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Emotional Face Perception: Event-Related Potentials (ERPS) Contribution to Differentiate Schizophrenia and Autism Spectrum Disorders in Adolescents

Valérie Bonnard-Couton[1*], Emmanuelle Dor[1], Andreia Santos[2], Michel Benoit[3] and Florence Askenazy[1]

[1]*University Child and Adolescent Psychiatry Department, Children's Hospitals of Nice CHU-Lenval, CoBTek EA7276 University of Nice Sophia Antipolis, Nice, France*

[2]*Autism Resources Center, University Child and Adolescent Psychiatry Department, Children's Hospitals of Nice Chu-Lenval, Cobtek Ea7276 University of Nice Sophia Antipolis, Nice, France*

[3]*Department of Psychiatry, University Hospital of Nice, France*

[*]**Corresponding author:** Bonnard-Couton V, et al. University Child and Adolescent Psychiatry Department, Children's Hospitals of Nice CHU-Lenval, CoBTek EA7276 University of Nice Sophia Antipolis, Nice, France; Tel: 0033492030372; E-mail: bonnardcouton.v@pediatrie-chulenval-nice.fr

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Abstract

Early onset schizophrenia (EOS) and autism spectrum disorders (ASD) share similarities in the area of social cognition and emotion processing. It remains unclear whether these similarities come from shared or disorder-specific mechanisms and pathways. This study compared three groups of adolescents matched for age and verbal IQ: 18 adolescents with EOS (mean age=15 ± 1.6), 19 adolescents with ASD (mean age=15 ± 2.1) and 20 typically developing (TD) adolescents (mean age=14 ± 1.7). All groups completed an implicit emotional face perception task while visual ERPs (P100 and N170 components) were recorded. Both EOS and ASD adolescents showed impairments in emotion processing, but distinct patterns emerged in each disorder. These findings support the need for distinct early intervention approaches.

Keywords: Autism spectrum disorders; Event-related potentials; Schizophrenia

Introduction

The schizophrenia and autism spectrum disorders (ASD) diagnoses have been conflated in the past. Although they are now recognized as different neurodevelopmental diseases with distinct features, both present disordered social cognition [1]. It remains unclear whether these social dysfunction similarities derive from shared or disorder-specific mechanisms and pathways [2].

Social cognition involves a wide range of cognitive skills applied to social situations. These include emotion perception and recognition, theory of mind, attribution styles, and social knowledge [3]. Impairments of social cognition are well-recognized features of both conditions, but only a few studies have directly compared social cognitive impairment in schizophrenia and ASD [4]. Our study focused on emotional face perception, which is significantly related to social skills, general social functioning, and quality of life [5].

One of the most pervasive aspects of schizophrenia in interpersonal communication is disturbance in emotion processing, both in first episodes and in people at high clinical risk of psychosis [6-9]. Research in adolescents suggests an emotional impairment at an early stage of schizophrenia and in psychotic-like experiences [10-12]. People with ASD characteristically have face and emotion processing disruption [13].

The cognitive and cerebral mechanisms underlying emotion processing could therefore be divergent or disease-specific [2]. Little is known about the neural mechanisms of event-related potentials (ERPs) in emotional face perception in either children or adults.

ERPs are a powerful means for assessing the timing of cognitive functions and are useful for a functional exploration of neurocognitive emotional perception mechanisms in early onset schizophrenia (EOS) and ASD. Their excellent temporal resolution and their simple and economic clinical use facilitate investigation of these questions, particularly in the pediatric population. Two ERP components implicated in early visual processing, the P100 and N170, are involved in face processing and are modulated by emotion [14-16].

In adult schizophrenia, ERP studies exploring face detection have suggested "global[ly] deficient visual processing of emotional faces" [17,18]. In ASD, several studies have revealed divergent processing strategies of faces with a predominant defect in the N170 "face-sensitive" component [19-22]. Frequently considered separately in the literature, each disorder revealed either comparable or different clinical and neural patterns of social cognition impairments. Similar patterns of social cognition impairments in schizophrenia and ASD have been found when performing theory of mind, and emotion recognition tasks [23,24]. A neural comparison in functional magnetic resonance imaging (fMRI) of social cognitive functioning between ASD and schizophrenia also suggested comparable levels of dysfunction during tasks of complex social cognition with reduced activation in the amygdala, the fusiform face area and the ventrolateral prefrontal cortex [25]. Divergent patterns of impairment in social cognition have also been found between schizophrenia and ASD. Children or adolescents with ASD have a poorer performance than children with schizophrenia on a deception task [23] and in facial affect recognition, reinforcing the idea of emotion detection deficits as part of the endophenotype of autism [26]. Adults with ASD had greater impairment in social orienting compared with individuals with schizophrenia [27]. A systematic review of fMRI studies of the neural networks involved in

social cognition in both disorders did find disorder-specific differences [28].

Schizophrenia and ASD literature report non-specific abnormalities in emotional face processing without clearly differentiating the two disorders. Moreover, since previous studies concern adult populations, little is known about this process in the early course of both of these neurodevelopmental diseases. The originality of this study was to explore emotional face processing in a paediatric population. A controlled comparison of adolescents with EOS and adolescents with ASD using a standard procedure offers the prospect of elucidation of the neural mechanisms of emotion processing in each condition.

In this study, emotional face perception was assessed in adolescents with a clinical diagnosis of schizophrenia or ASD. The neural bases for social cognitive impairment were investigated with two early ERP components involved in facial emotion perception, the P100 and N170.

We hypothesized that there would be abnormalities in the electrophysiological processes of EOS and ASD, and that specific differences in the ERP components would discriminate specific mechanisms between EOS and ASD.

Materials and Methods

Participants

This multicenter study was carried out in the three main Child and Adolescent psychiatry departments of the district, including a university hospital, with the approval of the local ethics committee in accordance with the Declaration of Helsinki. All subjects meeting the inclusion criteria were prospectively recruited and were stable outpatients at the time of testing. Patients were classified in three groups: adolescents with a diagnosis of early onset schizophrenia (the EOS group), adolescents with a diagnosis of ASD (the ASD group), and typically developing controls (the TD group). Groups were chronologically and verbal age matched.

Adolescents aged from 12 to 18 years old were eligible for the study. Written informed consent from parents and adolescents involved in the study was obtained. Patients with an IQ score at the Wechsler Intelligence Scale for Children IV or Wechsler Adult Intelligence Scale less than 70 were excluded. Potential participants with substance abuse, epilepsy, significant sensory or motor impairment, or any neurological or genetic disorder were excluded from the study.

EOS diagnosis was by DSM IV criteria (APA, 2000) with the Kiddie-SADS-Present Version K-SADS-PL. Subjects recruited in the EOS group had all been diagnosed in adolescence. All ASD participants had current clinical diagnoses of ASD (autism or Asperger syndrome) and met research diagnostic standards for ASD based on the autism diagnostic observation schedule (ADOS), the autism diagnostic interview (social and communication domains) (ADI-R) and expert clinical judgment informed by DSM-IV criteria. All ASD cases were first diagnosed in childhood. TD adolescents were volunteers free of any psychiatric disorder after a validated structured interview (K-SADS-PL), recruited from a general pediatric population. Inclusion and exclusion criteria were the same as those for adolescents with EOS or ASD [29-31].

Clinical ratings were done for EOS patients by the positive and negative syndrome scale (PANSS), the scale for the assessment of negative symptoms (SANS) and the scale for the assessment of thought, language, and communication (TLC) [32-34].

Stimulus materials and procedure

We used an emotional face perception task developed for a previous study using pictures from the Radboud Faces Database [35,36]. Participants are asked to silently observe a set of color images of adult, adolescent and child faces expressing various emotions, presented on a computer. The facial affect set displays faces with a neutral expression, or displaying three basic emotions: happiness, fear or sadness (Figure 1). The pictures were presented at the center of a black computer screen placed approximately 70 cm away from the subject's eyes. The stimulus duration was 500 ms and the interstimulus interval was 1400 ± 200 ms. Stimuli were presented randomly in 6 blocks of 40 trials while ERPs were recorded. A fixation cross was presented before each emotional stimulus. An attention task, which required participants to press a button on a target (a butterfly or a car) presented on the screen as quickly as possible, was used to control for attention.

Figure 1: Examples of the facial emotional stimuli used in the experiments.

Data recording and processing, ERP component identification

The EEG was recorded with a 500 Hz sample rate, at 32 sites of the 10-20 System, using active Ag/AgCl electrodes (Acticap). The forehead was used for ground and the vertex for online reference (with offline re-referencing to the mastoids –TP9/10). An electro-oculogram was recorded above and beside the right eye. The ERP recording and analysis was performed with Brain Recorder and Brain Analyzer software (Brain Products, Germany). All electrode sites were abraded prior to recording to ensure an impedance <5 KΩ. The EEG was recorded for 1000 ms from stimulus onset, with a 200 ms pre-stimulus baseline. Off-line high-pass and low-pass filters were set at 0.3 and 35 Hz, without a notch filter. After correction for blinking [37], trials were rejected if the voltage exceeded 50 µV. Each recording session lasted about 11 minutes. The minimum number of trials for a subject to be included in the average was set at 75% and above (45/60 for each emotion).

Electrode locations are illustrated in Figure 2. According to source localization of early stages of face processing, P100 was measured at occipital sites O1, Oz and O2, and the N170 peak was measured over parieto-occipital regions at electrode sites 01, 02, P3 and P4 [38]. The P100 peak amplitudes and latency were defined as the most positive data point between 80 and 160 ms post-stimulus in the target stimulus averages. The N170 peak was identified as the most negative data point between 120 and 240 ms after stimulus onset in the standard stimulus averages.

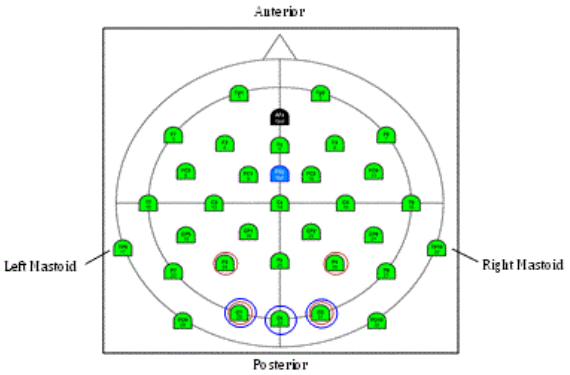

Figure 2: A schematic of the electrodes used in the analyses of P100 (O1, Oz and 02; blue circles) and N170 (O1, O2, P3 and P4; red circles).

Statistical analysis

The electrophysiological data were analyzed using repeated measures analysis of variance (ANOVA) with groups (EOS, ASD and TD) as a between-subjects factor. The dependent measures were the peak amplitude and latency of the P100 and N170 components within the specified time interval. The P100 amplitude and latency were submitted to repeated-measure ANOVAs with emotional valence of the stimulus (neutral, happy, sad and fearful) and site (O1, Oz and O2) as the within-subjects factors. For the N170, emotional valence, laterality (left: P3-O1, right: P4-O2) and site (2 levels) were defined as the within-subjects factors. Given the relatively small sample size and the exploratory nature of these analyses, there were no corrections for multiple comparisons. If significant interactions were found, we also performed post-hoc comparisons using Student's t-test or Tukey's honestly significant difference test.

Results

Group characteristics

Fifty-seven participants were included, 18 adolescents with a diagnosis of early onset schizophrenia (the EOS group); 19 patients with a diagnosis of ASD (the ASD group) and 20 typically developing controls (the TD group). Groups were chronologically and verbal age matched. There were no significant differences in age (EOS group M=15, SD ± 1.6 years, range 12-18 years; ASD group 15.4 ± 2.1 range 12-18 years; TD 14.04 ± 1.7 years, range 12-18 years), estimated total IQ (EOS group 92.9 ± 15.4; ASD group 98.2 ± 20.7; TD 106 ± 16.1) or verbal IQ (EOS group 102.9 ± 18.8; ASD group 106.6 ± 23.4; TD 107.8 ± 15.5) between the three groups (p>0.05). All patients of the EOS group except one were receiving antipsychotic drugs (162.47 mg chlorpromazine equivalence, range 0-1066 mg); four patients in the ASD group were receiving antipsychotic drugs (21.49 mg chlorpromazine equivalence, range 0-200 mg).

All demographic and clinical data are described in Table 1.

	EOS (n=18)	ASD (n=19)	TD (n=20)
Age (years) (Mean ± SD)	15 ± 1.6	15,4 ± 2.1	14,04 ± 1.7
Males/Females	5-14	18-2	11-9
IQ (Mean ± SD)	Total IQ: 92.9 ± 15.4	Total IQ: 98.2 ± 20.7	Total IQ: 106 ± 16.1
	Verbal IQ: 102.9 ± 18.8	Verbal IQ: 106.6 ± 23.4	Verbal IQ: 107.8 ± 15.5
PANSS total score (Mean ± SD)	39.37 ± 10.5	-	-
Positive score (Mean ± SD)	18.16 ± 6		
Negative score (Mean ± SD)	21.95 ± 8.4		
Disorganization score (Mean ±SD)	10 ± 4.4		
SANS total score (Mean ± SD)	55 ± 22.3	-	-
TLC total score (Mean ± SD)	9.16 ± 6.9	-	-
Medication (n)	17	4	0

Table 1: Demographic and clinical characteristics of adolescents with EOS, ASD and TD. EOS: Early Onset Schizophrenia; ASD: Autism Spectrum Disorders; TD: Typically developing adolescents. IQ: Intellectual Quotient; PANSS: Positive and Negative Syndrome Scale; SANS: Scale for the Assessment of Negative Symptoms; TLC: Thought Language and Communication.

Electrophysiological data

P100 peak amplitude

The results of the ANOVA revealed no main effect of group (F(2,54) =1.25, p=0.29) or emotion F(3,162) =0.19, p=0.89). A repeated measures ANOVA revealed a main effect of site (F(2,108) =4.83, p<0.05). Analysis of the post-hoc results indicated that the P100 peak amplitude was larger at the O2 (M=12.2 μV SD=1.6) than at the O1 electrode (M=11.8 μV SD=1.7) (p<0.05).

A significant site by group interaction was found (F(4,108) =3.99, p<0.05). Post-hoc analysis was completed and revealed that P100 amplitude was larger at O2 compared to O1 (p<0.001) and to Oz

(p<0.001) only in the TD group. In the EOS and ASD groups, there were no significant differences of site on P100 amplitude.

Furthermore, there was a significant group by emotion by site interaction (F(12,324) =1.91, p<0.05). In order to further track this interaction, post-hoc analysis was conducted and revealed that EOS compared to TD adolescents exhibited reduced P100 amplitude for fear (EOS M=9.4 μV SD=3; TD M=14.0 μV SD=2.8 p<0.05), and a trend for significant difference for the neutral emotion (p=0.056) at O2 electrode (Figure 4). No difference between EOS and TD adolescents was found for happiness and sadness on O2, and for happiness, sadness, fear or neutral expressions on O1 and Oz. P100 amplitude in the EOS group (M=9.1 μV, SD=3.1) was reduced compared to the ASD group (M=13.1 μV, SD=3) for neutral emotion at the O2 electrode (p<0.05) (Table 2). No significant difference in P100 amplitude was found between the ASD and TD groups.

P100 peak latency

Using ANOVA, there was no main effect of group on P100 latency (F(2,54) =2.29, p=0.11). A main effect of emotion was seen on P100 latency (F(3,162) =6.29, p<0.05). Post hoc analysis revealed that all participants had a shorter P100 latency to happy (M=110.6 ms, SD=3.8) than to fear (M=113.9 ms, SD=3.8) (p<0.05), neutral (M=114.5 ms, SD=3.8) (p<0.05) and sad (M=116.8 ms, SD=4.1) (p<0.001) expressions.

There was no main effect of site on P100 latency (F(2,108) =1.50, p=0.23).

N170 peak amplitude

The results of the ANOVA revealed no significant main effect of group on N170 peak amplitude (F(2,53) =0.09, p=0.90). A main effect of emotion across groups was observed (F(3,159) =4.68, p<0.05): N170 amplitude was larger for happy (M=1.7 μV, SD=1.1) expression than for fear (M=2.4 μV, SD=1.1) (p<0.05) and neutral expressions (M=2.6 μV, SD=1.1) (p<0.05). There was no difference on N170 amplitude between happy and sad expressions. A main effect of site was observed (F(1,53) =6.15, p<0.05): N170 amplitudes were higher at the occipital electrodes (M=1.5 μV, SD=0.9) than at parietal ones (M=2.9 μV, SD=1.4).

There was also an emotion by site interaction (F(3,159) =3.78, p<0.05): the amplitude of the four expressions were higher at the occipital site (p<0.001).

N170 peak latency

A repeated measures ANOVA revealed a main effect of group (F(2,53) =3.55, p<0.05). Adolescents with ASD (M=171.9 ms, SD=7.3) compared to TD (M=158.5 ms, SD=7.3) showed a delayed N170 latency (p<0.05) (Figure 5). No significant difference in N170 latency was found between ASD and EOS (M=167.9 ms, SD=7.5). A main effect of emotion was significant (F(3,159) =6.51, p<0.001): N170 latency was less to happy (M=162.1 ms, SD=4.4) than to sad (M=169.1 ms, SD=7.7) (p<0.001), neutral (M=166.1 ms, SD=4.9) (p<0.05) or fear (M=167.3 ms, SD=4.7) (p<0.05) expressions. No main effect of site was found on N170 peak latency (F(1,53) =0.09, p=0.75).

An interaction between groups, emotion, site and laterality was observed (F(6,159) =2.41, p<0.05). Post-hoc analysis revealed that at the O2 electrode EOS compared to TD exhibited prolonged latency to fear, happiness, neutral and to sadness (p<0.05) at P4; and to neutral (p<0.05) and sadness (p<0.05) at P3. ASD patients compared to TD showed delayed latency to sadness at P4 (p<0.05); happiness (p<0.05) and sadness (p<0.05) at O1; happiness (p<0.05), fear (p<0.05) and sadness (p<0.05) at O2. Moreover, patients with ASD compared to the EOS group had a longer N170 latency to fear at O1 (p<0.05) (Table 3).

Correlations between the P100 and N170 components and clinical variables

Correlations between clinical variables (age, IQ, PANSS, SANS and TLC scores, and chlorpromazine dose equivalent) and the peak amplitude and latency of P100 and N170 were evaluated using Pearson's r test.

Correlations between the severity of PANSS, SANS and TLC were evaluated in the EOS group using Pearson's r test. There was a significant negative correlation between P100 peak amplitude and PANSS general psychopathology scale (r= -0.59; p<0.05), SANS alogia (r= -0.57; p<0.05) and global ratings (r= -0.63; p<0.05) at O2, for neutral facial expression.

A positive correlation between N170 peak latency and PANSS general psychopathology scale (r=0.56; p<0.05), PANSS disorganization dimension (including conceptual disorganization, difficulty in abstract thinking, disorientation and poor attention) (r=0.61; p<0.05), PANSS total score (r=0.52; p<0.05), SANS alogia (r=0.51; p<0.05) and with the TLC (r=0.59; p<0.05), at P4 for sadness was observed.

No correlation was found between P100 latency or N170 amplitude and the rating scales for schizophrenia.

Finally, no significant correlation was observed between P100/N170 amplitude or latency values and the chlorpromazine dose equivalent in the treated subjects in EOS or ASD group (p>0.05).

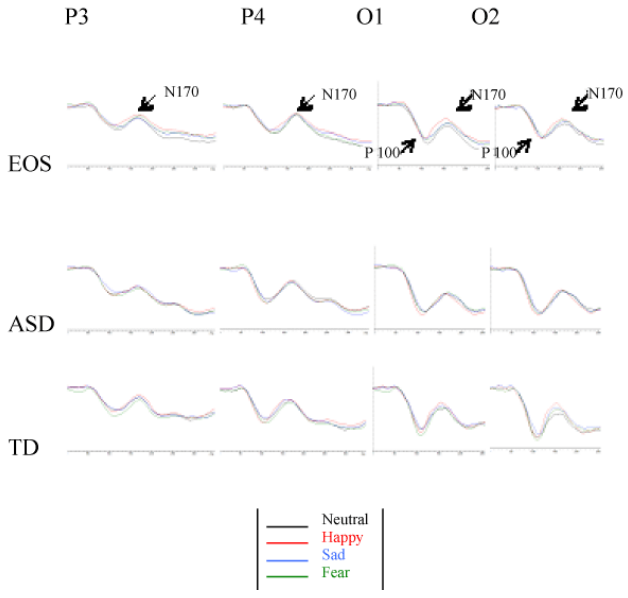

Figure 3: Grand average waveforms for each emotion (neutral, happy, sad, fear) at posterior electrodes for the EOS, ASD and TD groups.

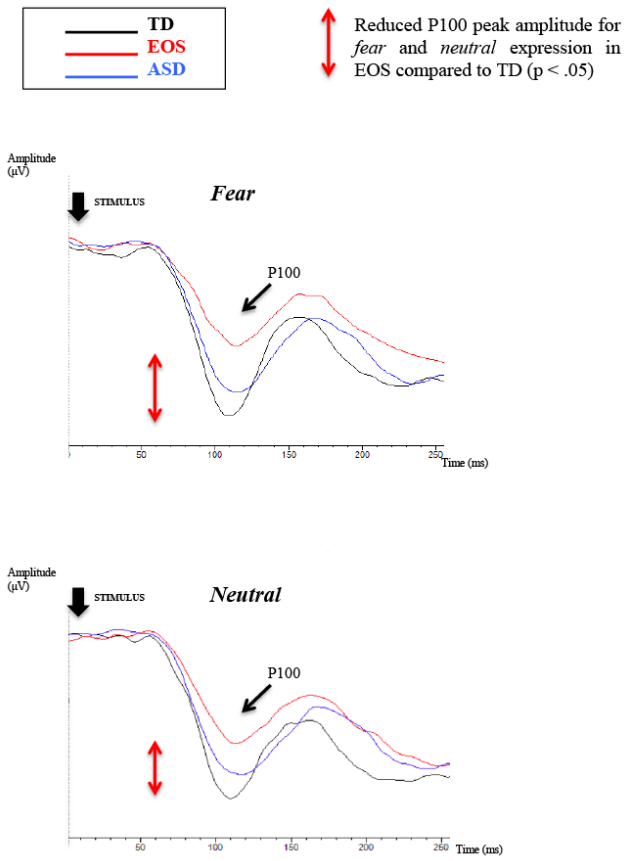

Figure 4: Grand average waveforms for fear and neutral emotion at O2 for the EOS, ASD and TD group.

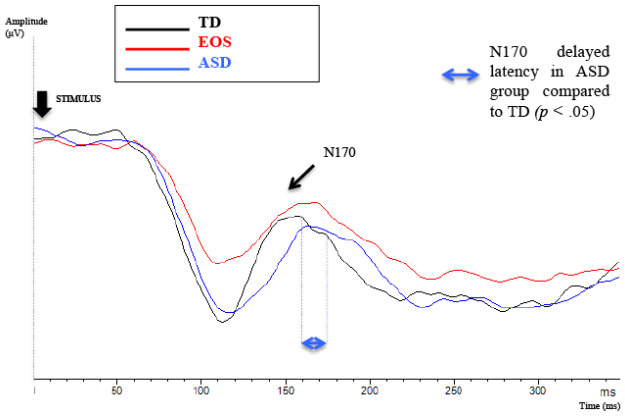

Figure 5: Grand average waveforms for all emotions at O2 for the EOS, ASD and TD group.

		EOS				ASD				TD			
		Neutral	Happy	Sad	Fear	Neutral	Happy	Sad	Fear	Neutral	Happy	Sad	Fear
O1	Voltage (μV)	11.2 ± 2.9	10.3 ±2.9	10.8 ±2.9	10.4±2.9	13.1±2.9	13.5±2.9	13.2±2.9	12.9±2.8	10.9±2.8	11.6±2.8	11.4±2.8	12.2±2.7
	Latency (ms)	113.9±7.2	109±7.6	114.2±7.9	112±7	122.2±7	117.6±7.4	123.1±7.7	119.1±6.7	111.6±6.9	109.1±7.8	112.8±7.6	111.4±6.6
Oz	Voltage (μV)	9.9±3	9.6±3	9.8±3	9.1±3	12.7±2.9	13.1±2.9	12.8±2.8	12.7±2.8	10.6±2.9	10.7±2.9	10.9±2.9	11.3±2.7
	Latency (ms)	113.9±8.2	107±6.8	113.7±8.2	109.8±7.5	118.6±7.9	114.9±6.6	122.8±7.9	117.1±7.3	110±7.8	107±6.4	113.3±7.7	111±7.1
O2	Voltage (μV)	9.1±3.1	10.2±3.3	10.1±3.3	9.4±3	13.1±3	13.5±3.2	13.4±3.2	13.4±2.9	13.5±2.9	13.8±3.2	13.1±3.1	14.0 ±2.8
	Latency (ms)	111±7.2	108.6±6.9	116.8±7.4	117.8±7.4	119.2±6.9	113.4±6.7	122.3±7.2	118.4±7.2	109.8±6.8	108.7±6.6	111.8±7	109±7.1

Table 2: Peak P100 amplitudes and latencies averaged in EOS, ASD and TD adolescents. Results (mean and standard deviation) are presented for each group (EOS, ASD, TD) at sites O1, Oz, O2 giving voltage (μV) and latency (ms) for each emotion.

		EOS				ASD				TD			
		Neutral	Happy	Sad	Fear	Neutral	Happy	Sad	Fear	Neutral	Happy	Sad	Fear
P3	Voltage (μV)	2.8±1.8	1.9±± 1.7	2.4±1.9	2.7±1.7	1.5±1.7	0.9±1.7	1.6±1.9	1.8±1.6	1.5±1.7	1.1±1.7	1.3±1.9	2.1±1.6
	Latency (ms)	171.2±9.9	161.1±10.6	178.3±10.3	170.7±11	168.7±9.6	166.4±10.3	174.5±10	175.6±10.7	156.2±9.6	155.6±10.3	162±10	163.5±10.7
P4	Voltage (μV)	1.3±1.9	0.7±1.9	0.9±1.9	0.9±1.7	0.7±1.9	0.2±1.8	0.9±1.9	1.2±1.7	1.9±1.9	1.4±1.8	1.4±1.9	2.3±1.7
	Latency (ms)	174±10.1	172.8±9.7	181.7±10.3	166.9±9.6	170.8±9.8	166.7±9.4	175.6±10.1	173.2±9.3	159.1±9.8	156.2±9.4	159.9±10.1	163.2±9.3
O1	Voltage (μV)	3.2±2.8	1.5±2.9	3±2.7	2.9±2.6	4.3±1.3	3.9±2.8	4.2±2.6	3.5±2.5	3.1±2.7	1.9±2.8	1.8±2.6	2.6±2.5
	Latency (ms)	161.7±12	159.7±11.9	169.4±11.5	159.3±12.3	169.7±11.7	174±11.6	179.1±11.2	178.4±11.9	165.5±11.7	153.7±11.6	156.2±11.2	162.3±11.9
O2	Voltage (μV)	2.6±2.7	0.8±2.9	1.9±2.5	1.7±2.6	4.2±2.6	3.4±2.8	3.8±2.4	3.9±2.6	3.7±2.6	2.1±2.8	2.3±2.4	3.3±2.6
	Latency (ms)	166.3±11.3	158.8±10.3	165.1±11	170.3±11.1	169.5±10.9	167.2±9.9	172.2±10.7	169.7±10.8	160.9±10.9	152.5±9.9	154.9±10.7	154.9±10.8

Table 3: Peak N170 amplitudes and latencies averaged in EOS, ASD and TD adolescents Results (mean and standard deviation) are presented for each group (EOS, ASD, TD) at sites P3, P4, O1, O2 giving voltage (μV) and latency (ms) for each emotion.

Discussion

This study investigated the ERPs (P100 and N170 components) in a visual task of emotional face perception in EOS, ASD and TD adolescents. We hypothesized that the electrophysiological patterns observed in EOS and ASD would differ from those found in TD participants, and that analysis of ERP component features would suggest specific mechanisms that would differentiate EOS and ASD patients. This is the first study to compare emotional perception between these three groups of adolescents, as far as we know.

Results indicated that both EOS and ASD adolescents showed impairments in emotional face processing, but distinct patterns were observed in each disorder. Firstly, in EOS, impairments were observed in the P100 amplitude while no significant difference was found in this component between the ASD and TD groups. The EOS group also exhibited a delay in the "face-sensitive" N170 component in specific emotion and sites. Outcomes in EOS also suggested that disruption in emotional face perception was correlated to clinical symptoms of schizophrenia. Furthermore, the ASD group showed no alteration of the P100 component, while it was altered in EOS. Results in ASD mostly reported a main effect of group on N170 latency: adolescents with ASD compared to TD showed a specific N170 latency delay.

Our first main result was the observation of smaller P100 peak amplitude in the EOS group compared to the TD group, for both fear and neutral expression at the occipital site O2. Early visual processing of these emotional faces could be disrupted in EOS. Similar impairment has been described in adult studies, suggesting inappropriate reactions to fear and potentially threatening situations [17,18,39]. Our result highlighted the same trait in an adolescent population, which may suggest a developmental marker for schizophrenia. The EOS group also exhibited a delay in the "face-sensitive" N170 component only in specific emotion and sites. Expertise in recognizing faces is altered in schizophrenia, with prolonged holistic face assessment [40,41]. Interestingly, this emotion and site-specific disruption was correlated to clinical symptoms of schizophrenia evaluated by clinical rating scales. Ventura and colleagues have also shown that facial recognition and emotion processing are linked to disorganization and negative symptoms, suggesting that the presence of these symptoms might disrupt the "fundamental cognitive process" [42]. In the future, the role of disorganization in early onset schizophrenia should be specified [43,44].

Secondly, results for the ASD group compared to TD adolescents were different from those of EOS group. The ASD group showed no alteration of the P100 component, while it was altered in EOS. Webb and O'Connor, both suggest that early ERP responses to emotional faces in ASD may not be affected. However, the findings in the P100 component across studies are often contradictory [20,21,45,46]. This discrepancy could be attributed to the heterogeneity of IQ, the severity of the autistic disorder, and the task design variability across studies.

In our study, the significant differences between ASD and TD adolescents occurred specifically within the N170 latency during face processing. This finding suggests that patients with ASD are impaired at processing emotional faces configurations and take longer to recruit neuronal networks involved in configural face processing [20,22,46]. This disruption in configural face processing in ASD results from greater reliance on individual facial features, and a tendency to favour local over configurational processing [47,48]. Thus, patients with ASD exhibited delayed N170 latencies to faces but not to objects, suggesting slower processing of facial information in ASD [21,49]. Furthermore, fMRI studies showed distinctive neural activity in the "social brain" in ASD, with greater activation in the anterior cingulate gyrus and the superior temporal lobe [50].

Thirdly, while divergent patterns of impairment have emerged in descriptions of EOS and ASD, our study provided the opportunity to a direct comparative study of EOS and ASD patients. Impairments in EOS involved the P100 amplitude, which was unaffected in the ASD group. This difference between EOS and ASD has not been previously described. It could underline different processing strategies, reinforcing the idea of "a more global deficit en visual processing deficit" in schizophrenics [18]. Moreover, the P100 component is considered as an attention marker [51]. According to O'Connor, adolescents with ASD could improve their ability to focus attention on faces, suggesting that early diagnosis, intervention and social skills training would be of benefit [20]. Dysfunctions in ASD adolescents were specifically related to a critical delay of the face N170 component, also compared to EOS, underlining main disruption in face processing in autism [52].

The current study has some limitations: the variable sex ratio across groups inherent to the overrepresentation of males in ASD, and the possible effects of psychotropic medication [53]. The major strength of this study was to compare EOS and ASD using the same emotional face perception design. Abnormalities in the electrophysiological processes and specific differences in the ERP components suggested specific mechanisms between EOS and ASD, reinforcing the idea that similarities in social dysfunction derive from disorder-specific mechanisms and pathways. Several clinical implications could result from these conclusions.

This preliminary study highlighted areas for future work to complete perspectives in understanding these two neurodevelopmental diseases. Distinctive ERP patterns emerged in these disorders, suggesting distinct brain mechanisms in spite of the "high degree of similarity" in social cognitive impairment and "comparable levels" of reduction in neural activation [24,25,54]. More than helping clarifying the dissociative features and distinct developmental trajectories of EOS and ASD, highlighting this divergent process provided a clinical benefit by promoting the development of "tailored treatment efforts" [2]. Specific social cognitive remediation approaches that improve functional outcome in schizophrenia and ASD should be developed [55,56]. Programs such as training of affect recognition targeting emotion impairments in schizophrenia, or cognitive training technologies such as an avatar assistant in ASD for improvement of facial recognition should be encouraged [57-58].

Our findings in adolescents with EOS also suggested that these impairments appear in early stages of the disease course. According to Wölwer, this impairment could precede the onset of the initial psychotic episode, suggesting a developmental process of emotional impairments in schizophrenia [59]. Future studies are needed to clarify this impairment and to help develop specific and earlier intervention approaches in adolescents with EOS and ASD.

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