al., 2010). For schizophrenia, it has been hypothesized that VER deficits are significantly related to the inability to process low level visual information, particularly that conveyed by the magnocellular visual pathway (Bedwell et al., 2013; Butler et al., 2009; Javitt, 2009). Though disturbances in low level visual processing are reported in ASD (Greenaway et al., 2013; Spencer et al., 2000), their contributions to VER impairments have not been established.

Batteries assessing AER are less well-established, with fewer manuscripts addressing patterns of deficit in neuropsychiatric disorders. In recent years, we have adapted and validated several social cognition tests to study schizophrenia, including the Juslin & Laukka Auditory Emotion Recognition Battery (JL-AER); (Juslin and Laukka, 2003) and the Ross Attitudinal Prosody Battery (RAP); (Orbelo et al., 2005). Both have strong psychometric properties and sensitivity to deficits in AER and sarcasm recognition, respectively, in SZ (Gold et al., 2012; Kantrowitz et al., 2014).

Investigations of AER within ASD are limited. Studies evaluating AER of basic emotion (happiness, sadness, fear, anger, surprise and disgust) have yielded inconsistent findings (Rutherford et al., 2002; Hollander et al., 2007; Boucher et al., 1998; Baker et al., 2010) despite reports of impaired sensory activation to basic vocal stimuli (Gervais et al., 2004), while AER tasks evaluating more complex emotion types such as those in the 'Reading the Mind in the Voice' test have been demonstrated to be impaired in ASD participants (Golan et al., 2007). To our knowledge, AER has only been studied in parallel with VER in one study of ASD children, who demonstrated impairment relative to healthy control participants (Taylor et al., 2015). In contrast, participants with SZ show severe deficits in basic VER and AER. AER impairment (as well as sarcasm detection) in SZ correlate with deficits in basic auditory sensory processing, as reflected in impaired tone matching ability, supporting a bottom-up model of social cognitive impairment. However, AER deficits in populations with SZ survive covariation for specific sensory impairments, suggesting parallel high level contributions to overall social cognitive impairment (Gold et al., 2012).

In SZ, the ER40 and JL-AER possess similar discrimination power for detecting emotion recognition impairments; moreover, deficits detected by each of these instruments correlate with modality specific reductions in sensory processing (Gold et al., 2012). The RAP also has been shown to be sensitive to prosodic processing impairments compared to deficits in basic auditory processing. Application of these batteries in concert to ASD individuals relative to SZ and control individuals thus permits comparison of patterns of social cognitive dysfunction across, as well as within, specific neuropsychiatric disorders. Herein, we apply these tasks within ASD, SZ and healthy control populations to determine if unique performance profiles (in presence or intensity of impairment) may lend insight into shared and differential neurobiology.

2. Methods

2.1. Participants

The ASD sample of 19 individuals was ascertained from the central research databases at both the Nathan Kline Institute (NKI) and New York State Psychiatric Institute (NYSPI). Participants with ASD were compared to a sample of 92 participants (inpatient or outpatient) with schizophrenia or schizoaffective disorder and 73 healthy control participants. Diagnoses were based on research consensus clinical diagnosis determined after administration of the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1994). ASD diagnoses were confirmed by application of DSM-IV criteria, and for 9 out of 19 individuals, clinical information was obtained from the Autism Diagnostic Observation Schedule, Second Edition (ADOS) administered by a research reliable examiner. ASD participants were considered "high-functioning" because education levels were similar to that of healthy participants (Table 1). Healthy control participants were obtained through a central Volunteer Recruitment Pool at NKI and through independent postings and advertisements. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki, the study design was reviewed and approved by the institutional review boards of both NKI and NYSPI; informed consent was obtained from the participants after the nature of the procedures had been fully explained.

2.2. Procedure

Tone matching was assessed using the Tone Matching Test (TMT) with pairs of 100-msec tones in series, with a 500-msec intertone interval (Gold et al., 2012). Within each pair, tones (50% each) either were identical or differed in frequency by a specified amount in each block (2.5%, 5%, 10%, 20%, or 50%). Participants reported whether the pitch was the same or different. Three base frequencies (500, 1000, and 2000 Hz) were used within each block to avoid learning effects. In all, the test consisted of five sets of 26 pairs of tones.

The auditory emotion recognition (AER) battery was adapted from the JL-AER. It consisted of 32 audio recording stimuli of native English speakers conveying four emotions while reading sentences otherwise neutral in content: anger, fear, happiness and sadness or no emotion (Gold et al., 2012). Participants were asked to rate both the affective category and intensity of emotion.

Attitudinal prosody (sarcasm perception) was assessed using the attitudinal subtest of the RAP (Orbelo et al., 2005). This battery consists of 10 semantically neutral sentences recorded by a female speaker in both a sincere and a sarcastic manner for a total of 20 unique utterances (10 pairs). These utterances were repeated twice for a total of 40 stimuli. After each stimulus, participants were instructed to state whether the speaker was sincere or sarcastic.

Recognition of visual emotion was assessed using the ER-40 (Gold et al., 2012; Gur et al., 2010) which utilizes 40 color photographs of adult faces expressing four basic emotions (happiness, sadness, fear, anger) along with neutral expressions. Eight photographs from each category are presented in random order. Using a computer mouse, participants are asked to select the emotion that best describes the photograph from five choices listed on the screen; they choose as rapidly as they can without sacrificing accuracy.

Processing speed was assessed using the digit symbol coding and symbol search subtests of the WAIS-III (Wechsler, 1997). Performance on these two subtests was combined to form a processing speed index (PSI) (Gold et al., 2012).

2.3. Data analysis

Between-group comparisons were performed using multivariate ANOVA, with follow-up independent-sample t tests, as required (Dunnett). The relationship between the social cognition measure (tone matching, AER, VER, and RAP) and a main effect of diagnosis was assessed using analysis of covariance (ANCOVA) with