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Cerebral Electrical Phenomena Elicited by Alcohol

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Summary. The authors investigated the EEG changes in young clinically healthy individuals for some hours after the administration of various quantities and qualities of alcohol during and after the absorption and excretion phase. During the period of EEG examination, hyperventilation and light stimuli of different frequencies were employed.

It was stablished that — in accordance with literary data — a slowing of the cerebral electric activity and an increase of the amplitudes ensued, which changed diversely under the influence of hyperventilation and light stimulus according to the individual sensitivity.

In the cases where pathological cerebral electric phenomena not associated with clinical disease symptoms were observed — as e.g. wave activity of pathological (epileptic-like) character affected by light stimuli — a significant impairment of the electric activity ensued already before the administration of alcohol being most marked chiefly in the hours following alcohol excretion. The authors call attention to the dangers of the post-alcohol state, mainly in the case of individuals who are clinically healthy, but who show pathological cerebral electroactivity during the EEG examination if subjected to physiological stimuli (hyperventilation, light stimuli). On the basis of their results, they recommend the routine introduction of EEG at the aptitude tests for drivers.

Zusammenfassung. Die Verfasser haben nach der Eingabe von Alkohol verschiedener Qualität und Quantität die EEG-Veränderungen in der Resorptions- bzw. in der Exkretionsphase sowie in den folgenden Stunden an klinisch gesunden Personen untersucht. Bei den EEG-Untersuchungen wurden Hyperventilation und Lichtreize mit verschiedenen Frequenzen angewendet.

Im Einklang mit Literaturangaben wurde eine Verminderung der elektrischen Aktivität, jedoch ein Anstieg der Amplituden festgestellt, die sich unter der Wirkung von Lichtreizen und HV auf verschiedene Weise — der persönlichen Empfindlichkeit gemäß — veränderten.

In solchen Fällen, bei denen pathologische Phänomene auftraten, z. B. pathologische Wellenaktivität (vom epileptischen Typ) auf Lichtreize, ist eine wesentliche Veränderung der elektrischen Aktivität schon vor der Einnahme des Alkoholgetränkes, besonders in den Stunden nach der Exkretion, eingetreten.

Wichtig sind die Gefahren der postalkoholischen Phase, besonders bei solchen klinisch gesunden Personen, die während der EEG-Untersuchungen — physiologischen Reizen ausgesetzt (Hyperventilation, Lichtreize) — eine pathologische cerebrale Aktivität zeigen.

Auf Grund der Ergebnisse erscheint es empfehlenswert, die routineartige Anwendung der EEG-Untersuchungen bei den Fahrtauglichkeitsprüfungen der Kraftwagenführer einzuführen.

Key words: Effect of alcohol, EEG-changes — EEG-changes, alcohol.

The cerebral electrical phenomena elicited by the effect of alcohol have been investigated by several authors [1—12]. It has been established that a slowing of the cerebral electrical activity and an increase of the amplitude ensues under the influence of alcohol.

The aim of our present experiments was to observe the changes of the cerebral electrical activity in clinically healthy individuals on 30 occasions. 23 of the experimental persons were men and 7 were women. Scotch whisky, grape pomace (grape brandy), cherry brandy, wine and beer respectively (all obtainable in shops) were used as drinks containing alcohol. The participants did not consume alcohol for 48 hrs before the experiment. They were permitted to eat and smoke during the experiments, but the consumption of coffee and drinks was prohibited.

The recording was performed by means of an EMG-electroencephalograph "8" channel apparatus. During each investigation a 4-minutes hyperventilation (HV) took place, and different light stimuli of 3—20 c/s frequency were applied. In some instances the ocular movements and the EKG curve were registered. In every case, during the EEG examination every hour or every 2 hrs resp., saliva and blood samples were taken during the resorption, excretion, and postalcoholic period. Later, alcohol determination was carried out according to the method of Widmark and ADH. The maximal values of alcohol level in the blood ranged from 0.99 to 2.28‰.

Our experimental data may be divided into three groups:

1. The EEG changes ensuing in healthy persons influenced by alcohol. In these cases pathological cerebral electrical phenomena were neither observable as long as the effect of alcohol lasted nor during the hours following excretion.

2. The pathological EEG curves of clinically healthy persons, which change, but remain pathologic under the influence of alcoholic drinks.

3. "Epileptic-like" responses elicited by alcohol in clinically healthy persons observed chiefly during the hours following excretion.

In the following certain characteristic results of our experiments will be presented:

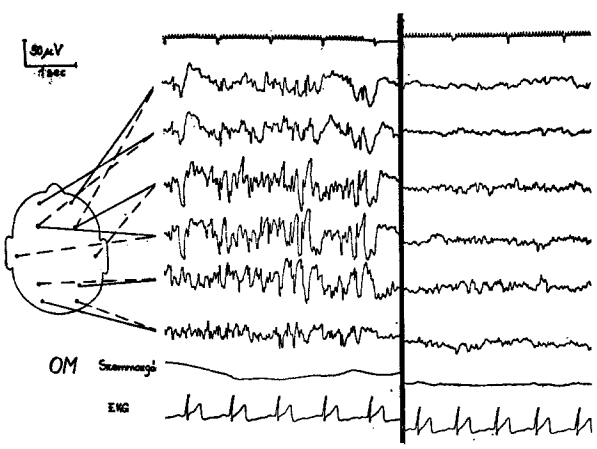

Fig. 1. Ocular movements and *EKG* electrocardiogram of a clinically healthy individual. In all recordings of the control EEG (A), polyspike activity was seen under the influence of 15 c/s light stimulation. The ocular movements were positive. B The irregularity of the A curve changes under the influence of whisky and light stimulation (at 0.81% blood alcohol concentration) with the exception of the frontal area, i.e. 4—5 c/s slow waves appear. There is no polyspike activity

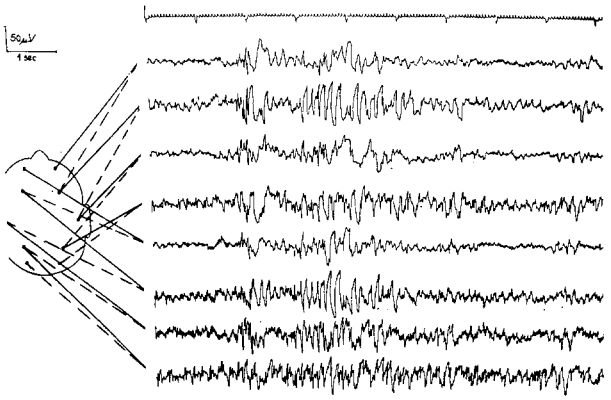

Fig. 2. After consumption of grape brandy (at 0.73% blood alcohol concentration) polyspike activity can be seen similar to that of the control

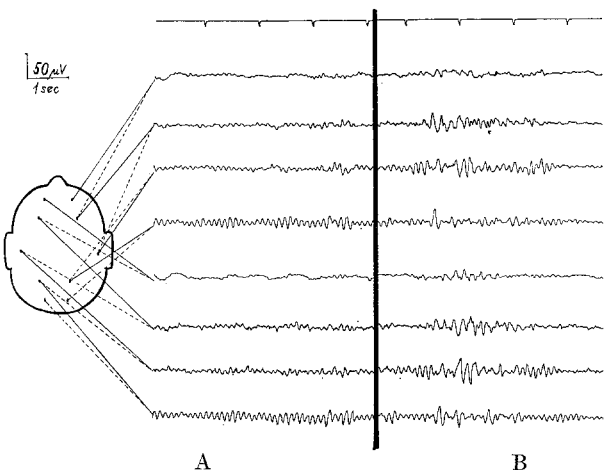

Fig. 3. A The control EEG shows normal electrical activity. B Following consumption of 7 dl. of Grey Friar wine (1.13% blood alcohol concentration) after a 4-minutes HV, generalized theta-paroxysmus and sharp wave-groups develop in the temporal regions in addition to a pronounced synchronization

K. M., a 25-year-old healthy woman. The resting and awake basic activity, the minimal amplitude-decrease appearing after a HV of 4 min. and a generalized desynchronisation elicited by 3—20 c/s light a stimuli can be observed.

Under the effect of whisky (blood alcohol: $1.85^0/_{00}$) the electrical activity desynchronizes minimally in the rostral regions, hardly at all during hyperventilation, but becomes striking when light stimulus is applied.

At $0.2^0/_{00}$ alcohol concentration in the blood, the cerebral electrical activity is essentially similar to that of the above. 5 hrs after the excretion of the alcohol, the basic activity is more desynchronizes as compared to the starting activity.

After 4 min of HV the sinusoid activity belonging to the alpha frequency band manifests itself in the frontal areas, while in the others a marked synchronisation appears with several sharp alpha waves in the occipital region.

3—6 c/s light stimuli elicit paradoxical hypersynchrone responses and not even do higher frequencies of light stimuli evoke desynchronization. Essentially similar results were obtained by

almost identical quantities of grape-brandy and wine with the difference that 5 hrs after the excretion of the wine, the resting and awake EEG is identical with the activity produced by whisky while the synchronization in the parietooccipital records is much more marked after hyperventilation lasting 4 min. Light stimuli elicit sharp alpha activity chiefly in the occipital regions.

Similar changes were observed in 13 other persons (this may be considered a so-called normal response).

B. P., a 26-year-old healthy man. At a control examination with 15 c/s light stimulation without signs, approximately 4 c/s generalized spike and wave groups appear, most marked in the middle temporal areas (Fig. 1).

After whisky comsumption slow sections of low voltage and of 4—5 c/s intensity appear, evoked by light stimuli at 0.81‰ blood alcohol concentration with the exception of the frontal area (Fig. 1 B). After drinking grape-brandy (0.73‰ blood alcohol level), a generalized single and grouped spike, wave, and poly-spike activity can be observed (Fig. 2). After drinking alcohol, a similar electrical response appears in the excretional phase. 3 days after excretion the spike and wave forms are essentially identical compared with the control curves.

K. S., a 25-year-old healthy man. His control examination showed a normal cerebral activity after a 4 min HV (Fig. 3 A). After consuming 7 dl. of Badacsonyi Szürke Barát (Grey Friar) (1.13‰ blood alcohol level), and after 4 min HV, frequent generalized theta paro-

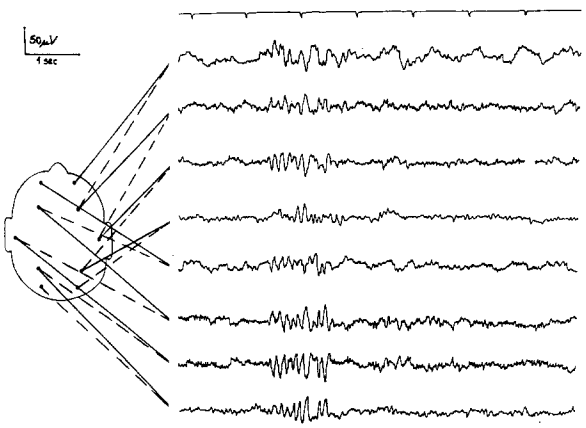

Fig. 4. In clinically healthy individuals generalized 6—7 c/s slow periods appear after 4 min HV

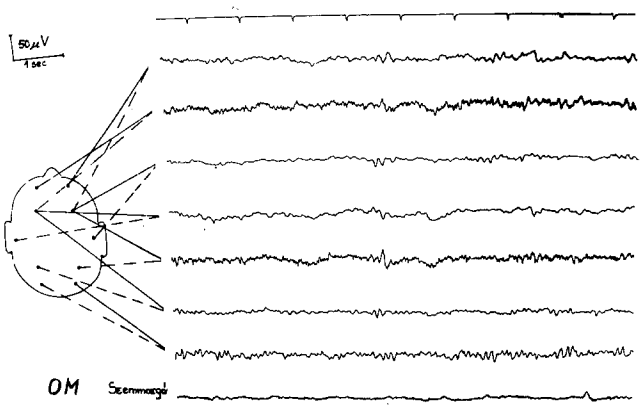

Fig. 5. At 0.63 blood alcohol value the 6—7 c/s phases seen in Fig. 4 disappear. Normal electrical activity

xysmus in addition to marked synchronization. In the temporal pairs almost regular sharp wave groups developed (Fig. 3B).

N. E., a 23-year-old clinically healthy woman. In the wakening basic activity, in all of the recordings, generalized 6—7 c/s waves can be observed after HV lasting 4 min (Fig. 4). At $0.63^0/_{00}$ blood alcohol concentration, nearly normal activity can be seen (Fig. 5). 6 hrs after the excretion of the alcohol, a generalized slowing and hypersynchronization was observable, while marked, in fact paroxysmal, waves of great voltage can also be seen on the right hemisphere.

Discussion

The EEG-changes ensuing under the influence of alcohol are ascribed unequivocally in literature to the decrease of the frequency and the increase of the amplitudes [2, 3, 6—8, 10]. Hedenström *et al.* pointed out that the cerebral centers of higher order are sensitive to alcohol. Allen *et al.* gave an account of the change of the EEG-sleep curves and associated sleep disorders of chronic alcoholics. Müller and Rutenfranz proved that the EEG-changes are identical with the blood alcohol values only in the period of resorption, but not in the period of excretion. Others [4, 5] pointed to the joint electric activity caused by alcohol and other substances.

Konuma [11] analysed the EEG curves of epileptics. However, he did not mention cases where epileptic-like EEG-changes occur in clinically healthy individuals under the influence of alcohol. The results of our experiments are identical with the literary data obtained hitherto. We have also observed the frequency decrease and the amplitude increase in a significant number of experimental persons. In some cases we detected EEG of paroxysmal pathological character only under the influence of alcohol. We also obtained EEG of pathological character even without alcohol in healthy persons, but after consuming alcoholic drinks of different quality, we received contradictory responses. In one case, for example, after drinking White Horse whisky, the cerebral electric irregulation became normal, while after the consumption of grape brandy, at a blood alcohol value corresponding to that of the former, the control curve remained unchanged, or only slight changes were observable.

The relatively small number of our experiments does not allow us to make far-reaching conclusions, but it might permit the following assumptions.

1. Under the influence of alcohol in resting-awakening state a slowing of the cerebral electrical activity ensues with an increase of the amplitude. Even 5 hrs after the excretion of the alcohol, paradoxical and/or hypersynchrone responses can be seen when light stimuli and HV are applied.

2. In those cases where pathological cerebral electrical phenomena were not associated with clinical signs, electrical activity of pathological (epileptic like) character was observed when light stimuli were applied. Under the influence of alcohol the disappearance of the pathological wave groups and, several hours after the excretion of alcohol, when light stimulation was applied, a generalized spike, wave, and poly-spike activity could be seen.

3. In some cases we found differences on the EEG-curve, which seemed to be an effect of drinks containing different qualities of alcohol. We cannot explain this phenomenon on the basis of our present data.

4. Under the influence of alcohol, pathological cerebral electric responses may ensue, which cannot be observed in the absence of alcohol.

5. We call attention to the danger of alcoholic conditions, chiefly in the case of those individuals who are clinically healthy, but where physiological stimuli (light, HV) elicit pathological forms of waves (spike, spike and wave groups). In such cases the granting of divers licences has to be considered.

6. On the basis of our experiences we propose the routine-like introduction of EEG when testing professional drivers.

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