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THE EFFECT OF SATIATION UPON CONDITIONED AND UNCONDITIONED SALIVARY RESPONSES

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There is no doubt that the conditioned food salivary reflexes are influenced by the intensity of hunger. However, there is no agreement as to whether this influence is direct or mediated by motor behavior. The data are also conflicting concerning the effect of hunger or satiation upon the unconditioned salivary response. Thus, Finch (1938) found that hunger affects the conditioned and unconditioned salivation in the same way; the more satiated the animal the smaller are salivary CRs and URs. Zener and McCurdy (1939) measuring both amount and rate of salivation in addition to the chewing movements established less clear relations. Satiation caused in their dogs a consistent decrease of conditioned salivation, but an increase of unconditioned secretion, with concomittant slowing of chewing rate and prolongation of eating time. The rate of salivation decreased markedly in case of CR and only slightly during eating. There was no consistent change of amount of saliva per chew. More recently James et al. (1966) observed a marked drop in salivary CRs within a session and concluded that salivation could be used as a convenient and practical index of drive.

Using an improved salivary fistula (Sołtysik and Zbrożyna 1957) and voluminographic recording by the use of Kozak's method (Kozak 1950) it is possible to obtain smooth and reliable records of salivary CRs and URs showing immediately the rate of secretion (Fig. 1). In the present report data is shown from an experiment aimed at studying the effect of gradual satiation during prolonged sessions upon conditioned and unconditioned salivation. Satiation was produced by prolonging the session (i.e., by increasing the number of trials) until the animals refused to eat. The standard portion of food used as the reinforcing US was about 70 g.

Three different magnitudes of food US were used during the satiation sessions: the standard portions, doubled portions, and 1/4 of the standard portion. These sessions were interspaced among routine training sessions. The results are presented in Fig. 2 in the form of best fitting regression

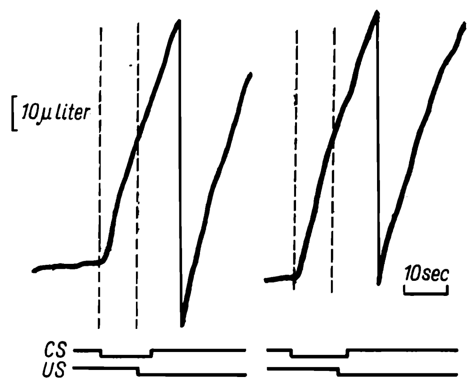

FIG. 1. Conditioned and unconditioned salivation in dog Rex. Cumulative (voluminographic) registration of salivary secretion is obtained by the use of Kozak's method. Vertical broken lines mark the onset of CS and US. Note the high rate of secretion during the CS exceeding the unconditioned salivation during eating.

lines, separately for each magnitude of reinforcement. In the graphs on the left, the changes in the rate of conditioned and unconditioned salivation are plotted against consecutive trials (during the satiation session) whereas on the right, the changes in the rate of salivation are plotted against the amount of food accepted and ingested.

Three dogs were selected from a greater group of animals trained in classical salivary CRs as good and steady responders representing three types of relations between salivary CR and UR. In Yapp the rate of conditioned salivation was slightly lower than the rate of unconditioned secretion. In Bryś the CRs were markedly lower than the URs. But in Rex the CRs consistently exceeded the URs (Fig. 1) — a phenomenon not frequently observed in salivary conditioning. It was important to include this dog in this study since the differential effects of satiety upon slow rate CRs and high rate URs might be explained by the submaximal intensity of the former and maximal reflex action in the latter ones.

The results are not homogeneous and not quite clear. In general the increasing satiation causes a steeper decrease of conditioned CRs than URs. Except for this conclusion the other features of the Fig. 2 must be considered separately for each dog. Thus in Yapp the rate of UR shows no decrement with standard and doubled reinforcement. Of course this

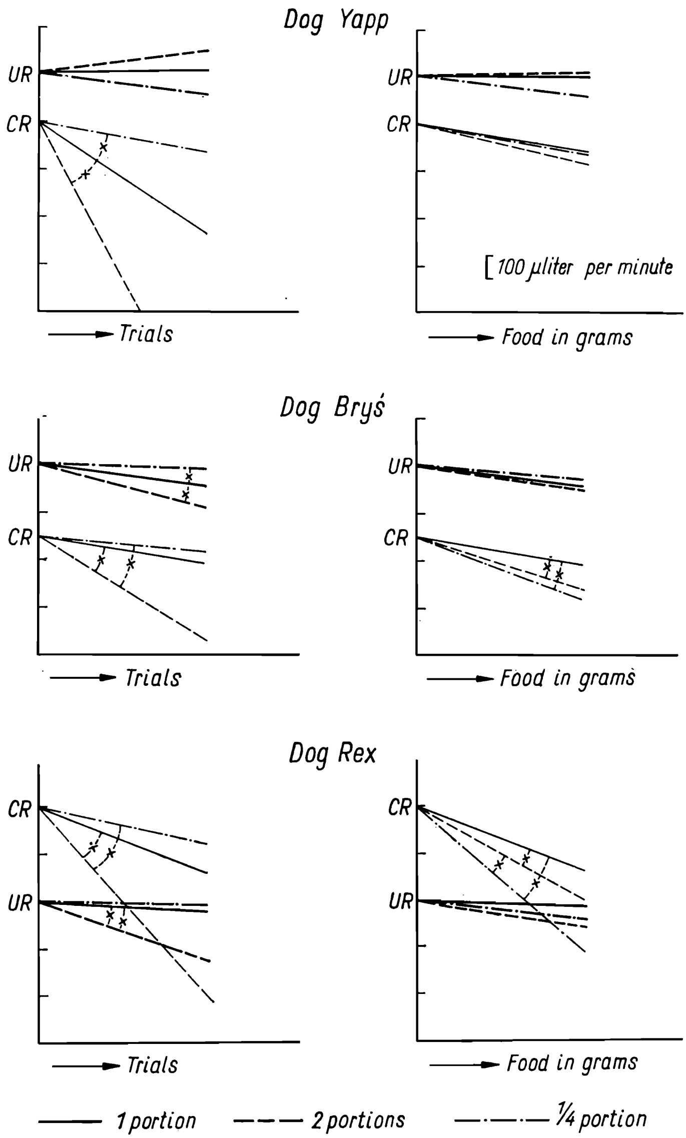

FIG. 2. Changes in the rate of salivation in the course of satiation session. Ordinates in all the graphs: rate of salivation. Abscissae in the left graphs: consecutive trials of the session; abscissae in the right graphs: increasing amount of ingested food. Heavy lines starting at UR show the regression lines calculated for unconditioned salivary reflexes. Thin lines starting at CR show the regression lines calculated for conditioned salivary responses. Continuous lines denote results obtained with the standard (70 g) amount of food reinforcement. Broken lines denote results from the sessions on which a doubled amount of food US was used. Dash-and-dot lines show the changes in salivation on sessions when a reduced (to one quarter of the standard portion) food reinforcement was applied. x-es denote statistical significance (0.05 or less) of differences between coefficients of regression.

and other comments concern only the right graphs where the change in rate of salivation is shown as a function of the increasing satiation. There is only a slight and not significant decrease of URs when one quarter of the standard portion of food was administered. Also conditioned salivation decreases very little if plotted against the amount of food ingested (the right graph) and there are no differences between the regression lines calculated from sessions with different magnitude of food US. In Bryś there is a small and parallel decrease of both CRs and URs when standard US was used. With either doubled US and 1/4 US the decrease of conditioned secretion was grater per amount of ingested food, showing that besides the absolute amount of food also the change of such parameters as the magnitude of food reinforcement or number of trials affects the intensity of the CR. Finally, in Rex the rate of CR was markedly decreasing during the satiation sessions whereas the smaller UR was hardly affected even with doubled US. Here again the changed US caused a steeper drop in the rate of CR than in UR, and the reduced US produced greater deterioration than the doubled reinforcement. It should be mentioned here, that the reduced US meant that the animal needed more trials (increased number of acts of eating) and more time (the intertrial intervals remained the same as with standard and doubled US) to ingest the same amount of food. Thus the development of humoral satiety could have played a more significant role in sessions with reduced US than in others. Unfortunately no registration of chewing movements was available to ascertain if the slight differences in URs could be correlated with changed rate of chewing movements.

These results show unequivocally that changing intensity of hunger has rather insignificant effect on the rate of unconditioned salivation, even when it is lower than the rate of CR. Thence the stronger effect of satiation upon the rate of conditioned salivation cannot be attributed simply to the differences in the intensity of the salivary reflex activation. It is plausible rather to assume that satiation (or decreased hunger) affects salivation indirectly by modifying the behavior during the presentation of CS. Shifts in attention paid to conditioned stimuli may be responsible for the change in amount and intensity of the neural input from the CS complex. Another possibility would be to assume that it is not the facilitating influence of hunger-drive upon the salivary reflex but the inhibitory influence exerted by the satiety "center" upon the salivary reflex. The relatively weak effect on the salivary UR and so much stronger suppression of the salivary CR might be explained by the fact that the mechanism of "attentional shift" as postulated above would operate on telereceptive CSs but not on the taste US.

Thus, a superior method of studying the effect of hunger or satiety upon salivation would be to apply a method of direct mouth feeding (*see* Kieryłowicz et al. 1968) using sialogenic food, but such a method waits for its inventors. The most preferable procedure would be a combined instrumental-classical conditioning of the Ellison–Konorski type (Ellison and Konorski 1964, 1965) so that the drive level could be independently observed through the instrumental performance.

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REFERENCES

ELLISON, G. D. AND KONORSKI, J. 1964. Separation of the salivary and motor responses in instrumental conditioning. Science 146: 1071–1072.

ELLISON, G. D. AND KONORSKI, J. 1965. An investigation of the relations between salivary and motor responses during instrumental performance. Acta Biol. Exp. 25: 297–316.

FINCH, G. 1938. Hunger as a determinant of conditional and unconditional salivary response magnitude. Amer. J. Physiol. 123: 379–382.

JAMES, W. T., PEACOCK, L. J., AND ROLLINS, J. B. 1966. The effect of satiation on the value of the conditioned salivary response. Acta Biol. Exp. 26: 245–250.

KIERYŁOWICZ, H., SOŁTYSIK, S. AND DIVAC, I. 1968. Conditioned reflexes reinforced by direct and indirect food presentation. Acta Biol. Exp. 28: 1–10.

KOZAK, W. 1950. Method of graphic registration of salivary secretion. Acta Biol. Exp. 15: 185–192.

SOŁTYSIK, S. AND ZBROŻYNA, A. 1957. The chronic fistula of shortened Stensen's duct in dogs. Acta Biol. Exp. 17: 339–344.

ZENER, K. AND MCCURDY, H. G. 1939. Analysis of motivational factors in conditioned behavior: I. The differential effect of changes in hunger upon conditioned, unconditioned and spontaneous salivary secretion. J. Psychol. 8: 321–350.

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