The Comparison of Omission, Extinction, and Extinction-2 Procedures in a Multiple Schedule

Dan O. Coldeway

Western Michigan University
THE COMPARISON OF OMSSION, EXTINCTION, AND EXTINCTION-2 PROCEDURES IN A MULTIPLE SCHEDULE

by

Dan O. Coldeway

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INTRODUCTION

Over the past few years there has been considerable attention focused on techniques for eliminating responding. Several attempts have focused on the use of punishment procedures to suppress responding (Estes, 1944; Church, 1963). While punishment can provide a rapid decrease in responding, many investigators have reported that aversive stimulation also produces undesirable side effects such as fighting, biting, as well as several autonomic responses like defecation, urination, and increased heart rate (Ulrich & Azrin, 1962; Hutchinson, et. al., 1971). Similar effects have also been reported using punishment and extinction in combination (Appel, 1960; Azrin & Holz, 1961; Rachlin, 1966; Uhl & Sherman, 1971) and extinction alone (Azrin & Hutchinson, 1966). In general, nearly all the work on response elimination has dealt with extinction and/or punishment procedures.

More recent attempts at response elimination have focused on omission training (OT) (Grant, 1964), in which the subject is reinforced for not making a previously reinforced response. The omission training procedure (sometimes called Differential Reinforcement of Other Behavior) uses two temporal parameters to specify the contingencies between the subject's behavior and reinforcement. The operation of these temporal intervals is equivalent to those occurring in nondiscriminated (Sidman) avoidance (Sidman, 1953) with the exception that reinforcement is substituted for shock. The parameters are as follows: (a) a response-reinforcement (R-S^R) interval which
determines the length of time that reinforcement is postponed after emission of a response, and (b) a reinforcement-reinforcement (SR-SR) interval which determines the length of time between reinforcements if no response intervenes. Recent data suggest that the relationship between these two temporal parameters is crucial in the success of omission training in rapid response elimination (Uhl & Sherman, 1971; Davis & Bitterman, 1971). The data indicate that response elimination is more rapid with shorter reinforcement-reinforcement intervals than response-reinforcement intervals. In general, omission training appears to be facilitated when the response-reinforcement interval is longer than the reinforcement-reinforcement interval because reinforcement is postponed longer due to a response.

Several investigators have shown omission training to be a successful method of response elimination when compared to extinction and punishment procedures (Uhl & Sherman, 1971; Uhl & Gracia, 1969). Omission training showed a rapid response elimination and had longer lasting effects. The question of the durability (lasting effects) of response elimination procedures is often neglected in evaluating their use. The effectiveness of each procedure should be evaluated not only during response elimination but also when the subject is placed in an environment the same as or similar to the one in which he acquired the behavior. Observations of the durability of response elimination procedures provide information concerning the mechanisms through which an organism learns to inhibit a behavior (Uhl & Garcia, 1969).

The long lasting effects of omission training also suggest that
During acquisition of behavior, reinforcement becomes a cue for further responding. This is especially true if reinforcement is programmed on a variable interval schedule in which the subject is responding at a steady rate. During omission training the "reinforcement cue" becomes a discriminative stimulus for not making the response that was previously reinforced (Uhl & Sherman, 1971). If the above is true, subjects undergoing extinction training should not be able to discriminate the change in reinforcement contingencies as readily as omission training subjects because of the absence of cues during extinction. To further test this, a second extinction procedure (ET-2) could be examined. This procedure would provide a cue to the subject that response elimination is in effect by only presenting contingent secondary reinforcers and withholding the primary reinforcers (sucrose, milk, food, etc.). This will allow the previously reinforced behavior to undergo extinction and provide an obvious cue to the subject to stop responding. The procedure in effect during extinction-2 is identical to a contingent, variable interval schedule except that only the secondary reinforcers are presented.

The data obtained using various methods of response elimination procedures suggest that a systematic comparison should be done to further evaluate the effectiveness and so called "durability" of each method. Although some investigators have examined the effects of combining response elimination procedures with punishment, little has been done with comparing these procedures with each other either concurrently or in sequence. The possibility of enhancing the effectiveness of a response elimination schedule by first exposing the or-
ganism to another similar schedule has not been determined, although the data suggest that during omission training extinction must first take place before the subject is reinforced for not responding. Furthermore, almost all the designs testing the effectiveness of response elimination procedures have employed a groups design allowing subjects to be exposed to only one response elimination component.

The present experiment is a comparison of omission training, extinction training, and extinction-2 training under the control of a specific stimulus presented at the onset of each response elimination component. Each subject is exposed to a different sequence of exposure to all three response elimination components with a chance to respond on the original acquisition schedule before each new exposure. The possibility that one particular schedule may later enhance the effectiveness of a second schedule, even when the organism was allowed to respond for contingent reinforcements between exposures, was tested along with the changes in durability that might occur from previous exposure to a separate response elimination technique.
METHOD

Subjects

The 3 subjects were male, albino, experimentally naive rats weighing 300-325 gm. and maintained in individual cages at 80% of base weight.

Apparatus

The apparatus consisted of a Grason-Stadler model 1111-9650 double-lever operant chamber equipped with a Lehigh Valley liquid dipper (.04 ml. cup), an overhead houselight, small lights over the left lever and dipper shroud, a speaker providing masking white noise from a Grason Stadler model 901-B noise generator, and a separate overhead speaker providing a 700 Hz tone from a Hewlett Packard model 200-ABR tone generator. Standard electro-mechanical programming equipment were used to control experimental events and record responses.

Procedure

After arrival at the laboratory, all subjects were maintained on ad. lib. food and water and their base weights taken for 5 days. The rats were then handled and reduced to 80% of base weight before beginning 3 days of 30 min. sessions of dipper training on a non-contingent VI 15-sec. schedule of .04 ml. of a 30% sucrose solution made accessible to the subject for 4 sec. On the day following dipper training, subjects were shaped to press the left bar, permitted to make 20 continuously reinforced responses, then placed on FR 2, FR 3,
and FR 4 for a total of 50 reinforcements. The following day, subjects were placed on a FR 4 schedule for 50 reinforcements. The next day, subjects began 3 days of VI 30-sec. training in the presence of white noise at -8.5 db.,\(^1\) each session lasting 30 min. All subjects were then run on a contingent VI 30-sec. schedule in the presence of a 700 Hz tone with an amplitude of 65 milli-volts and the white noise reduced to -20.0 dB. Each of the above stimulus conditions was then presented every other day on alternate days for 9 sessions to complete preliminary training.

All subjects were then randomly assigned to three treatment conditions. Each treatment was based on the positioning of omission training within the sequential multiple schedule (Table 1). Each response elimination procedure lasted for one 30 min. session or until no responding occurred for 10 min. Each response elimination session was also run in the presence of the reduced white noise and the 700 Hz tone. The day following each response elimination component, a 30 min. session of non-contingent VI 30-sec. of reinforcement was conducted as a "durability" test, followed the next day by a 30 min. session of contingent VI 30-sec. retraining. Both the non-contingent VI 30-sec. durability test and the contingent VI 30-sec. retraining were conducted with the tone off and the white noise increased to -8.5 dB. All subjects were tested for 36 continuous days allowing them exposure to each response elimination procedure, each non-contingent VI durability test, and each contingent VI retraining session 4 times.

The omission training procedure was programmed with reinforce-
Table 1

The positioning of each response elimination session for individual subjects following the 12 days of preliminary training on VI 30-sec. Each subject was exposed to the entire sequence 4 times.
<table>
<thead>
<tr>
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<th>S1</th>
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<td>NCVI</td>
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VI = VI 30-sec. "pre-training"
NCVI = non-contingent VI 30-sec.
ET = extinction
OT = omission
ET-2 = extinction-2
ment-reinforcement and response-reinforcement intervals of 10 and 30 sec. respectively. Any lever press response during omission training reset and started the response-reinforcement clock, delaying reinforcement for 30 sec., while cessation of lever pressing allowed reinforcement to be presented every 10 sec. The extinction-2 procedure was programmed identically to the contingent VI 30-sec. schedule used in preliminary training except the dipper tray was empty. Although reinforcement was contingent upon a response and appeared to be the same as reinforcement during preliminary training, the dipper cone was presented empty.
RESULTS

Data for all subjects are presented as a proportion of the response rate during preliminary training. This proportion is obtained by dividing the mean response rate during the last three days of preliminary training into the total number of responses in each session, i.e. a value of 1.00 indicates responding at the same rate as during preliminary training and a zero value indicates cessation of responding. In addition, data for all subjects collected during response elimination sessions are presented in the form of each subject's cumulative record.

Subject #1

Data showing the performance of subject #1 on extinction, omission, and extinction-2 training are compared in figure 1. There were no apparent differences in rate of responding between extinction, omission, and extinction-2 training with the exception of the low rate of responding during the first exposure to extinction-2. The general pattern of responding for subject #1 indicates a higher rate of lever pressing for a brief period when the sessions begin and an increase in time between responses as the sessions progress.

Subject #2

Performance on response elimination by subject #2 is shown in figure 2. There is little difference in subject #2's rate of responding on extinction or extinction-2 but slightly more responding does
Figure 1

Cumulative records for subject one on all days of response elimination. Sequence of exposure is shown from top to bottom. All sessions lasted 30 min. or until a criterion of no responding for 10 min. was achieved.
Figure 2

Cumulative records for subject two on all days of response elimination. (same format as figure one)
occur during omission training sessions. All omission training sessions show a characteristically high rate of responding as the session begins with a reduction in the rate as the session progresses. There is also a marked decrease in total responding on each component by days, as the subject is exposed to that component.

Subject #3

Data on response elimination for subject #3 are shown in figure 3. The performances on each component show a rapid decrease in rate of responding with only a slight increase during omission training in contrast to extinction or extinction-2 training. Most of the responses in each session occur in the first 2 min. with little or no responses occurring later in the session.

Non-contingent VI test for durability

Figure 4 illustrates the proportion of baseline responding for each subject during the non-contingent VI 30-sec. testing sessions. All three subjects responded less on the non-contingent VI sessions following omission than extinction or extinction-2 training.

The rate of responding on all days of non-contingent VI testing is markedly lower for subject #3 in comparison to the overall rate of responding on the non-contingent VI test for subjects #1 and #2. However, the rate of responding for all three subjects was less than 10% of baseline on the fourth exposure to the non-contingent VI test following their last session of omission training (figure 4). The last exposure to non-contingent VI for subjects #2 and #3 averaged approximately 40% of baseline responding following extinction and 65%
Figure 3

Cumulative records for subject three on all days of response elimination. (Same format as figure one)
Figure 4

The proportion of baseline responding on each day of the non-contingent VI 30-sec. durability test following extinction-2, (top) extinction, (center) and omission, (bottom) for all subjects.
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of baseline following extinction-2.

**Contingent VI retraining**

Proportion of baseline responding for each subject on the 4 sessions of contingent VI 30-sec. retraining, run to reestablish responding before the next response elimination session, are given in figure 5. Response rate recovery was rapid for all subjects. However, subject #3 showed less response resumption across response elimination components on later VI retraining than the other two subjects. There were no distinct differences in response resumption across response elimination components on later VI retraining for subject #2. However, subject #1 showed an increase of 23% over baseline responding across all days of VI retraining. Subjects #3's mean rate of VI retraining was 20% below baseline.

**Sequential Effects**

As figure 6 indicates, the positioning of the three separate response elimination components had an effect on the overall rate of responding during response elimination sessions. When omission training was presented first, followed by extinction and extinction-2 respectively (subject #2), there were considerably more responses made during all response elimination components than during any of the sessions in which the subjects were exposed to omission training later in the sequence. However, exposure to omission training before extinction or extinction-2 produced fewer responses on the non-contingent VI durability test than did exposure to extinction first, followed by omission training (subject #1), although the overall rate of re-
Figure 5

The proportion of baseline responding for all subjects on the VI 30-sec. retraining sessions.
Figure 6

The proportion of baseline responding for all subjects during response elimination sessions.
Responding was considerably lower for the later animal. Exposure to extinction-2 first, followed by extinction and omission training respectively (subject #3), produced the lowest overall response rate of the three sequences tested. As figure 7 shows, this sequence also produced the lowest overall rate of responding on the non-contingent VI durability test. This sequence characteristically produced less responding on that same test following omission training, and the overall rate of responding on non-contingent VI was lower than any of the sequences tested.

The pattern of contingent VI responding across sessions for each sequence tested is presented in figure 8. The same general pattern of responding was found with subject #3 (ET-2, ET, OT) showing the lowest overall rate of responding followed by subject #2 (OT, ET, ET-2) and subject #1 (ET, OT, ET-2) respectively.

The overall mean rates of responding for each of the three subjects on response elimination, non-contingent VI, and VI retraining, are given in Table 2. The effectiveness of the sequence presented to subject #3, especially on the non-contingent durability test, is again indicated.
Figure 7

The proportion of baseline responding for all subjects on the non-contingent VI 30-sec. durability test.
Figure 8

The proportion of baseline responding on the VI 30-sec. retraining session for each subject following extinction-2, (top) extinction, (center) and omission, (bottom).
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Table 2

The overall mean proportion of baseline responding for each subject on response elimination, non-contingent VI, and VI retraining. The mean of each column is given at the bottom.
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DISCUSSION

The present study further extends the findings by Uhl and Garcia (1969) concerning the durability and effectiveness of omission training and the results by Uhl and Sherman (1971) concerning the possible effectiveness of omission training in combination with other procedures in eliminating behavior. Comparisons between omission training and other procedures have consistently shown that response elimination is not achieved as rapidly with omission training although the difference is only slight. The present results also indicate that omission training is an effective response elimination procedure especially after the organism has been exposed to other response elimination procedures.

Previous investigations comparing the effectiveness of omission training with other procedures (Uhl & Garcia, 1969; Davis & Bitterman, 1971) have shown that omission training is handicapped by the discriminative control that reinforcement has over responding when the omission contingencies are in operation. Reinforcement becomes a discriminative stimulus for further responding during acquisition and because the same reinforcement procedure is used during omission training, obtaining reinforcement for not responding results in a resumption of responding, which resets the response-reinforcement interval and delays response elimination. Eventually, with further exposure to omission training contingencies, reinforcement loses its discriminative control over responding and becomes a discriminative stimulus for not responding. The change in discriminative control is indi-
icated by the improved durability of omission training over other re-
sponse elimination procedures during presentation of the non-contin-
gent reinforcement procedure and during later VI retraining. During
extinction, because of it's characteristic lack of cues, the organism
undergoes no change in cues and obtaining reinforcement after ex-
tinction results in the resumption of responding. The present study
suggests that during extinction-2, although secondary reinforcers
(dipper light, no house light, sound of dipper, and presence of dip-
per cone) are presented contingent upon a response, the primary rein-
for cer (sucrose) is not presented and the organism quickly stops re-
sponding. The secondary cues extinguish and the bar pressing rate
decreases now that sucrose is no longer made available for a lever
press. However, when sucrose is later presented on a non-contingent
VI schedule, a resumption of responding occurs. Also, since the stim-
ulus conditions present during non-contingent VI mimic those present
during VI preliminary training, the rate of lever pressing increases.
However, the rate of lever pressing later decreases when the subject
is reinforced while not responding. The rate of responding is usually
higher during non-contingent VI sessions following extinction-2
training than non-contingent VI sessions following extinction because
the lever press response is only indirectly extinguished during ex-
tinction-2. Extinction-2 subjects learn lever pressing is a "mistake"
and stop responding before the lever press response is completely
extinguished.

The present results also indicated that exposure to either ex-
tinction or extinction-2 procedures did enhance the later effectiv-
ness of omission training in response elimination. In addition, the
long lasting effects of omission training were not weakened by previous exposure to extinction or extinction-2 as was shown by the non-contingent durability test following omission training sessions. The efficacy of extinction-2 in response elimination was evident, especially when the extinction-2 procedure was presented first in the sequence. This sequence not only reduced responding during response elimination sessions, but in addition, the overall rate of responding was reduced. However, the durability of the extinction-2 procedure alone was less than with the extinction or omission training procedures alone.

The present data also demonstrate the effectiveness of clearly identifying response elimination sessions from preliminary training sessions by a change in stimulus conditions. Providing subjects with an added cue, which is consistently paired with only response elimination sessions, reduces the time necessary for subjects to discriminate the particular response elimination procedure in effect. Adding the cue during omission training sessions served a dual function, mainly, reducing the number of responses early in the session and reducing the time until the first reinforcement occurs, contingent upon not responding.
SUMMARY

In general, the data support the conclusions of other investigators as to the effectiveness of response elimination procedures in addition to punishment and extinction. The results also suggest that a closer examination of effects from combining response elimination procedures should be done. Also, the added effectiveness of discrete stimuli associated with the elimination of responding should be noted and a further examination of the possible stimulus control of response elimination studied.

The present data also suggest that preliminary training schedules of reinforcement and temporal variables associated with response elimination procedures are critical in the effectiveness and durability of omission and extinction-2 procedures, i.e. reinforcement-reinforcement and response-reinforcement intervals during omission; frequency of presentation of the empty dipper during extinction-2.
FOOTNOTES

1 All tone and white noise values are instrument dial settings.
BIBLIOGRAPHY


