THE INTERACTION BETWEEN EXTINCTIVE
AND SUPRALIMINAL INHIBITION

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In our previous work on the study of the interaction between supraliminal inhibition and various types of internal inhibition, we investigated the effect of increasing the volume of the positive and differential tones on the higher nervous activity of a dog with a strong type of behavior (Inga). It was found that supraliminal inhibition strengthens differential inhibition (undergoes summation with it). We also observed that when the inhibiting stimulus becomes louder, differentiation becomes more precise (of "zero" pattern), and when the positive stimulus increases in volume, the differential inhibition is primarily disturbed.

The present work was devoted to the study of the interaction between extinctive and supraliminal inhibition.

In I.P. Pavlov's opinion, the process of extinction of conditioned reflexes includes components of conditioned and components of unconditioned inhibition. Of special interest to our investigation are the views on the mechanism of extinction expressed by S.V. Kleshchov, V.F. Pleshkov and others [2]. These authors divided the process of extinction into a number of phases: a rise of the curve of secretion of saliva, followed by a sharp fall in the curve and a residual secretion that is slowly extinguished at a low level. These authors, and also G.V. Skipin [8] and V.K. Fedorov [11], considered that the sharp fall in secretion of saliva during extinction is due to overexcitation of the cortical cells, and consequently to the intervention of supraliminal inhibition.

Because of these views it was important to investigate the process of extinction of a conditioned reflex to an excessively strong stimulus, for in response to the action of such a stimulus the process of conditioned excitation must be more or less restricted in its intensity by the development of supraliminal inhibition. Should this stimulus by change not be reinforced, the developing extinctive inhibition must interact to some extent with this supraliminal inhibition. Since the process of extinction itself, according to the point of view stated above, includes elements of overexcitation (i.e., of a supraliminal nature), it might be expected that as a result of this "double overexcitation" (from the excessively strong stimulus and the process of extinction) new facts would

be obtained which would lead to a better understanding of the processes under study.

EXPERIMENTAL METHOD AND RESULTS

Experiments were carried out on a dog (Al'ma) with a strong type of nervous system, by the method of conditioned salivary food reflexes. Conditioned reflexes were established in the dog to a buzzer, to a pure sound of 400 cps (from an ordinary ZG-10 sound generator), a light and a metronome. A sound of intensity 50 db was used twice (in second and fourth places) in the system of the conditioned reflexes. The work was carried out in a soundproof chamber, and the secretion of saliva was recorded by the Ganike-Kupalov method (one scale division corresponds to 0.01 ml). Alimentary reinforcement was by means of 20 g of a meat and biscuit powder, diluted 1:1 with milk.

After consolidation of the conditioned reflexes (see their mean values in the table), the tone used twice in the system of stimuli was intensified to 122 db. The increase in the loudness of the tone caused an increase in all the conditioned reflexes (see table).

It must be pointed out that this dog was perfectly trained to the action of loud conditioned sound stimuli, and for this reason, when the intensity of the tone was increased, we did not obtain supraliminal inhibition in its "pure" form; from certain indirect signs, however, it could be assumed that this took place when the tone was intensified to 122 db (the maximum of which our amplifier was capable).

It can be seen from the table that the conditioned reflex to the excessively strong tone was smaller on the average than the conditoned reflexes to the weak tone and the buzzer. In many experiments the pattern of secretion of saliva in response to a very loud tone was distorted, i.e., instead of an increase taking place at the moment of reinforcement, the secretion of saliva decreased in response to the tone. In experiments 720, 721, 723, 724, etc., for example, when the secretion was recorded every 5 seconds, the values of the secretion of saliva were as follows (after a lag of 15 seconds): 10, 25, 12; 10, 25, 15; 5, 10, 8; 3, 20, 15. This pattern of secre-

TABLE. Mean Value (of 5 Experiments) of the Conditioned Reflexes Before and After Increasing the Loudness of the Tone to 122 db in the Dog Al'ma

Conditioned stimuli	Magnitude of reflexes before intensification of tone (in scale divisions)		Magnitude of reflexes after intensification of tone II (in scale divisions)		Change in magnitude of reflexes (as % of original)
	experiment		experiment		average of 10 experiments
	700-713	714-718	733-737	742-746	
Buzzer	45.4	49.8	61.0	59.6	+ 25
Tone I (50 db)	33.8	34.2	61.2	67.2	+ 89
Light	33.4	28.2	48.4	50.0	+ 60
Tone II	31.6	31.2	54.4	54.2	+ 73
Metronome	29.2	35.8	53.8	35.6	+ 37

Note. The tone was first increased in intensity in experiment 719.

tion in response to an excessively loud tone was often observed also in subsequent experiments. These facts, in our opinion, suggest that in this case we are dealing with the intervention of supraliminal inhibition in the process of conditioned excitation during the action of an excessively strong stimulus. Further support for this hypothesis is given by the fact that, in the first place, as the excessively loud tone is applied, the ensuing conditioned reflex to the metronome is considerably decreased (the presence of successive inhibition); secondly, when tone I and not tone II in the system was increased in intensity for a period of 5 days, the reflex in response to it fell on the average to 54 scale divisions, which corresponds very closely to the magnitude of the reflex to tone II. Consequently, the magnitude of the last reflex was less than that of the reflexes to the buzzer and tone I, not on account of the position of the stimuli in the stereotype but because of the effect of supraliminal inhibition.

As a preliminary step, before increasing the intensity of the tone, we carried out a sharp, continuous extinction of the conditioned reflexes to the tone (50 db), the light and the buzzer (until three "zeros" had been recorded), and obtained the extinction curves illustrated in Fig. 1.

After increasing the loudness of the tone, we again extinguished the buzzer, tone I (50 db) and tone II (122 db). The process of extinction of the reflexes to the first two stimuli was unchanged (Fig. 2), and extinction of the conditioned reflex to a very loud tone took place far more slowly, as a result of the prolongation of the second and third phases. Under these circumstances the animal showed an unusually intensive motor alimentary reaction (the dog thrust its mouth several times, during the time of action of the excessively loud tone, into the feeding bowl, sniffed at it, licked it and so on). The first phase (the rise of the saliva secretion curve) in these cases was either absent or very ill-defined (Fig. 3).

Extinction of the excessively loud tone caused no changes in the magnitude of the other conditioned reflexes, but after subsequent extinction of the conditioned
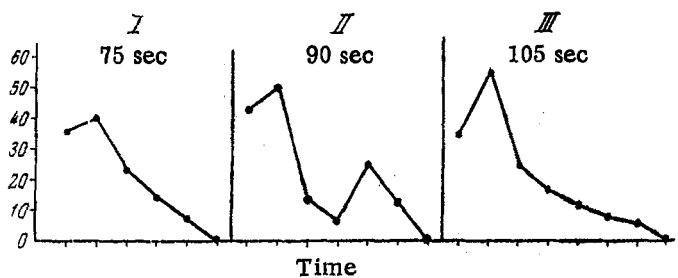

Fig. 1. Sharp continuous extinction of the conditioned reflexes to a stimulus of normal strength (medium — tone and buzzer; weak — light). I) Tone; II) buzzer; III) light. Along the axis of the ordinate — magnitude of secretion of saliva in scale divisions (1 division = 0.01 ml); along the axis of the abscissae — time from beginning of action of the stimulus (each division corresponds to 15 seconds).
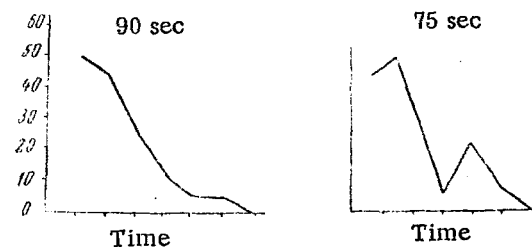

Fig. 2. Sharp continuous extinction of the conditioned reflexes to a buzzer (I) and a tone of intensity of 50 db (II) after increasing the intensity of the second tone to 122 db. Legend as in Fig. 1.

stimulus of normal strength, the process of extinction was altered: It was prolonged to 150 seconds. On the next day, however, extinction of the conditioned reflex to the same stimulus (metronome) occurred at the usual rate (in 90 seconds).

Analysis of the curves of extinction of the conditioned reflexes shown in Fig. 1 indicates that the conditioned reflex to a weak stimulus (light) was extinguished

rather more slowly (on account of the prolongation of
the third phase) than the conditioned reflexes to stimuli
of medium strength (105, 75 and 90 seconds, respectively);
the first phase was most pronounced during extinction of
a weak stimulus. The reflex to an excessively strong
stimulus (150 seconds; see Fig. 3) was extinguished even
more slowly than the conditioned reflex to light. In this
case the second phase of extinction was prolonged in
addition to the third phase; the first phase was rather
ill-defined.

According to the views of V.K. Fedorov [11], P.S.
Kupalov [4], and others, regarding the mechanism of ex-
tinction, it may be postulated that the extinction of any
conditoned reflex involves the participation of supra-
liminal inhibition, arising as the result of an increase in
the level of excitation of the cortical cells at the
moment of reinforcement by food and of summation of
the stimuli from the conditioned agent and of the condi-
tioned reflex to the time of taking food. Normally (with
reinforcement of conditioned stimuli) supraliminal in-
hibition does not arise, for these processes are inhibited
by the act of eating [1, 7, 9, and others]. The facts that
we have obtained may thus be explained as follows. The
action of a weak conditioned stimulus causes a less in-
tensive excitation than a conditioned stimulus of medium
intensity. After extinction of the weak stimulus the
level of excitation may rise before the limit of functional
capacity of the cortical cells is reached. This was shown
in our experiments by the sharp rise in the curve of
secretion of saliva in the first phase after extinction of
the conditioned reflex to light.

The presence of "reserves of functional capacity"
leads to the fact that a weaker supraliminal inhibition
develops than after extinction of the conditioned reflexes
to stimuli of medium intensity; in the latter case a fairly
intensive process of excitation develops, which rapidly
reaches its limit after extinction of the conditioned
stimulus. Firstly, this prevents a significant increase in
the secretion of saliva in the first phase, and secondly,
it causes a more marked supraliminal inhibition. On
extinction of the reflex in response to an excessively
strong stimulus, the conditioned reflex itself (before its
extinction) shows a fairly intensive supraliminal inhibit-
ion, which is still further intensified during extinction at
the moment of reinforcement. As a result of this, an
overstraining of the supraliminal inhibition takes place,
which is expressed predominance of the process of excit-
ation in the second and third phases and by irradiation of
the excitation to the motor area of the cerebral cortex.

An analogous phenomenon during overstraining of
supraliminal inhibition in the case of a considerable in-
crease in the intensity of the differential stimulus was
observed by Z.V. Troshikhina [10], Mei Chên-T'ung [5]
and N.N. Kudryavtseva [3]. Consequently, overstraining
of supraliminal inhibition during the extinction of a
conditioned reflex to an excessively strong stimulus (in
the second phase of extinction) causes a disturbance
(weakening) of the internal inhibition produced (third
phase of extinction). The prolongation of the phase of
residual secretion of saliva during the action of the
metronome, observed after extinction of the excessively
strong tone, may be attributed to a temporary weakening
of the inhibition caused by overstraining of the nervous
processes during extinction of the excessively strong
stimulus.

SUMMARY

Interaction between extinctive and supraliminal
inhibition was studied on dogs by the method of con-
ditioned salivary reflexes. In extinction of a conditioned
reflex to an excessively strong stimulus, there occurs an
overstraining of the subliminal inhibition, the sequence
of which is: predominance of excitation; disinhibition of
the extinction process; and irradiation of excitation to
the motor area of the cerebral cortex. The conditioned
reflexes in response to stimuli of different strength are
arranged by the rate of extinction in the following order:
Conditioned reflexes to stimuli of moderate strength are
the first to be extinguished; the next are those in response
to weak conditioned stimuli, and the last, to excessively
strong stimuli. Extinction of conditioned reflexes (Phase
1-the rise of the curve of salivary secretion) was most
pronounced in extinction of the reflex to the weak stim-
ulus (light), less pronounced in extinction of the reflex to
the moderately strong stimuli (metronome, buzzer, 50-db
tone), and very weak or even absent in extinction of the
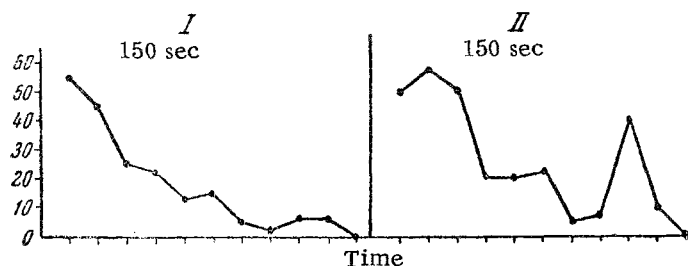reflex to the excessively strong stimulus (122-db tone).

Fig. 3. Sharp continuous extinction of the conditioned reflex
to an excessively loud tone (122 db). I) Experiment 732 (January
21, 1959); II) experiment 738 (January 29, 1959). Legend other-
wise as in Fig. 1.

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