
Social Drinking - Part II: Auditory Evoked Potentials, P300 Response and Contingent Negative Variation in Social Drinkers

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Abstract

The study aimed to determine if any neurophysiological evidence supporting cognitive changes exist in social drinkers. The sample comprised of 44 male social drinkers and 22 teetotallers matched for age and education. Details of drinking habits were elicited through interviews of the subjects. The experiments consisted of tests for late Auditory Evoked Potentials (AEP), Auditory P300 and Contingent Negative Variation (CNV). EEG was recorded from the Fz and Cz electrode sites of the 10-20 International electrode placement system. The two groups were compared on the mean amplitudes and latencies of P1-N1-P2 components of the AEP, the P300 and the early and late components of the CNV. Results showed that the two groups did not differ significantly on both the amplitude and latency measures of the various components, indicating that there is no electrophysiological evidence of change in cognitive processing or brain dysfunction in social drinkers.

Key words -

Social drinking,
Event related potentials,
AEP,
P 300,
CNV

Event Related Potential (ERP) responses have been reported to be sensitive to several aspects of alcohol use, including acute intoxication, withdrawal, tolerance, alcohol related chronic brain dysfunction, in utero exposure, social consumptions and familial risk for alcoholism [1], [2], [3], [4], [5]. There have been very few studies in social drinkers (SDs) using ERP measures and the results have been equivocal. Emmerson et al [3] compared 20 male SDs with 20 Teetotallers (TTs) and found that the two groups were comparable with respect of amplitude and latency measures of early visual evoked potential components and P300. On the other hand significant neuropsychological changes have been reported in SDs compared to TTs [6], [7], [8], [9], [10], [11]. Our investigation with groups of SD and TT subjects using neuropsychological tests showed that a significant disadvantage existed in SDs in the areas of immediate memory and abstract reasoning [11].

The purpose of the present study was to determine if social drinking leads to cognitive changes that can be detected by

ERP measures. The measures proposed for the investigation were the P1-N1-P2 components of late auditory AEP, P300 response and CNV. The AEP was included only as a base line measure of attention as there is no clear evidence that these components are affected in alcoholism. The P300 has been considered the most reliable and robust measure of signal detection and information processing [12], [13], [14], [15], [16], [17]. The CNV is a slow negative DC potential associated with anticipation and motor readiness [12], [13], [14], [15], [16], [17], [18]. Studies on alcohol dependent patients have shown that these measures can demonstrate significant effects and they are considered indicators of brain dysfunction due to chronic alcohol abuse in them [1], [2], [3], [4], [5]. Attempt was made in the present investigation to elicit evidence for the presence of a change in the electrophysiological status of the brain or brain dysfunction in the SDs compared to the TTs.

Material and Methods

The study was conducted on male social drinkers who volunteered to participate in the study. Forty-four male social drinkers and 22 teetotallers took part in the study. Details of inclusion and exclusion criteria for the SDs and the TTs are given in the study reported by Andrade and Mukundan [11], and the alcohol consumption and drinking pattern of the SDs are presented in Table II. The two groups were group matched on age and education and the mean and SD scores are presented in Table I. Informed consent was obtained from each subject prior to the study. The subject was seated on a reclining chair in a dimly lighted sound treated room. The F^Z and Cz electrode sites from the 10-20 international electrode system [19] with the linked earlobes as the reference electrode were used for recording the ERPs. Nihon Kohden AB620 bioamplifier system was used for signal conditioning. The signals were analyzed by Iwatsu SM2000B Signal Analyzer. The amplifiers and the Signal Analyzer were calibrated by a 50 microvolt sine wave of 4 Hz frequency.

The experimental paradigms used were the following:

1. Late Latency Auditory Evoked Potential

The subject was presented with tone bursts of 1000 Hz and of duration 50 ms with rise and fall time of 10 ms using a Nihon Kohden SMP-4100 Auditory / Visual Stimulator. The tones were presented through a pair of earphones at 60 dB intensity. A random interval with 2 sec central point was used between two stimuli, 60 tones were presented while the EEG was recorded with the eyes closed. The time constant was set to 1 sec and the low pass filter at 70 Hz. The Signal Analyzer was set for an epoch length of 624 ms with a prestimulus interval of 50 ms. The amplifier gain and the automatic noise rejection programme were set to reject epochs with responses above 30 microvolt either at the Fz or the Cz electrode sites. The subject was instructed to passively listen to the tone bursts. Noise free signals were averaged by the Signal Analyzer.

P1 was the maximum positivity or positive peak reached within 35-100 ms after stimulus onset. The N1 was the negative peak seen in the 70-140 ms range and the P2 was the positive peak seen in the 100-200 ms range. The amplitudes of the peaks from the base line and their latencies were determined on the Signal Analyzer for the averaged waveform.

2. The Auditory P300

This experiment was carried out by presenting two tone bursts of frequencies of 750 Hz and 1500 Hz at random. The former was the frequent tone and the latter infrequent tone presented at ratio of 4:1 (total 250). The duration of the tone burst and their rise/fall time and intensity were as in the AEP

experiment. The tones were presented at an interval of 2 sec with variability determined by the stimulator. The time constant and low pass filters were set to 1 sec and 70 Hz respectively. The analysis length was 624 ms. The gain of the amplifiers and the automatic noise rejection programme were set to reject epochs with responses above 30 microvolt, and the noise free signals were averaged by the Signal Analyzer. The subject was instructed to respond to the infrequent stimuli by a key press while he was to ignore the frequent tones. The EEG was collected with the eyes closed. The P300 was the maximum positivity or the positive peak seen in the range of 250-550 ms in the averaged wave for the infrequent stimuli. The amplitude from the prestimulus base line and the latency of the peak point were determined for each averaged wave.

3.CNV

The CNV experiment was also conducted using the SMP-4100 stimulator. The subject was instructed to listen to a click which was a warning signal that a second stimulus of LED flashes will appear after a present interval. The subject was instructed to press a key when the flashes occurred which switched off the photic stimulus. The click was for a duration of 1 ms with an intensity of 60 dB. The interval between the click and the LED flash onset was set to 3 sec. The time constant for this experiment was set to 15 sec and the low pass filter at 30 Hz. The Signal Analyzer was set for a 5 sec analysis length with a 1 sec negative delay which occurred prior to the click. The Signal Analyzer was DC coupled with the output the bioamplifiers and the A/D auto rejection program was set to reject EEG sweeps with DC shifts, eye blink or movement responses larger than 50 microvolt. The 3 sec epoch between the two stimuli was divided into an early and late phase and the maximum negativity reached in each phase with respect to the prestimulus base line was measured. The experiment consisted of 50 trials. This test was carried out by only the last 16 subjects from each group. A comparison of the age and education variables of these subgroups did not show any significant mean differences.

Results

The latency and amplitude measures of AEP, P300 and CNV were compared between the two groups using Analysis of Variance. The mean values and the SDs are given in Tables I to IV along with result of analysis.

Table I - Mean age and education (in years) of the SD and TT groups

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Table II - Drinking Variables in the SD's (n=44)

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Table III - Mean and SD scores of amplitude (in microvolt) and latency (in ms) of P1, N1 and P2 componenets of AEP in the SD and TT groups at the Fz and Cz electrode sites

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Table IV - Mean amplitude (in microvolt) and latency (in ms) of the P300 component and the mean amplitude of the early (1) and (2) CNV components in the SD and TT groups in the Fz and Cz electrode sites

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Discussion

Forty-four male SDs were compared with 22 age and education matched TTs on AEP, P300 and CNV. As alcohol dependant patients have shown significant deficits on the P300 and CNV measures in several earlier studies, it was hypothesised that some of these changes will predate alcoholism and hence may also be seen in social drinkers.

With regard to the latency and amplitude measures of P1, N1 and P2 components in the AEP experiment (Figure 1), there was no indication of a significant difference between the two groups at both the electrode sites. This is in keeping with the findings from our laboratory [5] and other studies reported [20], [21] in alcoholics and SDs. The P1 is a scalp positivity and associated with sensory registration and in humans it is suggested to be produced by cortical areas mediated by the reticular formation [12]. The P1 is also considered sensitive to the level of consciousness in subjects [22]. The N1 and P2 are components highly sensitive to the level and arousal of attention [23], [24], [25].

.Grand average of AER (A), P300 (B) and CNV (C) responses in the SD and TT groups at Fz

Both latency and amplitude of the P300 are known to be affected in alcohol dependent patients. In the case of SDs the mean latency and amplitude of P300 at the Fz and Cz electrode sites are highly comparable to that of the TTs (Figure 1). This demonstrates that changes seen in alcoholism are not predated in the SDs of comparable drinking history as of this study. The P300 is a robust cognitive potential and is associated with stimulus evaluation and is the most widely investigated cognitive potential. It can be easily elicited in the auditory, visual and somatosensory modalities. This potential occurring between 240-550 ms over the scalp is recorded during signal detection or while attending to a novel stimulus or change in the stimulus field. In the auditory oddball paradigm used, the P300 emerges when the subject attends to the infrequent stimuli, which indicates that it is closely associated with information processing related to the detection of a change in the stimulus characteristic. Donchin and Coles [26] presented a "context updating" hypothesis suggested by the studies of Karis et al [27], Neville et al [28] and Paller et al [29] suggested that the P300 is a measure of the strength of the memory trace formed at the time of the experiment. The normal P300 elicited in the SDs provides evidence that cognitive processing tested by this potential is unaffected by social drinking.

With regard to the mean amplitudes of the early and late components of the CNV, there is no significant difference between the two groups on either of the components (Figure 1). The CNV is formed between two stimuli, when the first one conditions the reaction to the second [30] (Walter et al [30]). It has been suggested [31], [32] that the CNV may be composite of two independent components and not an independent response. It is interesting to note that CNV has been elicited in various studies involving humans and in animals, which signifies the relevance and reliability of this potential. The

CNV can be elicited in any two stimuli paradigm which will incorporate a task demand of expectation, readiness, preparation for a perceptual judgement and preparation for a cognitive decision of latter stimulus with reference to the former, Regarding its electrogenesis, the CNV is considered related to widespread neural activation and its summation in the neocortex [12], [18]. The CNV data support that the capacity to remain alert and being in a state of anticipation and being prepared to execute voluntary motor act are not affected in the SDs.

The findings of the study do not support that social drinking may lead to neurophysiological changes that may in turn affect cognitive processes. However this finding has to be viewed with caution primarily because the definition of social drinking with reference to quantity of consumption strictly refers to the subjects of this study. Further all the subjects selected for the study were young with relatively small number of years of social drinking history. These findings are not in concurrence with the neuropsychological data available in a subgroup (n=26) of SDs. A clear disadvantage is seen in SDs with respect to the TTs on a few neuropsychological tests [11]. This discrepancy between behavioural and neurophysiological measures in the SDs can be explained in terms of the nature of the tasks and factors that affect performance on the behavioural tests. The behavioural tests used in the study are complex psychological experiments requiring affective inputs, motivation and cognitive processing, whereas the psychophysiological experiments involved passive participation and/or participation with relatively less complex cognitive processing. Thus the task demands in the two modes of investigations cannot be considered comparable, and this could have given rise to the above discrepancy. Nevertheless it is well established that P300 is a powerful marker of psychiatric and neuropsychiatric vulnerability, and it is a strong indicator of brain functioning both in adults and children, and hence the P300 not being affected in the SDs group is a strong indication of absence of such brain dysfunction in them.

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