International Journal of Psychophysiology 71 (2009) 84–90

Contents lists available at ScienceDirect

International Journal of Psychophysiology

journal homepage: www.elsevier.com/locate/ijpsycho

Event-related potentials and event-related oscillations during identity and facial emotional processing in schizophrenia

Julieta Ramos-Loyo [a,*], Andrés A. González-Garrido [a], Luis Miguel Sánchez-Loyo [a,b], Virginia Medina [c], Canan Basar-Eroglu [d]

[a] Instituto de Neurociencias, Universidad de Guadalajara, Mexico
[b] Departamento Estudios en Educación, Universidad de Guadalajara, Mexico
[c] Centro Comunitario de Salud Mental No. 1, Instituto Mexicano del Seguro Social, Guadalajara, Mexico
[d] Institute of Psychology and Cognition Research, University of Bremen, Bremen, Germany

ARTICLE INFO

Available online 23 July 2008

Keywords:
Emotional recognition
Schizophrenia
ERPs
Event-related oscillations

ABSTRACT

Impairments in emotional recognition have been consistently reported in schizophrenic patients. The main aim of the present study was to evaluate time-sequenced responses in ERPs and event-related oscillations during emotional recognition of happiness and fear compared to facial identity recognition in schizophrenic patients (SCH) versus healthy controls (CON). Ten paranoid SCH and ten CON subjects performed three oddball paradigm tasks, evaluating face identity recognition and facial emotional recognition of happiness and fear. Event-related potentials and event-related theta and alpha oscillations were obtained for each task. N170 and P2 components appeared with higher amplitude in SCH than in CON at the occipital locations. An early prefrontally distributed P3a component was observed while doing the identity task with lower amplitude in SCH than in CON. Comparatively, P3b amplitude was lower in SCH than in CON over parietal leads in the identity and happiness tasks. Additionally, theta oscillations showed significantly lower RMS values in SCH between 250 and 500 ms post-stimuli in frontal and central regions. On the other hand, the grand-averaged alpha oscillations demonstrated higher RMS values in the occipital leads in SCH compared to CON and the opposite over the frontal regions. Results are interpreted in the framework of a functional disruption in the distributed neuronal networks involved both in facial identity and emotional recognition in schizophrenics as indexed by the brain oscillatory activity and related ERP components.

1. Introduction

1.1. Schizophrenia

Interest in assessing emotional disorders in patients who suffer schizophrenia recently has increased. The contribution of these disorders in abnormal social functioning in this population has been recognized (Mueser et al., 1997; Poole et al., 2000). Several experimental evidence support the idea that schizophrenic patients present difficulties in recognizing facial and prosodic emotional stimuli, as well as failure in their abilities to verbally describe and expressed them in a contextual social situation in a proper way (Schneider et al., 1995; Edwards et al., 2001; Johnston et al., 2001; Ibarrarán et al., 2003; Kosmidis et al., 2006).

In regards to facial emotional recognition deficits in schizophrenia, it has been postulated that they could be emotion specific mainly in negative emotions (Bediou et al., 2005; Gur et al., 2006) or to be related to a more global cognitive deficit or even more to depend on facial identification deficits (Schneider et al., 1995; Mueser et al., 1997). Bruce and Young (1986) have proposed that initially there is a structural encoding of a face-specific configuration that is followed by the recognition of a familiar face and thereafter, the affect information will be processed. Another assumption is that facial and affect recognition are parallel but interrelated processes (Holmes et al., 2003; Pourtois et al., 2006). Therefore a disruption in one of these processes in schizophrenic patients would not necessarily impair the other one.

1.2. ERPs

Event-related brain potentials (ERPs) recording can reflect deficits in emotional processing in schizophrenic patients compared to a healthy control group and give hints about specific deficits in the two processing pathways related to facial identity and emotional recognition. In healthy subjects, N170 component has been related to late stages of facial structural encoding (Bentin et al., 1996; Eimer, 2000) and is primarily recorded in occipitotemporal regions, probably denoting activity from the lateral fusiform gyrus and temporal gyri (Allison et al., 1999). Eimer and Holmes (2002) reported an earlier component about 120 ms that can distinguish fearful from neutral

* Corresponding author.
E-mail address: jramos@cencar.udg.mx (J. Ramos-Loyo).

0167-8760/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpsycho.2008.07.008

faces suggesting that processing of facial emotions begins before face identification. As well, changes in P450 have also been addressed during categorization of facial emotions (Carretié and Iglesias, 1995; Orozco and Ehlers, 1998). Thus, different components in ERPs have been related to different stages of facial emotion recognition.

Few studies have addressed changes in ERP components during facial emotion recognition in schizophrenics. Herrmann et al. (2004) reported a reduction in the N170 in schizophrenia, and Horley et al. (2001) have described a generalized delay in ERPs latencies and a reduction in P200 amplitude during angry face presentation. Herrmann et al. (2006) also described that whereas controls demonstrated larger P3 and P4 amplitude in parietal regions during emotion decodification, schizophrenic patients did not show any difference. Johnston et al. (2005) reported that schizophrenics manifested lower vertex positive potential (VPP) that represents an anterior counterpart of the N170 early encoding stage of facial processing, and that it was correlated to subsequent P3 amplitude reduction. P3 amplitude reduction was observed in schizophrenic patients while performing two oddball tasks, with letters and happy faces recognition (Ramos et al., 2001). Thus, some ERP components have demonstrated alterations in schizophrenic patients compared to controls during facial emotion recognition, which may reflect alterations in between facial identity and emotion recognition tasks.

1.3. Oscillatory activity

Basar (1992) proposed that EEG emerges from the activity of an ensemble of generators producing rhythmic activities in several frequency ranges. Usually, these generators are randomly active, but when sensory stimulation occurs, generators become coupled and act together in a coherent way. Superimposition of this coherent activity in particular frequency ranges could, at least partially, determine ERP components. The transition from a disordered (spontaneous EEG) to an ordered state (during specific stimulation), a resonance phenomenon resulting in synchronization and enhancement of EEG activity, gives rise to "event-related oscillations" (ERO) in several frequency ranges.

Basar and colleagues have used oscillatory activities to assess face recognition (Özgören et al., 2005; Basar et al., 2006). They showed differences during recognition of the own grandmother's face and an older woman (unknown face) in different frequency bands, especially in beta and theta oscillations. Differences in brain oscillations related to emotional face expressions were reported (Güntekin and Basar, 2007). The amplitude of the alpha responses was higher during angry face stimulation at posterior locations while beta oscillations were higher at anterior regions. The aim of the present study was to evaluate the time sequence responses in the brain electrical activity, ERP and event-related oscillations, during facial emotional and facial identity recognition in patients with schizophrenia with regard to a control group. Of particular interest was the temporal and regional distribution of these electrical responses to facial identity and emotion stimuli recognition.

2. Method

2.1. Participants

Table 1 summarizes subject characteristics. Ten male schizophrenic (SCH) patients in a remission stage were recruited from the outpatient consult of Guadalajara Mental Health Center of the Mexican Social Security Institute. All of them were evaluated by two experienced psychiatrists and diagnosed as paranoid schizophrenics considering their medical history information and the international criteria of DSM-IV (American Psychiatric Association, 1995). In addition, symptoms were rated by means of the Brief Psychiatric Rating Scale (BPRS; Overall and Gorham, 1962) and the Positive and Negative Symptom Scale (PANSS). They all were medicated with typical neuroleptics, demonstrating a good response to them. In addition, a healthy control group (CON) was evaluated. All of the subjects were right-handed males and both groups were paired in terms of age (18–45 years) and educational level (at least 9 years). Individuals with neurological diseases or drug abuse were not included in the sample as well controls with psychiatric illness antecedents were excluded. All subjects gave informed consent to participate in the study after the procedures were fully explained to them.

Table 1
Demographic and clinical characteristics

	Controls	Patients
Age		30.2 (7.27)
Education (years)	26.1 (7.5)	11.8 (3.22)
Daily neuroleptic	12.6 (1.9)	330 (364)
Dosage[a]	–	25 (7.30)
BPRS	–	9.5 (3.34)
PANSS Positive	–	13.3
PANSS Negative	–	(4.64)
PANSS General	–	21.7
Psychopathology		(13.4)

BPRS, Brief Psychiatric Rating Scale; PANSS, Positive and Negative Symptom Scale.
[a] CPZ equivalent.

2.2. Stimuli and procedure

Participants sat at a comfortable armchair, in front of a computer monitor placed at a distance of 60 cm, where three tasks were presented to them by means of a specific program (Guevara et al., 2004). One task evaluated face identity recognition and the two others implied facial emotional recognition of happiness and fear.

2.3. Tasks

The stimuli consisted of black and white photographs of 10 models (5 males, 5 females) expressing happiness, angry, fear, surprise, disgust and sadness, in addition to a neutral expression (Ekman and Friesen, 1976). Participants were instructed to press a key, as fast as possible, when an individual portraying a happiness expression (target, 20%) appeared on the screen. Each task consisted on 300 sequentially presented black and white photographs that appeared during 500 ms in a PC screen, separated by a random intertrial interval from 1250 to 1500 ms. In a similar task, the subject had to recognize the facial expression of fear. Finally, in the identity task, the same stimuli were used but the subjects were instructed to recognize the face of a previously defined woman model regardless of her facial emotion. Subjects were familiarized with tasks demands through a block of 10 trials before each task. The tasks presentation order was randomized among subjects and each one lasted between 14.25 and 15 min. Behavioral performance measures of response accuracy and reaction time were obtained.

2.4. EEG recordings

Electroencephalographic (EEG) recording session took place between 10:30 and 14:00 h. EEG signals were recorded from Fp1, Fp2, F3, F4, F7, F8, C3, C4, T3, T4, P3, P4, O1 and O2 derivations using linked earlobes as reference according to the International 10/20 System on a 8 Plus Grass polygraph (cut-off filters 1–35 Hz). Electrode impedances were kept below 10 kΩ. EEG signals were captured by a PC computer through an analog to digital converter with a sample rate of 256 Hz (Guevara et al., 2000). Electro-oculogram was also bipolarly recorded to detect eye movement artifacts.