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RESULT OF CONTROLLED IMAGINATION

Numerous investigations have shown that hypnotic suggestion of a given age or state, as well as suggested perceptual changes, can induce changes in conditioned and even in unconditioned reflexes to accord with the suggested circumstances (Dolin [4], Korotkin and Suslova [5], Levin [7], Maiorov and Suslova [8], Pavlov and Povorinskii [10], Platonov [11], Povorinskii and Traugott [12], Barber [16], and many others). The physiological mechanism of that suggestion consists, as we know (Pavlov [9]), of the fact that verbal suggestion during hypnosis induces a concentrated focus of excitation in the brain with negative induction in other cortical regions promoting dissociation of the focus from other functional systems. One must assume that the same physiological mechanism underlies suggestion and autosuggestion in the waking state as well

We thought it would be of interest to investigate whether it is possible — and if so, to what degree

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— for a voluntarily imagined age or condition suggested to an individual while awake (differing from his own age and condition at the given moment) to change his higher nervous activity in the waking state during normal integrative cerebral activity. Such imaginings are usually more vivid in persons of the artistic type and would seem to be the basis for what is termed assumption of a new personality in actors. Therefore three professional actors and a number of active amateurs, i.e., persons better able to assume the desired condition, were employed in this research. An individual of the intellectual [myslitel'nyi] type was employed as control.

Naturally, it was not our intention to provide an analysis of the actor's creative process, nor can this be the concern of a physiologist. Our goal was to employ the capacities of artistic individuals to assume a new personality so as to shed light upon certain of the physiological mechanisms of the higher nervous activity underlying such voluntary personality change. These mechanisms appeared to us to be similar to those we discovered in investigation of post-

hypnotic suggestion (Korotkin and Suslova [5]). P. V. Simonov (13) also noted similarities between hypnosis and the state of theatrical emotion. In any case, we have grounds for assuming that they share the same physiological mechanism, inasmuch as theatrical personality change is indubitably associated with autosuggestion. That the physiological mechanism of suggestion in hypnosis and of autosuggestion is the same is also indicated by the data of Gershuni et al. (3) resulting from suggestion in hypnosis, and that of Anand et al. (15) in self-contemplation by yogas. (In both cases, it was found that external stimuli ceased to affect ongoing functions.)

We also regarded it as important to determine how reflexes induced to various degrees by the second signal system change under the influence of voluntary imaginings. Therefore we utilized the eyeblink response and motor reflexes (squeezing a rubber bulb with the right hand) and the respiratory component of conditioned and unconditioned reactions.

The subjects were between 32 and 55 years of age, and ten in number.

To begin with, stable conditioned reflexes to the identical conditioned stimulus were employed: the eyeblink reflex on the basis of unconditioned reinforcement, and motor reflexes primarily to verbal instruction. The conditioned stimuli were: a bell, a buzzer, a tone, and light.

After his reflexes were tested in his normal state of being, the subject was asked to imagine himself as older, then as younger, and then fatigued or in high spirits at either his actual or at a given age. Judging by verbal responses, the subjects, when asked to imagine an age other than their actual ages, centered their thoughts on the actual appearance and condition of some individual known to them.

Results

Identical results were found in all subjects except the control. Therefore only the most typical cases are cited.

After her reflexes were tested in the normal condition, subject V. was asked to imagine herself an old lady (she centered her thoughts on

her 72-year-old mother, sometimes in her normal condition and sometimes as fatigued) or as herself when fatigued. In every case without exception, her conditioned reflexes were markedly inhibited. Her unconditioned eyeblink response was also usually inhibited, but to a smaller degree. Inhibition manifested itself most strongly in the motor reflexes. This is clearly evident from the kymogram (Fig. 1A) for the case in which the subject imagined herself an old woman. After "switching" to her usual condition, positive induction was recorded both to motor and to conditioned and unconditioned eyeblink responses.

Subject K. was asked to imagine himself at one time as older than his actual age, and at another time as younger. As indicated by Fig. 1B, his conditioned reflexes became more pronounced (in this case, too, motor responses showed the highest rise), as did his unconditioned responses, in part. But imagining himself an old man led to considerable inhibition both of the conditioned and the unconditioned reflexes. When he "switched" from the old to the youthful image, positive induction was again observable, and it was more pronounced in the motor responses.

Inhibition of reflexes was also seen in a case in which the subject conceived of himself as "fatigued" but at his actual age. This is evident from the example of subject S. (Fig. 1C), who displayed marked inhibition of motor and eyeblink responses, as well as of unconditioned responses, the former being the more pronounced. Analogous results were obtained in the other subjects.

Thus, as in autosuggestion of high spirits, imaginary transfer to a younger age increases conditioned reflexes, i.e., elevates cortical tonus. However, imaginary transference to greater age or to a state of fatigue results in inhibition, sometimes very pronounced, of the motor and eyeblink responses, conditioned and even unconditioned. Upon progression in imagination from "age" or "fatigue" to the normal condition, one sometimes observes positive induction, but often, on the other hand, a clearly defined regular inhibition manifested in gradual return of reflexes to their normal levels.
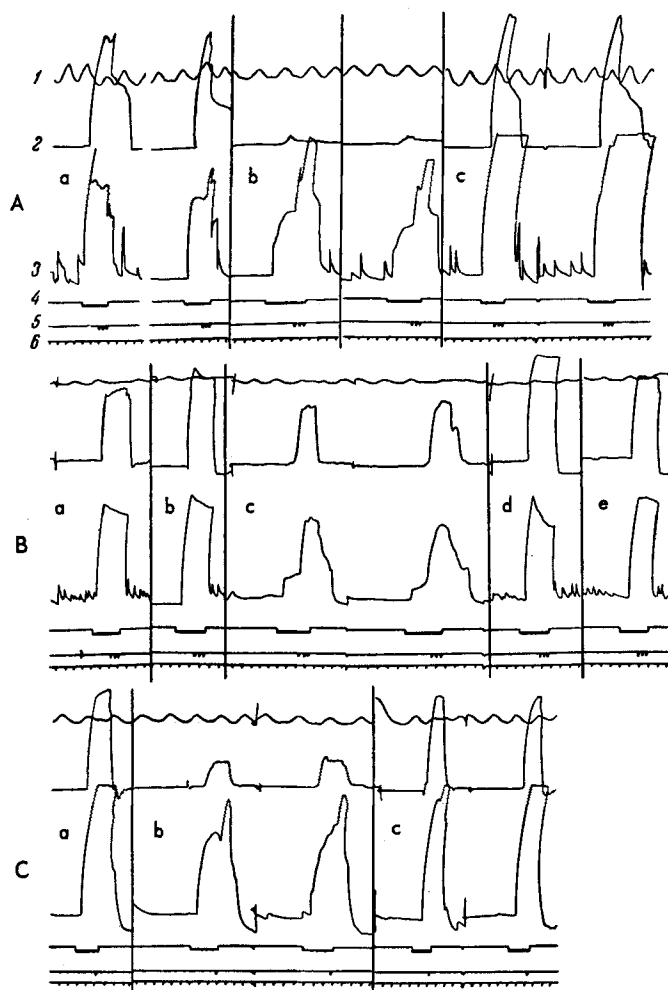
Fig. 1. Inhibition of eyeblink and motor responses upon imagined assumption of old age, and a condition of fatigue. Increase in responses upon imagined assumption of younger age. A — subject V., Expt. 8: a — at real age, b — "old age," c — real age, B — subject K., Expt. 19: a — at real age, b — at "younger" age, c — as "old man," d – as "young man," e – at real age; C — subject S., Expt. 1: a — condition of high spirits; b — "fatigue," c — high spirits. 1 — respiration; 2 — squeezing bulb; 3 — eyeblink reflex; 4 — record of conditioned stimuli; 5 — record of unconditioned stimulus; 6 — time, seconds.

Diminution in the general tonus of the cerebral cortex is manifested in weakening both of the stimulatory and the inhibitory processes. Decline in internal inhibition is particularly noticeable in its more complex forms. This is confirmed by investigation of the delayed conditioned responses and of continuous extinction.

Subject V. developed a delayed conditioned response to light in which reinforcement lagged ten seconds from the start of operation of the conditioned stimulus. After the response had become stable, the latency period was found to be 6 to 7 seconds for the motor response, and 7 to 8.5 seconds for the eyeblink (Fig. 2Aa). When the subject was imagining herself an old lady, the character of the reflexes changed: there was a pronounced decline in the conditioned (and even unconditioned) eyeblink response, and even more in the motor responses (Fig. 2Ab). The weakening of inhibition is clearly evident in the disinhibition of the inhibitory phase of the delayed response. The latency period of the motor response is shortened to three seconds, while that of the eyeblink response actually declined to 0.2 second. The latency period of the delayed conditioned reflexes continues to remain brief for some period after the subject has been "switched" to his normal condition. A reduction in the responses and disinhibition of the inhibitory phase of the delayed response was also obtained in subjects P. and K., but in them these changes were somewhat reduced.

The weakening of inhibition upon assumption of the status of age or fatigue was also seen in continuous extinction of the conditioned reflex. Thus, in subject C. there was an extinction of the conditioned bell response when the action of the unreinforced stimulus was increased to ten seconds (Fig. 2B). Whereas in the normal condition the motor conditioned reflex is extinguished after the lapse of 3.5 to 4 seconds, and the eyeblink response after 5 to 6 seconds (Fig. 2Ba), upon imagined conversion into an old woman, both the motor and the eyeblink responses diminish sharply (particularly the former), and extinction occurs after 12 seconds, i.e., within 2 seconds after the conditioned stimulus stops operating (Fig. 2Bb). Even after that, frequent weak eyeblinks and barely noticeable squeezing of the bulb continue for a period. The same occurred with the other subjects. For example, in subject
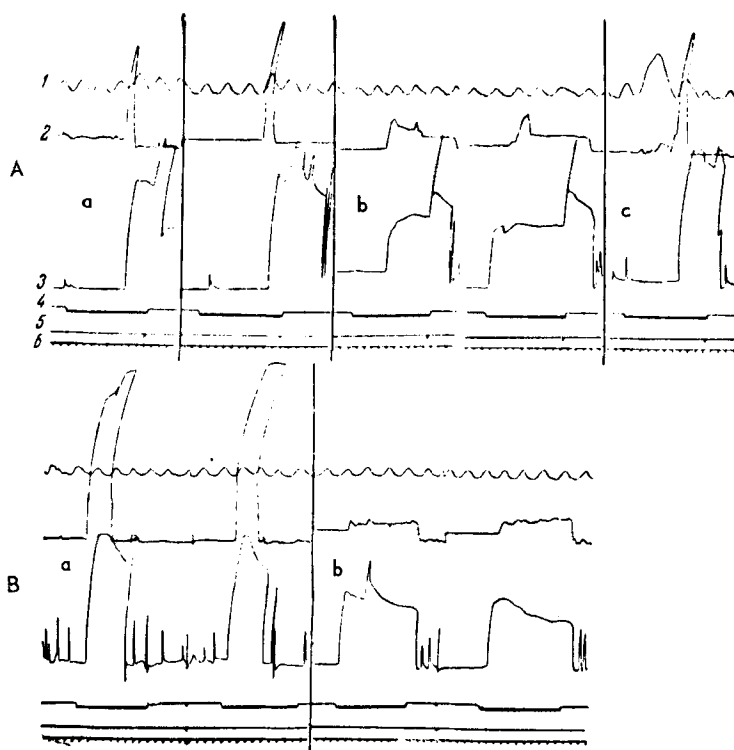
Fig. 2. Disruption of processes of internal inhibition upon imaginary change to old age. Subject V.: A — Expt. No. 10, which delayed the reflexes as follows: a — real age, b — "old age," c — real age; B — Expt. No. 14, continuous extinction: a — real age, b — "old age." Key same as of Fig. 1.

St., when in his normal condition, extinction of the motor reflex set in within 6 seconds and that of the eyeblink response within 5.5 seconds, but when he imagined himself a feeble old man, extinction took 9 and 20 seconds, respectively. In subject L., both reflexes were extinguished within 5, 3.8, and 4.5 seconds in her normal condition, and in 8, 7, and 6.2 seconds when she was in a state of "fatigue."

All this is evidence of weakening of cortical inhibition when subjects are transferred in imagination to a state of old age or of fatigue.

The respiratory response also provides evidence of diminution in general nervous system tonus and its responsiveness under these conditions. Whereas in the normal condition there is a change in amplitude and rate of respiration (most often delay in respiration, sometimes intensification in it) in response to conditioned and

unconditioned stimuli, these stimuli do not affect respiration in the condition of "old age" or "fatigue" (Fig. 1A, C; Fig. 2A, B). This is apparently a consequence of diminution in cortico-subcortical tonus in the given conditions.

External inhibition is also more pronounced in the condition of "age" than in the normal condition. Testing of the influence of additional stimuli other than those listed at the outset indicated that in certain subjects they inhibit conditioned reflexes in the normal condition, while in the condition of "old age," on the other hand, they disinhibit inhibited reflexes, which also confirms the existence of cortical inhibition in this state. We observed identical disinhibition when external inhibition arose on the part of the second signal system. For example, in the condition of "old age," subject C. was distracted by wayward thoughts, and the inhibited conditioned reflex was disinhibited. It is interesting that the subject herself noticed the change in her condition: "I was distracted a little, and perhaps was more nearly myself" (i.e., in the normal state).

Second signal system regulation of cortical tonus through assumed personality change proved to be quite delicate. Inhibition of reflexes in "old age" varied: it was more profound if subjects assumed the personality of a weak or tired old lady and less profound if the "old lady" was in a normal condition. The state of "fatigue" of the subjects at their actual ages occupied a midway position between the normal condition and "old age." This is evident from the diagrams in Figure 3, which show average levels of motor reflexes and the latency periods of motor and, in certain cases, of eyeblink responses, in particular experiments. (The difference in the magnitude both of the reflexes and of their latency periods in various conditions is so great that detailed statistical analysis was unnecessary.)

These data demonstrate that assumption of a state of old age or fatigue diminishes
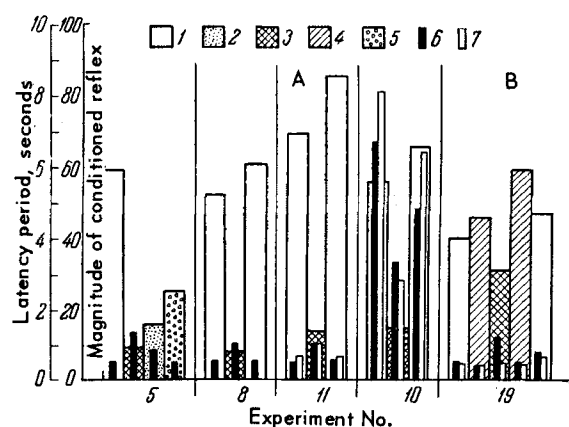
Fig. 3. Mean levels of conditioned responses and their latency periods upon assumption of various ages or conditions. A — subject V.; B — subject K. 1 — at real age, 2 — "old age," 3 — "weakness" in "old age," 4 — "fatigue" at actual age, 5 — "younger" age, 6 — latency period of motor response, 7 — latency period of eyeblink response.

cerebrocortical tonus and weakens cortical inhibition. This is expressed in diminution in the magnitude of conditioned and, in part, of unconditioned reflexes, and in extension of their latency periods. There is a weakening of active inhibition, as is evident from the disinhibition of the inhibitory phase of the delayed response (shortening of the latency period) accompanied by simultaneous diminution of the reflexes and extension of the time required for them to be extinguished, once again with simultaneous reduction in level. The degree of these changes corresponds to the condition into which the subject has transfigured himself. Here it is necessary to remark that the nature of the changes in motor and eyeblink responses was not reflected in the second signal system, and the subjects were not aware of it. They centered all their attention upon retaining the given image or condition. And this was not easy for all of them. Thus, one of the subjects asked to have the given condition "suggested" to her after each stimulus, inasmuch as her condition changed.

All this may be seen in persons in whom traits of the artistic type — allowing for the assumption of a personality state different from their actual

condition — predominate.

As has already been noted, a representative of the intellectual type, i.e., a person with relative predominance of the second signal system, was employed as control.

Subject B. successively imagined himself an old man in ordinary condition, a weak old man, a young person, an active young person and, finally, in his usual condition. We adduce a segment of the kymogram of one experiment (Fig. 4). No matter how conscientiously he tried to take on these various conditions (and he was convinced that he had succeeded), his conditioned and unconditioned responses did not change, nor did the latency periods. Apparently, in subject B. the effort to imagine himself in various conditions was limited by the activity of the second signal system which, in the given instance, was incapable of appropriately changing the established system of first signal responses.
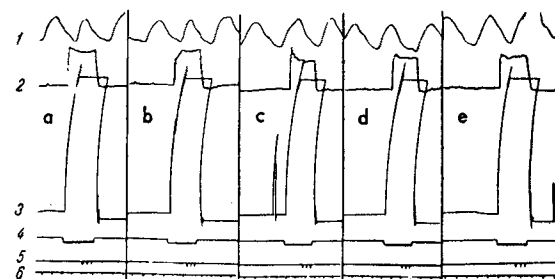

Fig. 4. Absence of change in reflexes when person of intellectual type sought to imagine himself as being of different ages and conditions. Subject B., Expt. 9: a — normal, b — "old man," c — "weak old man," d — "young man," e — "active young man." Key same as in Fig. 1.

Discussion

Here, naturally, we approach the problem of the physiological mechanisms of the phenomena described. The matter at issue is second signal system regulation of cortico-subcortical tonus reflected in what are usually unrecognized changes in the first signal system responses of the organism. The experimentally developed conditioned reflex activity of each subject

reflects the typological features and functional state of his nervous system at the given moment. Upon assumption of a given image or condition the subject, repelling the second signal system stimulus (the task), must temporarily switch over to a dominant condition new for him, on the basis of traces of previous experiences, his own or someone else's, derived from observations of the behavior of the people in his environment and of literary descriptions. In actuality this is a switch-over to a new dynamic stereotype, and it cannot be complete, because two stereotypes always coexist: that established by life (the subject's ego), and that which he is assigned to imagine. Here we observe the same thing that happens when an actor assumes a new personality. P. V. Simonov (13) has correctly noted that when this happens "surrounding reality acquires a dual character: that of life itself and that of the stage," i.e., two stereotypes coexist. And this is an important condition for second signal system monitoring of performance of a role.

It must be stated that in our case this switching to a new stereotype apparently presents problems not present in an actor's assumption of a different personality. For here, seated in an armchair, the subject lacks the external conditions, the second signal system and first signal system stimuli emitted by the stage environment, which make it easier for the new, assigned stereotype to dominate.

Therefore, switching to a new stereotype, particularly in our experimental conditions, cannot be as complete as desired, and the degree of change in the responses in accordance with the given image is actually a reflection of a state halfway between the real and the assigned. This was also observed by M. M. Suslova (14) upon bringing persons of various ages into the hypnotic state by suggestion. For example, when it was suggested to an adult that he was a child in age, the nature of his handwriting and drawings did not entirely correspond to those of the age group suggested, but had characteristics corresponding to the subject's real age.

The degree to which one assumes a given image would seem to depend upon the individual characteristics of the individual under study,

and particularly upon the degree to which traces of past experience, especially first signal system impressions, are vitalized by second signal system stimulation. The brighter and richer they are, the greater the degree to which the new functional condition induced by the given image predominates over the real one, the greater the changes will be in higher nervous activity.

The struggle among stereotypes is also confirmed by their inertness, expressed in the fact that change in the level of reflexes and their latency periods upon changeover from a real condition to an assigned one, and back again, often occurs gradually.

Summary

Thus, an assumption of the personality of old age or of a state of fatigue or weakness, induced through the second signal system, leads to a substantial reduction in the cortical tonus, which spreads to the subjacent nerve structures. As a consequence there is a sharp inhibition of conditioned and, in part, of unconditioned reflexes. Moreover, active cortical inhibition suffers particularly, and external inhibition is more pronounced. Upon "return" from this state of "inhibition" to the customary, real age or condition, one observes steady inhibition and, in some cases, positive induction. This confirms the presence of cortical inhibition in an arbitrarily induced condition of age or fatigue. If the subject regards himself as being of a younger age or in a more vigorous situation than usual, this will induce a certain increase in the reflexes.

The degree of these changes depends on the individual, and they are characteristic of persons in whom traits of the artistic type dominate. These are individuals who are able, through the second signal system, to arouse traces of prior experience and to create a first signal image (concept) corresponding to the assignment they were given. It proved impossible to find changes in reflex responses in a subject of predominantly intellectual character, despite second signal system assumption of the desired image.

Thus, in persons with the characteristics of

the artistic type predominating, the assigned
image may create, in the waking state and under
second signal system control, a cortico-subcorti-
cal dominant modifying higher nervous activity
in a manner according with the image called
forth. This correspondence is not absolute but
relative, inasmuch as a dominant created through
the second signal system coexists with the condi-
tion actually dominant in the subject.

Judging by the verbal reports of the subjects,
they are usually not aware of the changed re-
sponses we observed.

These changes are systematic in nature and
are based upon the physiological mechanism of
switch-over (Asratian [2]) to a new dynamic
stereotype arising, as in post-hypnotic sugges-
tion, as a consequence of the arousal of traces
of past experience associated with the given
image and modifying cortico-subcortical tonus
accordingly.

When we compare eyeblink and motor responses
upon assumption of a given new personality, it is
necessary to take note of the fact that the latter
change to a more pronounced degree. This cor-
responds with the data of N. Iu. Alekseenko, (1)
who has noted the dominant role of motor reflexes
developed in combination with the eyeblink re-
sponse, in response to a single stimulus. This
would seem to be related to the specific function
of the hand and to a higher degree of second sig-
nal system regulation of motor responses by the
hand than of eyeblink responses, and to the
greater significance of motor activity in panto-
mime, in "expressive" human behavior, and in
the expressiveness of the "external picture" of
the image.

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Footnotes

1) Alekseenko, N. Iu., Zh. vyssh. nervn. deiat.,
8, 322, 1958.

2) Asratian, E. A., Fiziol. zh. SSSR, 30, 13,
1941.

3) Gershuni, G. V., Kniazeva, A. A., and
Fedorov, L. N., Fiziol. zh. SSSR, 32, 557, 1946.

4) Dolin, A. O., Arkhiv biol. nauk, B, 36, 25,
1934.

5) Korotkin, I. I., and Suslova, M. M., Zh.
vyssh. nervn. deiat., 5, 697, 1955, No. 5.

6) Korotkin, I. I., and Suslova, M. M., Tr. In-
ta fiziol. AN SSSR, 5, 267, 1956.

7) Levin, S. L., Zh. nevropatol. i psikhiatrii,
53, 847, 1958.

8) Mairov, F. P., and Suslova, M. M., Tr. In-
ta fiziol. AN SSSR, 2, 290, 1952.

9) Pavlov, I. P., Polnoe sobranie trudov, 4,
337, 1947.

10) Pavlov, B. V., and Povorinskii, Iu. A.,
Zh. vyssh. nervn. deiat., 3, 381, 1953.

11) Platonov, K. I., Slovo kak fiziologicheskii
i lechebnyi faktor, 3rd ed., Medgiz, 1962.

12) Povorinskii, Iu. A., and Traugott, N. N.,
Arkhiv. biol. nauk, 44, 5, 1936, No. 2.

13) Simonov, P. V., Metod K. S. Stanislavskogo
i fiziologiia emotsii, Moscow, 1962.

14) Suslova, M. M., Tr. In-ta fiziol. An SSSR,
7, 251, 1938.

15) Anand, B. K., Chhina, G. S., and Singh, B.,
EEG and Clin. Neurophysiol., 13, 452, 1961.

16) Barber, T. X., Psychosom. Med., 24, 286,
1962.

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