Effects of Injection of Analgetics and Alcohol Drinking on Values of Electric Flicker

By

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Motokawa and Suzuki\(^1\) have previously reported that a flicker sensation of the eye can be used as a very convenient indicator for the measurement of fatigue. Motokawa & Iwama\(^2\) found that the electric threshold for phosphenes was very sensitive to oxygen lack. Suzuki and Umetsu\(^3\) investigated variation of electric flicker value (EF) in response to bleeding and transfusion of blood, and found that an increase and a decrease of oxygen content of the blood cause a decrease and an increase of EF, respectively.

In the present experiment the effects of various analgetics upon EF were investigated.

**Experimental**

**Method**

Subjects were 13 healthy men, and 9 of these were injected opium alkaloid solution (2\%, 0.5–1.0 cc), 3 were injected benadryl (30 mgr) and phenobarbital (1\%, 1.0 cc), and the other was injected thiopental (25\%, 12 cc).

For about 30 minutes before each injection, the subjects were laid down quietly. A series of measurements of EF and selective reaction time (SRT) were carried out after the rest to obtain control values. Similar measurements were made after the injection at intervals of 10 minutes.

The effect of alcohol drinking was examined on 6 healthy men. 200 cc of 15\% alcohol were given to each subject, and the same measurements, as described above, were made.

The apparatus used for the measurements of EF in the medicine injection experiments was the same as Motokawa’s original method.\(^1\) In this method the values of EF were expressed in mV. Stimulating elec-
trodes were placed at the outer corner of the eyes of a subject, and the eyes were stimulated with rectangular pulses of 20 cps. The stimulating voltage was increased from zero at a constant rate of 80 mV per second to determine the threshold for the appearance of flicker, $S_1$, and then the threshold for the disappearance of flicker, $S_2$, was determined by lowering the voltage from a sufficiently high level at the same rate as above. The EF ($\Delta S$) is represented by the difference of both sorts of threshold. As a value of EF an average of five determinations made in succession was used.

The apparatus used in the alcohol experiments was the same as described recently in Motokawa's report. Sinusoidal alternating currents of 20 cps were applied to the eyes through a pair of silver electrodes. The stimulating current was increased automatically from zero at a constant rate of 12 $\mu$A per second, to determine the threshold for appearance of electric flicker, $S_1$, and then decreased at the same rate to determine the threshold for disappearance, $S_2$. EF or $\Delta S$ was expressed in terms of $\mu$A, instead of in mV.

Measurements of SRT were made as follows: One of 3 lamps, red, blue and white in color was lighted in a random order at regular intervals. Subjects switched off the lighted lamp as quickly as possible by tapping the key for this lamp. The reaction time to the red lamp alone was measured, and the value was expressed in msec.

Results

I. Effects of medicine injection

Opium alkaloid injections were made to subjects No. 1 to No. 9. The results obtained are shown in Table I. In each case EF increased gradually after an injection, and reached a maximum about 30 minutes after the injection. Recovery was seen in about 60 minutes. The SRT was measured in cases (subj. Nos. 5, 6 and 9) and indicated in Table I. It can be seen from this table that after the medicine injection the values of EF and SRT run almost completely parallel. It is without saying that the difference between EFs before and after the injections is statistically significant.

On the other hand, we measured the values of EF and SRT after the injection of other kinds of analgetics (benadryl and phenobarbital). The results obtained are shown in Table I, too. These analgetics were found little effective on values of EF and SRT; the difference between values before and after the injection does not seem significant. But the value of EF after a thiopental injection increased remarkably (No. 13 in Table I).

II. Effects of alcohol drinking
TABLE I
Changes of EF (ΔS) and SRT after Injection of Analgetics or other Hypnotics

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Injected drug</th>
<th>ΔS in mV and SRT in msec. Time after injection in min.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Before 10 20 30 40 50 60</td>
</tr>
<tr>
<td>1</td>
<td>Opium alkaloid (2%) 0.6 cc</td>
<td>ΔS 20 172 420 452 400 360 320</td>
</tr>
<tr>
<td>2</td>
<td>&quot; 0.6 cc</td>
<td>ΔS 50 160 135 150 180 172 148</td>
</tr>
<tr>
<td>3</td>
<td>&quot; 0.6 cc</td>
<td>ΔS 92 150 176 216 208 178 96</td>
</tr>
<tr>
<td>4</td>
<td>&quot; 1.0 cc</td>
<td>ΔS 50 188 270 230 384 352 356</td>
</tr>
<tr>
<td>5</td>
<td>&quot; 0.6 cc</td>
<td>ΔS 200 400 468 570 570 502 460</td>
</tr>
<tr>
<td>6</td>
<td>&quot; 0.5 cc</td>
<td>SRT 678 772 820 898 880 842 830</td>
</tr>
<tr>
<td>7</td>
<td>&quot; 0.5 cc</td>
<td>ΔS 88 244 324 132 120 120 110</td>
</tr>
<tr>
<td>8</td>
<td>&quot; 0.6 cc</td>
<td>ΔS 136 168 216 140 148 124 130</td>
</tr>
<tr>
<td>9</td>
<td>&quot; 0.6 cc</td>
<td>ΔS 36 120 120 120 180 220 228</td>
</tr>
<tr>
<td>10</td>
<td>Benadryl 30mg Papaverin 0.5 cc</td>
<td>ΔS 48 100 52 68 72 140 100</td>
</tr>
<tr>
<td>11</td>
<td>Benadryl 30 mg</td>
<td>ΔS 62 124 190 96 90 92 100</td>
</tr>
<tr>
<td>12</td>
<td>Phenobarbital (10%) 1.0 cc</td>
<td>ΔS 200 200 250 220 200 200 200</td>
</tr>
<tr>
<td>13</td>
<td>Thiopental (2.5%) 12.0 cc</td>
<td>ΔS 700 1400 800 850</td>
</tr>
</tbody>
</table>

200 cc of 15% alcohol were administered to each subject.

The results of EF obtained are represented in Fig. 1, A. As can be seen in this figure, the values of EF (ΔS) after alcohol drinking increased gradually and reached a maximum in 30 minutes. 60 minutes after drinking recovery was not yet complete in some subjects. The values of SRT which were measured under one and the same conditions are indicated in Fig. 1, B. It can be seen in this figure that the curves of EF and SRT go almost parallel with each other. Moreover, the effects of the alcohol drinking and the opium alkaloid injection on EF and SRT have remarkable resemblance.

In a subject, 30 minutes after drinking (15% alcohol, 200 cc), a second administration of alcohol (15%, 50 cc) was made. The time courses of EF and SRT were prolonged remarkably, as is illustrated in Fig. 1, C and D.
K. Suzuki, J. Umetsu, M. Kobayashi and M. Kameyama

Fig. 1. A and B: Changes of electric flicker values (A) and of selective reaction time (B) after 15% alcohol drinking. C and D: Change of electric flicker (C) and of selective reaction time (D) when a subject drank again alcohol 30 minutes after the first drinking. Abscissas: Time after the first alcohol drinking. Ordinates: Values of EF (\(\Delta S\)) in \(\mu\)A and SRT in msec.

By means of a photoelectric colorimeter, the alcohol content in the blood of 2 subjects after drinking was measured at intervals of 20 minutes. The EF values in these subjects were measured in parallel. The continuous curves in Fig. 2 refer to the alcohol content, and the broken ones

Fig. 2. Variation of alcohol content in blood after alcohol drinking in 2 subjects (A and B). Curves a and b refer to electric flicker values measured in parallel.
to EF values. It can be seen in this figure that the alcohol content and the value of EF increase and decrease almost in parallel.

**DISCUSSION**

Washburn\(^5\) showed that, when the central nervous system was paralyzed by analgetic injections, values of SRT increased generally.

In our experiment such an increase of SRT always appeared after the analgetic injection (opium alkaloid and thiopental) and after the alcohol drinking as mentioned above. And similar increases were found also in the values of EF. But the injection of benadryl and phenobarbital caused little changes in EF and SRT. It is difficult at present to explain this difference in the mode of action, but it may be supposed that the difference is related to the difference in loci upon which the two groups of analgetics act. Benadryl and phenobarbital are said to act upon the brain stem more strongly than upon the cortex. The other analgetics, especially opium alkaloid, are known as effective narcotics on the cortex.

**SUMMARY**

By means of Motokawa’s method of electric flicker, we measured for 60 minutes the variation of electric flicker values of 9 subjects after opium alkaloid injections, of 3 subjects after analgetic (benadryl and phenobarbital) injection and of 5 subjects after 15% alcohol drinking. In some cases selective reaction time (SRT) was measured in parallel.

1. After the opium alkaloid injections and alcohol drinking, the values of EF and SRT increased gradually, reached a maximum about 30 minutes after an injection or alcohol drinking, and decreased to the initial value in about 60 minutes.

2. In case of benadryl and phenobarbital injections, no significant change of electric flicker values and selective reaction time could be found.

3. In some subjects the alcohol content of the blood was measured together with EF and it was found that both changed almost in parallel.

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**References**