

EFFECT OF CAFFEINE ON SUMMATION IN THE SUBMAXILLARY GLAND

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The action of caffeine on the secretion of the salivary glands is of interest for two reasons; first, because of its effect on the summation of stimuli, and secondly because of its action on the gland itself, this being the last stage in the conditioned food reflex, from which inferences are made about the basic processes in the cerebral cortex.

The present work is a study of the effect of caffeine on summation in the submaxillary gland.

METHOD

Thirty-one experiments were performed on cats. A combined anesthetic was used; induction was with ether which was followed by injection of a 0.25-0.3 g per kg body weight of a 2% solution of Medinal.

The gland was separated from the nervous system only, by cutting the lingual nerve, and the preganglionic fibers of the sympathetic nerve supply. The rate of secretion was recorded from the movement of the liquid meniscus in a glass tube connected to a fistula in the duct of the gland. In each case, the ability of the gland to summate was determined from the number of electrical stimuli to the gland required to cause secretion before and after the administration of caffeine. Intravenous injections were given of coffeinum benzoicum in a 2-10% solution; in 10 experiments the amount was 0.0067-0.062 g and in 6 experiments it was 0.1 g per kg body weight.

RESULTS

The action of caffeine could be observed as early as five minutes after its injection. In all the 16 experiments, the number of stimuli required to elicit the secretion was less after the injection (Table 1).

For example in Experiment 10, with stimulation at one second intervals, before the injection of caffeine, 98 stimuli were required but after the injection only 20 were needed; at 4 per second, before injection 42 and after injection 22 stimuli were required.

With lower rates of stimulation, caffeine also caused a considerable reduction in the number of stimuli required. In the range from 8 stimuli per second to 1 stimulus per 2 seconds, the slower the rhythm the greater was the reduction.

In 8 experiments there was a displacement of the minimum rate towards a lower value. Thus, in Experiment No. 1, before caffeine the minimum rate was 4 per second, and after, 1 per second.

In the second set of experiments we measured the greatest interval between electrical stimuli at which summation occurred (Table 2).

TABLE 1

The Effect of Caffeine on the Secretory Reaction of the Gland in Response to Electrical Stimulation

| Expt.No. | Strength of Stimulus (distance between the induction coils in cm.) | Rate of stimulation (No. of stimuli required to cause secretion) | Minimum number of stimuli required to cause secretion | |
|----------|--|--|---|-----------------------------|
| | | | Before injection of caffeine | After injection of caffeine |
| 1 | 17 | 1/1 | 42 | 25 |
| | | 2/1 | 44 | 24 |
| | | 4/1 | 38 | 30 |
| | | | | |
| 2 | 25 | 2/1 | 120 | 48 |
| | | 4/1 | 138 | 94 |
| | | 8/1 | 112 | 88 |
| | | | | |
| 6 | 24 | 1/2 | 50 | 27 |
| | | 1/1 | 35 | 24 |
| | | 2/1 | 29 | 19 |
| | | 4/1 | 30 | 22 |
| | | 8/1 | 40 | 24 |
| | | | | |
| 10 | 25 | 1/1 | 98 | 20 |
| | | 4/1 | 42 | 22 |
| | | 8/1 | 44 | 28 |
| | | | | |
| 11 | 15 | 1/1 | 28 | 5 |
| | | 2/1 | 24 | 8 |
| | | 4/1 | 32 | 11 |
| | | 8/1 | 46 | 22 |
| | | | | |

After the injection of caffeine the gland was able to summate the effects of stimuli, at intervals which before the injection were too great to be effective. After caffeine the maximum interval between the stimuli was increased 3-5 times.

We have found no references in the literature to the effect of caffeine on summation or other functions of the salivary glands.

As our work has shown, caffeine increases the reactivity of the gland, as is shown by its increased power to effect summation. We found no clear relation between the summation effect and the dose; the dose range was very great, from 0.0067 to 0.1 g per kg body weight.

TABLE 2.

Effect of Caffeine on the Maximum Interval between Stimuli at which Summation is Effective

| Expt. No. | Interval between stimuli (in seconds) | |
|-----------|--|-----------------------------------|
| | Before injection of caffeine | After injection of caffeine |
| 19 | 1 | 3 |
| 21 | 1 | 3 |
| 22 | 1 | 8 |
| 25 | 1 | 4 |
| 26 | 2 | 12 |
| 28 | 2 | 10 |
| 29 | 2 | 20 |
| 11 | 2 | 15 |
| 17 | 3 | 10 |
| 20 | 3 | 12 |
| 18 | 4 | 5 |
| 13 | 4 | 5 |
| 24 | 5 | 20 |
| 31 | 6 | 24 |
| 31 | 7 | 20 |

SUMMARY

In cats with the lingual nerve and the preganglionic sympathetic nerve trunk dissected intravenous injection of caffeine enhanced the ability of the submaxillary gland to summate induction current stimuli eliciting a secretory effect.