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J. Konorski and S. Miller (1937)

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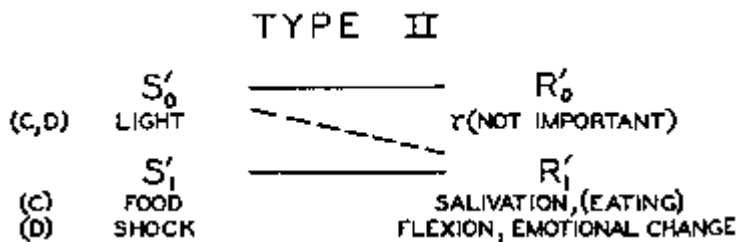
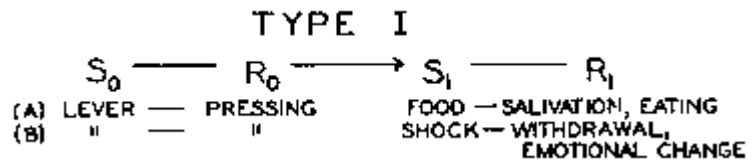
ON TWO TYPES OF CONDITIONED REFLEX[1]

J. Konorski and S. Miller (1937)

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Skinner's paper on two types of conditioned reflex (15) is of considerable interest as an attempt to introduce [sic] more clarity and precision than has been formerly done into that old and often discussed topic of conditioned reflex. In his paper, which is based on his former experimental findings (10, 11, 12, 13) and on certain theoretical considerations of his own concerning general nature of the reflex (9, 14), Skinner gives two following paradigms [in which S = stimulus, R = response, (S - R) = reflex ----- = is followed by].

Given such a sequence, conditioning occurs as a change in strength of (S₀ - R₀): an increase in (A) and a decrease in (B).



It is quite obvious that while Type II corresponds to the ordinary Pavlovian conditioned reflex, Type I (and the appropriate "pseudo-type") represents a phenomenon of habit formation by the method of "prize and punishment." The problem of the

relation between the two the author solves in the following way. Though habit can be classified as a conditioned reflex, it is of a different type from the classical one, and it is hardly possible [p.265] to reduce the two to one type - too many important differences separate them.

The expressing of habit formation as a distinct form of conditioned reflex is, naturally, of prime importance, so much more in view of a frequent tendency to state in merely general terms the identification of habits with conditioned reflexes, or to proclaim such an identification as a program. The drawing up of an exact fundamental pattern lays a foundation for future research and makes it possible to investigate habits according to their basic properties. It constitutes a procedure similar to the methods employed by the school of Pavlov. It is, therefore, most important that this first step in the investigation of habits (or of similar phenomena) be conducted correctly. If the structural analysis of facts under examination contain some error, further researches may be conducted in an altogether wrong way.

In our opinion, Skinner's main lines of analysis are correct. He rightly discriminates two types

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of conditioned reflex - his Type I against the classical Pavlovian type - and stresses the absence of the signaling function in the former. Nevertheless, the very construction of his Type I is built up in a faulty manner and is not in agreement with the present state of experimental facts.

As we have since 1928 been conducting physiological investigations of the phenomena which in psychology are known as habits, we would desire to make on the basis of our findings a critical examination of some of Skinner's statements.

To begin with, a little remark on terminology for the sake of avoiding confusion of terms. In our first paper published in 1928 (8) we made a discrimination between the ordinary conditioned reflex and a new type of reflex, which, by all appearances, corresponds to Skinner's Type I. That new type we have named "the conditioned reflex Type II," since in relation to the classical Pavlovian conditioned reflex it presents a next form of conditioning. We have demonstrated that this reflex, Type II, is based on a different cortical mechanism from that of the ordinary reflex, and that its mechanism cannot be reduced to one of the Pavlovian conditioned reflex, Type I, although it implies the functioning of such. In the paper referred to, we expressed a supposition that other new cortical mechanisms might possibly be discovered in the future and that they would represent further types of conditioned reflex. Accordingly, it would seem to be desirable to change the numeration of types given by Skinner and to call the classical Pavlovian conditioned reflex the reflex Type I, and the new one, the reflex Type II, all the more so, as Skinner himself used such a numeration in one of his former papers (11).

Let us now pass to the merit of the case. Skinner builds up a new type of reflex - chiefly making use of his own experimental material - in the following way. An animal has a reflex, $S_o - R_o$, e.g., an "investigatory [p.266] reflex" of pressing a lever upon seeing it. When this reflex is reinforced by food, its strength increases, and, when it is reinforced by a stimulus eliciting a defensive response, e.g., an electrical shock, its strength diminishes. Such a strengthened or weakened reflex constitutes the very new type of conditioned reflex. In addition to that, Skinner introduces a special form of this reflex, the one of "pseudo-conditioned reflex," in which the reaction of pressing a lever is associated with some indifferent external stimulus, e.g., light. The formation of "pseudo-conditioned reflex" is, according to Skinner, based on differentiation - the animal at first responds exclusively to the lever, but later, as the combination, "lever + light," is continually reinforced by food, while the lever alone is not reinforced, the animal learns to press the lever solely, or nearly so, when the light is present.

As we see, the main point in Skinner's conception is that the new type of conditioned reflex is formed from an already existing reflex, the strengthening, *resp.* weakening of the connection being the only acquisition. This property is to discriminate the new type from the old one, since the latter begins "at zero" and ends in an entirely new connection. To be consistent in application of this discriminative property, Skinner attempts to explain a special case, his "pseudo-type" where this property seems to be absent. This is the case when the animal learns to react to a stimulus (light) formerly having no connection with the given response. According to Skinner, the "true" stimulus in the "pseudo-type" which elicits a reaction of pressing the lever is not light but the sight of the lever. Light is supposed to serve here only as a factor determining *when* the reflex "lever - pressing" gains in strength. Skinner says, "the response is not principally to the light, but to the lever; the light is only a component member of the whole stimulus, and 'light - pressing' is not legitimately the expression of the reflex."

To bring out the fallacy in Skinner's way of conceiving the structure of the new type of conditioned reflex, let us consider the following experiment. As a primary reflex $S_o - R_o$, let us choose, instead of an investigatory reflex used by Skinner, a more distinct one - the raising of a leg in a dog under weak electrical shock. A dog is kept in a stand in an experimental camera, and every display of reflex $S_o - R_o$ is reinforced by food. Falling in line with Skinner, we should expect as a result of reinforcement an increase of strength in reflex $S_o - R_o$ (electrical shock - raising a leg). But what actually happens is that after a few reinforcements the animal starts to raise its leg independently of electrical shock - as soon as it finds itself in the given

experimental situation (2, 4). If, following Skinner, we denote the stimulus value of the experimental situation by S_G , the above result will indicate the establishment of a *new* reflex, $S_G - R_o$.

How should Skinner classify this reflex?

He could not identify it as his true reflex of the new type, since there is no increase of strength in the primary reflex $S_o - R_o$. Neither could he recog-[p. 267] nize it as his "pseudo-reflex," since it is not established through differentiation. In fact, the stimulus S_G is here not merely a determining factor for the elicitation of R_o by S_o , but the very stimulus eliciting R_o .

To consider further possibilities of reinforcement we could proceed, after the reflex $S_G - R_o$ is just started, in two different ways: (1) to reinforce every movement of raising a leg displayed in situation S_G , or (2), following strictly Skinner's paradigm, to reinforce only those movements of raising a leg which follow the application of electrical shock. In the first case, the animal would learn to raise its leg with maximal possible frequency, and the electrical shock would become wholly superfluous. The new reflex, $S_G - R_o$, would then be fixed. In the second case, contrary to Skinner's assumption, the strength of the response R_o to the stimulus S_o would not increase, but diminish. The reason for this is that the electrical shock under continual reinforcement soon becomes a conditioned stimulus for food reaction, and, in consequence, its unconditioned defensive reaction, according to the law of negative induction, becomes inhibited. [This matter had been treated in detail in the well-known old experiments of Erofeeva (1)]. Of course, the movements of the leg, which at first started to appear in response to the stimulus S_G , would be extinguished as unreinforced.

As we see, the mechanism of the new type of conditioned reflex is quite different from what Skinner thinks. The primary reflex, $S_o - R_o$, does not grow in strength, but subsides. In the new type, the stimulus, S_o , is replaced by a new stimulus, S_G . This amounts to saying that an entirely new reflex, $S_G - R_o$, is established.

What could have caused Skinner's erroneous interpretation, which at first glance seemed to fit facts so easily? The error, it seems, is due to his fundamental experiments' not being quite happily chosen. The lever in his experiments plays a double role. On one hand, it is S_o , as far as it elicits an investigatory response R_o (pressing). On the other hand, it is also a prominent component of the whole experimental situation, S_G . Since the true mechanism of the new type of conditioned reflex consists, as we have shown, in the replacement of S_o by S_G , this substitution in Skinner's experiments could not have been noticed, since S_o and S_G were represented by the same object. The only effect he could have recorded was an increase in frequency of pressing the lever, a fact which he erroneously attributed to the increase in strength of the investigatory reflex. The mere fact of increase in frequency is quite natural if we remember that any investigatory reflex, on account of its general property to become easily extinguished, is normally displayed rather rarely, while the new reflex, $S_G - R_o$, if reinforced by food, shows continued existence.

It is to be pointed out that the stimulus, S_o , plays only a subsidiary role in the formation of a conditioned reflex of the new type. It serves only to bring about the response, R_o , and once the connection, $S_G - R_o$, is estab-[p.268] lished, it loses any further experimental significance. What is more, the movement, R_o , may be brought about not necessarily by way of reaction to some stimulus, but simply by mechanical means, as a passive movement, e.g. when the experimenter lifts a dog's leg (2).

It would be of interest to mention here one of our experiments analogous to those of Skinner (4). In that experiment the passive striking with a dog's leg at a lever has been used as a movement, R_o . The dog in relation to the lever displayed none of the investigatory reflexes and never would have come to the point of striking the lever, had not this been artificially brought about. After reinforcing this passive movement by food, we brought it about that the dog started to strike the lever by himself. There the lever acted exclusively as a prominent part of the stimulus, S_G . The stimulus, S_o , was entirely lacking, since the movement, R_o , was passive.

It is not our task to present here the full mechanism of the formation of conditioned reflexes of the new type. This matter has been discussed by us elsewhere (4,7). We shall confine ourselves only to those points which pertain to the explanation of the phenomena taking place in Skinner's experiment.

When, in a given experimental situation, S_G , the movement, R_o - brought about by one of the following ways: as a response to electrical shock, as an investigatory response, or as a passive movement - is reinforced by food, the first thing to happen is the establishment of a conditioned food reflex to the whole complex of stimuli entering into S_G . If, after Skinner, we denote food by S_1 and the unconditioned food reaction by R_1 , the resulting reflex will be $S_G - R_1$, the so-called "situational conditioned reflex," so well known in Pavlov's laboratories. This phase of conditioning however, is transitory. The reflex, $S_G - R_1$ cannot be fixed, since S_G is followed by food only when combined with R_o . As a result, differentiation sets in, and S_G , when without R_o , becomes inhibited. The conditioned food stimulus that remains is the complex $S_G + R_o$, i.e., the movement, R_o (more correctly - the kinaesthetic stimuli aroused by that movement), at the background of the experimental situation, S_G . [2]

Thus, in the second phase of conditioning a double effect is achieved. On one hand, a conditioned food reflex is built up which has for its stimulus [p.269] a complex of kinaesthetic excitations raised by the movement, R_o ; this is $R_o - R_1$. On the other hand, the experimental situation, S_G , has become an inhibitory stimulus for food reaction giving rise to an inhibitory reflex, $S_G - (-R_1)$.

The facts rest so far wholly on the laws of Pavlovian conditioned reflexes. But, as our experiments have brought out, in this second phase of conditioning a certain new phenomenon occurs which is not considered by the Pavlovian laws. The specific stimulus eliciting the movement R_o becomes superfluous, for the animal starts to respond to the experimental situation, S_G , by the movement, R_o . In other words, a conditioned reflex of a *new type* makes its appearance. Its fixation and continued existence depends on food reinforcement. When it has ceased to be reinforced by food, it is extinguished simultaneously with the extinction of the conditioned food reflex, $R_o - R_1$. It can also be differentiated, Skinner's "pseudo-type" being then obtained.

As it could be seen, this new type of reflex arises under the following conditions.

1. The movement which constitutes its effect if a conditioned food stimulus.
2. The stimulus for that movement is an inhibitory food stimulus in a certain phase of inhibition.

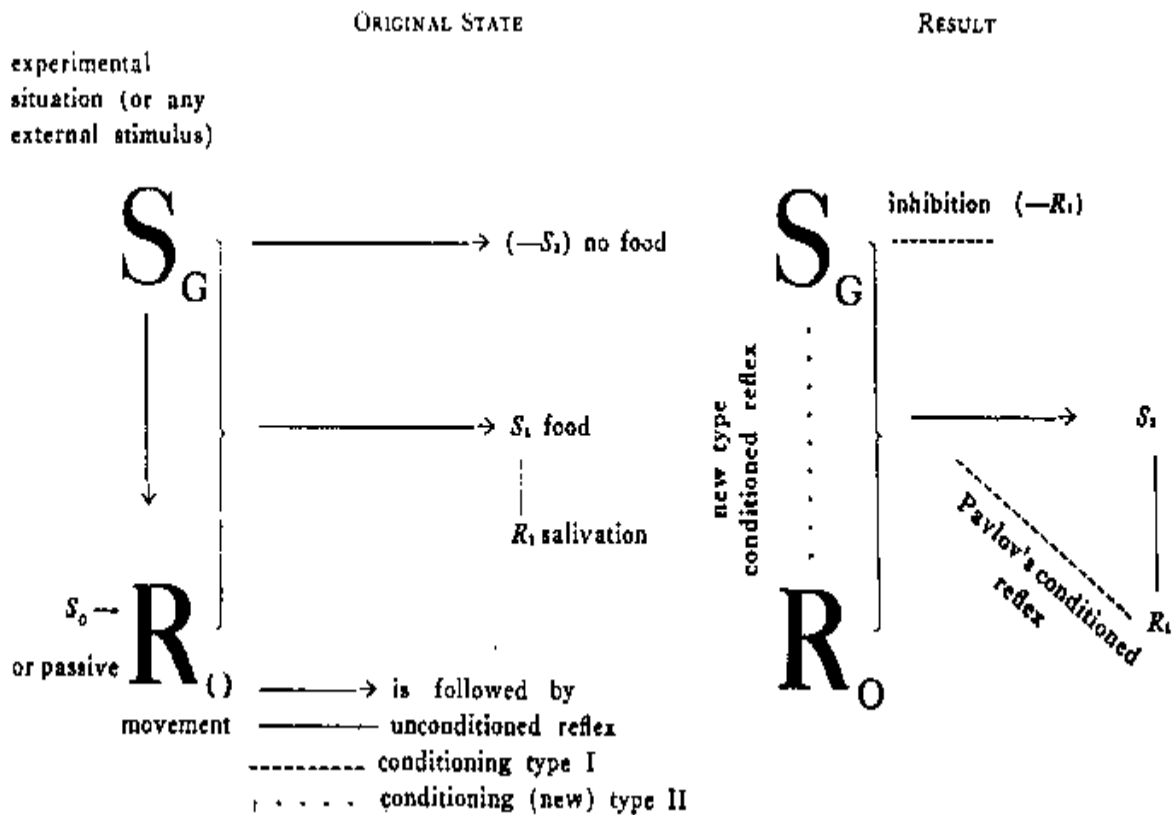
The universality of these conditions has been demonstrated by us in various experiments (3, 4, 5, 7).

The paradigm on page 270 presents the structure of this reflex.

Coming back to Skinner's experiments, we can easily see that their results fall in line with our explanation. By virtue of food reinforcement, the experimental situation becomes to a rat a

conditioned stimulus for food reaction. Be it continually reinforced - independently of pressing the lever - it should remain a conditioned food stimulus, and no conditioned reflex of the new type could ever be built on it. Since, however, by not giving food, save when the movement appears, Skinner makes out of it an inhibitory stimulus, and, on the other hand, by constant reinforcing pressing movement, he makes out of it a conditioned food stimulus - both conditions stated by us are fulfilled, and a conditioned reflex of the new type is established: the animal, as soon as it finds itself in the experimental situation, starts to perform the movement of lever pressing as long as this movement is reinforced. When the reinforcement is discontinued, the reflex $S_G - R_0$ does not return, as Skinner guesses (12), to its former state of an investigatory reflex, but becomes extinguished, i.e., *actively inhibited*.

Skinner's interpretation of the second (B) group of conditioned reflexes of the new type (see paradigm I) is also incorrect. This group embraces those reflexes which are formed under negative reinforcement, e.g., by application of electrical shock instead of giving food. According to him, the [p.270]



[p.271] strength of such reflexes decreases. When faced with actual facts, one can see that there is something more to it (4). We have shown that under negative reinforcement the movement, R_0 , as a response, is transformed into an antagonistic movement, $-R_0$, while the same movement, R_0 , as a stimulus, becomes a conditioned stimulus for a defensive reflex, $S_1 - R_1$. The whole process may be described thus: The animal inhibits the movement, R_0 , which signals to him an obnoxious stimulus, and makes instead a preventive, antagonistic movement, $-R_0$. This shows that negative reinforcement has a more complex effect than a mere decrease of strength in reflex, $S_0 - R_0$. It leads to the formation of a new, antagonistic reflex.

Let us point out one more detail overlooked by Skinner. Speaking of reaction, R_0 , we used an expression, "the movement R_0 ," instead of "the response R_0 ." We did it for the following reason. According to the existing state of knowledge - and we dispose of no facts to the contrary - the conditioned reflex of the new type (our Type II) is confined exclusively to striped

muscles, while the classical type has no restrictions laid on effectors and includes among them, besides striped muscles, smooth muscles and glands. Skinner's imaginary case [see (15), p.67] shows that he overlooks this restriction, saying that a salivary hypothetical reaction to a stimulus different than food (unconditioned), e.g., light, is liable to be increased by food reinforcement. Being a glandular reaction, salivation cannot by any means be made a conditioned reaction of the new type. Skinner's case is not so much imaginary as impossible.

In conclusion we must say that the structure of Skinner's paradigms for the new type of conditioned reflex contains important errors and gaps. Yet, we must point out once more that his seeking of new forms of conditioned reflex and his attempts to present their fundamental properties with great detail and discrimination are to be applauded.

Footnotes

[1] We desire to express here our gratitude to N. G. Olekiewicz for his valuable suggestions and for his help in translating this paper.

[2] A slight inaccuracy is here introduced for the sake of simplification, for, as a matter of fact, the complex followed by food consists of $S_G + S_o + R_o$. This simplification, however, has no practical consequences for the experiments of the kind conducted by Skinner, S_o being there almost wholly identical with S_G . In experiments similar to those with electrical shock, S_o ought to be made sufficiently weak to be prevented from becoming a disturbing factor. Further discussion of this matter exceeds the limits of the present paper.

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