PHYSIOLOGY

CONDITIONED REFLEX CHANGES IN THE MOBILITY OF THE COLD RECEPTORS IN THE SKIN

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Study of the process of the functional mobility of the thermoreceptors in the skin, expressed as variations in the number of active elements, showed a complete correlation between the "accommodation" reaction of the given receptors and the conditions of the medium surrounding the organism. When the external temperature is lowered, the number of cold receptors which are active at a given moment increases; increasing the temperature involves a decrease in the number of active cold receptors.

An investigation of the functional mobility of the heat receptors in the skin, carried out by O. D. Kolyutskaya also established the dependence of the mobility of these receptors on the temperature fluctuations of the surrounding environment. In this case, increasing the temperature causes an increase in the number of active heat elements, while lowering it causes a decrease. Even insignificant temperature fluctuations within the limits of one degree in either direction cause quantitative changes in the active cold and heat receptors of the skin.

Thus, the physiological phenomenon of the functional mobility of the skin temperature analyzer represents a process of the organism's accommodation to changing temperature conditions of the external environment.

For a deeper analysis of the role of the cerebral cortex in the regulation of the accommodation of the cold receptor apparatus of the skin, we undertook a study of the conditioned reactions which change the mobilization level of the elements of the above-mentioned system.

EXPERIMENTAL METHODS

Conditioned reactions which changed the degree of mobilization of the cold receptor apparatus of the skin were developed in three persons 16, 17 and 50 years of age.

A decrease in the room temperature of 1-2° was the unconditioned stimulus. A metronome with a frequency of 120 beats per minute, a metronome with a frequency of 60 beats per minute and the verbal warning "I'm turning on the cold" were used as the conditioned stimuli. The conditioned signal preceded the unconditioned one by 5-15 seconds. The conditioned signals were given without any regular stereotyping and at various intervals of time—within the limits of 6-15 minutes.

The methods which were developed by us of developing conditioned reactions to change the degree of mobilization of the cold receptors of the skin were essentially as follows. The temperature of the room where the investigation was carried out was raised to 21-24° with the help of electric heating equipment. The subject was placed behind screens so that he could not see the sources of the stimuli. After 15-20 minutes of preliminary adaptation to this temperature, 20 cold spots were found on the skin surface of the inner side of the forearm with the help of a cold thermo-esthesiometer and fixed with indelible paint. Then, in 2-5 minutes their activity with respect to cold perception was checked 3-4 times. The last number of active spots which was established served

as the "null" background. After an isolated conditioned signal (5-15 seconds), the number of active cold spots was determined. The difference between this and the number of background spots served as the measure of the conditioned reaction.

The conditioned signal was combined with a decrease of 1-2° in the room temperature, achieved by disconnecting the heaters and ventilating the area for one minute. Then the number of active cold spots was again determined. The difference between the number of active spots and the background number was the extent of the unconditioned reaction. Then the room temperature was increased to the original, the number of active background cold spots was again established, and the investigation proceeded in the same order.

EXPERIMENTAL RESULTS

When an inadequate stimulus (metronome 120) was combined with a change in the temperature of the surrounding environment (temperature decrease of 1.5°), this stimulus acquired the properties of a conditioned signal. Even after several combinations, just switching on metronome 120 caused an increase in the number of active cold spots. A steady association of these temporary connections occurred within 15-20 combinations of the action of metronome 120 with decreased temperature. The worksheet of one of the regular investigations is shown in Table 1.

TABLE 1

Observation on 17 April, 1953. Subject S., 17 Years Old
Original Surrounding Temperature 22°

Time of observation	Background number of active spots	Number of combinations	Conditioned stimulus	Time the isolated conditioned stimulus acted (in seconds)	Extent of conditioned reaction	Unconditioned stimulus (Decrease of room temperature in degrees)	Extent of unconditioned reaction	Comments
3:10 P. M.	9							
3:14 "	8							
3:16 "		25	M_{120}	15	2	1	3	Cooling 1 minute after M_{120}
3:25 "	8							
3:28 "		1	"I'm turning on the cold"	10	2	1	2	Cooling 1 minute after the words "I'm turning on the cold"
3:35 "	7							
3:38 "		2	"I'm turning on the cold"	10	2	1	3	The same
3:43 "	8							
3:45 "		3	"I'm turning on the cold"	10	2	1	3	The same
3:50 "	8							
3:52 "		26	M_{120}	15	2	1	2	Cooling 1 minute after M_{120}
3:59 "	7							
4:01 "		4	"I'm turning on the cold"	10	3	1	3	Cooling 1° 1 minute after the words "I'm turning on the cold"

It can be seen from Table 1 that out of 20 marked spots, 8 proved to be active at 3:14 P.M. After the isolated action of the conditioned signal–metronome 120, which had been combined 25 times with cooling, the number of active cold spots reached 10. Thus, the extent of the conditioned reaction was taken to be equal to 2.

The verbal warning "I'm turning on the cold", when first used, caused basically the same increase in the number of active cold spots among all the subjects as the direct decrease of the room temperature.

In addition to the positive conditioned reactions, we observed the development of several types of internal inhibition: differentiation and extinction.

A metronome with a frequency of 60 beats per minute, the action of which was not accompanied by a decrease in the temperature of the experimental room, was used as the differentiating agent. Differentiation of the sound of metronome 120 from that of metronome 60 was achieved by the subjects after several applications of these signals.

In Table 2 are presented the results of an investigation of the development of differentiation .

TABLE 2

Observation on 22 January 1953. Subject S., 16 Years Old
Original Surrounding Temperature 22.5°

Time of observation	Background number of active spots	Number of combinations	Conditioned stimulus	Time the isolated conditioned stimulus acted (in seconds)	Extent of conditioned reaction	Unconditioned stimulus (Decrease of room temperature in degrees)	Extent of unconditioned reaction	Comments
12:45 P.M.	3							
12:46 "		18	M_{120}	10	2	1	2	Cooling 1 minute after M_{120}
12:50 "	4							
12:51 "		1	M_{60}	10	2	-	-	No cooling
12:53 "	3							
12:55 "		19	M_{120}	10	2	1	1	Cooling 1 minute after M_{120}
1:00 "	3							
1:01 "		2	M_{60}	10	0	-	-	No cooling
1:03 "	3							
1:05 "		20	M_{120}	10	3	1	2	Cooling 1 minute after M_{120}
1:09 "	2							
1:11 "		3	M_{60}	10	0	-	-	No cooling
1:15 "	3							
1:17 "		21	M_{120}	10	3	1	2	Cooling 1 minute after M_{120}

The first application of metronome 60 caused the same increase in the number of active cold spots as the application of the reinforced conditioned signal–metronome 120. A generalization of the excitation process was observed. However, complete differentiation began quickly (at the third application of metronome 60).

With repeated application of the positive conditioned signal–metronome 120 – without an accompanying decrease in the temperature of the air in the room, a gradual decrease in the activity of the conditioned stimulus was observed, i.e., extinction of the conditioned reaction began – an increase in the number of active cold spots.

In Table 3 is presented a worksheet of the development of extinction

TABLE 3

Observation on 20 February 1953. Subject S., 17 Years Old

Time of observation	Background number of active spots	Number of combinations	Conditioned stimulus	Time the isolated conditioned stimulus acted (in seconds)	Extent of conditioned reaction	Unconditioned stimulus (Decrease of room temperature in degrees)	Extent of unconditioned reaction	Comments
4:47 P.M.	2							
4:50 "	3							
4:51 "		66	M_{120}	10	3	2	3	Cooling 1 minute after M_{120}
4:56 "	3							
4:58 "		67	M_{120}	10	4	-	-	Not reinforced
5:00 "		68	M_{120}	10	2	-	-	"
5:02 "		69	M_{120}	10	0	-	-	"
5:06 "		70	M_{120}	10	1	-	-	"
5:10 "		71	M_{120}	10	0	-	-	"
5:13 "		72	M_{120}	10	0	-	-	"

From the experiments which were carried out, the fact was established that the level of the mobilization of the cold receptors changes not only with the action of adequate stimuli, but also with the action of inadequate ones, if they are combined with adequate ones. The conditioned-reflex changes in the degree of mobilization of the cold receptors in the skin indicate that the process of functional mobility of the cold receptors occurs both as an unconditioned reflex and as a conditioned reflex.

The development of a quick and intense conditioned reaction of mobilizing the cold receptors in response to the verbal stimulus "I'm turning on the cold" is undoubtedly explained by the specificity of verbal stimuli for man.

The methods which we worked out of studying conditioned reactions which change the degree of mobilization of the skin thermoreceptors make it possible to follow the regulation of functional mobility in the temperature analyzer of the skin under normal, as well as pathological, conditions. In addition, the above method can be used to study the conditioned reflex reactions of man.

SUMMARY

The level of the mobilization of the cold receptors changes not only under the effect of adequate stimuli, but under that of inadequate ones as well, provided the latter are combined with the adequate stimuli.

Conditioned reflex changes of the mobilization degree of the cold reception in the skin reveal that the functional mobility of cold receptors occurs both as an unconditioned and a conditioned reflex.