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Electrophysiological correlates of the disrupted processing of anger in alcoholism

Pierre Maurage [a,*], Salvatore Campanella [b], Pierre Philippot [c], Nicolas Vermeulen [c], Eric Constant [d], Olivier Luminet [c], Philippe de Timary [d]

[a] Cognitive Neuroscience unit, Faculty of Psychology, catholic University of Louvain, 10 Place C. Mercier, 1348 Louvain-la-Neuve, Belgium
[b] Department of Psychiatry (EEG), Brugmann Hospital, Free University of Brussels, 4 Place Vangehuchten, 1020 Brussels, Belgium
[c] Clinical Psychology Research unit, Faculty of Psychology, catholic University of Louvain, 10 Place C. Mercier, 1348 Louvain-la-Neuve, Belgium
[d] Department of Psychiatry, St Luc Hospital, catholic University of Louvain, 10 Avenue Hippocrate, 1200 Brussels, Belgium

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ABSTRACT

Objective: Recent studies have shown that alcoholism is characterized by a deficit in the processing of emotional facial expressions (EFE), and that this deficit could be "emotion specific". The present study explored the hypothesis that there is a specific deficit for the EFE of anger compared to another negative emotion (disgust). Moreover, on the basis of event-related potentials (ERPs), this study aimed at determining the locus of this deficit in the information-processing stream.

Methods: Fifteen patients suffering from alcoholism and fifteen matched healthy controls took part in the study, which used a "modified emotional" oddball paradigm. ERPs were recorded in response to repetitions of a particular facial expression (i.e. anger) and in response to two deviant (rare) stimuli obtained by a morphing procedure, one depicting the same emotion as the frequent stimulus, the other depicting a different emotion (i.e. disgust). The participants' task was to press a key as soon as they spotted the deviant stimulus.

Results: Behavioural data showed an absence of categorical perception effect for anger (but not for disgust) stimuli among alcoholic patients. Moreover, electrophysiological data revealed that alcoholism is associated with an impaired processing of anger at the attentional level (N2b/P3a complex), extending to the decisional level (P3b).

Conclusion: This study demonstrated disturbed processing of anger in alcoholism, at behavioural and electrophysiological levels. These preliminary results strengthen the proposition of a specific deficit for anger, and localize its possible origin to the attentional level (N2b/P3a complex) of the information processing stream. The clinical implications of these results are discussed.

1. Introduction

The decoding of emotional facial expressions (EFE) has been extensively investigated in normal individuals over the last decades, leading to a huge amount of data (Camras et al., 1993; Ekman, 1984). The appropriate processing of EFE is clearly a major skill for the development and maintenance of adapted interpersonal relations (Ekman, 1989; Feldman et al., 1991). In this perspective, studies have explored EFE decoding deficits in different psychopathologies (Power and Dalgleish, 1997), such as schizophrenia (Archer et al., 1992), social phobia (Winton et al., 1995) and depression (Hale, 1998).

More specifically, recent electrophysiological studies demonstrated the usefulness of an "emotional oddball paradigm" (based on the detection of an infrequent deviant stimulus among a succession of frequent standard stimuli) in the exploration of EFE deficits: One possible use of this paradigm is to define, for each clinical population showing an EFE deficit, where the disturbance originates in the information processing stream (Campanella and Philippot, 2006). Psychopathy (Campanella et al., 2005), anxiety (Rossignol et al., 2005), drug addiction (Mejias et al., 2005) and schizophrenia (Campanella et al., 2006) have been investigated using this technique, with results suggesting that the initial level of impairment leading to disturbed EFE processing is specific for each population (i.e. perceptual level for schizophrenia, attention level for depression, decisional level for anxiety and psychopathy). Nevertheless, all the stimuli used in these experiments were faces depicting a neutral expression for the frequent stimulus and an EFE for the rare stimuli, as illustrated in Fig. 1 (part A). The key limitation of this method is that it leads to major physical differences between the frequent (neutral) and rare (emotional) stimuli, as the physical distance between a face displaying a neutral or an emotional state is not controlled for. This bias weakens the conclusions that can be drawn from this paradigm, because one cannot exclude the possibility that the differences observed between

* Corresponding author. Université catholique de Louvain, Faculté de Psychologie, NESC, Place du Cardinal Mercier, 10, B-1348 Louvain-la-Neuve, Belgium. Tel.: +32 10479245; fax: +32 10473774.
E-mail address: pierre.maurage@uclouvain.be (P. Maurage).

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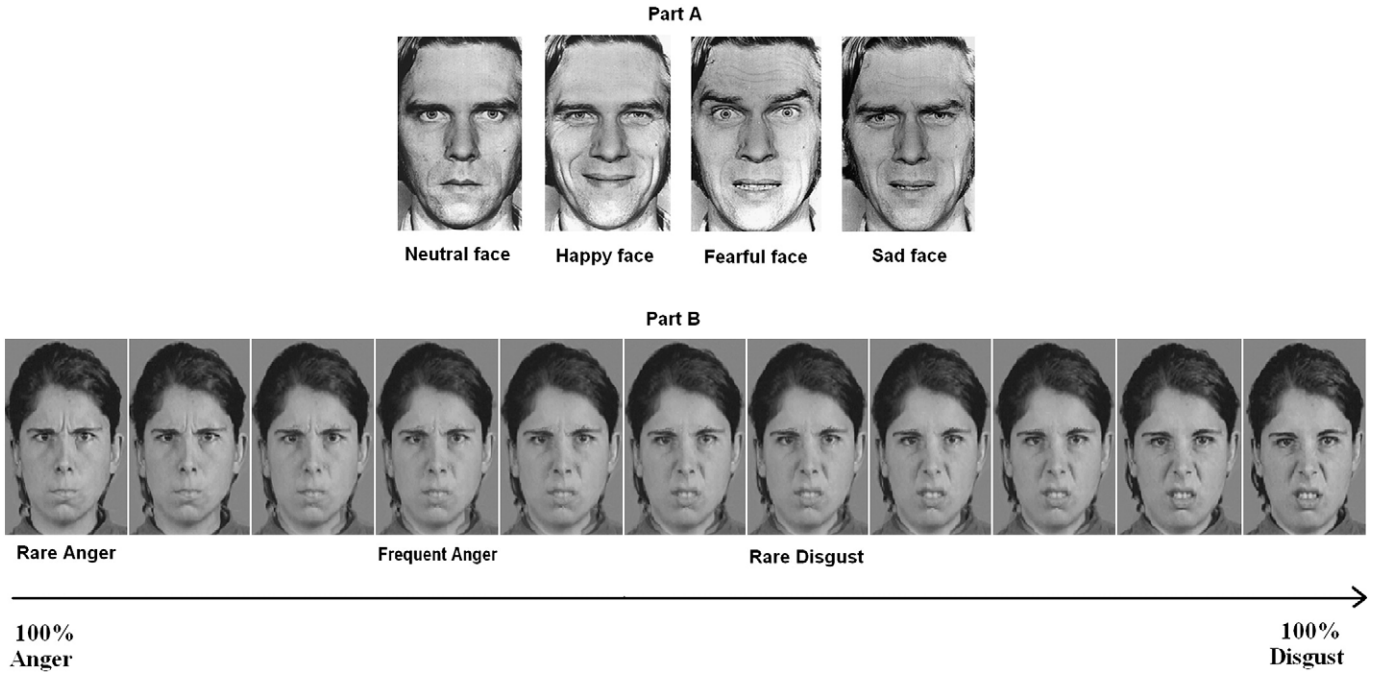

Fig. 1. Illustration showing the stimuli used in previous studies based on an emotional oddball paradigm (Part A) and the stimuli (stemming from the morphing procedure) used in our modified emotional oddball paradigm (Part B).

frequent and rare stimuli could at least partly be explained by uncontrolled physical variations (and not by the explored emotional dimension).

The present study used an adaptation of this emotional oddball paradigm to control for the physical differences and ensure that the results observed were linked to the emotional factor. Indeed, a morphing technique allowed the generation of a continuum of different morphed faces moving linearly from one EFE to another, with an identical physical distance between the frequent and every rare stimulus. For example, as seen in Fig. 1 (part B), a morphed continuum moving from an angry face to a disgusted one enabled the creation of one frequent face (i.e. containing 65% anger and 35% disgust) and two rare faces (i.e. respectively containing 95% anger–5% disgust and 35% anger–65% disgust). Hence the physical distance between the frequent stimulus and the two rare ones was identical (30%), but the first rare stimulus displayed the same emotion as the frequent one (here, anger), while the second mainly showed the other emotion (here, disgust). This technique thus led to a "purer" oddball paradigm, where the non-emotional (physical) differences are controlled for: The results are then uniquely linked to the emotional variations (see "Task and procedure" for further methodological details).

In addition, this study focused on alcoholism. Alcoholism leads to social and interpersonal dysfunctions, and notably to a degradation in the alcoholic's social life (e.g. Buu et al., 2007; Kornreich et al., 2002). These negative social consequences of alcoholism can partly be attributed to a direct effect of alcohol on the subject's interpersonal behaviour. Moreover, some alcoholic subjects also present (independently of alcohol consumption) emotional deficits that directly alter their social competences. Various defects in emotional processing have indeed been described in alcoholism: Alexithymia (Taieb et al., 2002; Uzun et al., 2003), emotional intelligence (Riley and Schutte, 2003; Szczepanska et al., 2004), and EFE decoding (Oscar-Berman et al., 1990; Townshend and Duka, 2003). Globally, alcoholic individuals overestimate the intensity of the EFE, misinterpret these EFE, and are not aware of this impairment (Kornreich et al., 2001). The link between emotional and social deficits (Nixon et al., 1992) could lead to a vicious circle: A deficit in EFE decoding, induced by the neurotoxicity of alcohol, worsens interpersonal problems, which in turn may increase alcohol consumption used as a coping strategy (Kornreich et al., 2002). Nevertheless, other studies only showed limited impairments (Frigerio et al., 2002) and even no deficit for the EFE decoding in alcoholism (Uekermann et al., 2005). It thus seems crucial that the presence of this deficit is confirmed. The present study explored this deficit by means of event-related potentials (ERPs). ERPs have been used for decades to explore cerebral functioning in alcoholism, mainly showing reduced amplitude and delayed latency of the P300 component (Hansenne, 2006; Polich, 2004; Porjesz and Begleiter, 2003). Nevertheless, most of the previous studies used basic visual or auditory stimuli (see, for example, Porjesz and Begleiter, 1981; Rodriguez Holguin et al., 1999) and alcoholism has not yet been investigated with an emotional oddball paradigm using EFE.

It furthermore appears that the specificity of this deficit varies across emotions: While some emotions seem to be correctly evaluated (particularly fear and disgust), alcoholism is mainly linked with impairment for anger (Frigerio et al., 2002; Marlatt, 1979; Philippot et al., 1999). Moreover, this impairment has been found to be correlated with the frequency of aggressive and violent behaviour among alcoholics (Bushman and Cooper, 1990; Wall and Wekerle, 2002). It thus seems highly relevant to explore the differential impairment among emotions, particularly regarding anger deficit, in alcoholism. Anger decoding, which seems to be impaired in alcoholism, was compared to disgust decoding, used as a control emotion (as disgust decoding appears to be preserved in alcoholism, e.g. Philippot et al., 1999).

Finally, earlier studies on psychopathology (see Campanella and Philippot, 2006 for a review) showed that ERPs allow the successive stages of cognitive processing to be separated, and therefore the initial level of impairment in a specific population to be defined. Indeed, different ERP components, reflecting different functional processes, are produced in an oddball paradigm, mainly:

- Perceptual processing: First, the P100, a positive deflection maximal at occipital sites around 100 milliseconds (ms) after appearance of the stimulus. This wave is generated in response to every visual stimulus and reflects the exogenous cortical activity associated with the early primary visual processing of the stimulation (Heinze and Mangun, 1995). It has been shown more recently (e.g. Debruille et al., 1998; Seeck et al., 1997) that the P100 may also be modulated by the