PHYSIOLOGY

THE DEVELOPMENT OF AN INHIBITORY PROCESS DURING PRODUCTION OF CONDITIONED INHIBITION AND CHRONIC EXTINCTION WITH AN ADDITIONAL AGENT

V. I. Syrenskii

From the Institute of Experimental Medicine (Scientific Director – Active Member of the AMN SSSR Prof. P. S. Kupalov) of the AMN SSSR, Leningrad

(Received June 21, 1957. Submitted by Active Member of the AMN SSSR Prof. P. S. Kupalov)

The aim of the present work was to study the characteristics of development of inhibition by the action of a conditioned inhibitory combination (of conditioned inhibition) by comparison with the development of inhibition during extinction and formation of differentiation. In the article is given an account of the results of comparison of the formation of conditioned inhibition and extinction. Extinction was brought about by the method which was described in articles by several workers [P. K. Anokhin (1), G. V. Skipin (5), N. V. Zimkin (2), S. S. Serebrennikov (4) and F. P. Maiorov (3)]. After the conditioned reflex had been firmly established we extinguished it, while concurrently with the conditioned stimulus some indifferent stimulus was acting (extinction with an additional agent).

EXPERIMENTAL METHOD

The experiments were carried out by the method of alimentary conditioned reflexes in a dog with a strong variation of a weak type of nervous system. At the moment of formation of the forms of internal inhibition in which we were interested in the dog, positive conditioned reflexes were formed to the following stimuli: buzzer, metronome, luminous revolving disc (disc). The time of withdrawal of the conditioned stimuli from the unconditioned was 30 seconds, the pauses were 3-5 minutes. We tried to bring about chronic extinction with an additional agent and production of a conditioned inhibitory combination in identical conditions. For comparable conditional stimuli we used auditory stimuli of equal physical force: the sound of an electric bell without a metal cover (crash) and the sound emitted by a metal cog wheel rubbing against a metal disc (scrape). The volume of secretion due to the action of these and other positive conditioned stimuli varied from 20-30 divisions on the scale (one division on the scale corresponded to 0.01 ml). As an additional agent in both cases we used the same auditory stimulus – a bell. As a prelude to 2 experiments the bell was sounded in the pauses between the conditioned stimuli. Its action was accompanied by slight secretion of saliva and a feeble orientation reaction (experiment No. 202).

After this we set about producing the forms of internal inhibition in which we were interested. For this purpose in one experiment the bell was sounded together with the "scrape" (conditioned inhibitory combination): the bell for 10 seconds and then the "scrape" for 30 seconds. This combination was not reinforced. In the same experiment the "scrape" was also used independently as a positive conditioned stimulus. In another experiment we produced extinction of the positive conditioned stimulus "crash" in combination with the bell, adding to the "crash" a bell in the same order as that in the conditioned inhibitory combination (10 seconds of the bell and 30 seconds of the "crash"). These combinations were used on alternative days. In one experiment we set out to produce conditioned inhibition, using as a conditioned stimulus the "scrape" both in combination with the bell and independently, and in the following experiment we extinguished the positive conditioned stimulus – the "crash" in combination with the bell.

EXPERIMENTAL RESULTS

The usual magnitude of the conditioned reflexes before the introduction of the combination can be seen from the findings in experiment No. 202. On the first addition of the bell to the "scrape" and "crash" the rate of secretion was altered: it rose at the beginning of the action of both stimuli. In this way the general secretory effect to the "scrape" was increased and that of the "crash" was almost unchanged. With the action of these stimuli the dog looked in its feeding bowl. Ringing the bell in both cases was accompanied by slight secretion of saliva and turning of the animal to the side of the stimulus (experiments Nos. 203 and 204, compare with experiment No. 202).

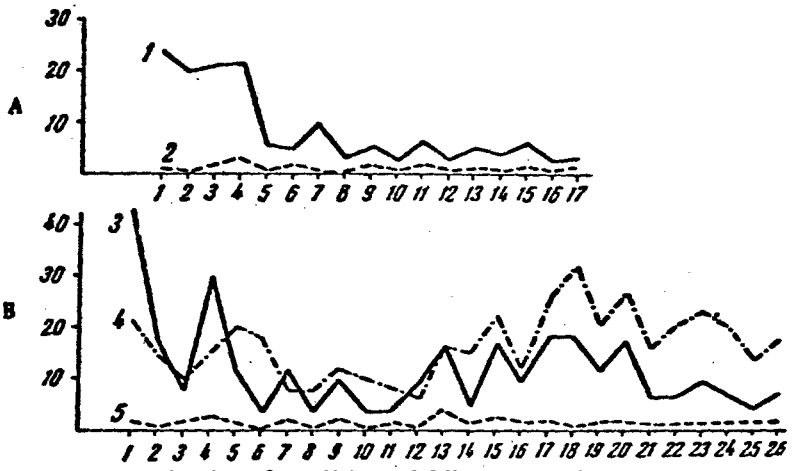
From the second application of both combinations a fall began in the secretion on account of an equal diminution in its rate (to a rather greater degree at the beginning of the action of these combinations). The rate of secretion fell not only to the bell but also to the "scrape" which followed it, or to the "crash". On the 5th or 6th applications of these combinations the volume of secretion to these had already fallen considerably. This was due to an increase in the period of delay and to a still greater reduction in the rate of secretion (experiments Nos. 213 and 214). Starting from this moment, both combinations acquired an inhibitory importance (see Table).

Change in the Magnitude of Conditioned Reflexes in the Dog "Kashtanka" During Production of Conditioned Inhibition and Chronic Extinction with an Additional Agent

Number of stimulus application	Stimulus	Time of isolated action of cond. stim., sec.	Latent period, sec.	Magnitude of cond. reflex (in scale divisions)		Remarks
				in each 5 sec.	in 30 sec.	
			Experiment 202 21/I 1954			
269	M_{120}	30	3	3+3+2+7+5+12	32	—
38	"Scrape"	30	4	1+0+1+4+5+8	19	—
2	Bell	10	6	0+2	2	Weak orientation reaction
270	M_{120}	30	3	3+3+4+7+5+9	31	—
38	"Scrape"	30	11	0+0+3+5+7+5	20	—
6	Bell	30	10	0+0+1+1+4+6	12	—
			Experiment 203 22/I 1954			
271	M_{120} Bell	30	3	2+2+2+6+6+8	26	
1		10	4	1+1	2	Looks at stimulus
	"Scrape"	30	3	3+7+7+11+6+9	43	Looks at feeding bowl
272	M_{120}	30	16	0+0+4+3+4+9	20	—
39	"Scrape"	30	1	6+3+2+2+4+5	22	—
7	Disc	30	12	No divided registration	8	—
201	Buzzer	30	3	2+2+1+3+5+9	22	—
			Experiment 204 23/I 1954			
273	M_{120}	30	3	1+0+3+5+9+10	28	—
	Bell	10	7	0+1	1	Looks at stimulus
1	"Crash"	30	2	4+3+1+2+7+7	24	—
274	M_{120}	30	16	0+0+2+2+4+5	13	—
8	Disc	30	12	0+0+1+0+2+5	8	—
276	M_{120}	30	4	1+0+0+0+4+9	14	—

(Table continued)

Number of stimulus application	Stimulus	Time of isolated action of cond. stim., sec.	Latent period, sec.	Magnitude of cond. reflex (in scale divisions)		Remarks
				In each 5 sec.	In 30 sec.	
		Experiment 213 3/II 1954				
291	M_{120}	30	3	4+2+1+3+7+11	28	
6	Bell	10	—	0+0	0	No motor-alimentary reaction. Looks first at the feeding bowl then to the side.
	"Scrape"	30	26	0+0+0+0+0+4	4	
292	M_{120}	30	14	0+0+1+0+2+9	12	—
43	"Scrape"	30	4	1+2+1+1+4+10	19	—
16	Disc	30	8	0+1+0+0+3+4	8	—
209	Buzzer	30	3	2+3+2+1+2+8	18	—
		Experiment 214 4/II 1954				
293	M_{120}	30	4	1+2+4+3+7+13	30	—
6	Bell	10	4	1+2	3	No motor alimentary reaction Looks first at the feeding bowl then to the side.
	"Crash"	30	4	1+1+1+0+0+2	5	
294	M_{120}	30	22	0+0+0+0+3+10	13	—
17	Disc	30	16	0+0+0+1+1+6	8	—



Simultaneous production of conditioned inhibition and chronic extinction with an additional agent.

A) Process of chronic extinction with an additional agent; B) process of production of conditioned inhibition. On the ordinate axis is shown the magnitude of conditioned secretion in divisions of the scale, on the abscissa — the days of application of the inhibitory combination. The figures 1-5 signify the change in sectetion under the influence of: 1) a conditioned stimulus, extinguished in combination with an additional agent; 2) the additional agent of the extinguished combination; 3) a conditioned stimulus forming part of the conditioned inhibitory combination; 4) the same stimulus but applied separately in the experiment; 5) the additional agent of the conditioned inhibitory combination.

These experiments show that the character of the change in the course of secretion from the effect of inhibitory combinations was roughly the same – the rate of secretion was diminished evenly during their action (slightly more intensively at first). This suggests that the development of the inhibitory process in both cases followed the same path. In the following experiments with chronic extinction with an additional agent the volume of secretion under the action of the inhibitory combination, starting with the 8th application, was maintained at a level close to zero. The volume of secretion under the influence of the conditioned inhibitory combination fell more gradually and with greater variations: only to about the 20-25th application was it settled at a low level. As an illustration of the above we give a diagram which shows the changes in the volume of secreation under the influence of each of the components of the inhibitory combinations and, in addition, of a positive conditioned stimulus ("scrape") applied separately in the experiment (see Diagram). As can be seen from the diagram the inhibitory process developed and was consolidated more rapidly during chronic extinction than during conditioned inhibition.

These facts suggest that inhibition develops with greater ease and speed during chronic extinction with an additional agent than during the production of conditioned inhibition. In spite of the fact that in both cases inhibition is formed on combined stimulation, the above-mentioned types of internal inhibition differ considerably from each other in duration and difficulty of their production. It may be thought that these stimuli give rise to nervous processes which differ in their "structure". In conditioned inhibition the "structure" of the nerve processes is more complicated since the production of inhibition to a conditioned inhibitory combination prevents all the time the excitation caused by a positive conditioned stimulus. It is possible that in conditioned inhibition the synthesis of the components of the conditioned inhibitory combination is made more difficult. It seems to us that the special features of this synthesis also distinguish conditioned inhibition from other forms of internal inhibition. The next task is to explain the mechanisms inherent only in conditioned inhibition by comparison of this with other forms of internal inhibition.

SUMMARY

The following was established in comparing the development of conditioned inhibition and extinction of a positive conditioned stimulus in combination with an additional agent: development of the process of inhibition in formation of the above-mentioned types of internal inhibition is uniform in the same dog. However, inhibition is developed more easily and rapidly in chronic extinction with an additional agent, than in formation of conditioned inhibition.

LITERATURE CITED

[1] P. K. Anokhin, in the book: Proceedings of the Academician I. P. Pavlov Physiological Laboratory, 2, 2, pp. 125-134 (1928).*

[2] N. V. Zimkin, Fiziol. Zhurn. SSSR, 17, 5, p. 921 (1934).

[3] F. P. Maiorov, in the book: Proceedings of the Academician I. P. Pavlov Physiological Laboratory, IX, 440-445 (1940).*

[4] S. S. Serebrennikov, in the book: Proceedings of the Academician I. P. Pavlov Physiological Laboratory, IX, pp. 340-343 (1940).*

[5] G. V. Skipin, in the book: Proceedings of the Academician I. P. Pavlov Physiological Laboratory, 3, pp. 139-145 (1928).*

* In Russian.