DIFFERENTIATION OF THE INTENSITY OF FOOD STIMULI APPLIED AS CONDITIONED STIMULI TO DOGS

(UDC 612.821.63.08)

Yu. Ya. Zakher

Laboratory of Comparative Physiology and Pathology, Institute of Experimental Medicine (Director, Active Member AMN SSSR Professor D. A. Biryukov) of the AMN SSSR, Leningrad
(Presented by Active Member AMN SSSR D. A. Biryukov)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 57, No. 5, pp. 7-10, May, 1964
Original article submitted April 5, 1963

It has been shown [2] that while it is being eaten, food may become the signal for another conditioned feeding reaction (running towards the point of reinforcement). It has also been found that dogs easily differentiate between different foodstuffs used as conditioned stimuli. On the other hand, it has long been known that the magnitude of the conditioned reflex is very precisely graded in relation to the magnitude of the unconditioned food reinforcement [3, 4].

We were interested in finding out whether it was possible to form differentiation to the same type of food as is used as the conditioned stimulus, but in a different amount. So far no such investigations have been conducted in dogs in experiments on pigeons [1] it was found possible to produce this type of differentiation).

EXPERIMENTAL METHOD

Experiments were carried out on two mongrel dogs—Kutya (male) and Kokosha (female) and on a German sheep-dog Vesta (female). In the first two dogs positive and negative reflexes to various types of food were formed at the beginning of the investigation. Before these experiments, Vesta had taken part for a short time in completely different experiments.

Vatsuro's modification of the free behavior technique [2] was used. A piece of cooked meat, cubical in shape, was thrown from a special feeding bowl hanging above the dog's bed. The dog ate the meat and, if it was a positive conditioned stimulus, ran to the opposite end of the room, where it obtained a second piece of meat from an "automatic" feeding bowl; the animal then returned to its bed. The differential stimuli were not reinforced by meat from the automatic feeding bowl. The sign of inhibition of the conditioned reflex was absence of running in response to the stimulus (meat). The movement of the dogs was recorded in written form and on a kymograph.

In the initial stage of the investigation pieces of meat weighing 1.5 g were used as positive conditioned stimuli for Kutya and Kokosha, and pieces weighing 1 g for Vesta. For the last dog a second positive stimulus was used, namely the light from a 25 W lamp. The differential stimulus for all the animals was a piece of meat weighing 3 g. Reinforcement from the "automatic" feeding bowl was given in the form of pieces of meat weighing 3 or 6 g. Kutya and Kokoshka received 8 positive and 4 differential stimuli in the course of the experiment, as a definite stereotype. Vesta received 4-5 positive (not counting the light) and differential stimuli, not in the form of a stereotype, and sometimes 2-3 inhibitory stimuli in succession.

EXPERIMENTAL RESULTS

The positive conditioned reflex to a small piece of meat appeared in Kutya and Kokosha after the first application, for it had been established in the previous experiments. In Vesta the reflex to 1 g meat appeared for the first time after the 24th presentation, and it became stabilized only after 96-105 presentations.

Meat pieces weighing 3 g were used for Kutya and Kokasha from the first day of the experiments, and to Vesta after the 20th experiment, when the reflexes to 1 g meat and to light had become established. Kutya first

Percentage of Positive Reactions to Pieces of Meat of Different Size (Mean Values for Each of Successive Groups of Experiments)

Kutya

Weight of meat (in g)	Number of experiments in group													
	5	10	10	10	10	10	10	9	12[1]	7[1]	8[1]	11[1]	10	10
1,5—1	49	80	91	90	94	96	76	96	44	57	77	86	96	94
	(39)	(79)	(80)	(84)	(80)	(80)	(80)	(71)	(111)	(57)	(64)	(87)	(88)	(80)
3	35	15	7,5	10	11	17,5	20	26	32	48	62,5	91	77,5	61
	(17)	(39)	(39)	(42)	(40)	(40)	(40)	(35)	(30)	(28)	(32)	(43)	(44)	(40)

Kokosha

Wt. of meat (in g)	Number of experiments in group															
	8	10	10	10	10	10	10	10	12	10[1]	10[1]	11[1]	10[1]	10[1]	11[1]	10	10
1,5—1	73	68	86	70	82,5	91	87,5	91	92	35	59	36	75	79	68	63	89
	(62)	(82)	(79)	(79)	(79)	(80)	(80)	(76)	(61)	(102)	(79)	(102)	(80)	(76)	(82)	(84)	(74)
3	78	31	35	10	35	35	35	30	41	57	53	42	70	70	60	48,5	47
	(29)	(40)	(39)	(39)	(39)	(40)	(40)	(39)	(41)	(15)	(39)	(30)	(40)	(37)	(40)	(33)	(38)

Vesta

Weight of meat (in g)	Number of experiments in group										
	12	10	10	10	10	10	10	10	10	10	14
1	50	89	74	92	82	82	87,5	90	97,5	100	100
	(131)	(44)	(41)	(39)	(40)	(40)	(40)	(39)	(40)	(40)	(56)
3	—	62	21	39	18	19	1	21	35	35	22
		(42)	(52)	(56)	(55)	(49)	(50)	(51)	(50)	(50)	(70)

[1]Groups of experiments in which meat was presented as rissoles. The number of applications of the corresponding stimulus in the particular group of experiments is shown in parentheses.

exhibited inhibition to the piece of meat weighing 3 g at the 7th application, and it was accompanied by inhibition of the positive reflex. After a period of fluctuating changes in the conditioned reflexes and differentiations, relatively adequate reactions of the dogs were reestablished on the 12th-13th day of the experiments. After the 15th experiment the stimuli began to be given without stereotype, but no disturbances resulted. In a series of experiments adequate reactions were observed to all stimuli. On the other hand, the accuracy of differentiation was not improved when, after the 69th experiment, the weight of the piece of meat given to Kutya as positive stimulus was reduced to 1 g.

Kokosha first exhibited differentiation at the 16th presentation of meat weighing 3 g. Although the stimuli were presented as a stereotype almost to the end of this particular series of experiments, the positive and inhibitory reflexes in this dog were slightly less stable than in Kutya. Only in occasional experiments did adequate reactions develop in this animal in response to all 12 stimuli.

To facilitate the process of differentiation in Kokosha, after the 52nd experiment the size of the piece of meat used as positive stimulus was also reduced to 1 g, but this did not result in any appreciable stabilization of differentiation. On the other hand, when the stimuli began to be given at random the number of inhibitory reactions to 3 g of meat was reduced still further.

Differentiation first appeared in Vesta at the 7th presentation, and was not stabilized until after 60-65 applications of meat weighing 3 g. Thereafter, in many experiments differentiation in this animal was absolute.

The dynamics of differentiation between the pieces of meat in the groups of experiments throughout the period described is shown in the table. The number of positive conditioned reactions to an unreinforced piece of meat weighing 3 g, as a rule, was much smaller than that to a reinforced piece of meat weighing 1.5-1.0 g. The significance of these differences, determined for each group of experiments by means of Student's criterion "t," was very high in all three dogs ($P<0.0001$). The only exception was the first group of experiments on Kutya and Kokosha, when the differences were not significant.

The facts described demonstrate beyond doubt that the dogs were capable of differentiating between pieces of meat differing by twice to three times in weight. Five analyzers may play a part in this differentiation: visual (the dog sees the piece of meat when lifting it from the floor), auditory (when the pieces of meat fall to the floor they make different sounds depending on their weight—this difference could be distinguished even by the experimenter), olfactory, kinesthetic (impulses from the muscles of mastication) and taste (including tactile reception from the oral cavity). In the work of I. S. Beritov and M. N. Akhmeteli, cited above, differentiation was performed by the visual analyzer. Our object was to elucidate the role of the taste analyzer in this process.

For this purpose, in another series of experiments on the dogs Kutya and Kokosha similar pieces of meat were thrown on their beds, but mixed with dough in the form of a rissole. These rissoles were identical in external appearance, and when falling to the ground they all gave (or so it appeared) the same sound, regardless of whether they contained 1 g or 3 g of meat. In this case differentiation rested entirely on the receptors in the oral cavity. Otherwise, the experimental method remained as before. Stimuli were applied in random order.

These experiments showed that initially the conditioned reflex to the rissole was absent. A positive reflex to 1 g meat in rissole form had therefore, to be formed de novo. After 50 applications to Kutya and 100 applications to Kokosha, the positive reaction began to appear in more than 50% of cases.

Altogether 38 experiments were performed on Kutya and 62 on Kokosha using the rissoles, but differentiation between the weights of the pieces of meat could not be attained in this case. The corresponding values of the positive reactions to 1 g and 3 g of meat in this series of experiments are given in the table. Where differences are present, they are not significant. Most frequently, irrespective of the value of the stimuli as conditioned signals, either positive or inhibitory reactions were predominant, with frequent fluctuations from one to the other.

Control experiments on Kutya and Kokosha using "empty" rissoles (dough without meat) showed that this stimulus could also elicit running to the second feeding bowl. Hence, both components of the complex stimulus (the rissole)—meat and dough—were effective in evoking the conditioned reaction.

The return to the original method of presenting the pieces of meat—without dough—showed that the positive reflex to 1 g meat was fully preserved, and that inhibition to 3 g meat was partially disturbed. However, differentiation was gradually restored, although the stimuli continued to be applied without the stereotype. In the last group of the ten experiments on Kutya and Kokosha (see table) the differences in the number of positive reactions to 1 and 3 g meat were again significant ($P<0.0001$).

The results described demonstrate that differentiation by dogs between pieces of meat used as positive and negative conditioned stimuli and differing by 2-3 times in weight is easily attained, but it takes place almost entirely on account of the telereceptors—visual, auditory, and olfactory. It may be postulated that the differential thresholds of taste and tactile reception from the oral cavity are higher than those of the telereceptors. In this case, if instead of giving rissoles pieces of meat are placed directly into the dog's mouth (so that the animal does not see them), differentiation between pieces of different size will be no better than when rissoles are used.

It may also be assumed that differentiation between meat in rissole form was difficult because of interference caused by the presence of the accessory stimulus—the dough—which produced a noise of its own, interfering with discrimination of the useful signal. If this latter hypothesis is correct, when pieces of meat are placed directly into the mouth, their differentiation must take place far more successfully than when meat is presented as rissoles. An attempt was made to carry out such experiments on Kutya, but it led to the gradual inhibition of the positive conditioned reflexes and to disorders of the dog's behavior during the experiment, so that the investigation had to be abandoned.

SUMMARY

A positive motor conditioned reflex was elaborated in 3 dogs. Pieces of meat weighing 1.5-1 g. given from

one plate served as a conditioned stimulus, meat from another plate served as a reinforcement. In the given conditions differentiation of the size of meat pieces proved significant. However, dogs were incapable of differentiating the same pieces of meat mixed with dough. This led to a conclusion that differentiation of meat pieces in the given conditions occurred only through the agency of distant receptors, and not of those in the oral cavity.

LITERATURE CITED

1. I. Beritov and M. Akhmeteli, Transactions of the I. S. Beritashvili Institute of Physiology [in Russian], No. 3, p. 375. Tbilisi (1937).
2. E. G. Vatsuro, Zh. vyssh. nervn. deyat., 1, 70 (1959); ibid., 4, 660 (1961); ibid., 6, 1012 (1961); Abstracts of Proceedings of the 1st Congress of the Society of Psychologists [in Russian], No. 2, p. 8 (1959).
3. P. S. Kupalov, Zh. vyssh. nervn. deyat., 4, 457 (1952); ibid., 2, 156 (1955).
4. A. I. Makarychev, The "Law of Strength" in the Theory of Higher Nervous Activity [in Russian], Moscow (1947).