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Face Perception Predicts Affective Theory of Mind in Autism Spectrum Disorder but Not Schizophrenia or Typical Development

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Autism spectrum disorder (ASD) and schizophrenia spectrum disorder (SCZ) have overlapping symptomatology related to difficulties with social cognition. Yet, few studies have directly compared social cognition in ASD, SCZ, and typical development (TD). The current study examined individual differences in face recognition and its relation to affective theory of mind (ToM) in each diagnostic group. Adults with ASD (n = 31), SCZ (n = 43), and TD (n = 47) between the ages of 18 and 48 years-old with full scale IQ above 80 participated in this study. The Reading the Mind in the Eyes Test (RMET) measured affective ToM, and the Benton Facial Recognition Test (BFRT) measured face perception. Adults with ASD and SCZ did not differ in their affective ToM abilities, and both groups showed affective ToM difficulties compared with TD. However, better face recognition ability uniquely predicted better affective ToM ability in ASD. Results suggest that affective ToM difficulties may relate to face processing in ASD but not SCZ. By clarifying the complex nature of individual differences in affective ToM and face recognition difficulties in these disorders, the present study suggests there may be divergent mechanisms underlying pathways to social dysfunction in ASD compared with SCZ.

General Scientific Summary
This study demonstrates that worse face recognition is associated with worse reasoning about emotional mental states of others in adults with autism but not schizophrenia or typical development. This suggests distinct underlying pathways to social dysfunction in adults with autism compared with schizophrenia and has practical implications for designing interventions aimed at improving social–cognitive abilities and reducing social difficulties in both disorders. Results suggest the value of targeting face perception in ASD but not SCZ to improve social cognition.

Keywords: autism, schizophrenia, face perception, affect, theory of mind

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Autism spectrum disorder (ASD) and schizophrenia spectrum disorders (SCZ) share a long history of comorbidity and diagnostic confusion due to common social symptomology (Kanner, 1965; Ornitz & Ritvo, 1968). The extent to which symptoms of these two disorders overlap and diverge has been of interest to clinicians and researchers for decades (Chisholm et al., 2015; Foss-Feig et al., 2019; Stone & Iguchi, 2011). Since the diagnostic categories of ASD and SCZ were formally separated with the publication of the *Diagnostic and Statistical Manual of Mental Disorders-Third Edition* (*DSM–III*; American Psychiatric Association, 1980), large independent literatures have emerged studying the mechanisms of each disorder. Yet, few studies have directly compared the two disorders, impeding progress in understanding the mechanisms of social dysfunction in either disorder (Sasson et al., 2011).

Social cognition, the processes of perception and interpretation of social information, predicts individual differences in social dysfunction in both SCZ and ASD (Brothers, 2002). Shared difficulties with social cognition in ASD and SCZ are central to the ongoing debate about whether the disorders lie on the same phenotypic continuum (Anomitri & Lazaratou, 2017; Martinez et al., 2017). However, the few comparative studies of social cognition in ASD and SCZ have produced mixed results (for a systematic review and meta-analysis, see Fernandes et al., 2018). The direct comparison of social–cognitive abilities in ASD and SCZ is a crucial avenue of research that may reveal shared and divergent mechanisms underlying pathways to social dysfunction (Sasson et al., 2011).

Theory of Mind in Autism and Schizophrenia

A key facet of social cognition is theory of mind (ToM), the ability to reason about the mental states of others, including their beliefs, desires, intentions, and emotions (Premack & Woodruff, 1978). The meaning of ToM is often vague and inconsistent, and the methods used to study it are heterogeneous (Apperly, 2012). Consistent with the majority of research in both clinical and nonclinical populations to date, we consider social cognition to be an overarching term that describes the ability to think about the social world, ToM as a subtype of social cognition that refers to inferring the mental states of others, and affective ToM as a subtype of ToM that refers to the ability to both recognize the emotional facial expressions of others *and* infer that those emotional expressions are demonstrations of their mental states (Schaafsma et al., 2015). ToM abilities are considered critical for successful social functioning, and ToM performance predicts better social and adaptive functioning in both ASD (Altschuler et al., 2018; Bennett et al., 2013; Bishop-Fitzpatrick et al., 2017; Lerner et al., 2011) and SCZ (Mike et al., 2019; Peyroux et al., 2019; Vaskinn & Abu-Akel, 2019; Wang et al., 2018). Because of its relevance to social functioning, many studies have independently explored ToM ability in ASD or SCZ in comparison with individuals with typical development (TD) and found significantly diminished ToM performance in both ASD and SCZ compared with TD (Gilleen et al., 2017). However, group differences in ToM between ASD and SCZ are not well established. In a recent meta-analysis, Fernandes et al. (2018) found no significant differences in social cognition between SCZ and ASD, suggesting performance on ToM tasks is similarly diminished in both conditions. Similarly, in a recent study, Pinkham et al. (2019) compared ToM in a large sample of adults with ASD, TD, and SCZ and found that both ASD and SCZ groups showed diminished performance in ToM compared with TD. Results indicate similar levels of social–cognitive difficulty in ASD and SCZ and point toward a need for additional work delineating what mechanisms may differentially underlie social–cognitive difficulty in ASD versus SCZ.

Despite the clear importance of understanding ToM difficulties in ASD and SCZ, certain types of ToM may be more clinically relevant than others. Cognitive ToM (i.e., the ability to reason about cognitive mental states) and affective ToM (i.e., the ability to reason about affective mental states) are distinct subtypes, and preliminary research suggests affective ToM but not cognitive ToM may predict symptom severity in ASD and SCZ (Altschuler et al., 2018; Shamay-Tsoory et al., 2007). Moreover, other research reveals significant affective ToM difficulties in each group compared with TD (for a meta-analysis, see Chung et al., 2014), further supporting the specific relevance of affective ToM to understanding social difficulties in both ASD and SCZ. Taken together, although more literature is needed to confirm the centrality of affective ToM difficulties and disentangle the extent to which affective ToM is predictive of different symptom domains in ASD and SCZ, recent studies indicate that affective ToM performance is diminished and uniquely predictive of symptom severity in both clinical groups, suggesting ASD and SCZ share, at least in part, some common social–cognitive processing difficulties. As yet, little is known about the potential mechanisms that may underlie difficulties in the advanced social–cognitive ability of attributing emotional mental states to others in ASD versus SCZ. The recognition of complex emotional states is thought to involve higher-level integration of social emotional information (i.e., ToM) but also low-level perceptual processes (for a review, see R. Mitchell & Phillips, 2015), suggesting a link between ToM and emotion recognition. Moreover, since meta-analyses have shown that individuals with ASD (Uljarevic & Hamilton, 2013) and SCZ (Kohler et al., 2010) have difficulties in facial emotion recognition, it is important to consider the potential influence of challenges with perceptual face processing on affective ToM difficulties.

Relevance of Face Recognition Ability

One possible candidate mechanism for predicting individual differences in affective ToM is face perception ability, given the literature suggesting face perception performance is diminished in ASD (see Weigelt et al., 2012, for review) and SCZ (see Bortolon et al., 2015, for review). Face recognition is a type of face perception, comprised of the perceptual capabilities needed to identify, encode, recognize, and recall faces (Baron, 1981; Tsao & Livingstone, 2008). Despite the relevance of face recognition as a potential prerequisite to successful decoding of emotional expressions, only a few studies have examined the association between face recognition and emotion recognition in ASD and SCZ. Better face recognition performance associates with more accurate emotion recognition in ASD (Humphreys et al., 2007; Yeung et al., 2019) and SCZ (Ventura et al., 2013). However, whether face recognition differentially explains individual differences in affective ToM decoding—a type of emotional face processing that involves inferring mental states based on others' emotional expressions conveyed through their eyes—in ASD and SCZ is an open question that will shed light on the mechanisms of social dysfunction.

A small body of literature suggests that different processes may underlie facial emotion processing in ASD and SCZ (Sachse et al., 2014; Sasson et al., 2016, 2007). In one study, Sachse et al. (2014) found that individuals with SCZ were comparable with individuals with TD in measures of emotion recognition but showed reduced visuo-perceptual skills. In contrast, individuals with ASD showed poorer face recognition and poorer facial emotion recognition compared with both SCZ and TD, suggesting distinct cognitive processes may underlie emotion recognition difficulties in ASD and SCZ. In light of these findings, it may be the case that affective ToM and face recognition are uniquely related in ASD but unrelated in SCZ and TD. Examining affective ToM and face recognition simultaneously in these clinical groups will help tease apart affective ToM from more general face processing skills and may clarify the reasons *why* these groups struggle in these social–cognitive and perceptual domains.

Present Study

Given the centrality of affective ToM challenges in ASD and SCZ and the role of face recognition ability in affective ToM, the present study examined individual differences in face recognition and their relation to affective ToM in ASD and SCZ in comparison with TD. The first aim of the study was to examine whether adults with ASD and SCZ differ in affective ToM and face recognition ability. We hypothesized that adults with ASD and SCZ would not differ in these abilities but that both would be diminished relative to TD counterparts. The second aim of the study was to examine relations between face recognition and affective ToM in ASD and SCZ. We hypothesized that affective ToM and face recognition would be related in ASD but unrelated in SCZ and TD, suggesting contributors to affective ToM in ASD are distinct from those in SCZ and TD. Such findings would inform study of different mechanisms underlying social cognition in ASD versus SCZ and help resolve the debate in the field about their shared versus distinct features.

Material and Method

Participants

One-hundred and twenty individuals participated in this study. Participants included community samples of adults with ASD (n = 31), TD (n = 47), and SCZ (n = 42) between the ages of 18 and 48 years-old with full scale intelligence quotient (IQ) of 80 and above as measured by the Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-2; see Table 1). ASD and SCZ participants were recruited for this study after seeking treatment, services, and/or research participation at the Yale Developmental Disabilities Clinic, the Specialized Treatment for Early Psychosis Clinic, or the Yale Psychiatric department in New Haven, CT. TD controls were recruited from the local community and from research databases. Yale University's institutional review board approved all study procedures under Protocol 0303025065, Understanding Face Deficits in Autism Using ERPs: An EEG study of Correlates of Face Processing and Neural Plasticity. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki, the study design was reviewed and approved by an appropriate ethical committee, and informed consent of the participants was obtained after the nature of the procedures had been fully explained.

Inclusion criteria included the ability to complete study measures in English, no history of neurological conditions, and no comorbid functionally impairing substance use in the past 6 months. ASD, TD, and SCZ participants all completed an identical comprehensive evaluation by a licensed clinical psychologist, which included the Autism Diagnostic Observation Schedule–Second Edition (ADOS-2; Lord et al., 2012), the Structured Clinical Interview for DSM Axis I Disorders (SCID-R; First et al., 2002), the Mini International Neuropsychiatric Interview (MINI; Hergueta et al., 1998), and clinical diagnosis based on the *Diagnostic and Statistical Manual of Mental Disorders–Fifth Edition* (*DSM–5*; American Psychiatric Association, 2013). Diagnoses were confirmed by clinicians with extensive experience with both ASD and SCZ. Clinician judgments about diagnoses were informed by a variety of information sources, including clinical interaction with participants during administration of diagnostic assessments and review of prior psychiatric and medical history. Participants in the ASD group had an ASD primary diagnosis, and participants in the SCZ group had a SCZ primary diagnosis, as confirmed by clinical judgment and diagnostic assessments (i.e., ADOS-2 and *DSM–5* criteria were used to rule in or out an ASD diagnosis, and SCID-R, MINI, and *DSM–5* criteria were used to rule in or out a SCZ diagnosis). Participants were excluded if they met criteria for both ASD and SCZ diagnoses (n = 2). Participants in the TD group did not have ASD or SCZ, a family history of ASD or SCZ, or any psychiatric diagnosis. Although comorbid diagnoses in the ASD and SCZ groups were not exclusionary criteria, we examined the rates of comorbid disorders in all three groups since prior literature suggests mood disorders could potentially impact ToM (Wang et al., 2018) and face recognition (Frantom et al., 2008) performance. As expected, TD participants were

Table 1
Participant Descriptive Characteristics by Diagnostic Group

	Group mean (*SD*), range			Group comparison statistic, *p*-value		
Characteristic	ASD	SCZ	TD	ASD vs. TD	SCZ vs. TD	ASD vs. SCZ
Age	24.16 (5.28), 18−35	25.38 (6.41), 19−48	26.53 (6.58), 19−47	t = 1.67, p = .10	t = −0.76, p = .45	t = 0.93, p = .36
FSIQ	106.10 (12.61), 83−130	96.88 (10.15), 81−118	111.04 (11.58), 89−130	t = 1.78, p = .08	t = −6.10, p < .001	t = −3.46, p = .001
VIQ	104.42 (15.79), 72−134	97.62 (11.56), 77−137	112.30 (13.05), 86−138	t = 2.40, p = .02	t = −5.59, p < .001	t = 2.13, p = .037
NVIQ	106.16 (10.59), 89−131	97.21 (10.58), 81−127	106.91 (11.49), 85−137	t = 0.29, p = .77	t = −2.40, p < .001	t = 3.57, p = .001
Sex ratio	8 f: 23 m	7 f: 35 m	20 f: 27 m	χ^2 = 2.28, p = .13	χ^2 = 7.03, p = .01	χ^2 = .91, p = .339

Note. ASD = autism spectrum disorder; SCZ = schizophrenia spectrum disorder; TD = typical development; FSIQ = full scale intelligence quotient; VIQ = verbal intelligence quotient; NVIQ = nonverbal intelligence quotient.

not diagnosed with any disorders. Similarly, ASD participants were not diagnosed with any other disorders. In the SCZ group, eight participants had a diagnosis of substance abuse or dependence, and one participant had a diagnosis of posttraumatic stress disorder (PTSD). The comorbid SCZ group did not differ from the pure SCZ group on the BFRT or the RMET, and the BFRT and the RMET were unrelated in both the comorbid SCZ group and the pure SCZ group. The ASD and TD groups were matched on age, full scale IQ, and sex ratio. The SCZ and ASD groups were matched on age and sex ratio but not full scale IQ. The SCZ and TD groups were matched on age but not full scale IQ or sex ratio (see Table 1).

Procedure

Participants were screened for inclusionary and exclusionary criteria before enrollment. During a research visit, all participants completed the clinical assessments, self-report questionnaires, and behavioral tasks. Clinical assessments and diagnoses were completed by PsyD- or PhD-level licensed clinical psychologists who are also practicing psychologists in renowned ASD and SCZ clinics. These psychologists have expertise in ASD and SCZ diagnosis according to DSM criteria, and they are research reliable on the diagnostic measures used in this study. Self-report questionnaires and behavioral tasks were administered by BA- and BS-level clinical research fellows who received training on administration by senior members of the laboratory.

Materials

Intelligence Quotient

The Wechsler Abbreviated Scale of Intelligence-Second Edition (WASI-2; Wechsler, 2011) measures intelligence quotient (IQ) for individuals between the ages of 6 and 90 years-old. The WASI-2 consists of four subtests. The Vocabulary and Similarities subtests comprise a Verbal Comprehension Index, assessing verbal, crystallized ability, which is used to index verbal IQ (VIQ). The Block Design and Matrix Reasoning subtests comprise a Perceptual Reasoning Index, assessing nonverbal, fluid ability, which is used to index nonverbal IQ (NVIQ).

Face Recognition

The Benton Facial Recognition Test (BFRT; Benton, 1994) assesses the ability to recognize and discriminate among faces. The BFRT presents faces in a stimulus booklet and requires the participant to match a target face to either one face under the same viewpoint and lighting (six items) or three of six faces that vary in viewpoint and lighting (16 items). Higher scores reflect better BFRT performance. The maximum score is 54.

Affective Theory of Mind

The Reading the Mind in the Eyes Test (RMET; Baron-Cohen et al., 2001) assesses the ability to recognize others' emotional mental states based on the pictures of others' eyes and is thought to measure affective ToM, or decoding of others' emotional mental states. The RMET presents photographs of the eye region of different human faces and involves choosing from four adjectives (one target and three foils) that best describes what the individual in the photograph is feeling. It consists of 36 photographs (18 males and 18 females). All of the photographs present emotional states. Participants are provided with a glossary of the adjectives and their definitions to refer to if they are unfamiliar with their definitions. One outlier in the SCZ group was removed prior to analysis for scoring outside 1.5 times the interquartile range and well below chance on the RMET. Higher scores reflect better RMET performance.

Analytic Approach

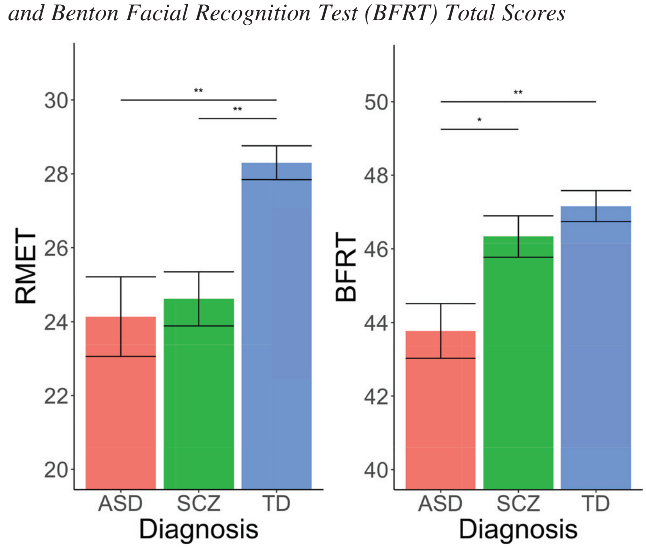
Analyses were conducted in accordance with study aims. First, a one-way multivariate analysis of variance (MANOVA) was conducted to detect group differences in face recognition and affective ToM in ASD, TD, and SCZ. Then, correlations among variables of interest were examined for the diagnostic groups separately to assess whether there were distinct relations between face recognition and affective ToM in ASD, SCZ, and TD. Statistical differences in Pearson's correlations between SCZ and ASD, ASD and TD, and SCZ and TD were estimated using Fisher's r-to-Z transformation. Fisher's r-to-Z transformation converts the difference between Pearson's correlations to a standardized Z score (Cohen et al., 1983).

Results

Group Differences in Affective Theory of Mind and Face Recognition

A one-way MANOVA was run to determine the effect of diagnostic group on affective ToM and face recognition (see Figure 1). The difference among the diagnostic groups on the combined dependent variables of RMET and BFRT scores was statistically

Figure 1
Group Differences in Reading the Mind in the Eyes Test (RMET) and Benton Facial Recognition Test (BFRT) Total Scores



Note. ASD = autism spectrum disorder; SCZ = schizophrenia spectrum disorder; TD = typical development. Error bars represent standard errors. * $p < .01$. ** $p < .001$. See the online article for the color version of this figure.

significant, $F(4, 218) = 7.56$, $p < .001$, Wilk's $\Lambda = .77$, $\eta^2_p = .12$. Follow-up univariate ANOVAs showed that both RMET scores ($F(2, 110) = 10.19$, $p < .001$, $\eta^2_p = .16$) and BFRT scores ($F(2, 110) = 7.90$, $p = .001$, $\eta^2_p = .13$) were statistically different among the diagnostic groups, using a Bonferroni adjusted α level of .025. Tukey post hoc tests showed that, for RMET scores, adults with TD ($M = 28.30$, $SD = 3.01$) had significantly higher mean scores than adults with ASD ($M = 24.13$, $SD = 5.88$; $M_{diff} = 4.17$, 95% confidence interval (CI) [1.59, 6.75], $p < .001$, Cohen's $d = .89$) and SCZ ($p < .001$; $M = 24.62$, $SD = 4.55$; $M_{diff} = 3.69$, 95% CI [1.29, 6.09], $p = .001$, Cohen's $d = .95$), but there was no statistically significant difference in RMET scores between adults with ASD and SCZ ($M_{diff} = .48$, 95% CI [−.31, 2.15], $p = .676$, Cohen's $d = .09$). For BFRT scores, Tukey post hoc tests showed that adults with TD ($M = 47.16$, $SD = 2.79$) had significantly higher mean scores than adults with ASD ($M = 43.77$, $SD = 4.15$; $M_{diff} = 3.39$, 95% CI [1.78, 4.99] $p < .001$, Cohen's $d = .96$) but did not differ in BFRT scores from adults with SCZ ($M = 46.33$, $SD = 3.52$; $M_{diff} = .826$, 95% CI [−.677, 2.329], $p = .279$, Cohen's $d = .26$). Adults with ASD had significantly lower BFRT scores than adults with SCZ ($M_{diff} = 2.56$, 95% CI [.915, 4.205], $p = .003$, Cohen's $d = .67$).

Association Between Affective Theory of Mind and Face Recognition

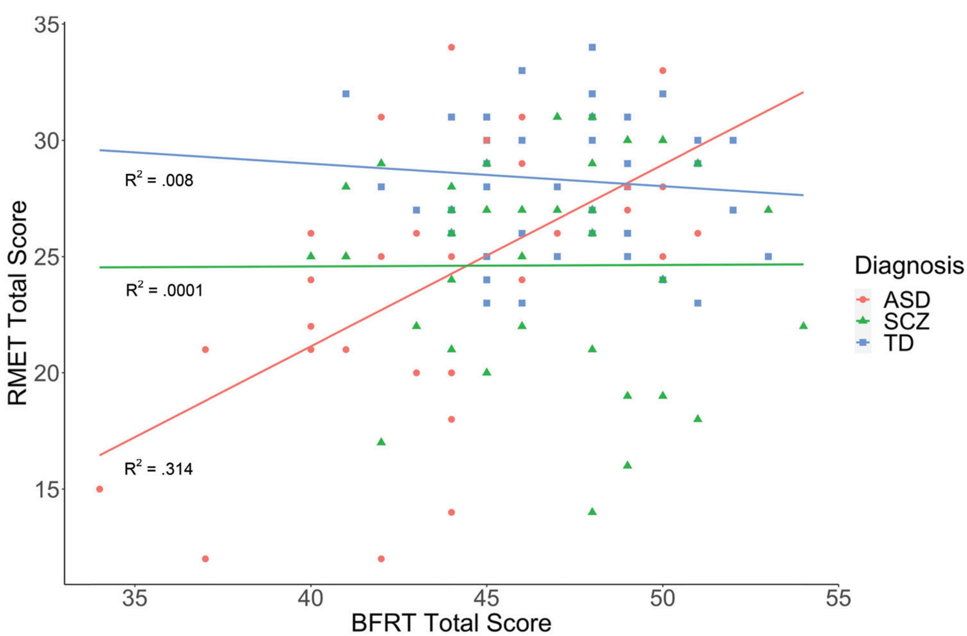
Pearson's correlations assessed whether the constructs of affective ToM and face recognition are differentially related in adults with ASD, SCZ, and TD (see Figure 2). In the ASD group, the BFRT was positively related to the RMET ($r = .56$, 95% CI [.24, .87], $p = .001$), indicating that better face recognition ability was associated with better affective ToM in adults with ASD. In contrast, the BFRT was not significantly related to the RMET in the TD ($r = -.09$, 95% CI [−.40, .22], $p = .565$) or SCZ ($r = .01$, 95% CI [−.31, .32], $p = .976$) groups, indicating that face recognition ability was not associated with affective ToM in adults with TD or SCZ. Hierarchical multiple regression analyses confirmed that the BFRT is associated with the RMET only in the ASD group, even after controlling for the potential influence of sex and IQ (see online supplemental materials).

Statistical differences in r between SCZ and ASD, ASD and TD, and SCZ and TD were estimated using Fisher's r-to-Z transformation. Fisher's r-to-Z transformations indicated significant group differences in the magnitude of the correlation between the BFRT and RMET in ASD versus TD ($Z = 2.90$, $p = .002$) and ASD versus SCZ ($Z = 2.46$, $p = .008$). They also indicated no significant group difference in the magnitude of the correlation between the BFRT and RMET in SCZ versus TD ($Z = .41$, $p = .68$).

Discussion

This study examined group differences in face recognition and affective ToM in adults with ASD, SCZ, and TD, as well as associations between these constructs within each group. Adults with

Figure 2
Association Between Affective Theory of Mind and Face Recognition



Note. In the autism spectrum disorder (ASD) group, the Benton Facial Recognition Test (BFRT) was positively related to the Reading the Mind in the Eyes Test (RMET), indicating that better face recognition ability was associated with better affective theory of mind in adults with ASD. In contrast, the BFRT was not significantly related to the RMET in the typical development (TD) or schizophrenia spectrum disorder (SCZ) groups, indicating that face recognition ability was not associated with affective ToM in adults with TD or SCZ. See the online article for the color version of this figure.

ASD and SCZ did not differ in their affective ToM abilities, and both groups showed affective ToM difficulties compared with TD; however, face recognition ability was uniquely associated with affective ToM ability in ASD.

Our results suggest distinct relations between face recognition and affective ToM in in ASD and SCZ and add to a nascent literature directly comparing social–cognitive performance between the two disorders (Fernandes et al., 2018; Pinkham et al., 2019). As hypothesized and consistent with prior literature, adults with ASD and SCZ did not differ in affective ToM, but both showed difficulties relative to TD, suggesting affective ToM is similarly difficult in adults with ASD and SCZ. Our results extend those of Pinkham et al. (2019), which found similarity in diminished performance on the RMET in adults with ASD and SCZ and argued that such similarity helps to pinpoint common mechanisms in line with the National Institute of Mental Health's Research Domain Criteria (RDoC) framework. Adults with ASD had worse face recognition abilities than adults with SCZ, which is also consistent with the results of Pinkham et al. (2019). It is important to note that Pinkham et al. (2019) reported their ASD and SCZ groups were not matched on age or sex and argued that future comparative studies should match groups on these variables. Indeed, a large strength and extension of our present study is that the SCZ and ASD groups were matched on age and sex, further adding credence to our findings that replicate and extend those of Pinkham et al.(2019). This pattern of results comparing performance on these social–cognitive tasks suggests that common affective ToM difficulties in both groups may stem from difficulties in different lower-level processes.

Crucially, when examining how these social–cognitive constructs were associated, we found that in ASD, face recognition performance was diminished and associated with affective ToM. But in SCZ, face recognition was preserved, and observed affective ToM difficulties were not associated with face recognition. These findings add crucial data that help resolve the debate in the literature regarding the extent to which SCZ and ASD are disorders with distinct social–cognitive mechanisms (Boada et al., 2020; Eack, 2020). It has previously been argued that similar behavioral outcomes in ASD and SCZ can result from distinct causes, without implying mechanistic differences (Crespi, 2020; Crespi & Badcock, 2008). However, our study supports and extends the growing empirical (Morrison et al., 2017; Sasson et al., 2016, 2007) and theoretical (Pinkham & Sasson, 2020; Sasson et al., 2011) literature that argues, in contrast, there may be different mechanisms within ASD and SCZ that lead to similar behavioral outcomes. Indeed, our results show that despite both showing worse performance on affective ToM in both ASD and SCZ compared with TD, only the ASD group seems to show face recognition as a mechanism underlying difficulty with affective ToM. Our study is the first, to our knowledge, to document the distinct association between face perception and affective ToM in ASD that does not appear in SCZ or TD. By examining the extent to which face recognition and affective ToM are differentially associated in ASD, SCZ, and TD, the present study extends prior literature and suggests the mechanisms of social–cognitive dysfunction may be more distinct than prior work has suggested. Therefore, ToM difficulties in SCZ may stem from another underlying difficulty, dissociating them mechanistically from those seen in ASD.

Face recognition as a potentially unique social–cognitive difficulty in ASD has many important implications for understanding the extent to which ASD and SCZ diverge across the phenotypic continuum. According to a model of facial emotion recognition by Adolphs (2002), recognizing emotions in others' faces first involves visual perceptual processing of faces, followed by a conceptual and lexical analysis of the specific emotion being conveyed by others' expressions. Our findings suggest that this theory is only accurate for individuals with ASD, wherein when face processing performance is diminished, so too is the ability to accurately attribute mental states to others based on their emotional facial expressions. In SCZ and TD, however, it may be that conceptual analysis of emotions, or some other contributor, is a stronger driver of ultimate affective ToM ability. Recent literature has examined potential mechanisms underlying social–cognitive difficulties in SCZ, such as a general nonsocial cognitive deficit (Sjølie et al., 2020). Other work suggests impaired processing of facial motion within peripheral vision may explain social–cognitive difficulties in SCZ (Patel et al., 2020). Therefore, despite the appearance of social–cognitive similarities when considering affective ToM performance by itself, unpacking the reasons why clinical groups have ToM difficulties begins to reveal divergent mechanisms of social dysfunction in ASD and SCZ (Sasson et al., 2011; Vaskinn & Horan, 2020), and more work is needed to directly compare ASD and SCZ on candidate mechanisms of affective ToM difficulty. Moreover, future work is needed to determine whether prior theories of facial emotion recognition may need to be reconceptualized that account for these distinct associations in ASD, SCZ, and TD.

The present study also sought to replicate past research demonstrating that adults with ASD and SCZ show difficulties in affective ToM and face recognition ability compared with adults with TD. Findings were only partially consistent with prior research. As hypothesized, adults with ASD and SCZ each showed diminished performance in affective ToM compared with adults with TD. This result supports the large literature documenting affective ToM difficulty in SCZ and ASD compared with TD (Gilleen et al., 2017). Also in line with our hypotheses, we found that adults with ASD showed diminished performance in face recognition ability compared with TD adults, which corroborates the literature on face recognition difficulties in ASD (Lozier et al., 2014; Weigelt et al., 2012). However, in contrast to our hypotheses, adults with SCZ did not show diminished performance in face recognition ability compared with TD adults. While the majority of the literature documents face recognition difficulties in SCZ (Bortolon et al., 2015), a small number of prior studies have also found no difficulties in face recognition ability (Hall et al., 2004; Pomarol-Clotet et al., 2010; Scholten et al., 2005; van't Wout et al., 2007). In a review, Bortolon et al. (2015) found that, for the studies in which diminished face recognition performance was not found, individuals with SCZ had a shorter mean duration of illness compared with the studies in which diminished face recognition performance was found. Indeed, a variety of illness-related factors have been found to influence face processing difficulties in SCZ, including symptom severity, age of illness onset, and inpatient treatment (Kohler et al., 2010). Thus, one possible reason for our unexpected finding is that the clinical characteristics of our sample were less severe, as individuals with SCZ recruited for this study from the Specialized Treatment for Early Psychosis clinic were currently experiencing the early course stage of SCZ. While evidence suggests that much of the cognitive challenges related to SCZ have already occurred by the first episode, it is still likely that more chronic forms of SCZ exhibit more severe cognitive difficulties (García-Fernández et al., 2020). Relatedly, a possible explanation for our unexpected finding is range restriction on the BFRT in the SCZ sample, although the range of performance on the BFRT in the SCZ group (i.e., 41–53) was comparable with that of the ASD group (i.e., 34–51). Moreover, another factor that may explain the lack of expected differences between the SCZ and TD groups on face recognition ability is that the exclusion of comorbid ASD from our SCZ sample, and vice versa, could have produced such a null finding, given that having higher levels of ASD traits in individuals with SCZ has a negative association with social cognition (Deste et al., 2020; Ziermans et al., 2020). It is similarly possible that other differences in our SCZ sample compared with past literature, such as the requirement for participants to have an IQ above 80 for appropriate group comparisons and validity of task participation, might help explain why we found a lack of group differences between SCZ and TD groups on the face recognition task. Some argue that clinical characteristics should be carefully assessed, controlled for, and compared in future studies to accurately examine how groups differ on different types of social cognition, particularly face recognition ability. Nonetheless, our sample characteristics and analytic approach are consistent with the argument that controlling for symptom differences between ASD and SCZ may artificially reduce the same differences that define the disorders, thereby potentially negating the reason to compare them in the first place (Pinkham et al., 2019).

Our findings may also have practical implications for how to optimally design interventions aimed at improving social–cognitive ability and reducing social difficulty in ASD versus SCZ. Indeed, it is well documented in the literature that face recognition ability and ToM ability are associated with social and adaptive functioning in ASD (Baron-Cohen et al., 2000; Trevisan & Birmingham, 2016). Despite there being a large literature on ToM interventions that are designed to target ToM to improve social ability in ASD (Fletcher-Watson et al., 2014), the literature on face recognition interventions in ASD is limited (Faja et al., 2007). Future research is needed to examine the possibility that interventions that target face recognition ability, rather than ToM by itself, may more directly improve social and adaptive functioning in ASD, though they would be expected to be less useful in SCZ.

Some limitations of the present study should be addressed in future research. The SCZ group had significantly lower IQ scores than the ASD group and the TD group, which may have affected the pattern of findings. However, IQ was unrelated to performance on the BFRT in ASD, SCZ, and TD, and the direction of the relation between IQ and performance on the RMET was the same for both ASD and SCZ (see online supplemental materials). In addition, when running linear regressions controlling for IQ and sex, the results remains the same, suggesting that our findings are meaningful above and beyond any differences in IQ and sex ratio (see online supplemental materials). While both ASD and SCZ are spectrum disorders, future research is needed to examine our findings in larger samples with more heterogenous symptom severity, age, and stage of illness development. Another limitation of the present study is that the RMET has been questioned for use in neuropsychiatric populations, as ecological validity is weakened by static images, the specificity of cues, and the forced-choice response format (Eddy, 2019). However, the RMET remains a widely used measure of affective ToM across clinical and nonclinical populations, and validity is supported by strong associations with other social–cognitive measures, strong test–retest reliability, and consistently documented associations with clinical change in psychosis as well as ASD social symptom severity (Eddy, 2019; Rosenthal et al., 2019). Finally, the correlational design of the present study and the time constraints of clinical research that prevented a larger behavioral testing battery from being administered are limitations that should be addressed in future work. It is likely that other factors, other than solely face perception, are involved in affective ToM difficulties in both ASD and SCZ that were not examined in the present study. Future experiments should test the possibility, for example, that the problem in ASD may not be one of a difficulty with face perception per se, but rather with associating one set of stimuli (i.e., emotions) variably with another set (i.e., facial expressions). Future experimental work, as well as studies with larger behavioral testing batteries of different social, cognitive, and affective measures and larger sample sizes, are needed to further delineate the complex mechanisms that underlie affective ToM difficulties in ASD and SCZ.

It is also critical for future theoretical and empirical work to consider how the social–cognitive constructs in the present study should be theoretically conceptualized and empirically measured. Indeed, there is a longstanding debate in the literature regarding the ways in which ToM should be defined and measured (Apperly, 2012; Conway et al., 2019; Schaafsma et al., 2015; Turner & Felisberti, 2017; Wellman, 2014). Classic affective ToM decoding tasks, such as the RMET, have been criticized for relying on the ability to recognize complex emotional states rather than pure affective mental state reasoning (Oakley et al., 2016). Given Oakley et al.'s (2016) finding that alexithymia—defined as poor recognition of one's emotions—predicted RMET performance, rather than ASD diagnosis, some researchers argue that more psychometric work is needed to design and validate tasks that may better capture the construct of affective ToM as a factor distinct from facial emotion recognition. However, the overlapping conceptual relation between emotion perception and ToM is not yet well understood in clinical or nonclinical populations (R. Mitchell & Phillips, 2015). Even critics of the RMET acknowledge that a possible alternative interpretation is that the "process of emotion recognition could be defined as a form of mental state inference" and that "the link between ToM and emotion recognition is relatively underinvestigated" (p. 821; Oakley et al., 2016). Indeed, leading ToM theorists subscribe to the idea that the ability to recognize facial emotions in others is an essential *component of* advanced affective ToM—a theoretical viewpoint resting on the assumption that humans likely use a mix of strategies that cut across social–cognitive processes (e.g., face recognition, emotion recognition) to infer the mental states of others (Apperly, 2012; J. Mitchell, 2005; Schaafsma et al., 2015; Wellman, 2014). Nonetheless, more basic science work is needed to examine the construct validity of tasks that were designed to measure affective ToM in individuals with and without SCZ and ASD. Particularly as our field is only beginning to "deconstruct and reconstruct" the conception of ToM (Schaafsma et al., 2015), future work that replicates our findings using other measures of affective

ToM, and other related social–cognitive constructs, will be informative.

In summary, by directly comparing social cognition in adults with ASD and SCZ, our results add critical evidence to the long-standing debate in the literature about the extent to which behavioral manifestations of these two disorders overlap and diverge (Chisholm et al., 2015). They suggest that despite similar social–cognitive difficulties compared with TD, the mechanisms of social–cognitive dysfunction in ASD, compared with SCZ, may be more related to visual perceptual processing of faces. Furthermore, our data suggest that affective ToM is uniquely related to face recognition in ASD. This study provides a critical understanding of the ways in which social–cognitive difficulties are similar and different between SCZ and ASD and calls for future research to examine other potential underlying mechanisms of social–cognitive difficulties across different disorders.

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