# STUDY OF THE OCULO-CARDIAC REFLEX IN MONKEYS

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The oculo-cardiac reflex has been studied both in the laboratory and in the clinic. As a result of these studies [8, 4, 5, 3, 1] it has been shown that the afferent limb is the trigeminal nerve, while efferent impulses are distributed by the vagus nerve. A number of factors are of significance in the realization of the reflex; these include vascular and humoral factors, as well as cortical control.

I. I. Rusetskii [4] distinguishes 4 types of the reflex in humans, according to change in the pulse rate; these types were named positive, strongly positive, negative, and inverted. M. A. Epler [6] distinguishes two types of reflex in humans, differing in the rate of development of slowing of the pulse.

L. A. Kotlyarevskii [2], A. A. Epshtein [7], Glaser [9], and others have drawn attention to the greater strength of the reflex usually encountered in young individuals.

Notwithstanding the wide variety of studies made of the oculo-cardiac reflex, we have been unable to find any reference in the literature to investigations on monkeys. The present paper is devoted to a study of this reflex in healthy monkeys.

## EXPERIMENTAL METHODS

Twenty monkeys were studied (13 hamadryad baboons and 7 rhesus); their age distribution was as follows: 1.5 to 3.5 years – 5; 3.5 to 5.5 years – 10; and 5.5 to 13 years – 5 animals. The monkeys were kept in a sound-proof room (the large baboons were immobilized in special chairs). The experiments were conducted at exactly the same times of day, in the interval between the morning and mid-day feeds, from 1000 to 1300 hr. Pressure of uniform strength was applied by the right middle and index fingers of the operator to the right eye, lasting 45 seconds, at intervals of 8-10 minutes.

Electrocardiograms were taken, using the second standard lead, with needle electrodes connected through an amplifier to an oscillograph. Recordings were made on paper with an ink fed stylus, marking the time base in seconds, and registering application of the stimulus. The monkeys were subjected to preliminary training in the experimental procedure.

The reflex was evoked after establishment of the normal heart rhythm for each animal, and was evaluated according to three criteria – speed of development of the reaction of slowing of the pulse, phase nature of the response (alternation of retardation and acceleration of the rhythm), and intensity of the reaction of retardation.

## EXPERIMENTAL RESULTS

Two forms of reflex could be distinguished in monkeys, according to the rate of development of the reaction of retardation of the heart rhythm. In 5 animals retardation appeared 10-20 seconds after beginning to apply pressure, and was at a miximum during the second half of the stimulation period (Fig. 1, Tracings II and III). In the remaining 15 animals slowing of the heartbeat ensued during the first few seconds of application of

pressure, and was maximum during the first half of the period (Fig. 1, Tracing I). According to M. A. Elper [6], the former type of reflex is the most common in humans.

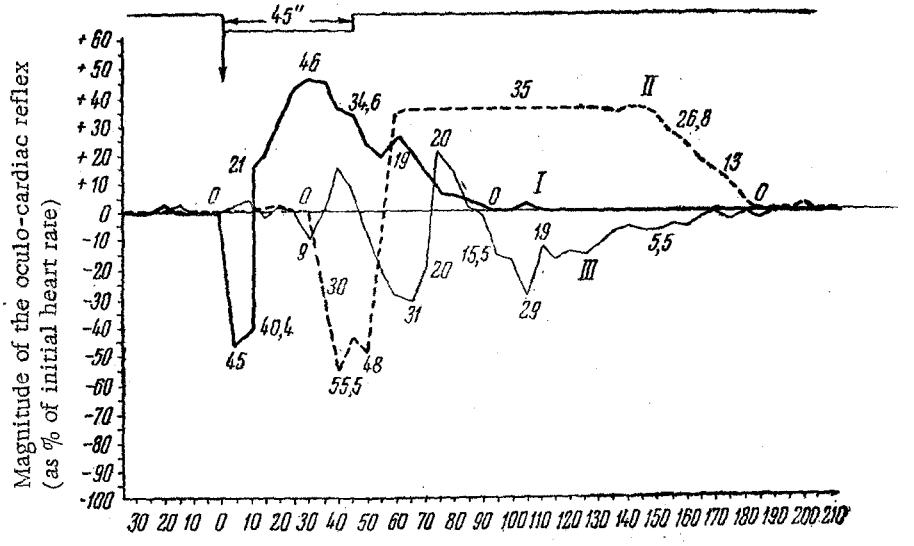


Fig. 1. Dynamics of the magnitude of the oculo-cardiac reflex in the monkeys Muruk (I), Dergach (II), and Dukh (III). Below the zero line – percentage retardation, above it – percentage acceleration. Below: time marker (5 second intervals) Above: stimulation marker.

The response reaction was of a definitely phasic nature in all the monkeys studied; retardation was usually succeeded by a compensatory tachycardia, with return to normal rhythm on the average during the second minute after cessation of application of pressure. A secondary retardation of heart rhythm was observed in 5 animals after the usual diphasic reaction (Fig. 1, III). We suggest the term phasic reflex for this form of response reaction, in distinction from the usual form (bradycardia followed by compensatory tachycardia) encountered in 15 monkeys (Fig. 1,I, II).

Two types of reflex could be distinguished, according to the strength of the response reaction. The positive type of reflex (retardation of up to 20% of the initial pulse rate) was displayed by 7 monkeys, and a strongly positive reflex (retardation of more than 20% of the initial rate) in the remaining 13 animals (Fig. 1, I, II, III). This shows that the oculo-cardiac reflex is stronger in monkeys than in humans. It should, further, be considered that since the strongly positive reaction is encountered in most of the animals studied, it should not be taken as evidence of a pathological condition.

The condition of the animals before the experiment, and the effect of their environmental conditions, influenced the intensity of the reflex. Thus, emotionally stimulated or physically stressed animals displayed much feebler reflexes, which were even entirely missing in a number of cases. Where tachycardia existed initially, under conditions of relative tranquility, the reflex was more marked than with initial bradycardia.

Primary negative and inverted reflexes, found by us in 6 animals, are interpreted by us as consequences of exploratory and defence reactions; subsequently after the monkeys had become habituated to the lay-out and to the manipulations, these paradoxical effects disappeared. In order to accelerate the process of habituation we applied 6 pressures per experiment, instead of the usual 2 or 3.

During the first day of experimentation, pressure on the right eyeball of the monkey Zelenchuk caused considerable acceleration of the heartbeat. On the second day, the first application of pressure caused insignificant acceleration, and the second had no effect on the rhythm. On the third day, the first application of pressure caused a barely perceptible acceleration, the 2nd, 3rd, and 4th gave no effect, and finally the 5th resulted in a sharp fall in heart rate (– 23.8%). A retardation reaction was observed after the first compression on all subsequent days (Table 1).

It was found in later experiments that repetition of pressure often led to considerable enfeeblement of the reflex (usually after the 5th repetition).

TABLE 1

Extract from Records of Experiments on the Monkey Zelenchuk

| Day of Expt. | Serial No. of test | Magnitude of reflex, % |
|---|---|---|
| 1 | 1 | +32.6 |
| | 2 | +30.32 |
| 2 | 1 | +5.37 |
| | 2 | 0 |
| 3 | 1 | +3.5 |
| | 2 | 0 |
| | 3 | 0 |
| | 4 | 0 |
| | 5 | —28.3 |
| | 6 | —23 |
| 4 | 1 | —26 |
| | 2 | —11.7 |

The first 4 applications of pressure evoked the usual retardation of heart rate in the monkey Muruk, but the effect was much smaller for the 5th and 6th tests (Table 2).

TABLE 2

Extract from Records of Experiments on the Monkey Muruk

| Serial No. of test | Magnitude of reflex, % |
|---|---|
| 1 | —44.1 |
| 2 | —21.54 |
| 3 | —20 |
| 4 | —21 |
| 5 | —4.77 |
| 6 | —3.3 |

The age of the monkeys has a definite effect on the magnitude of the oculo-cardiac reflex, amounting on the average to a 36.7% retardation for animals less than 3.5 years old, and to 20% retardation for older animals.

In some animals the oculo-cardiac reflex caused changes in the electrocardiogram (Fig. 2), consisting in bradyarrhythmia, considerable diminution in the R wave, occasionally with its dissociation, and considerable accentuation of the T wave, which became higher than the diminished R wave.

In one case a weakly negative T wave, and in another an isoelectric T wave, became markedly negative during the compression period.

The oculo-cardiac reflex facilitated recognition of, and considerably aggravated, defects in conduction of nervous impulses to the myocardium, because of disappearence of the QRST complex without change in the PQ intervals (arrhythmia, usually of the trigeminal type), in one monkey, suffering from neurosis (Karabas, Fig. 3). This animal was taken for experiment after more than 6 months rest, during which time its neurotic symptoms had disappeared. Its heart rhythm was initially normal, but after evocation of the reflex the conduction defect at first became manifest on a background of retardation of rhythm. In further experiments (Fig. 3, c) this defect was more evident on a background of tachycardia, succeeding the primary phase of retardationof heart rate. In some experiments this partial defect developed into complete heart block. The arrhythmia ceased 2 or 3 minutes after cessation of pressure, when the pulse rate had reverted to normal. This observation suggests that evocation of the oculo-cardiac reflex may be of use clinically, for the diagnosis of latent conduction defects of the heart.

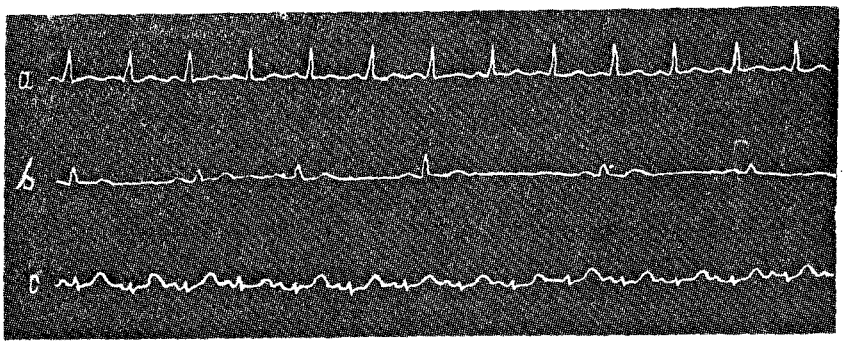

Fig. 2. Electrocardiogram of the monkey Fata. a) initial b) during application of pressure to the eyeball (diminution of R waves, on a background of bradyarrhythmia) c) shortly after cessation of pressure (acentuation of T wave, with continuing depression of the R wave, on a background of transition from compensatory tachycardia to reversion to normal rhythm).

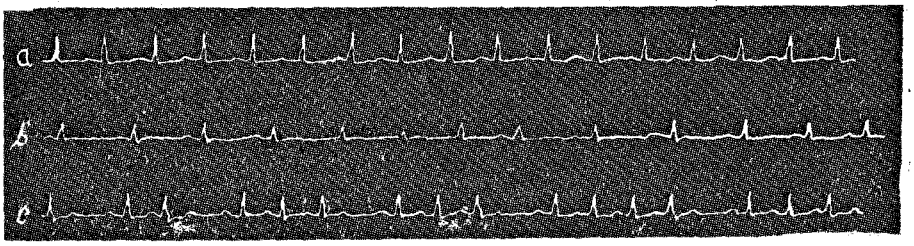

Fig. 3. Electrocardiogram of the monkey Karabas. a) initial b) during application of pressure (bradycardia) c) after cessation of pressure, on a background of tachycardia (disturbed cardiac rhythm – abolition of QRST complex).

This disturbance in heart rhythm was later observed in the same animal during emotional excitement and physical stress, i. e., on a background of tachycardia, without evocation of the oculo-cardiac reflex (confirmed by auscultation and electrocardiographically).

The experiments described allow us to consider the oculo-cardiac reflex as one of the characteristic tests for evaluation of the functional state of the autonomic nervous system of monkeys, and for the study of nervous regulation of the activity of the normal and pathological heart.

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