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CHARACTERISTICS OF THE INSTRUMENTAL RESPONSE RECOVERED FROM EXTINCTION BY FREE REINFORCEMENT

by

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A previous paper⁽⁵⁾ reported that the extinguished lever-pressing response in a free responding situation had recovered if Ss were given incentive when they reached the extinction criterion. According to Herrnstein and Morse⁽⁶⁾, such an incentive as this, that is given to Ss without contingent upon their instrumental responses is named free-reinforcement. The recovery by free reinforcement was not due to reconditioning, because the delivered incentive had not any chance to become accidentally contiguous to the lever-pressing. Furthermore it had to be distinguished from spontaneous recovery and from those due to disinhibition by sudden delivery of the incentive. It was therefore best regarded as a result of increase in incentive motivation, and r_o-s_o was suggested as a possible mechanism of it.

So far as our previous experiment is concerned, another explanation seems to be possible; the incentive inherently reduces drive, but if the amount of delivered incentive is very small and if Ss can not obtain any more incentive, no matter how vigorously they may press the lever, it may induce frustration instead of reducing drive. If frustration thus occurs, it heightens tension, which could be reduced by doing activities of every kinds. Ss will use very likely the lever-pressing as one of means to reduce tension, which in turn makes the extinguished lever-pressing reappear.

One of the purposes of this experiment is to examine whether the recovery of lever-pressing by the free reinforcement is genuinely due to increase in incentive motivational factor or due to frustration. Then, how is the response produced by frustration different from the one due to incentive motivation? The former aims at reduction of the tension which could be reduced not only by doing learned response but also by doing many other learned or inborn responses; on the contrary, the response motivated by incentive is directed toward goal-object and the tension in this case could not be reduced by other way than obtaining goal-object. The present writer, therefore, says that they differ from each other in their goal-directedness. In Skinner-box situation, the most goal-directed response is the lever-pressing which is followed by an approach-response to the food tray. If the lever-pressing occurs without accompanying the approach-response, that kind of response must be regarded less goal-directed. Accordingly, in order to examine the goal-directedness of lever-pressing it is necessary to count the

lever-pressings and the approach-responses separately.

The second purpose is as follows; if it becomes clear that the recovery is genuinely due to the increase in incentive motivation, the next task is to decide whether the mechanism underlying such an action of free reinforcement is r_g-s_g hypothesized by Spence⁽⁶⁾ Being itself a conditioned response, r_g will be extinguished by non-reinforcement. When a free reinforcement is given, however, the tendency of the situation to evoke r_g will return again, for the free-reinforcement reconditions r_g to the situation. The degree of this reconditioning may be a function of the similarity of the environmental cues at the situation where free-reinforcement was given and those of the situation where usual reinforcement during training was given, for the recovery of conditioned response by reconditioning may be most complete when it is undertaken under the same situation to which the response was originally conditioned.

For the above two purposes, it was necessary to set up the lever apart from food tray enough for counting the number of lever-pressings and the tray-approach responses separately.

Method

Subjects: Ss were 33 naive rats of Wistar strain, aged 90-120 days at the start of the experiment. They were divided into three groups of equal size, eleven in each group. Two rats were discarded half-way in the experiment.

Apparatus: The Skinner-box used in our previous experiment⁽⁵⁾ was modified as was shown in Fig. 1. During training the food pellets were all delivered into the front tray. A lever was inserted from a directly opposite wall of front tray. A side tray was newly set up, its shape and color were different from those of front tray. A hole of 6 mm. in diameter was made in ceiling of transparent glass of the experimental box. The side tray and ceiling hole were used only to deliver the free reinforcement.

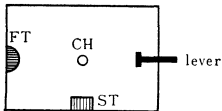


Fig. 1. Experimental box

FT=Front Tray

ST=Side Tray

CH=Ceiling Hole

Procedure: As far as the acquisition of lever-pressing response, the experimental procedures were all the same as those in our previous experiment; drive was hunger of 23 hours food deprivation, reward was 0.06 gm pellet of bread.

On the first day of acquisition training, the lever was inserted immediately above the front tray and Ss were trained to press a lever for food pellet twenty times on each of two successive days. After these trainings the lever was removed to the opposite wall in the box as was shown in Fig. 1, and on each of the following three days 40 lever pressings were reinforced continuously.

Extinction began about 23 hours after the end of the last training and ran until Ss failed to respond within five minutes after a preceding lever-pressing. All three groups were treated equally thus far. When they reached the criterion of extinction, a pellet of food was delivered to them in the following ways; one group received it from the front tray (FT-group), another group from the side

tray (ST-group), and the third group through the ceiling hole (CH-group). When the pellet of food was delivered through the ceiling hole, it was suspended by thread from the hole so that S could catch it. After Ss took the delivered pellet they were allowed to respond freely for ten minutes, and the lever-pressing-response and the approach-response to each of front tray, side tray and ceiling hole were recorded. The recording of lever-pressing was automatic, but the approach responses were all recorded manually by experimenter through observation. In order to exclude inconsistency in identifying these responses, a definite cubic space was imagined to be distinguished just above each tray and below the ceiling hole respectively, and each time the head of Ss entered into this space, the S was regarded as having made one response.

Results

Number of lever-pressing responses to extinction: The average number of lever-pressing required to reach the extinction criterion were 92.2 in FT-group, 88.6 in ST-group and 81.8 in CH-group. Though the difference among these average numbers seemed rather great, the analysis of variance applied to the group difference gave, however, $F=0.470$, $n_1=2$, $n_2=28$, $p>0.05$. Accordingly the difference was not significant, so that subsequent differences must be the consequence of the difference in the ways of delivering free reinforcement.

Lever-pressing responses recovered by the free-reinforcement: The lever-pressing responses during ten minutes after the free reinforcement are shown in Fig.2 in terms of mean number in successive one minute. The total number

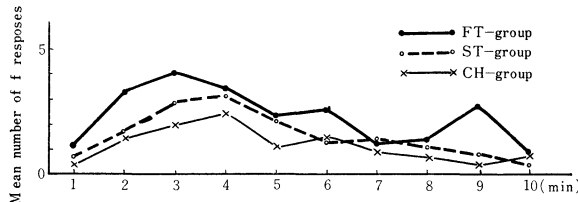


Fig. 2. Mean number of lever pressing responses in successive one minute after the free reinforcement

of lever-pressing responses emitted during over-all ten minutes are involved in Fig.3. The analysis of variance applied to group difference in these responses gave $F=16.320$, $n_1=2$, $n_2=28$, $P<0.001$; the difference was thus significant. Dividing the total ten minutes into the first half and the latter half, the difference in the number of response was tested in each half and it was found to be significant in the first half ($F=9.908$, $n_1=2$, $n_2=28$, $P<0.05$), but non-significant in the latter half ($F=1.856$, $n_1=2$, $n_2=28$, $P>0.05$.) The front tray was the same tray used during training. The side tray was different from the front tray in shape, color and its location, but not so much different as the ceiling hole was. Accordingly it may be concluded that the effect of free-reinforcement on the recovery of extinguished response varies with the

degree of similarity of the situation of delivering free-reinforcement to that of delivering usual reinforcement during training.

Approach-responses emitted during ten minutes after the free-reinforcement: The mean numbers of responses to the front tray are shown in Fig.3. The analysis of variance applied to the difference among the groups gave $F=16.320$, $n_1=2$, $n_2=28$, thus the difference was significant at 0.05 level of confidence. By the way, as the approach to the front tray (FT-response) is the response which had been already learned by every Ss during training and extinguished afterward, the reappearance of it means also that a extinguished response recovered. Therefore the relationship found in the recovery of lever pressing, between the effect of free-reinforcement and the situation where it was derived was confirmed again in the FT-response.

The number of approach to the place where S received free-reinforcement can not be rightly compared among three groups, since in ST-and CG-group it was quite other than the approach-response to the front tray, while in FT-group the two are the very same response, furthermore an "operant level" to each of these places may be different from each other. A few implications, however, are revealed from the relations represented in Fig.3: It is natural that the FT-group should make this response the most, since it had been once learned by this group and was then reconditioned. CH-group made these responses more than ST-group, while the former group was superior to the latter in both of the lever-pressing and FT-response, on the other hand, these two groups made no difference, as is shortly seen in the total of all three kinds of response. These facts would imply that in CH-group the approach to the place of free-reinforcement might have occurred at the sacrifice of other kinds of responses. Going a step further, in the case of ST-group the responses originally directed toward ST might have been distributed to ST and FT as the ST was relatively similar to FT.

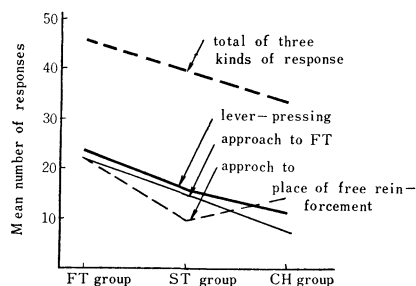


Fig. 3. Mean number of each kind of responses emitted during ten minutes following free-reinforcement.

As lever-pressing, FT-response and approach to the place of free-reinforcement are all directed toward the incentive, it is not absolutely unreasonable to lump them together. The total of three kinds of responses is shown in Fig. 3. The difference among three groups seems to be significant, but the analysis of variance gave $F=0.119$, $n_1=2$, $n_2=28$, $P>0.05$, thus it was proved not significant.

Ratio of ET-response to lever-pressing:

Several attempts had been made intending to estimate the degree of association between the recovered lever-pressing and the FT-response, but it was found to be rather difficult task to determine which

lever-pressing was rightly followed by FT-response, because a lever-pressing was sometimes followed first by a response as ST-response, and immediately afterward by a FT-response, and sometimes followed directly by a FT-response without any intervening one, but a little too late. As a rough indicator, therefore, ratio of the FT-responses to the lever-pressings was calculated in each quarter of the extinction period from the beginning to the point when Ss reached the extinction criterion, excepting the five minutes of no responding just before the free-reinforcement, and in each half of the period after the free-reinforcement. Fig.4 shows the results.

Assuming that the more the ratio deviates from 1.00 toward zero, the less goal-directed the lever pressing would be, we could infer from these values the degree of goal-directedness of the lever-pressing.

As is apparent from the figure, these ratios in all groups are relatively close to 1.00 at the initial stage of the extinction and then gradually decrease with the progress of extinction. But after the free-reinforcement they rise far beyond their final level during extinction. Such rises in the ratio after the free-reinforcement must be interpreted as suggesting that the recovered lever-pressing be goal-directed fairly well in its nature.

Discussion

The extinguished lever-pressing was recovered by free-reinforcement, even though the place of the free-reinforcement was at a distance of the lever. If it was due to frustration, it should be also accompanied with the increase in other kinds of response. Further as three groups were equally treated with the exception that the place where they received a free-reinforcement was different, the degree of frustration, if any, cannot vary with the groups, which in turn leads to no difference among groups in the total of three kinds of responses. The fact that significant difference was not found in these values, agreed with the above suppositions. However, the numbers of the totals have obvious tendency of decreasing in such order as FT-, ST- and CH-group, and that the value of $F=3.119$ falls short only a little of the criterion of five percent level, i.e., 3.34. If the number of Ss were larger, it is certain that the significant difference could be found. Further, the ratios of the approach-response to the front tray have become closer to 1.00 after the free-reinforcement, which implies that the recovered lever-pressing has the goal-directed character. Accordingly the recovery could not be regarded merely as a consequence of frustration. It would

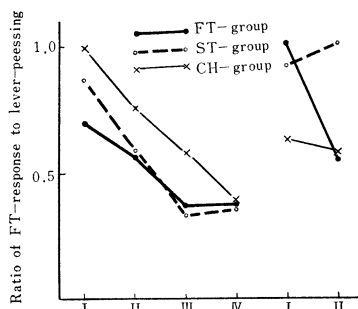


Fig. 4. Ratio of the Number of FT-response to that of lever-pressing during extinction and ten min. after the free reinforcement.

be rather due to the increase in incentive motivation.

In general, there are two ways in which the decrease in performance level is brought. In the first case it is decreased by the repetitions of non-reinforced trial, and the another way is to reduce the amount of incentive given to Ss contingent upon their response. The first way in itself always involves the latter way, since not to reinforce is to reduce the amount of incentive to zero, so that the decrease of performance by extinction should involve, at least partly, the element which is due to the loss of incentive (cf.2).

According to the current theories of learning^(1,4,5) the incentive determines the performance level through its influence upon the motivation of the S, therefore the no responding state of S at the final stage of extinction must be brought about by the reduction of motivation as well as the decrease in habit-strength. If the free-reinforcement is given to Ss, their motivation can be increased, the increased motivation in turn makes the lever-pressing recover. If the mechanism underlying such an action of the free-reinforcement is truly the r_g-s_g , the degree of the recovery of lever-pressing should be determined by that of the recovery of r_g , on the other hand, the recovery of r_g is supposed to be a function of the similarity of the place where Ss receive the free-reinforcement to the place where they had been taking the pellet of food; the more dissimilar the former place from the latter, the less would be the degree of the recovery of r_g . Accordingly, in case of the present experiment, FT-group must recover the lever-pressing the least. Such a deduction from the r_g-s_g hypothesis agrees to the results of the present experiment, not only in the number of lever-pressing response but also in that of the FT-response.

Summary

Three groups of white rats were trained to press a lever for food in the situation where the lever was set up apart from food tray enough for counting the number of the lever-pressing response and approach-response to the tray, separately. Afterward the lever-pressing was extinguished, and when the Ss reached the extinction criterion, the first group was given a pellet of food delivered to the food tray which had been used during training, the second group was also given a pellet, but the pellet was delivered to a new tray attached to a side wall, and the third group was given it from a hole made in ceiling.

The extinguished lever-pressing was recovered in all groups by these treatment, but the degree of the recovery varied with the groups; it was most superior in the first group and decreased in such order as the second, then the third group.

The characteristics of the recovered response was found to be goal-directed fairly well, The mechanism underlying such an action of incentive was discussed in reference to the r_g-s_g hypothesis presented by Spence.

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Zusammenfassung

Drei Gruppen von weissen Ratten waren darauf dressiert, dass sie den Hebel niederzudrücken, um das Futter zu gewinnen. Diese Dressur wohl aber wurde ausgeführt unter dem Zustande, wo der Hebel aufgestellt genug abseits von dem Futterteller ist, womit man die den Hebel niederdrückende Reaktion und die nach dem Teller herannahende Reaktion getrennt zählen kann. In der Folge die Hebel-niederdrückende-Reaktion wurde erlöscht, und als die Versuchstieren in dieser Expeirmente einem bestimmten Extinktionskriterium erreichten, dann wurde zur ersten Gruppe ein Stückchen Futter aus demselben Futterteller abgegeben, welcher anfangs während der Dressuren gebraucht worden war, auch zur zweiten Gruppe gleichfalls das Stückchen, doch diesmal aus einen Teller eingerichtet an der Seitenwand, und zur dritten Gruppe es aus einem Loch, das in die Decke der Vorrichtung vorausgemacht wurde.

Durch diese Verfahren wurde erholt wieder die vorher erlöschte Hebel-Niederdrückung bei gesamten Gruppen, nur variierte sich die Erholungsgrad unter den Gruppen; die erste Gruppe erreichte am höchsten, und nahm sich nach der Reihe bei der zweiten und dritten ab.

Schliesslich stellte es sich heraus, dass die Charakteristik der erhaltenen Reaktion ziemlich ziel-gerichtet war. Somit die solch einer Wirkung des Auslösers (incentive) unterliegende Mechanismus wurde zur Erörterung gebracht mit Bezugnahme auf die " r_g-s_g Hypothese" von Spence, K. W.