

Event-Related Potentials to Emotional and Neutral Stimuli in Alcoholism

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Abstract

Several studies have demonstrated that the emotional value of stimuli affects P300 amplitude. In the present study, the influence of alcohol-related stimuli in alcoholic patients was investigated. Subjects were 10 alcoholic inpatients (3 female) and 10 age- and sex-matched controls. Eight alcohol-related and 8 neutral words served as stimuli in a visual oddball paradigm. Alcohol-related words were targets (48 stimuli, 33%) and neutral words were standard stimuli (96 stimuli, 66%). Results showed that P300 amplitude for targets did not differ significantly between the two groups. However, P300 latency for targets as well as reaction time were significantly shorter in male alcoholic patients. In contrast, P300 latency was increased in female alcoholic patients but reaction time did not differ. These results suggest that male alcoholics process information linked to alcohol cues more rapidly than neutral cues, probably because a specific semantic network is activated in these patients. The decreased reaction time confirms the impulsive behavior frequently found in male alcoholism, as it has been described in type II alcoholism. Besides, the results imply that information processing was delayed in female alcoholic patients. Therefore this study demonstrates a gender-dependent impact of alcohol-related stimuli on information processing.

Key Words: Alcohol ; P300 ; event-related brain potentials ; emotion

Introduction

The P300 component of the event-related potential (ERP) is a positive deflection that occurs when a subject detects an informative task-relevant stimulus. It is particularly interesting for the study of cognitive processes in normal and psychopathologic subjects [1-4]. P300 reflects memory updating [1] or context closure [5,6]. P300 is related with 'external control', which favors attentional mechanisms directed at the environment [7], and it perhaps represents the transfer of relevant information to consciousness [1]. The P300 amplitude is related to stimulus probability, stimulus significance, task difficulty, motivation, and vigilance [8], and P300 latency reflects the stimulus evaluation time [9]. P300 latency is mainly influenced by task complexity and it is only weakly influenced by response selection processes [10].

Several studies reported that the emotional value of stimuli affects P300 amplitude. In a study where subjects were shown two slides of a woman showing angry, happy or neutral expressions, the P300 area was larger when the target was happy and the peak amplitude was greater when the target was angry. No differences between neutral target faces were found for P300 amplitude [11]. Moreover, depressed patients showed a smaller P300 amplitude in response to negative than to positive words, while normal controls showed the inverse pattern and recovered patients showed a response pattern which similar to that observed in depressed patients [12]. In addition, the impact of emotional stimuli on P300 has been largely assessed in posttraumatic stress disorder (PTSD). With a standard oddball paradigm, a lower P300 amplitude is usually found in PTSD [13], but combat-related pictures elicited enhanced P300 amplitude in PTSD patients only [14, 15]. Interestingly, an increased P300 amplitude is observed only for trauma-relevant combat stimuli but not for trauma-irrelevant, social-threat stimuli. Results were consistent with resource allocation models of psychopathology, which suggest that some psychopathological conditions are characterized by attentional bias to anxious or negative stimuli at the expense of attention to emotionally neutral information [16, 17].

Several behavioral studies have reported that alcoholic subjects show altered performance on a modified Stroop test. Sharma et al. [18] showed that alcoholic participants displayed significantly longer reaction time to respond to the color of alcohol-related words than to neutral category words. In another study, alcoholics showed longer reaction times to both alcohol-related and emotional than to neutral words, which suggests that the content of these words interfered with the ability to pay attention to the color of the words, and that it is difficult for alcoholics to regulate their attention to alcohol stimuli [19]. Consequently it has been proposed that alcoholics' processing of alcohol-related information may be automated. In other words: alcoholics exhibit more difficulties to inhibit responses to stimuli associated with alcoholic cues. Cox et al. [20] demonstrated that the effects of alcohol cues on automatic cognitive processes previously found in alcohol-dependent drinkers also occur in social drinkers. The magnitude of these effects varies directly with social drinker's level of habitual alcohol use.

While some of the studies investigating the impact of emotional (i.e. alcohol-related) stimuli in alcoholism have recorded psychophysiological measures (i.e. heart rate) [19], none of them included P300 recording. Therefore the aim of this study was to explore whether emotional stimuli could modulate P300 amplitude in alcoholic subjects. Based on previous findings, an impact of alcohol-related words on P300 amplitude was expected.

Table 1. *Alcohol-related and neutral words used in the study (translated from the French)*

Alcohol-related words	Neutral words
Alcohol	Water
Whisky	Apple
Beer	Meadow
Aperitif	House
Cocktail	Flower
Pub	Seal
Gin	Paper
Dutch gin	Pepper

Subjects and Methods

Subjects

The study was conducted on 10 alcoholic patients admitted to the department of Psychiatry of the University of Liège (Belgium). The sample comprised 7 men and 3 women with a mean age of 47.9 years (SD = 6.9). All the patients met the criteria for alcohol dependence and/or alcohol abuse according to DSM-IV-TR [21]. The diagnosis was established by one senior psychiatrist (E.P.), and the patients included here did not present major Axis I or Axis II comorbidities. The patients were compared to 10 healthy controls matched for age and gender, and who reported no personal and/or familial antecedents of alcohol abuse and/or dependence. The protocol was approved by the Ethic Committee of the University of Liège, and all subjects gave their informed consent.

P300 Procedure, Recording and Data Analysis

The P300 recording was carried out in a sound-attenuated room. The visual stimuli were displayed on a computer monitor placed 1 m from the subject. The stimuli consisted of 8 alcohol-related and 8 neutral words, between 5 and 10 cm long and with a height of 1.8 cm (table 1). They were presented 6 times each in a random series at the rate of 1 trial/s and a duration of 100 ms. The frequent stimuli were neutral words (66%, 96 stimuli), the other 33% (48 stimuli, target) were alcohol-related words. The subjects were asked to press a button for the target stimuli as quickly as possible.

EEG was recorded using silver-silver chloride electrodes attached at Fz, Cz, Pz, F4, F3, C4, C3 using linked earlobes for reference and right forehead for ground. All sites were cleaned with acetone and abraded to maintain a resistance below 5 k Ω . EOG was recorded from above the left eye. Amplifier gains were set at 10,000, with a band pass of 0.08-35 Hz. The EEG was digitized at 250 sample/s for 900 ms with a 200 ms prestimulus baseline. Trials on which the EEG or EOG exceeded 50 μ V were rejected automatically. P300 amplitude and latency were measured as the difference in voltage between baseline and the peak positive amplitude between 280 and 600 ms after the stimulus.

Psychometric Assessment

Severity of depressive symptoms was assessed by the Carroll Rating Scale (CRS) for depression [20]. Moreover, the Obsessive Compulsive Drinking Scale (OCDS) was used to assess the cognitive and behavioral aspects of craving [23].

Statistical Analysis

Version 5.5 of the Statistica software [24] for Windows was used for all analyses. Group differences were calculated by double ANOVA with P300 latencies and amplitudes as dependent variables, group and gender as independent variables, and Carroll's scores as cofactor.

Results

Alcoholic patients exhibited higher CRS scores than controls ($F = 14.53$, $p < 0.002$). However, no significant differences between the groups existed for the OCDS scores.

No significant differences between groups, gender or significant interactions were found for P300 amplitude.

Again, no significant differences between groups and gender were observed for P300 latency. In contrast, significant group \times gender interactions were found for P300 latency for all the electrodes (fig. 1). Analysis of reaction time (RT) revealed a significant difference between groups, with alcoholic subjects displaying a shorter RT than controls ($F = 5.65$, $p = 0.03$), and a significant group \times gender interaction ($F = 10.3$, $p < 0.01$). Figure 2 shows that alcoholic males exhibited shorter RTs than male controls, but alcoholic females did not differ from female controls.

Fig. 1. P300 latency in alcoholic and control subjects by gender (significant group \times gender interaction).

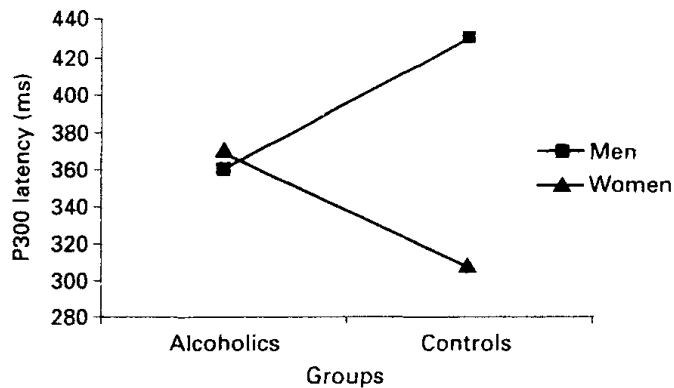
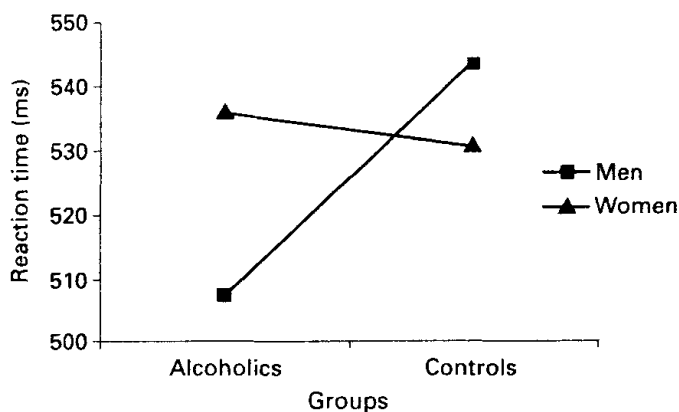


Fig. 2. Reaction time in alcoholic and control subjects by gender (significant group \times gender interaction).



Discussion

In the present study, alcohol-related words were used to assess the emotional impact of stimuli on P300 event-related brain potential. Previous studies that manipulated the emotional values of stimuli in PTSD, depressed subjects and controls [11, 12, 14, 15] showed that emotional stimuli significantly affected P300 amplitude. However, the results of our study do not demonstrate an impact of alcohol-related words on P300 amplitude. In other words, alcoholic patients do not pay more attention to alcohol-related words than controls. A possible explanation is that alcohol-related words were equally attractive to both groups. Indeed, the level of attraction of the alcohol-related words used here was not assessed before the study.

The present results show that male alcoholics exhibit a shorter P300 latency compared to controls and that female alcoholics tend to have a longer P300 latency compared to controls. A robust finding observed in alcohol-dependent patients is an increase of P300 latency [25-27]. Since P300 latency reflects stimulus evaluation time and memory functions, the enhanced latency observed in alcoholism is usually interpreted as a consequence of memory and attention deficits. The results obtained in female alcoholics confirm these studies, whereas the results found in male alcoholics are dramatically opposed. This means that alcoholic males tend to process the information associated with alcohol-related cues more quickly, which suggests a facilitation mechanism of an alcoholic semantic network. The time required for the evaluation of the stimulus is reduced when the stimulus contains alcohol-related cues. This result can be interpreted in the light of the approach hypothesis of Stormark et

al. [28]. They suggest that when alcoholics selectively pay attention to emotionally relevant stimuli, the ability to shift attention away from such material is impaired: alcohol-related cues elicit emotional associations that, subsequent to initial stimulus identification, cause a disruption in the attentional system. In addition, the present results are in agreement with behavioral studies conducted with a modified Stroop test showing interference in the situations where alcohol-related words are used [18-20]. Interference is interpreted as a consequence of the manifest difficulties that alcoholics have in regulating their attention to alcohol-related stimuli, suggesting that alcoholics' processing of alcohol information is automated [19, 29]. Finally, the fact that P300 latency is shortened only in males and not in females could be due to the personality traits associated with type II alcoholism in males (described in more detail by Cloninger [30]): greater novelty seeking and lower harm avoidance. The greater novelty seeking dimension is connected to the approach hypothesis of Stormark et al. [27].

RT is reduced in alcoholic males. As for P300 latency, this result suggests that alcohol-related words are processed more quickly, it is also in agreement with impulsive behaviors associated with alcoholism [31, 32]. In fact, alcoholics tend to respond more rapidly but make more mistakes than controls: both stages of stimulus time evaluation (P300 latency) and motor response processes (RT) are shortened. Impulsivity implies decision-making deficits due to an inability to inhibit behavior, similar to behavior observed in patients with frontal lesions [33]. Impulsivity in alcoholism is probably also determined by an hypersensitivity to reward and novelty seeking [30, 32].

In conclusion, the present study suggests that male alcoholic patients process information linked to alcohol cues more rapidly than neutral cues, probably because a specific semantic network is activated in these patients. The shorter RT confirms the impulsive behavior frequently found in male alcoholics, as has been described in type II alcoholism. Besides, the results imply that information processing is delayed in female alcoholic patients. Therefore, this study demonstrates a gender-dependent impact of alcohol stimuli on information processing. However, given the limited sample size, the preliminary nature of our results should be underlined. Further studies, with larger samples and a more sophisticated procedure, should be conducted to replicate these findings.

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