Misperceptions of Facial Emotions Among Youth Aged 9–14 Years Who Present Multiple Antecedents of Schizophrenia

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People with schizophrenia display a marked impairment in recognizing emotions in the faces of others, particularly anger, sadness, and fear, and less difficulty recognizing happy expressions.1,2 Facial emotion recognition (FER) difficulties are associated with poor social functioning3 and have implications for the development, course, and outcome of the disorder.4 Yet, interventions to improve FER performance (eg, Training of Affect Recognition)5 can reduce these deficits and elicit generalized improvement in other social cognitive domains.6

FER impairments are apparent not only among individuals with chronic schizophrenia (for review see Kohler et al 2010)2 but also among individuals experiencing a first episode of psychosis7,8 and among unaffected adolescent (though only for neutral facial expressions)9 and adult first-degree relatives of individuals with schizophrenia.10 Thus, abnormalities in FER are present at illness onset and may also index vulnerability for schizophrenia. Prospective studies following individuals at elevated risk for developing schizophrenia are needed to determine the extent to which impairments of FER precede illness and represent potential targets for early intervention. Among symptomatic, help-seeking individuals meeting ultra-high risk (UHR) criteria for psychosis,7,8,11–13 evidence for FER impairments is mixed. Two studies reported FER impairments relative to healthy participants,7,11 while another study indicated specific difficulties in correctly identifying neutral expressions.13 A study of a large British birth cohort comprising 5267 children reported no association between FER at 8 years and subclinical psychotic symptoms at 12 years.14

Similar to adults with schizophrenia, youth at high risk for developing schizophrenia present difficulties in recognizing emotions in faces. These difficulties might index vulnerability for schizophrenia and play a role in the development of the illness. Facial emotion recognition (FER) impairments have been implicated in declining social functioning during the prodromal phase of illness and are thus a potential target for early intervention efforts. This study examined 9- to 14-year-old children: 34 children who presented a triad of well-replicated antecedents of schizophrenia (ASz), including motor and/or speech delays, clinically relevant internalizing and/or externalizing problems, and psychotic-like experiences (PLEs), and 34 typically developing (TD) children who presented none of these antecedents. An established FER task (ER40) was used to assess correct recognition of happy, sad, angry, fearful, and neutral expressions, and facial emotion misperception responses were made for each emotion type. Relative to TD children, ASz children presented an overall impairment in FER. Further, ASz children misattributed neutral expressions to face displaying other emotions and also more often mislabeled a neutral expression as sad compared with healthy peers. The inability to accurately discriminate subtle differences in facial emotion and the misinterpretation of neutral expressions as sad may contribute to the initiation and/or persistence of PLEs. Interventions that are effective in teaching adults to recognize emotions in faces could potentially benefit children presenting with antecedents of schizophrenia.

Key words: emotion recognition/high risk/child and adolescent psychopathology/social functioning/psychotic-like experiences
psychotic-like experiences (PLEs) on questionnaires were poorer at recognizing facial emotional expressions, primarily sadness.\textsuperscript{15} Unfortunately, as with many previous FER studies, no information was provided about the nature of the facial emotion misperceptions committed when processing facial expressions. Though PLEs in childhood are significantly associated with later psychotic illness,\textsuperscript{16,17} they are also associated with an increased risk of anxiety disorders\textsuperscript{16} and other psychiatric disorders including affective disorders, drug use disorders, and personality disorders,\textsuperscript{18} albeit to a lesser extent. Thus, PLEs constitute a relatively nonspecific marker of risk for subsequent psychiatric disorders. Further, cross-sectional data from the general population indicate significant comorbidity of PLEs with emotional and behavioral problems,\textsuperscript{19,20} implying that the observed relationship between PLEs and FER reported by Roddy et al\textsuperscript{15} might reflect the presence of unreported internalizing and/or externalizing psychopathology.

To better characterize the nature of FER associated with schizophrenia, several studies have examined facial emotion misperceptions. Relative to healthy adults, individuals with schizophrenia more often mislabel negative emotions to faces displaying no or neutral expressions.\textsuperscript{21,22} Adolescent relatives of individuals with schizophrenia, compared with adolescents from healthy families, also more often incorrectly label neutral expressions as displaying negative emotions, predominantly mislabeling them as sad.\textsuperscript{9} Among individuals with schizophrenia, and individuals at high risk for psychosis,\textsuperscript{23} functional imaging has revealed hyperactivation of the amygdala during the processing of neutral expressions, which could reflect emotional salience being assigned to neutral stimuli.\textsuperscript{24} It has been suggested that the tendency to misinterpret neutral facial expressions as displaying emotion may contribute to the development of positive symptoms in schizophrenia.\textsuperscript{23} Previous research indicates that facial emotion misperceptions might constitute the cognitive mechanism contributing to the social impairment that characterizes UHR samples\textsuperscript{13} and is a critical component to understanding FER difficulties in samples at risk for schizophrenia.

Until recently, there has been no practical method for identifying children who are at elevated risk for schizophrenia. Despite the high heritability of schizophrenia, only approximately one-third of individuals with schizophrenia have a first- or second-degree relative with the illness. Consequently, a positive family history identifies only a subset of children who will develop the illness.\textsuperscript{25} Prospective investigations of birth cohorts have demonstrated consistently that, by middle childhood, individuals who later developed schizophrenia presented delays in motor and language development; disturbances in social, emotional, and behavioral functioning; and PLEs.\textsuperscript{17} Based on this evidence, we developed questionnaires, to be completed by children aged 9–12 years and their primary caregiver, to identify children who present a triad of these replicated antecedents of schizophrenia (ASz).\textsuperscript{26,27} We defined ASz to include (1) early speech and/or motor developmental delays/abnormalities; (2) social, emotional, and/or behavioral problems in the clinical range; and (3) PLEs. It is thought that the identification of children who present multiple antecedents of schizophrenia that have been replicated in prospective longitudinal studies will offer greater sensitivity and specificity for later development of schizophrenia than any one antecedent.

We are currently following the development of ASz children to determine the specificity and sensitivity of the triad of antecedents for later schizophrenia development. We anticipate that some ASz children will develop schizophrenia and spectrum disorders, some will develop other disorders, and others will remain healthy. In the interim, our investigations have shown that ASz children, compared with typically developing (TD) children who present no antecedents and no family history of schizophrenia or a spectrum disorder, are characterized by features observed among adults with schizophrenia including (1) deficits in performance on standardized intelligence and neuropsychological tests of executive function and memory,\textsuperscript{28} (2) dyskinetic movement abnormalities,\textsuperscript{29} (3) reduction in the amplitude of the error-related negativity event-related potential component generated in the anterior cingulate that indexes internal monitoring of behavior,\textsuperscript{30} and (4) structural brain abnormalities in the superior/middle temporal gyri.\textsuperscript{31} Further, among children aged 9–12 years, two-thirds (69%) of those presenting with the triad of antecedents report distress and/or functional impairment associated with their PLEs.\textsuperscript{27}

This study sought to determine whether ASz children present FER difficulties similar to those reported among individuals with schizophrenia and at-risk youth, after accounting for intelligence quotient (IQ) differences between ASz and TD groups,\textsuperscript{28} which may contribute to FER performance. The study examined overall performance on FER tasks, as well as the specific nature of facial emotion misperceptions. We hypothesized that ASz children would be less accurate than TD children in identifying emotions in facial expressions and that they would more often mislabel neutral faces with other emotion expressions. In particular, we anticipated that ASz children would misidentify neutral expressions as sad, as was reported in a study of youth with family histories of schizophrenia using the same FER task.\textsuperscript{9}

Method

Participants

Classrooms of children aged 9–14 years and their caregivers completed questionnaires to assess replicated antecedents of schizophrenia (see online supplementary material for further details). In brief, ASz children were defined as those presenting (1) a score in the clinical range
(top tenth percentile of UK population norms) on the
child-reported emotional symptom scale or the caregiver-
reported conduct problems, hyperactivity-inattention,
or peer relationship problem scales of the Strengths
and Difficulties Questionnaire (SDQ); (2) a child-
reported “certainly-true” response on at least 1 of 9 PLE
items assessing subclinical hallucination and delusion
symptoms, and (3) a caregiver report of a motor and/
or speech delay and/or abnormality. TD children were
defined as those meeting none of these 3 criteria and who,
in addition, had no first-, second-, or third-degree relative
with schizophrenia or a schizophrenia spectrum disorder,
as assessed by the Family Interview for Genetic Studies
conducted with the child’s caregiver.

Screening questionnaires were completed by 1504 chil-
dren aged 9–12 years and their primary caregiver, who
represented 19% of children attending 73 collaborating
primary schools in Greater London, United Kingdom.
Among these, 9.4% of children met criteria for ASz and
22.9% presented none of the 3 antecedents and were thereby
defined as TD. Approximately half of the families partici-
pating in questionnaire screening provided information,
allowing us to recontact them for further research. Among
families approached to participate in further research, 41% of
ASz and 42% of TD families declined participation. There were no differences observed as to age, sex, ethnicity,
and prevalence of ASz triad components among ASz and
TD children who participated and ASz or TD children
who did not take part, with 1 exception. The proportion of
ASz children who completed the FER task who obtained
SDQ scores for emotional problems in the clinical range
was significantly smaller than that of the ASz children who
did not participate in this study.

The sample included 34 ASz and 34 TD participants,
the latter selected as the best individual matches to the
ASz children on sex and ethnicity from among 44 TD
children who completed the FER task. Five ASz children
in this study had at least 1 second-degree relative with a family history of schizophrenia or a schizophrenia
spectrum disorder. None of the children presented a
diagnosis of autism or Asperger’s disorder, neurological
disorder, or learning difficulties (IQ < 70), or had ever
taken antipsychotic medication. As presented in table 1,
at the time of testing, ASz and TD children did not differ
on age, proportion male, ethnicity, or length of time
since initial assessment. ASz children were characterized
by significantly lower IQ than TD children.

Children provided written assent, and caregivers pro-
vided written informed consent, for participation in the
study. Ethical review of the study was provided by the
Joint South London and Maudsley National Health
Service Foundation Trust and the Institute of Psychiatry
Research Ethics Committee.

Table 1. Demographic and Intellectual Characteristics of Participants

<table>
<thead>
<tr>
<th></th>
<th>ASz (n = 34)</th>
<th>TD (n = 34)</th>
<th>Statistics</th>
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<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
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<tr>
<td>Proportion male</td>
<td>23 (68)</td>
<td>20 (59)</td>
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<tr>
<td>Ethnicitya</td>
<td>9 (27)</td>
<td>12 (35)</td>
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<tr>
<td>White British</td>
<td>9 (27)</td>
<td>7 (19)</td>
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</tr>
<tr>
<td>White other</td>
<td>7 (19)</td>
<td>11 (32)</td>
<td></td>
</tr>
<tr>
<td>Black African; African Caribbean</td>
<td>9 (27)</td>
<td>7 (21)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9 (27)</td>
<td>4 (12)</td>
<td></td>
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<tr>
<td>Age at facial emotion assessment</td>
<td>Mean</td>
<td>Mean</td>
<td></td>
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<tr>
<td></td>
<td>12 y, 1 m</td>
<td>12 y, 5 m</td>
<td>t(66) = −1.2, P = .2</td>
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<td></td>
<td>17 m</td>
<td>16 m</td>
<td></td>
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<tr>
<td>Mean time between completion of antecedent screening questionnaires and facial emotion assessment</td>
<td>Mean</td>
<td>Mean</td>
<td></td>
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<tr>
<td></td>
<td>23 m</td>
<td>28 m</td>
<td>t(66) = −1.5, P = .1</td>
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<tr>
<td></td>
<td>14 m</td>
<td>14 m</td>
<td></td>
</tr>
<tr>
<td>IQb</td>
<td>98.6</td>
<td>109.7</td>
<td>t(66) = −4.1, P &lt; .001</td>
</tr>
<tr>
<td></td>
<td>10.3</td>
<td>12.2</td>
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</tbody>
</table>

Note: ASz: presenting the triad of antecedents of schizophrenia; TD: presenting none of antecedents of schizophrenia or family history
of the disorder; y: years; m: months.

aEthnicity was assessed according to the UK Census ethnic categories defined by the Office of National Statistics 2001; “Black African;
African-Caribbean” included children of mixed white-black African Caribbean ethnicity; “Other” included children predominantly of
mixed ethnicity.

bIQ estimated using Wechsler Abbreviated Scale of Intelligence.
facial expressions (8 photographs of each emotional expression). The photographs were balanced for the intensity of emotion expressed (mild or high), and the age, gender, and ethnicity of the faces. Each face was presented serially on a computer screen, in random order, with 5 response options displayed to the right of each photograph (ie, “happy,” “sad,” “angry,” “fear,” or “no emotion” [neutral]). For each photograph, participants were instructed to select the response that best described the displayed emotion, as quickly and as accurately as possible. Responses were selected by computer-mouse click. Each face was displayed until a response was recorded. Details of task construction and ratings have been reported previously.37

Dependent variables extracted from the task for analysis were (1) number of correct responses for each type of emotion expression and (2) number of misattribution and mislabeling responses made for each type of emotion.

Procedure

Eligible children and their primary caregivers were invited to participate in a research study that incorporated the ER40 task within a comprehensive battery of assessments including measures of biological, psychosocial, and neurocognitive functioning. The ER40 was administered by a trained researcher using standard instructions. Participants practiced the task to ensure understanding of instructions. Testing time was approximately 10 min.

Statistical Analyses

Comparisons of the ASz and TD children on age at time of FER assessment, time since initial assessment and group assignment, and IQ, assessed using the Wechsler Abbreviated Scale of Intelligence,38 were made using independent t tests; group differences on sex and ethnicity were tested using chi-square analyses. IQ was entered as a covariate in all FER analyses.

Previous investigations have indicated that FER performance improves during childhood and adolescence.39 Accordingly, we performed correlation analyses between each ER40 variable and age; parametric correlation analyses (Pearson coefficient) were conducted on normally distributed performance variables, and nonparametric correlation analyses (Spearman coefficient) were performed on nonnormally distributed performance variables. No significant associations between task performance variables and age were detected.

Correct Identification of Facial Emotions. To examine the accuracy of facial emotion expression identification, a 2-group (ASz, TD) by 5-emotion (happy, sad, angry, fearful, and neutral) repeated-measures ANCOVA adjusting for IQ was conducted on the number of correct responses recorded for each emotion.

Facial Emotion Misperceptions. Facial emotion misperceptions were examined by summing the total number of responses that (1) misattributed each emotion (eg, sadness) to faces expressing another emotion (eg, misattributing happy expressions-as-sad, angry expressions-as-sad, fearful expressions-as-sad, and neutral expressions-as-sad error types) and (2) incorrectly labeled each emotion (eg, mislabeling angry-as-happy expressions, angry-as-sad expressions, angry-as-fearful expressions, and angry-as-neutral expressions). For each of these 10 variables, proportions of total misperceptions were created by dividing these sums by the total number of incorrect responses possible (ie, 32) and multiplying by 100 to obtain a percentage for each misattribution and mislabeling misperception response type. Group differences were then explored using independent samples t tests for normally distributed proportions or Mann-Whitney U tests for nonnormally distributed proportions. Significant group effects were then further examined using repeated-measures ANCOVAs on the mean number of misattribution or mislabeling responses, with IQ as a covariate. The mean number of misattributions and mislabeling responses were not normally distributed, and a square root transformation was applied.40

For all ANCOVAs, follow-up simple main effects testing with Bonferroni adjustments for multiple comparisons were also conducted. Greenhouse-Geisser correction for repeated measures was employed for all but the mislabeling of emotions to face displaying anger and with estimates of effect size for each analysis reported.

Assessment of Triad Stability. FER assessments were completed, on average, 2 years after the initial identification of children using antecedent screening questionnaires. At the time of FER assessments, children completed the same questionnaires used to determine group assignments in order to reassess the 2 ASz triad components that could change over time. Of the 34 ASz children, 4 (12%) obtained scores on the SDQ psychopathology subscales in the “normal” range based on UK population norms, and they responded “not true” on all 9 PLE items. All ANCOVAs were repeated excluding these 4 children. As results were similar to those obtained with the complete sample who met ASz criteria at the initial community screening assessment, these analyses are presented in online supplementary material.

Associations With ASZ Components. Four multiple linear regression models were computed to explore associations of the components of the antecedent triad with the 4 facial emotion processing outcome variables on which ASz children performed significantly more poorly than TD peers: total correct facial emotion identifications, misattribution of neutral expressions to faces displaying other emotions, mislabeling of other emotions to faces displaying anger, and mislabeling of sadness to faces displaying neutral expressions. Each model included the
6 predictors assessing the triad components, total PLE score, total number of speech and/or motor delays or abnormalities, and scores for SDQ subscales assessing emotional problems, conduct problems, hyperactivity-inattention, and peer relationships problems.

**Results**

Table 2 presents means and standard deviations for correct responses by emotion type and for the 4 total emotion misperceptions (misattribution and mislabeling error) that showed statistically significant group differences. Cohen’s $d$ effect sizes indicating the magnitude of difference among groups (where an effect size of 0.2 indicates a small effect, 0.5 a medium effect, and 0.8 a large effect) and Bonferroni adjusted $P$-values are also indicated. Figure 1 illustrates the proportions of misidentifications of each emotion to faces displaying no emotion, separately for ASz and TD children.

**Correct Identification of Facial Emotions**

The 2-group (ASz, TD) by 5-facial emotion type (happy, sad, angry, fearful, neutral) ANCOVA on the number of correct responses, including IQ as a covariate, indicated a significant main effect of group [$F(1,65) = 8.5, P = .005, \eta^2 = .12$], with TD correctly identifying more emotions than ASz. No significant main effect of emotion type [$F(3.1, 204.3) = 2.1, P = .09, \eta^2 = .03$] or group-by-emotion interaction was detected [$F(3.1, 204.3) = 2.0, P = .11, \eta^2 = .03$].

**Facial Emotion Misperceptions**

Among the 10 analyses conducted on the proportion of emotion misperception response types, 4 significant differences between ASz and TD were detected: (1) misattribution of sadness to faces displaying other emotion ($z = -1.9, P = .05$), (2) misattribution of neutral expressions to faces displaying other emotions ($z = -2.7, P = .007$), (3) mislabeling other emotions to faces displaying angry expressions ($z = -2.6, P = .01$), and (4) mislabeling other emotions to faces displaying neutral expressions ($z = -2.2, P = .02$).

**Misattribution of Sadness to Faces Displaying Other Emotions**

A 2-group (ASz, TD) by 4-facial expressions misattribution type (happy-as-sad, angry-as-sad, fear-as-sad, and neutral-as-sad) repeated-measures ANCOVA, including IQ as a covariate, indicated no main effect of group [$F(1.65) = 2.6, P = .11, \eta^2 = .04$], no main effect of misattribution type [$F(2.1,136) = 0.63, P = .54, \eta^2 = .01$], and no group-by-misattribution type interaction [$F(2.1, 136) = 2.4, P = .09, \eta^2 = .04$].

**Misattribution of Neutral Expressions to Faces Displaying Other Emotions**

A 2-group (ASz, TD) by 4-facial expression misattribution type (happy-as-neutral, sad-as-neutral, angry-as-neutral, and fear-as-neutral) repeated-measures ANCOVA, including IQ as a covariate, indicated a significant main effect of group [$F(1.65) = 7.6, P = .007, \eta^2 = .11$] due to ASz misattributing neutral expressions to faces displaying other emotions relative to TD (ie, failing to detect emotion). No main effect of misattribution type [$F(2.8,185.5) = 0.50, P = .68, \eta^2 = .008$] or group-by-misattribution type interaction was detected [$F(2.8, 185.5) = 1.2, P = .32, \eta^2 = .02$].

| Table 2. Comparisons of Performance on the ER40 Facial Emotion Recognition Task by ASz and TD Children |
|--------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Performance Variable (Maximum Score Possible)   | ASz ($n = 34$) | TD ($n = 34$)  | Effect Size     |
| Mean number of total correct responses (40)     | M (30.2) SD (3.7)| M (33.1) SD (2.4)| $<.01; 0.9$    |
| Mean number of correct responses                |                 |                 |                 |
| Happy expressions (8)                           | 7.8 (3.7)       | 7.9 (4.0)       | $.37; 0.2$      |
| Sad expressions (8)                             | 5.3 (1.7)       | 6.1 (1.3)       | $.05; 0.5$      |
| Angry expressions (8)                           | 4.0 (1.6)       | 4.9 (1.1)       | $.02; 0.7$      |
| Fear expressions (8)                            | 6.7 (1.3)       | 7.1 (1.2)       | $.81; 0.3$      |
| Neutral expressions (8)                         | 6.4 (1.9)       | 7.2 (1.2)       | $.15; 0.3$      |
| Mean number of misperceptions$^a$               |                 |                 |                 |
| Other emotions misattributed as “Sad” expressions| 2.5 (3.7)       | 1.4 (1.5)       | $.11; 0.6$      |
| Other emotions misattributed as “Neutral” expressions| 3.9 (2.2) | 2.5 (1.4) | $.01; 0.8$      |
| “Angry” expressions mislabeled as other emotions| 4.0 (1.6)       | 3.0 (1.1)       | $.01; 0.7$      |
| “Neutral” expressions mislabeled as other emotions| 1.7 (1.9)       | 0.8 (1.2)       | $.14; 0.6$      |

$^a$Face emotion misperceptions repeated-measures ANCOVAs were performed on square-root transformed data.

$^b$Bonferroni adjusted $P$-values.
Facial Emotion Misperceptions Among At-Risk Youth

Mislabeling of Other Emotions to Faces Displaying Angry Expressions

A 2-group (ASz, TD) by 4-mislabeling type (angry-as-happy, angry-as-sad, angry-as-fear, and angry-as-neutral) repeated-measures ANCOVA, including IQ as a covariate, was computed. Results indicated a significant main effect of group \[ F(1,65) = 7.1, P = .01, \eta^2 = 0.1 \], with ASz more often mislabeling angry expressions as displaying other emotions relative to the TD. No main effect of misattribution type \[ F(3,195) = 0.19, P = .90, \eta^2 = 0.003 \] or group-by-mislabeling type interaction was observed \[ F(3,195) = 0.45, P = .72, \eta^2 = 0.01 \].

Mislabeling of Emotion to Faces Displaying No Emotion (Neutral Expressions)

A 2-group (ASz, TD) by 4-mislabeling (neutral-as-happy, neutral-as-sad, neutral-as-fear, and neutral-as-angry) repeated-measures ANCOVA, including IQ as a covariate, was conducted. Results indicated no main effect of group \[ F(1,65) = 2.2, P = 0.14, \eta^2 = 0.03 \] or mislabeling type \[ F(1.9,122.2) = 0.12, P = 0.88, \eta^2 = 0.01 \]. A significant group-by-mislabeling type interaction was detected \[ F(1.9, 122.2) = 3.2, P = .05, \eta^2 = 0.05 \], with ASz significantly more often mislabeling neutral expressions as sad than TD \( P = .04 \).

Associations With ASz Components

From all 4 regression models, only 1 significant relationship was detected: hyperactivity-inattention problems independently predicted misattribution of sadness to faces with neutral expressions \( (\beta = 0.10, t = -2.2, P = .04) \).

Discussion

This study of FER extends our recent work characterizing dysfunctions among children presenting multiple, well-replicated antecedents of schizophrenia.\(^{28,30}\) At the initial assessment, these children were younger than youth with a family history of schizophrenia or who met UHR criteria previously examined in FER investigations. As hypothesized, ASz children performed more poorly on FER than TD children after accounting for group differences in IQ. This finding is similar to that reported for older UHR samples.\(^{8,11,13}\) These findings extend previous observations of FER impairments among adults with schizophrenia,\(^ {21}\) and individuals at risk for schizophrenia, in some\(^ {7,9,13,15,36}\) but not all\(^ {8,11,12}\) studies. In addition, ASz children, compared with TD children, misattributed faces displaying emotions as neutral expressions, and more often mislabeled neutral expressions as sad. Further, the examination of mislabeling of faces displaying anger indicated that ASz children had some difficulties identifying anger. Among ASz children, FER performance was not associated with specific components of the antecedent triad, with the exception that the score for hyperactivity-inattention problems independently predicted misattribution of sadness to faces with neutral expressions. Previous studies have not reported specific biases in FER task performance among adolescents with Attention Deficit Hyperactivity Disorder but indicate that these adolescents show random patterns of performance associated, perhaps, with impulsivity.\(^ {42}\) Thus, for the most part, the components of the triad of antecedents did not independently account for FER difficulties observed among ASz children. Rather, it was the
combination of all of the antecedents defining ASz that was associated with anomalies in FER task performance.

ASz children had difficulty correctly identifying angry facial expressions relative to TD children. However, among adults with schizophrenia and individuals with first-episode psychosis, pronounced difficulties are apparent in recognizing negative emotions such as anger, fear, and disgust. An investigation of individuals who met UHR criteria, and who were approximately 3 years older than children in this study, reported difficulties only in recognizing fear and sadness. More recently, a study of youth aged 10–13 years who reported PLEs observed difficulties identifying sadness in faces using a pencil and paper version of the ER40 task. By contrast, trend level impairment in recognizing fear was reported among young adults with high levels of nonclinical psychosis relative to those experiencing low levels, using the well-validated computerized version of the ER40 task. Inconsistent evidence for an impairment in recognition of negative facial emotion expressions among at-risk individuals suggests that these difficulties may become more apparent when FER skills are fully developed.

Alternatively, inconsistencies in results of FER impairments across high-risk samples may result from differences in methodologies, including task design, emotion expressions that are assessed, and stimulus complexity. In particular, the absence of neutral facial expressions in some FER paradigms is notable. Of the studies that included neutral faces and reported differences in FER among individuals at high risk for schizophrenia relative to a healthy comparison group, 2 reported a specific impairment in the recognition of neutral facial expressions among the high-risk participants. The studies that detected no difference in FER performance between at-risk and healthy individuals did not include neutral facial expressions in their FER paradigms.

ASz children misattributed emotions to neutral expressions, and more often mislabeled a neutral expression as sad compared with healthy peers. It was not possible to explore potential interactions between emotion type and intensity of the expressions. Consequently, this study could not determine whether the response bias shown by ASz children reflected problems identifying emotions of low intensity in faces. Previously reported hyperactivation of the amygdala during processing of neutral expressions may explain, at least in part, the mislabeling of emotions to neutral expressions by ASz children, and, as suggested in previous reports of similar findings, the result from this study is consistent with the notion that the development of schizophrenia involves the aberrant assignment of salience to insignificant stimuli.

ASz children, by definition, present several of the known antecedents of schizophrenia including motor/speech abnormalities; PLEs; and social, emotional, and/ or behavioral problems. Previous studies by our group have also shown that they present with dysfunctions characteristic of individuals with schizophrenia. This study shows that these children also exhibit difficulty recognizing emotions in the faces of others, thereby lacking crucial information needed to guide their own behavior and to understand the behavior of others. It is plausible that the misinterpretation of facial emotions may contribute to the initiation of and/or persistence of PLEs. Indeed, previous research has indicated that difficulties in accurately perceiving emotion in the faces of others, particularly the mislabeling of neutral faces as negative expressions, contributes to some symptoms of schizophrenia such as delusion formation and suspicious thoughts. It was not possible to determine the precise temporal association between the onset of PLEs and poor FER in this study. However, FER difficulties were observed in these children who continued to present the triad of ASz at time of FER assessment, approximately 2 years after the initial assessment. Thus, poor FER may be associated with persistent PLEs and social, emotional, and behavioral difficulties. Furthermore, difficulties with FER may also contribute to the poor social functioning observed among adults with schizophrenia, to the declining social and role functioning that characterizes the prodromal period, and also to the premorbid social impairments reported among youth at high risk for schizophrenia. Thus, interventions that have been shown to increase the accuracy of FER among adults with schizophrenia could potentially benefit ASz children. This study has several limitations. The ER40 task output did not distinguish correct emotion responses by the 2 levels of emotional intensity displayed in the faces. Therefore, it is not clear whether the significant differences between ASz and TD children in mislabeling a neutral expression as sad or incorrectly identifying emotional expressions as neutral or sad occurred primarily in facial expressions of low intensity. In real-life social interactions, faces typically display subtle variations in emotional expressions. Further, FER difficulties observed among ASz children may also be due to basic face identification/perception deficits that were not examined. Deficits in face perception have been identified in some, but not all, studies of adults with schizophrenia and may reflect impairments in memory and attention. To date, only 1 study has included a task of face perception while investigating FER deficits among individuals at-risk for schizophrenia, and findings indicated no impairment. Finally, this study was limited by a relatively small sample. Nonetheless, despite limited statistical power, the results consistently demonstrated that children who presented multiple antecedents of schizophrenia since late childhood presented FER difficulties compared with TD peers.

This study benefited from using a FER test that has been used widely in previous studies of schizophrenia and, importantly, incorporated neutral facial expressions.
This allowed for meaningful comparisons of results with some previous studies. The study identified children characterized by multiple, well-replicated antecedents of schizophrenia. This strategy may capture a broader range of children at risk for schizophrenia than selecting children with a family history of illness and a smaller number with higher risk than studies using only 1 antecedent such as PLEs to select children. Only follow-up of children defined as presenting ASz will determine the specificity and sensitivity of this strategy for identifying children who will subsequently develop schizophrenia.

This study obtained evidence of impairments in FER abilities among children and adolescents who may be at elevated risk for developing schizophrenia in adulthood. The study provided further support for the accumulating evidence that misattributions of emotional facial expressions as neutral, and the identification of neutral expressions as sad, may represent early risk markers for later development of schizophrenia. These impairments may represent targets for preventive interventions, which may in turn facilitate generalized improvements in social and emotional functioning among individuals at risk for schizophrenia.

**Supplementary Material**

Supplementary material is available at [http://schizophrenia.bulletin.oxfordjournals.org](http://schizophrenia.bulletin.oxfordjournals.org).

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