THE DEVELOPMENT OF EXTINCTIVE INHIBITION DURING THE ACTION OF EXTRANEOUS AND CONDITIONED STIMULI

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Extinctive inhibition occupies an intermediate position between unconditioned (cortical) and conditioned inhibition, and it has therefore attracted the attention of many researchers.

According to P. S. Kupalov [3], no complete gap exists between conditioned and unconditioned inhibition in the cerebral cortex. An example of this is given by extinctive inhibition: if a conditioned stimulus is not reinforced, it appears at once, without preliminary preparation (consequently, in its mechanism this inhibition is unconditioned in nature); during subsequent applications of the conditioned stimulus without reinforcement, this is combined with a newly developed, internal inhibition, which is added to the unconditioned inhibition, strengthening it, sometimes to the extent of the almost complete absence of secretion to an extinguished stimulus.

In order to study the relationship between the processes of excitation and inhibition during extinction of conditioned reflexes to the action of an extinguishable stimulus in greater detail, we added others of different strength and observed the changes caused by these agents in the process of extinction. Experiments were carried out on the same dog and with the same technical conditions as were described in our paper dealing with the study of the interaction between extinctive and limiting inhibition [2].

TABLE 1. Addition of Extraneous Agents to Extinguishable Conditioned Stimuli

Expt. No.	Stimuli (first—extinguishable, second—added)	Time to extinguish reflex (sec)	Secretion of saliva during every 15 sec of action of stimulus (scale divisions)								
			15	30	45	60	75	90	105	120	135
758	Light (normal extinction)	85	35	55	25	17	12	0	—	—	—
762	Light + sound,1,000 cps after 15 sec	50	35	**18**	6	0	—	—	—	—	—
769	Light + sound,1,000 cps after 15 sec	40	25	**27**	0	—	—	—	—	—	—
773	Buzzer (normal extinction)	100	63	28	7	15	9	4	0	—	—
780	Buzzer + sound,2,000 cps after 15 sec	50	77	**15**	30	0	—	—	—	—	—
793	Buzzer + sound,1,500 cps after 30 sec	45	60	45	**0**	—	—	—	—	—	—

Note. The figures printed in bold type (here and in the subsequent tables) denote secretion during the action of two stimuli.

After studying the extinction of conditioned reflexes to all the usual conditioned stimuli (buzzer, metronome, light, sound of 400 cps and intensity of 50 and 122 db), we began to add others (extraneous and conditioned) to the extinguishable stimulus during extinction, allowing them to act for 15 sec at different phases of extinction of the reflexes. Extinction was usually brought about once in an experiment, and only if the other conditioned reflexes were of the usual magnitude. In this way we found that the addition of physically weak extraneous and conditioned stimuli to the extinguishable stimuli diminished secretion, i.e., strengthened the process of inhibition (Tables 1 and 2); the addition of a very loud sound (intensity 122 db) to supplement the action of the extinguishable stimuli, on the other hand, disinhibited the extinction (Table 3).

TABLE 2. Addition of Conditioned Stimuli (light, sound 400 cps 50 db) to Extinguishable Stimuli (buzzer, very loud sound of 122 db)

Expt. No.	Stimuli (first—extinguishable, second—added)	Time to extinguish reflex (sec)	Secretion of saliva during every 15 sec of action of stimulus (scale divisions)											
			15	30	45	60	75	90	105	120	135	150	165	180
771	Buzzer (normal)	100	57	52	11	18	14	6	0	–	–	–	–	–
785	Buzzer + sound 400 cps 50 db after 15 sec	50	60	**32**	4	0	–	–	–	–	–	–	–	–
786	Buzzer + sound 400 cps 50 db after 30 sec	60	60	50	**6**	15	0	–	–	–	–	–	–	–
738	Sound 400 cps 122 db (normal)	155	50	53	57	50	20	22	5	7	40	9	0	–
802	Sound 400 cps 122 db + light after 45 sec	120	45	32	18	**5**	17	6	14	3	0	–	–	–
806	Sound 400 cps 122 db + light after 30 sec	75	55	20	**5**	7	8	0	–	–	–	–	–	–
804	Sound 400 cps 122 db + light after 15 sec	90	72	**30**	11	8	19	9	0	–	–	–	–	–
808	Sound 400 cps 122 db + light at once	80	**58**	21	7	30	6	0	–	–	–	–	–	–
808	Sound 400 cps 122 db (normal)	120	45	45	20	15	20	11	14	7	0	–	–	–

TABLE 3. Addition of Very Loud Sound to Extinguishable Stimuli (buzzer and light)

Expt. No.	Stimuli (first—extinguishable, second—added)	Time to extinguish reflex (sec)	Secretion of saliva during every 15 sec of action of stimulus (scale divisions)											
			15	30	45	60	75	90	105	120	135	150	165	180
773	Buzzer (normal)	100	63	28	7	15	9	4	0	–	–	–	–	–
792	Buzzer + sound 400 cps 122 db after 15 sec	150	58	**55**	20	14	6	7	13	15	12	6	0	–
794	Buzzer + sound 400 cps 122 db after 30 sec	130	55	35	**40**	10	15	15	7	13	0	–	–	–
795	Buzzer + sound 400 cps 122 db after 45 sec	180	40	55	22	**48**	25	8	7	15	7	8	13	0
758	Light (normal)	85	35	55	25	17	12	0	–	–	–	–	–	–
796	Light + sound 400 cps 122 db after 45 sec and after complete cessation of secretion	225	38	30	13	**47**	13	15	14	8	0	0	**35**	30
797	Light + sound 400 cps 122 db after 30 sec	120	37	20	**40**	30	9	6	15	0	–	–	–	–
798	Light + sound 400 cps 122 db at once	200	**55**	36	16	7	15	7	7	8	6	4	3	2
799	Light (normal)	75	38	25	7	6	7	0	–	–	–	–	–	–

It may be seen from Table 1 that the addition of an extraneous stimulus (sound of 1000 cps) to the action of the extinguishable light stimulus greatly reduced the secretion of saliva, which was extinguished to below 50 and 40 sec from a normal value of 85 sec. The same result was observed after addition of an extraneous stimulus (sound of 2000 cps) to a buzzer (this reflex was extinguished to below 50 and 45 sec from a normal value of 100 sec). Similar facts were observed when other conditioned stimuli were added to the extinguishable stimulus (see Table 2).

The addition of a weak sound (400 cps, 50 db) to the extinguishable buzzer greatly reduced the secretion of saliva both during the action of the sound and after its withdrawal; the reflex to the buzzer was extinguished to below

50 and 60 sec from a normal value of 100 sec. This phenomenon was also observed when the light was added to the extinguishable very loud sound: 30 and 45 sec after discontinuation of the sound, the secretion was greatly reduced during the action of the light, and after its removal, the reflex to the sound was inhibited more quickly than normally. The addition of light during the first 15-30 sec of action of the sound caused a decrease in the extinction time to 90 and 80 sec (compared with 155 and 130 sec).

The addition of a very strong sound to extinguishable stimuli always disturbed the process of extinction (disinhibited it) during the action of the sound and its after-effect (see Table 3). For instance, whereas normally the reflex to the buzzer was extinguished in the course of 100 sec, after the addition of a very loud sound extinction was prolonged to 130-180 sec; whereas the conditioned reflex to light was normally extinguished in 75-80 sec, after addition of the sound, extinction was prolonged to 120-200 sec.

We consider that these phenomena may be explained as follows. In the first two cases, the added stimuli induced an orienting reaction in the animal, in the course of which external inhibition (negative induction) developed, which combined with the extinctive induction, thereby intensifying it. The addition of a very loud sound also caused an orienting reaction, but of a far stronger degree. In this case irradiation of the strong excitation was observed, so that it spread to the extinguishable reflex and caused it to become disinhibited.

The facts described indicate that, depending on the physical strength of the added stimulus and, consequently, on the intensity of the orienting reaction which it causes, the excitation either irradiates throughout the cerebral cortex and, in so doing, disturbs the process of extinction, or it is concentrated in a more or less localized area of the cortex, when the accompanying negative induction intensifies and accelerates extinction of the conditioned reflex. Hence it may be concluded that the external (in our case – induction) inhibition may be combined with the extinctive inhibition, thus strengthening it. Our facts also afford further confirmation of the view, previously put forward by us, that external and internal inhibition are common phenomena, identical in nature [1, 5, 6, 4, and others].

SUMMARY

This work was conducted according to I. P. Pavlov's method of salivary conditioned reflexes. After the elaboration of stable conditioned reflexes to various stimuli in dogs extinction of these reflexes was provoked (only one in each experiment). After the study of the reflex extinction in normal condition other stimuli of various intensities (foreign and conditioned) were added to the action of the stimuli extinguished. As revealed, an addition of weak agents to the extinguished stimulus (light, low tone) intensified the extinction inhibition, whereas an addition of extremely strong stimulus (tone of 122 db) caused disinhibition of the extinguished reflex. These phenomena are explained by the development of orientative reaction, which is concentrated in the first case in a more or less limited area of the brain cortex (of large hemispheres) provoking the development of external (induction) inhibition. This inhibition is summated with the extinction inhibition and intensifies the latter. In the second case orientative reaction is very strong, and therefore excitation spreads to the extinction reflex as well, provoking disinhibition of the latter.

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