

# THE POSSIBILITY OF DEVELOPMENT OF POSITIVE AND NEGATIVE CONDITIONED REFLEXES FROM SYMMETRIC AREAS OF THE SKIN

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The problems of differentiation of symmetric stimuli present considerable interest in connection with investigation of the mechanism of paired activity of the cerebral hemispheres.

There is no agreement in the literature concerning the possibility of development of positive and negative conditioned reflexes from symmetric skin areas.

Some authors consider that differentiation of stimuli from two symmetric skin areas does not take place [2], others consider that it is possible though differentiation occurs with difficulty and is fairly unstable [1, 3, 4, 5].

Detailed analysis of the positive cases of development of differentiation from symmetric skin areas as described in the literature draws attention to the fact that differentiation occurs in the presence of additional factors which potentiate the physiologic effect of cutaneous mechanical stimulation. In one case this was a marked shaking-off reflex [5] in another the use of large doses of meat-bread powder or acid for reinforcement of the tactile conditioned reflex [4, 3].

The impossibility of development of differentiation in symmetric skin areas under the usual conditions led I. P. Pavlov to suggest that the process of excitation arising on the action of a positive conditioned stimulus at a certain point of one hemisphere was constantly transmitted to a symmetric point of the other, and abolished or neutralized the process of inhibition which began to arise there in the course of development of differentiation.

From this point of view the role of additional factors is understandable: these factors, increasing the physiologic power of cutaneous-mechanical stimulation to a definite extent, favor limitation of its irradiation along the cortex, since it is known that the most readily irradiated stimuli are the weak and the very strong ones.

On the basis of these hypotheses we attempted to create those conditions, without changing the physiologic power of the cutaneous-mechanical stimulation, under which the animal would be able to differentiate symmetric stimuli.

With this aim in view we undertook to initiate simultaneously the development of a positive tactile conditioned reflex and development of differentiation from a symmetric skin area. In other words, an attempt was made to create simultaneously a focus of excitation in one hemisphere and one of inhibition in the other.

## EXPERIMENTAL METHOD

Experiments were performed on 4 dogs with bilaterally exteriorized parotid glands. Observations were made on dogs with different types of nervous systems: Elza was a strong type with predominant excitatory processes, Ryzhii – a strong balanced type with good mobility of nervous processes, Volchok – strong variant of the weak type and Sedoi – weak type.\*

\* The typologic features of the dogs' nervous systems were determined on the basis of special tests and prolonged observation of their conditioned reflex activity.

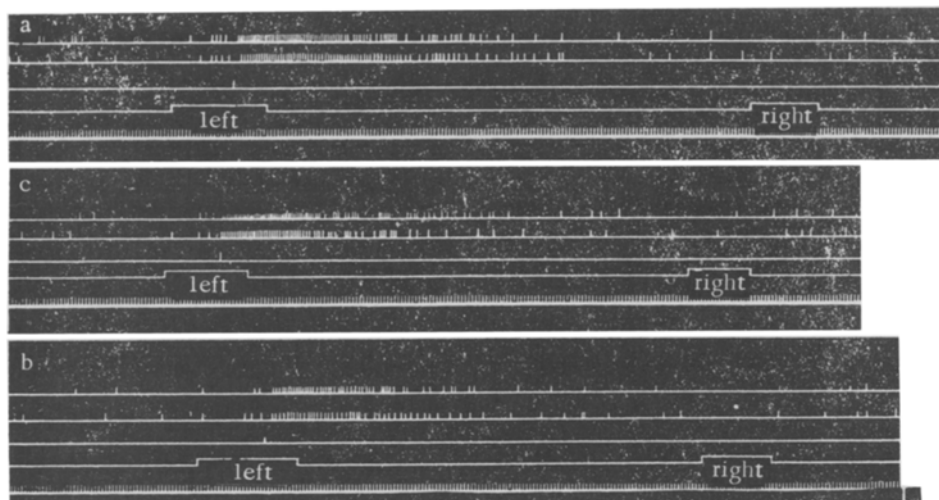


Fig. 1. Positive (left touching device) and negative (right touching device) conditioned reflexes from symmetric skin areas in the dog Elza.  
a) Experiment February 5, 1957, combination No. 163; b) experiment February 7, 1957, combination No. 165; c) experiment February 25, 1957, combination No. 178. Records from above down: saliva secretion from the left gland, right gland, feed marker, conditioned stimulation marker, time marker (1 second).

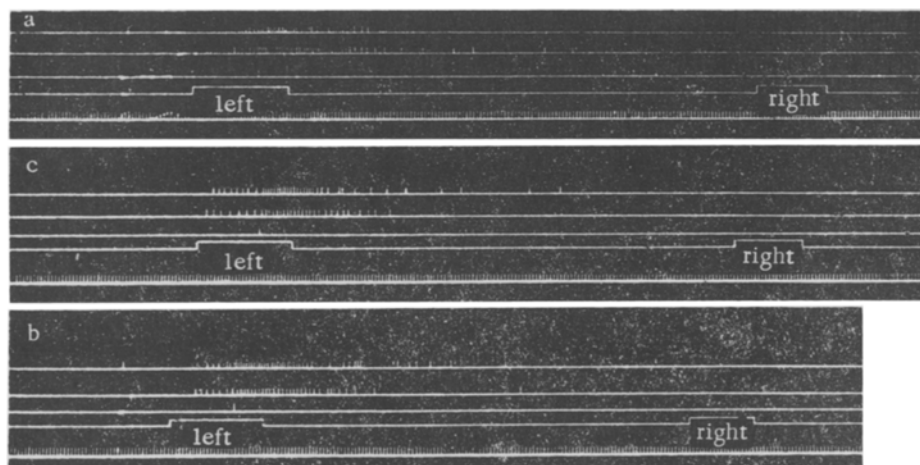


Fig. 2. Positive (left touching device) and negative (right touching device) conditioned reflexes from symmetric skin areas in the dog Ryzhii.  
a) Experiment February 7, 1957, combination No. 151; b) experiment April 17, 1957, combination No. 216; c) experiment April 22, 1957, combination No. 220. Records the same as in Fig. 1.

Tactile conditioned stimuli (touching devices) were used in combination with other (auditory and light) conditioned stimuli used in the same sequence at equal intervals of time (5 minutes).

Positive conditioned reflexes were reinforced by meat-bread powder (20 g), which was slightly moistened with water.

Salivation was recorded by means of a hydraulic system according to A. I. Makarychev's method, using electric recording of drops on a film.

TABLE 1

Change in Stereotype in Experiment of March 16, 1957 on the Dog Ryzhii

Time of experiment	Ordinal no. of combinations (stim)	Conditioned stimulus	Time of isolated action (sec)	Magnitude of cond. reflex (drops)		Latent period	Motor reaction	Food stimulus	Magnitude of uncond. reflex (drops)		Remarks
				Left gland	Right gland				Left gland	Right gland	
10 hrs 30 min	1532	Bell	20	12	9	5'5"	+	Reinforcement	49	35	Looked over in the direction of the touching device & bent low over the feed box
10 hrs 35 min	192	L. t. d.*	20	10	10	7'4"	+	Reinforcement	45	32	
10 hrs 40 min	192-a	L. t. d.*	20	4	6	15'11"	+	Reinforcement	44	38	
10 hrs 45 min	192	R. t. d.*	20	0	0	—	—	Differentiation			Sitting without change of position with back to feed box
10 hrs 50 min	734	Intermittent light	20	8	10	9'2"	+	Reinforcement	52	38	
10 hrs 55 min	1029	M <sub>120</sub>	20	9	8	9'6"	+	Reinforcement	53	37	
11 hrs	1533	Bell	20	12	7	8'8"	+	Reinforcement	36	33	

\* L. t. d. = left touching device; R. t. d. = right touching device.

Negative and positive tactile stimuli from symmetric skin areas were given at the same rate — one touch per second applied to the skin on the hip.

## EXPERIMENTAL RESULTS

In the case of dogs of the strong type with predominance of excitation (Elza) the introduction into the stereotype of simultaneous symmetric positive (on the left) and negative (on the right) tactile stimuli was accompanied during the first 2-3 days by a marked orientation reaction, salivation being absent during the action of both touching devices.

Later, increased saliva secretion was observed from the left and right parotid glands for several days when either the positive or negative conditioned stimulus was applied. During subsequent days a slight difference could be noted in the magnitude of conditioned reflexes depending on the action of positive or negative stimuli. However, there was fairly frequent replacement of relative differentiation by periods when conditioned reflex salivation predominated during the action of the negative stimulus. As in the case of other conditioned stimuli, the conditioned reflex salivation on the right and left was not equal. This period in the development of a positive and a negative conditioned reflex from symmetric skin areas was the longest. More or less constant adequate responses to the action of the positive and negative touching device were only observed starting from the 178th combination. Differentiation was usually incomplete (Fig. 1). This dog often showed divergence of motor and secretory reactions. An adequate motor reaction during the action of symmetric positive and negative stimuli was developed considerably earlier and was more constant.

In the case of a strong balanced type with good mobility of nervous processes (Ryzhii) salivation was absent during the action of the positive tactile stimulus during the first few days of introduction of symmetric positive and negative tactile stimuli into the stereotype, whereas during the action of the negative stimulus salivation was considerable. This was followed by a period of inhibition of the secretory reaction both during the action of the positive and the negative tactile stimulus: this period lasted several days. Then the magnitude of the positive conditioned reflexes increased gradually, differentiation became enhanced and beginning with the 133rd combination

TABLE 2

Alteration of Stereotype in Experiment of February 13, 1957 on the Dog Volchok

Time of experiment	Ordinal no. of combinations (stim.)	Conditioned stimulus	Time of isolated action (sec)	Magnitude of cond. reflex (drops)		Latent period	Motor reaction	Food stimulus	Magnitude of uncond. reflex (drops)		Remarks
				Left gland	Right gland				Left gland	Right gland	
10 hrs 30 min	1486	Bell	20	9	7	5' 10"	+	Reinforcement	55	44	Assumed a standing position quickly, turned and bent low over feed box On the 5th second turned, looked at feed box then turned away and stood sideways towards the feed box
10 hrs 35 min	169	L. t. d.*	20	5	8	6' 2"	+	Reinforcement	38	37	
10 hrs 40 min	1005	M <sub>120</sub>	20	11	14	6' 2"	+	Reinforcement	37	42	
10 hrs 45 min	712	Intermittent light	20	10	12	5' 3"	+	Reinforcement	36	36	
10 hrs 50 min	169	R. t. d.*	20	2	1	8' 19"	±	Differentiation			
10 hrs 55 min	1488	Bell	20	11	14	4' 1"	+	Reinforcement	50	53	

\* L.t.d. = left touching device; R.t.d. = right touching device.

firm (positive and negative) conditioned reflexes from symmetric skin areas became established (Fig. 2). No divergence of motor and secretory reactions was observed. Adequate motor reaction to symmetric stimulations was formed considerably earlier than the secretory one.

In order to make certain that the formation of the conditioned reflexes occurred in fact in response to the site of action of the tactile stimulus, and not the position of the conditioned stimulus in the stereotype or the sequence of stimuli in the experiment, control experiments were staged in which the stereotype was altered. Differentiation, which was moved from third to fourth place in the experiment, did not become disinhibited but remained zero (Table 1). When the stereotype underwent more complex alteration (replacement of the negative right touching device by a metronome and shift of differentiation from third to fifth position) the dog showed reaction adequate for these stimuli — a high, positive conditioned reflex during the action of the metronome and preservation of differentiation during the action of the negative tactile stimulus, although the differentiation was somewhat weaker (1-2 drops).

The dog Volchok, a weak type (strong variant) showed slight salivation in the first 2-3 days during the action of both stimuli when symmetric positive (left touching device) and negative (right touching device) conditioned stimuli were introduced into the stereotype. Subsequently there was gradual parallel increase in positive conditioned reflexes and reduction of salivation during the action of the negative conditioned stimulus. Absolute differentiation was sometimes observed. Beginning with the 133rd combination there was formation of symmetric positive and negative conditioned reflexes from the skin. Differentiation was mostly incomplete (Fig. 3). Adequate motor reaction was formed parallelly with the secretory. At the beginning of the development of conditioned reflexes from symmetric skin areas there was divergence of the motor and secretory reactions.

Control experiments with alteration of the stereotype showed that Volchok, like Ryzhii, actually developed positive and negative conditioned reflexes at the site of action of the tactile stimulus.

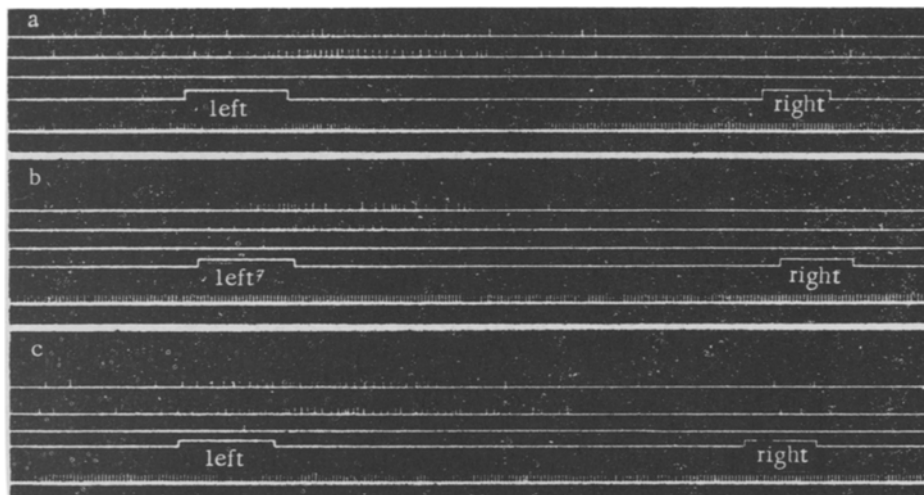


Fig. 3. Positive (left touching device) and negative (right touching device) conditioned reflexes from symmetric skin areas in the dog Volchok.

a) Experiment of February 14, 1957, combination No. 168; b) experiment of April 11, 1957, combination No. 209; c) experiment of April 22, 1957, combination No. 218. Records the same as in Figure 1.

In the case of a dog of extreme weak type (Sedoi) it proved impossible to develop stable positive and negative conditioned reflexes from symmetric skin areas despite the large number of combinations (over 300). Adequate motor reaction to the action of the positive (left) and negative (right) tactile stimuli was very marked although it was fairly inconstant. Divergence of motor and secretory reaction was observed frequently.

We thus succeeded in developing a positive and a negative conditioned reflex from symmetric skin areas in 3 dogs. Ryzhii, a dog of strong balanced type, showed replacement of a high positive conditioned reflex associated with the action of the left tactile stimulus by absolute differentiation when the right tactile stimulus was applied to a symmetric area. Two other dogs (Elza and Volchok) also developed differentiation from symmetric skin areas, although in their case it was often incomplete. Only one dog, of extremely weak type (Sedoi), proved unable to differentiate stimulation of symmetric skin areas.

It must be noted that the process of differentiation of stimulation of symmetric skin areas constitutes a fairly difficult problem for dogs. Considerable time is required for the development of a positive and a negative conditioned reflex.

The process itself is characterized by a phasic course: the reflexes tend to appear and disappear and only become more or less constant starting from a definite time different for each dog).

As shown by our experiments, the motor reaction in most cases developed earlier than the secretory one, and it was also observed in the dog of extreme weak type (Sedoi), although in this case it was less constant.

Observations on conditioned reflex regulation of the activity of paired parotid glands when unilateral symmetric stimuli were applied revealed that during the action of a positive conditioned stimulus on one side (left hip) salivation occurred from both glands but was unequal. There was predominance of activity on the part of one, then the other gland, or, if the amount secreted was equal, the onset of salivation was asynchronous on the two sides. Similar phenomena were seen when a unilateral negative stimulus was applied.

It would appear that simultaneous appearance of a focus of excitation in one hemisphere and a focus of inhibition in the other can, by means of "counterimpediment" lead to gradual limitation of the sphere of stimulation which helps the creation of the most favorable conditions for differentiation of symmetric stimuli.

#### SUMMARY

The possibility of development of positive and negative conditioned reflexes from symmetrical areas of

the skin was shown in experiments on dogs. However, the process of development is rather prolonged (from 133 to 178 combinations).

The rapidity and the possibility of development of symmetrical positive and negative conditioned reflexes from the skin and their stability are determined to a considerable extent by the typological peculiarities of the animal's nervous system. The author assumes that simultaneous creation of a focus of excitation in one hemisphere and that of inhibition in another is evidently of great significance for the formation of positive and negative conditioned reflexes from symmetrical areas of the skin.

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\* In Russian.