

QUALITATIVE SYMMETRY OF SECRETIONS OF PAIRED SALIVARY GLANDS FUNCTIONING SIMULTANEOUSLY

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The infrared spectra of samples of secretions from the right and left submandibular glands of the cat obtained in response to intravenous injection of acetylcholine, pilocarpine, and noradrenalin and to stimulation of the sympathetic and parasympathetic secretory nerves.

The qualitative composition of the samples of secretions from homonymous salivary glands produced in response to simultaneous excitation of secretory activity by humoral stimuli was found to be the same, and the spectra of samples obtained in response to stimulation of the chorda tympani and stimulation of secretory activity by cholinergic drugs also were similar and differed from the spectra of samples obtained during stimulation of the sympathetic nerve and intravenous injection of noradrenalin (the latter also were identical).

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Investigations have shown that unconditioned-reflex [6, 13] and conditioned-reflex [5, 6, 13] secretion of the salivary glands is absolutely identical on the left and right sides. Meanwhile, many investigations [1-4, 7-9, 11, 12, 14-16] have shown that paired salivary glands function asymmetrically, starting their secretion at different times and secreting different volumes of saliva.

This asymmetry can be explained either by differences in the physiological state of the paired glands or their receptor systems [1, 4, 6, 7, 9, 16] or by differences in central influences controlling the activity of the glands [2, 3].

Pavlov [10] considered that asymmetry of the reflexes cannot be explained by morphological differences between the paired salivary glands. Other workers have also demonstrated the identity of function of paired glands [19-21, 23, 24].

To investigate whether qualitative asymmetry exists between the secretions of paired salivary glands when functioning simultaneously in response to excitation by stimuli of equal strength, the method of infrared spectrophotometry was used in the present investigation.

EXPERIMENTAL METHOD

Nine cats were anesthetized with hexobarbital and the ducts of both submandibular glands dissected and incubated with polyethylene canulas. Secretion of the salivary glands was evoked by intravenous injection of acetylcholine (0.5 mg/kg), noradrenalin (50-60 μ g/kg), alternate stimulation of the chorda tympani and sympathetic nerve, and intravenous injection of pilocarpine (0.75 mg/kg). Each successive stimulus was applied 30 min after secretion evoked by the preceding stimulus had stopped completely. The first portions of secretion were not analyzed.

Infrared spectra were photographed on the UR-20 dual-beam apparatus. Agar films were prepared to photograph the spectra [17]. The spectra were recorded using four slits covering the region from 4000 to 666 cm^{-1} at a speed of 64 $\text{cm}^{-1}/\text{min}$. Some spectra were photographed on the IKS-21 apparatus at a speed

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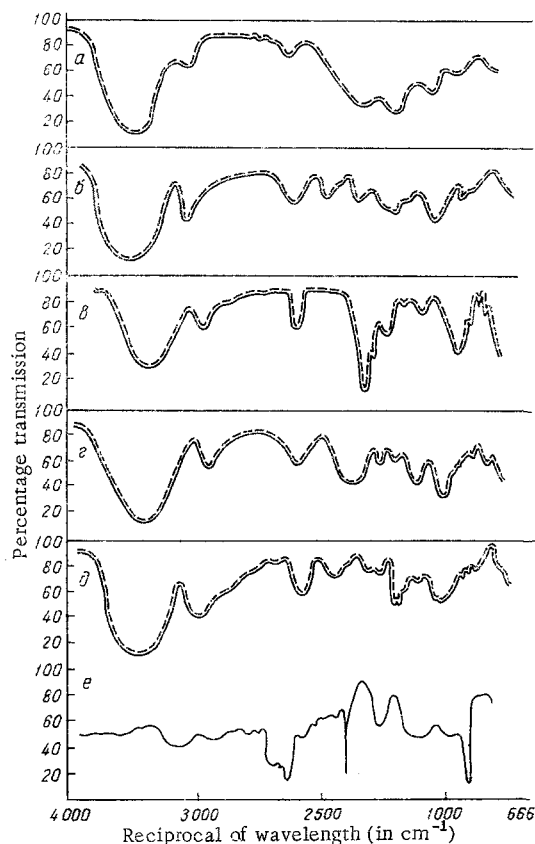


Fig. 1. Infrared spectra of secretions of submandibular salivary glands of a cat recorded on the UR-20 dual-beam apparatus. a) Intravenous injection of acetylcholine; b) of pilocarpine; c) stimulation of parasympathetic nerves; d) of sympathetic nerves; e) intravenous injection of noradrenalin; f) differential spectrum of secretions of right submandibular salivary gland obtained in response to stimulation of right sympathetic and parasympathetic nerves. Top curve: differential spectra of right and left glands; continuous lines: right gland; broken line: left gland.

autonomic nerves were also compared. Even in the case when the quantity of secretion produced by the right and left glands in response to unequal stimulation of the nerves differed, its qualitative composition was the same (Fig. 1c, d).

Since a dual-beam instrument was available, it was possible to record the differential spectrum of secretions by passing one beam through the sample from the right gland and the other through that from the left (Fig. 1a-e, top curves). The differential spectra of samples of secretions from the paired glands showed 100% transmission. Consequently, the salivary glands produce a qualitatively identical secretion both in response to excitation by humoral stimuli and to stimulation of the secretory nerves, even in the case of quantitative asymmetry of secretions.

One further fact was considered during analysis of the spectra: spectra of samples of secretions obtained during stimulation of the glands by acetylcholine and pilocarpine were identical, and they differed sharply from the spectra of samples obtained during stimulation by noradrenalin. It was interesting to compare the spectra of these samples with those of samples obtained during stimulation of the chorda tympani (c) and sympathetic nerve (d). Analysis of these spectra revealed considerable similarity of qualitative

of $4 \text{ cm}^{-1}/\text{sec}$. The spectra were plotted graphically by subtracting the background spectrum from those of the samples at points corresponding to different wavelengths.

EXPERIMENTAL RESULTS AND DISCUSSION

Characteristic spectra obtained by analysis of the secretions of paired salivary glands are shown in Fig. 1. In this study no attempt was made to identify each individual peak in the spectrum. Attention was concentrated mainly on the general character of the spectrum and the position of the transmission band, because infrared spectra of substances of identical composition are themselves identical [17]. Spectra of samples of secretion from the right and left glands were compared in order to determine their qualitative similarity or difference. Spectra of secretions obtained by excitation of the right (continuous line) and left (broken line) submandibular glands in response to intravenous injection of acetylcholine are shown in Fig. 1a. The volume of secretion produced in response to intravenous injection of acetylcholine (and to all subsequent humoral stimuli) was the same for the left and right glands. The infrared spectra of samples of secretions of the paired glands were identical. So also were the spectra of samples of secretions from the right and left glands during stimulation by noradrenalin (Fig. 1e) and pilocarpine (Fig. 1d).

The qualitative composition of the secretions during simultaneous excitation of the right and left submandibular glands in cats by adrenergic humoral stimuli is thus identical, from which it can be concluded that qualitative symmetry is characteristic of the secretory activity of the paired salivary glands. Quantitative relationships between the various components of secretions from both glands are perhaps also identical, because the ratios between the heights of the peaks in the spectrum were the same. Spectra of secretions obtained in response to stimulation of

composition between secretions obtained by stimulation of the parasympathetic nerve, intravenous injection of acetylcholine and pilocarpine, on the one hand, and stimulation of the sympathetic nerve and intravenous injection of noradrenalin, on the other hand. The qualitative composition of secretions obtained by stimulation of the sympathetic and parasympathetic nerves differed appreciably, as shown by the differential spectrum (Fig. 1f). The attempted statistical analysis of spectra of samples of secretions from different animals without allowing for their individual differences caused the spectra to be smoothed out and obscured their regular patterns (this may perhaps explain unsuccessful attempts to use infrared spectra for analysis of the saliva of different individuals with dental caries [24]).

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