THE DEPENDENCE OF THE EFFECT OF STIMULUS STRENGTH IN ACID-DEFENSE CONDITIONED REFLEXES

V. D. Bykov

Laboratory of Age Physiology of the Central Nervous System (Director – Prof. A. A. Volokhov), Institute of Normal and Pathological Physiology (Director – Active Member AMN SSSR V. N. Chernigovskii), AMN SSSR, Moscow

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The law of dependence of the conditioned reflex effect on the strength of the conditioned stimulus has been established chiefly on the evidence of food conditioned reflexes. Manifestations of this law have subsequently been demonstrated in other reflexes as well, both in man and animals.

According to some literature data, however, acid-defense conditioned reflexes do not show such consistent dependence of effect on stimulus strength [6, 2].

Thus, V. K. Fedorov's experiments [6] on a dog in which food and acid-defense conditioned reflexes were established simultaneously showed that the food reflexes exhibited clear dependence of effect on stimulus strength while in the acid reflexes this dependence was constantly disturbed.

In the author's opinion this difference is determined by the fact that the acid unconditioned center, unlike the food one, does not possess a constant level of excitability.

This question received no further investigation. At the same time the offered explanation is in many respects inadequate, particularly with regard to the reason for the fluctuation in the level of excitability of the acid center. This problem therefore needs to be examined further.

EXPERIMENTAL METHOD

Experiments were carried out on two dogs. One of these (Belyi) had strong, balanced and mobile nervous processes, the other (Chernyi) belonged to the strong excitable type of nervous system. Two independent systems of conditioned reflexes were established in these animals – food and acid-defensive. Experiments with food reflexes were performed in the morning , those with acid reflexes in the evening . The following conditioned food stimuli were used: bell (strong) metronome 60 (medium), tone (weak); acid-defense reflexes were developed to a buzzer (strong), crackling noise (medium) and light (weak). Acid reflexes were reinforced by 5 ml 0.25% hydrochloric acid. The interval between the conditioned stimuli was 4 minutes.

EXPERIMENTAL RESULTS

Conditioned reflexes, both food and acid, were formed at approximately the same rate, within range of 10-15 combinations.

Food conditioned reflexes quickly reached a very high and stable level. The dependence of effect on stimulus strength was well marked.

In contrast to this, acid-defense conditioned reflexes were irregular both in magnitude and in length of the latent period and showed no consistent dependence of effect on stimulus strength (records of experiments No. 26 and 28 and No. 25 and 27 and Fig. 1).

Records

Belyi — Experiment No. 26 — 10/8/1954

Food reflexes

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
56	Bell	15	3	29	175	
47	Metronome^{60}	15	2	27	186	
45	Tone	15	4	23	165	
48	Metronome^{60}	15	3	25	160	
46	Tone	15	3	20	170	
57	Bell	15	2	22	155	

Belyi — Experiment No. 28 — 10/8/1954

Acid reflexes

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
61	Buzzer	15	7	12	50	
53	Crackling noise	15	5	15	64	
50	Light	15	9	9	105	
54	Crackling noise	15	13	5	70	
51	Light	15	5	15	65	
62	Buzzer	15	4	16	65	

Chernyi — Experiment No. 25 — 10/9/1954

Food reflexes

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
54	Bell	15	2	33	180	
45	Metronome^{60}	15	3	24	190	
42	Tone	15	2	25	175	
46	Metronome^{60}	15	2	29	195	
43	Tone	15	4	22	185	
55	Bell	15	2	30	180	

As can be seen from the records and Fig. 1, the magnitude of acid conditioned reflexes fluctuates greatly not only from experiment to experiment but also within a single experiment. Considerable variations in the secretory effect are also observed in response to unconditioned stimulation. Similar dynamics of acid-defense conditioned reflexes have also been described by other authors [2, 6].

Chernyi Experiment No. 27 10/9/1954

Acid reflexes

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
57	Buzzer	15	8	9	95	
51	Crackling noise	15	4	16	80	
49	Light	15	5	18	50	
52	Crackling noise	15	9	6	65	
50	Light	15	10	7	70	
58	Buzzer	15	9	3	90	

Belyi Experiment No. 32 10/14/1954

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
69	Buzzer	15	2	40	205	
61	Crackling noise	15	1	43	190	
58	Light	15	2	30	190	
62	Crackling noise	15	2	38	200	
59	Light	15	2	34	180	
70	Buzzer	15	1	45	195	

Chernyi Experiment No. 33 10/16/1954

No. of stimulus	Type of stimulus	Time of isolated action of conditioned stimulus in seconds	Latent period of conditioned reflex in seconds	Magnitude of conditioned reflex in scale divisions	Magnitude of unconditioned reflex in scale divisions	Remarks
69	Buzzer	15	1	53	195	
63	Crackling noise	15	2	44	210	
61	Light	15	2	41	200	
64	Crackling noise	15	1	48	195	
62	Light	15	2	37	205	
70	Buzzer	15	1	50	200	

The described phenomena can be understood if, in accordance with the factual material, it is assumed that the excitability of the acid center changes not only from experiment to experiment but also from combination to combination, with no directional consistency. However, there is no adequate evidence on the strength of which such physiologic properties could be ascribed to the acid center. The cause of these distinctive features of acid conditioned reflexes must, therefore, be sought elsewhere.

It has long been established that saliva is secreted predominantly from that salivary gland which is ipsilateral to stimulation of the oral cavity [1, 3, 4, 5]. This was particularly clearly demonstrated in K. S. Abuladze's experiments [1] on dogs in which two small symmetrical areas of the tongue were externalized together with the ducts of the two parotid glands.

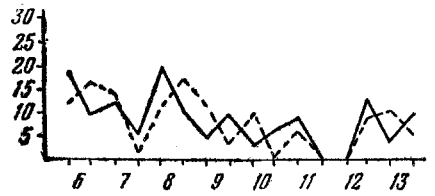

Fig. 1. Dynamics of acid-defense conditioned reflexes in the dog Belyi in response to a buzzer (solid line) and to light (broken line). Ordinate – amount of conditioned secretion in scale divisions, abscissa – number of experiments.

In work on acid-defense reflexes, however, the apparatus for introduction of the acid and the balloon for recording salivation are usually attached to the opposite sides of the dog's mouth for purposes of convenience. Irrigation of the oral mucosa with acid thus occurs chiefly on one side, while the salivary reaction is recorded from the gland situated on the opposite side, which is naturally exposed to much smaller amounts of acid.

It is natural to suppose that the peculiarities in the course of acid-defense conditioned reflexes were determined by the fact that stimulation was carried out on one side whereas salivation was recorded from the other.

This was fully confirmed by experiments. When salivary secretion was recorded from the side ipsilateral to stimulation in the same animals as those used in above-mentioned experiments, the unconditioned and conditioned reflexes showed a marked increase from the first day of experiment. From the third experiment using the new technique the conditioned reflexes became established at a new and much higher level (records of experiments No. 32 and 33).

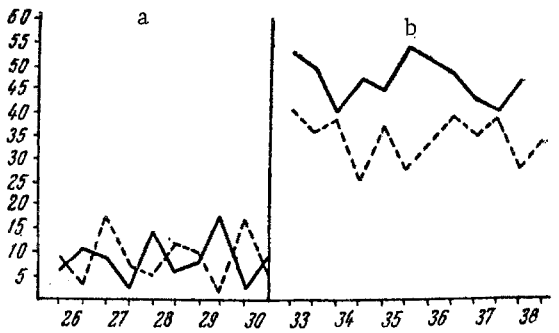

Fig. 2. Acid-defense conditioned reflexes in the dog Chernyi: a) on recording salivation from left parotid gland when acid is introduced from the right side of mouth; b) on introduction of acid and recording of salivation from the same side. Records as in Fig. 1.

The records show that the conditioned reflexes more than doubled on average, their latent period shortened to 1-3 seconds, they became stable and, most important, began to show consistent strength-effect dependence (Fig. 2). Moreover, while before food conditioned reflexes in these animals exceeded appreciably the acid-defense ones, the latter now became considerably greater than the former. This investigation provides, to our mind, convincing evidence that the absence of regular dependence of effect on stimulus strength is not a specific property of acid conditioned reflexes. There is also no basis for considering that the acid center, unlike the food center, is unable to maintain a given level of excitability.

SUMMARY

The law of dependence of the magnitude of reflexes on the strength of the stimulus is not less pronounced in acid-defense conditioned reflexes than in food reflexes.

The absence of consistent dependence of the effect on the strength of the stimulus noted by other authors was due to the peculiarities of the methods employed by them. If in formation of acid reflexes the acid is poured into the mouth of the animal on one side, while the salivary secretion is recorded on the other the conditioned reflexes show instability and the effect does not depend on the strength of the stimulus. This does not occur when the salivary secretion is recorded for the gland on the side of acid introduction.

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