ON THE QUESTION OF THE FUNCTIONAL RESPONSE OF PAIRED SALIVARY GLANDS WHEN A PORTION OF THE ORAL MUCOSA IS ANESTHETIZED

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When studying the inter-linked activities of paired parotid glands, we demonstrated that salivary secretion is not the same in each gland when unconditioned and conditioned stimulators were employed [2].

At the present time, it has been well established by the work of I. P. Pavlov and his school that the functional state of the corresponding nerve centers largely determines the intensity of salivary gland activity. From this it follows that, for the causes leading to a difference in the type and amount of secretion, we must examine the mechanism of the differences in the functional state of the corresponding centers in the right and left cerebral hemispheres.

To confirm this supposition, we attempted to set up an experiment which would permit some judgment as to the reasons for the unequal responses elicited from the paired glands.

It is accepted as a fact that the degree of excitation of the nerve centers is largely determined by the intensity of the afferent stimulation of the corresponding receptor zones. By altering the intensity of the impulses entering the central nervous system from the periphery, by increasing or decreasing their number, we can correspondingly increase or decrease the degree of irritability of the centers associated with them. Each parotid gland has been shown by the studies of K. S. Abuladze [1] to be stimulated by impulses reaching the center principally from the ipsilateral half of the oral mucosa.

We set up experiments having the aim of observing one-sided partial anesthesia of the oral mucosa and the effects produced by it upon the salivary secretion of paired parotid glands. Such experiments are able to demonstrate the significance of the usual stimuli of the oral mucosa and the response they evoke in the nerve centers and, hence, determine the quantity of salivary secretion under such conditions.

We are aware of only one such study having been made on the changes produced in unconditioned reflexes when salivary secretion of paired parotid glands was studied [4]. Analogous studies on salivary secretion employing conditioned reflexes, we have not uncovered.

EXPERIMENTAL METHODS

The experiments were conducted on dogs Red (strong, well-balanced type), Elsa (strong, unstable type) and Wolf (feeble type). These general characteristics of the animals were determined by three-year long studies of their response to conditioned reflexes and with the aid of special tests (experiments with caffeine, day-long fast, prolongation of the differentiation, "inaccuracy").

Up to the moment of conducting experiments with the anesthesia of a portion of the oral mucosa, definite

conditioned responses to bell ringing were established, metronome 120 strokes per minute, blinker light and one differentiation to metronome 120 – metronome 60 strokes per minute.

The anesthetizing substance used was Dicaine.

In the first series of experiments upon dogs we inserted inside the left cheek a tampon moistened with 5% Dicaine solution. The muzzle was held together firmly by means of the hand so that the dog could not roll the tampon to the other side. The cheek holding the tampon was massaged lightly. Then the tampon was removed. Beginning after 5-7 minutes following this procedure on the dog, the salivary secretion of the paired parotid glands was observed using the established conditioned reflexes. The Dicaine was applied outside the chamber. The depth and duration of the anesthesia was verified by using the solutions first on the experimenter. It would begin within 5 minutes of application and last 25-30 minutes.

At the moment of applying the tampon, all the dogs were observed to have salivary secretion from the left parotid gland.

EXPERIMENTAL RESULTS

In dogs of the strong, stable type (Red), commencing within 10 minutes after the Dicaine application, there was observed a gradual weakening of the conditioned reflex response on the anesthetized side until zero level was reached, then, by the time 30 minutes had passed, as the action of the Dicaine would disappear, there would be seen a complete restoration of the conditioned reflex response. The dog acted quite normally within the chamber, eating well.

The conditioned salivary secretion from the opposite side was not altered materially (Fig. 1).

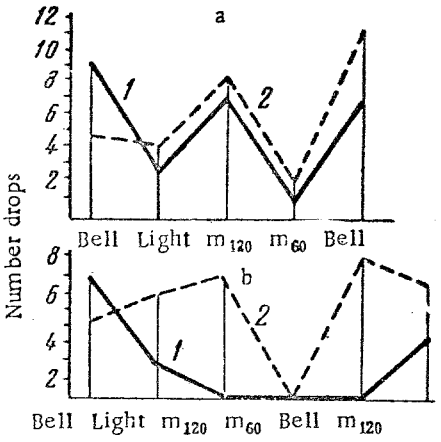

Fig. 1. Conditioned reflex salivary secretion in dog Red.
a) Normal; b) after anesthetizing left cheek with 5% Dicaine; 1) conditioned reflex salivary secretion from left parotid gland; 2) same from right.

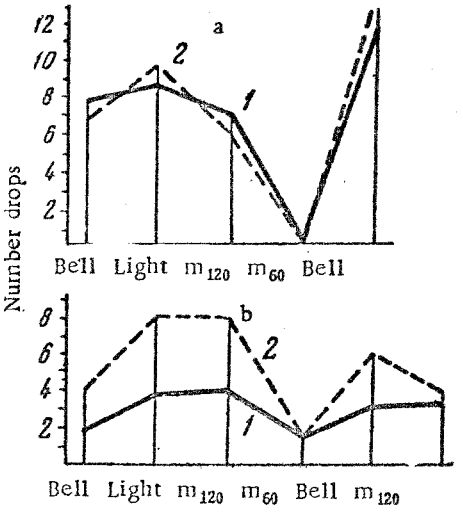

Fig. 2. Conditioned reflex salivary secretion in dog Elsa.
a) Normal; b) after anesthetizing left cheek with 5% Dicaine; 1) conditioned reflex salivary secretion from left parotid gland; 2) same from right.

In a dog of strong, unstable type (Elsa) conditioned reflex salivary secretion also diminished on the anesthetized side, beginning within 5 minutes of the application to the mucosa and remained at low levels throughout the duration of the experiment (30 min.) (Fig. 2). The behavior of the dog within the chamber was normal, food being well-consumed.

In a dog of the feeble type (Wolf) the salivary secretion of the conditioned reflexes was lowered from both glands, indeed, being greater on the side opposite the anesthesia. This was especially striking at the greatest depth of the anesthesia (15 min. after applying Dicaine). Only toward the end of the experiment (30th minute)

did the response to the positive stimulator m_{120} become equalized (Fig. 3). The behavior of the dog within the chamber was markedly altered. With the application of the first positive condioning stimuli, the dog Wolf had the usual reaction of movement: the appearance of the food would cause Wolf to throw himself on it, but, having consumed only a portion of it, he would move away. After that, Wolf would eat only in the presence of the experimenter, first with hand re-enforcement, then, from the feed-box. He would take food independently only toward the end of the experiment.

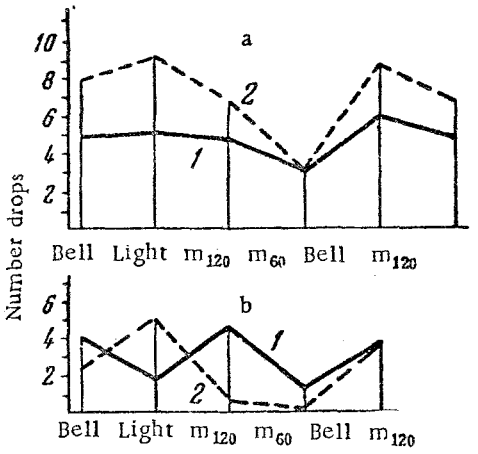

Fig. 3. Conditioned reflex salivary secretion in dog Wolf.
a) Normal; b) after anesthetizing left cheek with 5% Dicaine; 1) conditioned reflex salivary secretion from left parotid gland; 2) same from right.

In this fashion, it can be seen that anesthesia of a portion of the oral mucosa by use of 5% Dicaine in dogs of the strong type depresses conditioned reflex salivary secretion only on the anesthetized side, not altering the animal's reaction to food, while in a dog of the feeble type, reflex conditioned salivary secretion is altered in both glands, in addition the response to food being also changed.

In a second series of experiments, 10% Dicaine solution was used to produce the anesthesia.

The method used was identical with the first series.

In the experiments of this second series, it was observed that Red, on the anesthetized side, even within 5 minutes had a marked weakening of the conditioned reflex, when the bell rang. By the 10th minute the use of the positive stimulator (m_{120}) led to a marked diminution of salivary secretion on both sides. Differentiation almost did not change, being slightly weaker on the side opposite to the anesthesia. Within 20 minutes the salivary secretion from the conditioned reflex stimulation was fully restored on the anesthetized side while remaining depressed and below the usual by the 30th minute on the opposite side. The behavior of the dog while within the chamber remained unaltered, food being well consumed.

In Elsa anesthesia of the oral mucosa with 10% Dicaine produced sharp changes in the activities of the parotid glands when responding to conditioned reflexes. At the beginning, at the 5th minute, salivary secretion was markedly depressed on the opposite side while remaining quite large on the anesthetized side. By the 10th minute, the activities of both glands were markedly altered undergoing ultraparadoxical and paradoxical phases. The secretory response to the positive stimulator (m_{120}) was totally supressed while the response to the negative stimulator (m_{60}) was one of copious salivation. Also, the weak stimulator (light) produced a greater conditioned reflex response than the powerful stimulators.

The behavior of the dog while within the chamber was also changed very sharply as it would eat only with the action of a weak stimulator-light. When powerful stimulators acted, the experimenter had to be present before the dog would eat. However, by the end of the experiment (30th minute) the powerful stimulators caused it to eat voraciously on its own.

In Wolf anesthesia with 10% Dicaine caused a gradual extinction of the response to the conditioned reflex stimuli, both left and right sides being affected.

Thus, it seems that exclusion of some of the afferent receptors by means of anesthesia of a portion of the oral mucosa produces changes in conditioned reflex salivary secretion: the stronger the anesthesia, the greater the changes in observable salivary secretion.

The type-specific characteristics of the nervous system possessed by the individual animals seem to have great significance in the changes which are produced. In a dog of the feeble type even 5% Dicaine produced considerable alteration in the conditioned reflexes of both the left and right sides. In a dog of the strong, unstable type 5% Dicaine altered salivary secretion on the anesthetized side, while still stronger anesthesia (and, in all probability, by its action through the blood stream) could not be counterbalanced by the nervous system so that conditioned reflex activity changed on the right side as well as the left. In an animal of the strong,

stable type 5% Dicaine produced an effect only on the anesthetized side. It required a 10% solution of Dicaine to affect the opposite side also, although not profoundly, the changes having a quantitative character only.

In analyzing the various mechanisms causing changes in the salivary secretion of the parotid glands by the application of the Dicaine to the oral mucosa, it is essential to remember that the anesthetic might be acting directly by reason of being absorbed into the blood stream. If that were so, the changes should be the same for both parotid glands, right as well as left. Yet we always observed an asymmetrical response in the working of the parotid glands and in a number of instances there was seen a marked diminution of salivation on the anesthetized side.

The data we have accumulated seem to demonstrate that afferents stimulated in the oral mucosa of the mouth exert an important influence upon the functional state of nerve centers present in the right as well as the left cerebral hemispheres and, therefore, aid in determining salivary secretion on both sides whether either conditioned or unconditioned reflexes are employed in determining an answer to this question. This conclusion is aided by our studies with partial searing of the oral mucosa [3]. The presence of additional stimuli (focus of inflammation) going centrally from the oral mucosa, as well as exclusion of the usual stimuli, both lead to changes in the activities of the paired parotid glands. With all this, we have additional data which testify to the fact that the degree of stimulation of both the right and left cerebral hemispheres depends not only on the stimuli coming from the oral mucosa but also is influenced by other internal and external alterations of the environment of the organism.

SUMMARY

Dogs having paired parotid gland fistulae and studied for three years by the investigator were used to observe the alterations in the conditioned reflexes caused by anesthesia of a portion of the oral mucosa. It was concluded that the basic type characteristics of the dogs used had much to do with the response obtained.

Dogs of the strong type had inhibition on the anesthetized side only when 5% Dicaine was used. In dogs of the weak type the conditioned reflexes were inhibited on both sides. With stronger anesthesia the changes observed were greater. Dogs of the unstable type manifested both an equalizing and a paradoxic phase. As with the 5% Dicaine, use of the 10% Dicaine in dogs of the weak type produced abolition of the conditioned reflexes on both sides.

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