DECREASE OVER TIME IN THE GENERALIZATION OF CONDITIONED SUPPRESSION

By

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A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfilment of the Requirements

for the Degree

Master of Arts

McMaster University

September 1966

MASTER OF ARTS (1966) McMASTER UNIVERSITY
(Psychology)

TITLE: A decrease over time in the generalization of conditioned suppression.

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NUMBER OF PAGES: 28

SCOPE: A response conditioned to a specific stimulus will generalize to similar stimuli. Various reports have indicated that the slope of the gradient of generalization changes over a period of time. The experiments reported here investigated the generalization of an emotional response, originally conditioned to an 80 db. white noise to a 60 db. white noise. In different groups the tests for generalization were begun immediately after conditioning or after a 4 day waiting period. In further groups the animals' time during the delay period was variously taken up with bar pressing sessions; new conditioning trials with a light CS; unsignalled shock presentations, or they merely stayed in their home cages.

ACKNOWLEDGEMENT

Without special encouragement from Dr. L. J. Kamin it is extremely doubtful that this thesis would ever have been begun. The author would therefore like to express to Dr. Kamin his sincerest thanks.

INTRODUCTION

In some unpublished research (Kamin, 1966) involving compound stimulus conditioning of the conditioned emotional response, certain control groups revealed a phenomenon of some interest. One group of rats (group A) was given standard conditioned suppression training with a 3 minute light CS. The animals received 4 CS-US pairings a day for 2 consecutive days. By the end of the second day all animals completely or almost completely suppressed their bar pressing during the CS. The next day the light CS was changed by the addition of an 80db white noise of equal duration, thus making it a simultaneous compound, light/noise CS. Pairings of this new CS and shock were continued on the usual 4 trials a day schedule, but it was noted that on the first presentation of the compound the animals showed almost as much suppression as they had shown to the light alone. That is the suppression was only slightly attenuated by the change due to the addition of the noise component. A second group (group B) was trained exactly like group A, but before it was switched to the light/noise compound CS a period of 4 days elapsed during which the rats remained in their home cages. During the 4 day wait they were maintained on their regular food deprivation schedule, and on the fifth day they were returned to the conditioning units for the conditioning session with the compound CS. On the first presentation of the light/noise CS the group B animals, unlike those in Group A, showed considerable attenuation of the suppression. Although the only difference between the groups was that B waited 4 days after

the original training before it was tested with the compound, the group B rats were not as "afraid" of the compound CS as were those in group A.

A group that was conditioned in the same way as A and then given a 4 day rest period before it was tested again on the same, single component, light CS showed no attenuation of suppression. Suppression after a 4 day wait was the same as on the last day of the original conditioning. In summary, it appears as though changing the stimulus leads to attenuation of the suppression only if an interval of time intervenes between conditioning and testing. Two other groups that were originally conditioned to the compound CS and were then switched either 1 or 4 days later to a single component of that compound performed in the same way as groups A and B; that is, the change, this time in the form of subtracting a component from the compound, again produced severe attenuation only after the waiting period.

One possible way of thinking about the phenomenon is in terms of a change in the shape of the generalization gradient over a time period such that the changed stimulus is less effective in eliciting the conditioned response after the four day interval. The change of shape necessary to produce the effect would seem to be a sharpening of the gradient.

With such a notion in mind it was decided to attempt a replication of the finding described above using an intramodal change in the stimulus. The original CS therefore was an 80 db white noise which was changed, after 1 or 4 days, to 60 db. The design is described in full later in the appropriate section.

HISTORICAL INTRODUCTION

There have been a number of papers that report changes in the shape of a generalization gradient over a period of time. There are, however, considerable discrepancies in the findings. Some authors report that the gradient flattens over time with the result that there is greater response strength to the generalized stimuli when they are tested after a period of time than when they are tested shortly after conditioning. Others report the opposite, namely, that conditioned response strength to the generalized CS's is greater the sooner after conditioning they are tested--such findings would indicate that the gradient sharpened over time.

In the literature on stimulus generalization there is a well established finding concerning the change in the shape of the generalization gradient over the course of a series of extinction trials. Typical procedure in experiments that plot generalization curves is to give each subject a series of extinction tests with the original and generalized stimuli. For example Desiderato (1964) using rats, studied the generalization of conditioned suppression along a frequency dimension. After suppression had been established to either a 3500 cps or 670 cps tone all rats were tested on the following frequencies: 3500, 2280, 1500, 1000, and 670 cps. All test stimuli were presented once per daily session in a random order. The testing was carried out each day for five days. Over the course of the five days of extinction testing it was found that the generalization curve became steeper; the mean suppression to the original CS showed only slight extinc-

tion but the amount of suppression to the generalized stimuli extinguished quickly so that by the fifth day, although there was still appreciable suppression to the original CS, there was very little evident to the generalized stimuli.

Hoffman (1965) reports the same effect in another conditioned suppression study using pigeons, The stimulus generalization dimension was again frequency. After suppression was established to a 1000 cps tone, test stimuli of 300, 450, 670, 1000, 1500, 2250, and 3400 cps were tested in extinction. They were presented in random order once in each daily session for 25 sessions. If the generalization curves are plotted in terms of 5 session blocks, a sharpening of the generalization curves around the 1000 cps training stimulus is evident from block to block. The curve for sessions 1-5 is almost flat indicating that, in the early stages of testing, suppression generalizes almost completely. By block 5, however, the curve is sharply peaked with essentially no suppression to tones on the ends of the generalization dimension..

A similar effect has been reported in studies of human GSR conditioning. Littman (1949) shows the effect in a group of subjects who were conditioned to a 153 cps tone and then tested with tones of 468, 1000 and 1967 cps. On the first "cycle" of tests the generalization curve was flatter than on the next three test cycles. Wickens, Schroder, and Snide, (1954) also showed the effect using human GSR conditioning. Subjects were conditioned to tones of either 153, 468, or 1000 cps. They were then formed into 3 groups and each group was extinguished on only one of the

test stimuli. One group was composed of subjects that were tested on a stimulus that was one level removed from their training stimulus; the second group was tested with a stimulus two levels removed from the training stimulus, and the third group was tested on the stimulus used in their original training. The groups were counterbalanced to equalize the frequency of the tone employed in the extinction series and to equalize the frequency with which the extinction tone was higher, or lower than the original conditioning tone. Eight extinction trials for each test stimulus were given after 16 conditioning trials. When generalization curves were plotted for test stimuli that were 0, 1, or 2 levels removed from the training stimulus, the authors report a flat curve for trial 1 with a gradual steepening of the curves over the following 7 trials.

The studies mentioned to date all agree in finding a steepening of the generalization gradient over a number of extinction trials. The time period over which the trials occurred varies from 25 days in the Hoffman (1965) research to a few minutes in the case of the last mentioned Wickens, et. al. (1954) paper. It would appear then that the extinction experience, not the period of time, was the important fact in the production of the steeper generalization curves. In fact, Hoffman (1965) reports no change in the shape of the generalization gradient of conditioned suppression in some of his birds that were retested after a 2½ year period. It should be noted though that these birds had been through a series of extinction tests and had already developed the steepened gradients before they were put away for 2½ years.

There is, then, no comparison in any of the studies mentioned so far that would rule out the possibility that some of the sharpening effect might be due just to the passage of time.

Perkins and Weyant (1958) seem to be the first to deal directly with the possibility that the passage of time, independent of extinction experience, might have some effect on the shape of generalization gradients. Their male albino rats were originally trained to run an elevated runway to a goal box for food. All animals received 8 trials a day for 12 days. On days 4-11 reward was given on an intermittent schedule--the animals performing 2 reinforced and 6 nonreinforced runs. For half the animals the runway and goal-box were white and for the remainder they were black.

In the test phase of the experiment all animals received 8 unreinforced trials on test day 1 and another 10 trials on the next day. For half the animals the first test session began 60 seconds after training while the remainder did not begin their test trials until 1 week later. Half of the animals in each of the "immediate" or "delayed" test group were tested on a runway of the same colour as used in their original training, and half were tested on a runway of the other colour, e.g. train on white--test on black. There were thus 4 groups: one tested immediately under the same stimulus conditions as during training; one tested immediately with a different runway; one tested after a 1 week delay under "same" conditions, and a fourth that was given delayed testing under "different" conditions. The measure reported is response speed in traversing the runway.

To assess any differences between the "immediate" and

"delay" group in the generalization decrement due to the changes made in the colour of the runway, median response speed on the first test day for each subject in the group tested immediately on a "different" runway was subtracted from the median response speed of an S from the group tested immediately on the "same" runway. These two S's would have been run at the same time. (The animals were run in squads of four). The differences between these pairs of animals (N=11) that were tested immediately after training were significantly greater than the comparable differences between delayed-test animals. A change in the stimulus conditions, then, produces less response decrement if the test is not made until a week after training. It is as though the slope of the generalization gradient became flatter with the passage of time. Perkins and Weyant suggest that animals forget the colour of the runway faster than they forget the running response. Forgetting the colour of the runway after the 1 week delay period would have the effect of making the test situation more similar to the training situation, thus producing a flat generalization gradient.

Thomas, Ost, and Thomas, (1960) trained pigeons to peck a key illuminated with 550 mu. They were reinforced for pecking this key on a VI schedule, but when it was lit with 570 mu. light they received no reinforcement. After this discrimination training the 15 birds were divided into 3 groups. All birds were then tested for generalization of the pecking response to key colours ranging over 490-610 mu. Group I was tested the day after training ended, but the other two groups were maintained on their feeding schedule and not tested until 7 and 21 days, respectively, after original training. Typical generalization curves are reported

but there were no differences between the groups in the steepness of the gradients. The generalization gradient in this situation is apparently quite stable over a 21 day period. In noting the discrepancy between their findings and those of Perkins and Weyant (1958) the authors note the obvious differences in the experiments, such as specie and response employed, but they also point out that their procedure involved discrimination training before the generalization tests whereas Perkins and Weyant's animals received only single-stimulus training. They note further that they would expect the discrimination training to produce a more stable generalization gradient.

Thomas and Lopez (1962) trained 3 groups of pigeons to peck a key illuminated by light of 550 mu. The birds were given 10 days of VI training to peck at this wavelength only. In contrast to the Thomas et. al. experiment (1960), no discrimination training was involved. After this training, group I was immediately tested for generalization to key lights ranging from 500-600mu; group II was not tested until the next day, and group 3's test was delayed for 1 week. Although overall response rates did not differ in the tests, the percentage of responses emitted to the training stimulus wavelength did show differences. The generalization gradient for the 1 day and 1 week groups were significantly flatter than the gradient for the immediately tested group. The 1 day group's curve was not different from the 1 week's.

The authors interpret their finding of a flatter gradient after a delay period in the same way as Perkins and Weyant (1958) explained theirs; namely, that it reflects a forgetting of

the exact CS value without a forgetting of the response. The failure to find the flatter gradient in the earlier Thomas et. al. (1960) experiment was put down to the fact that the animals in that experiment had discrimination training.

Data that again indicate a flattening of the generalization gradient over time is reported by McAllister and McAllister (1963). Their hooded rats were first fear conditioned with 35 pairings of a 6 second light CS which was paired with a 2 second shock to the animals feet. CS-US interval was 4 seconds. They were then returned to their home cages for a delay period of either 3 minutes or 24 hours. After the appropriate delay the animals were tested in a hurdle jumping apparatus. The stimulus for the hurdle response being the CS that had previously been paired with shock. During the original conditioning half of the animals received the CS-US pairings in a grid box that was later used as the start-box in the hurdle apparatus--for this group, then, the conditioning-box is the same as the hurdle apparatus start-box. The other half of the animals were originally conditioned in "a replica of the start-box of the hurdle jumping apparatus". For this group, then, (although, to quote McAllister and McAllister, the conditioning-box was a "replica" of the start-box), the conditioning box was different from the start-box of the hurdle apparatus. In all there were 4 groups: one was tested in the hurdle apparatus 3 minutes after being fear conditioned in the start-box of the apparatus; a second group was conditioned and tested similarly but a 24 hour interval was interposed between conditioning and testing. A third group was tested 3 minutes after

being conditioned in a box similar to but different from the start-box; the final group was conditioned and tested in a like manner but here again a 24 hour delay intervened between the conditioning and testing. One might feel certain confusion as to what the differences really were between the conditioning-box and the start-box that were "replicas" of each other. It is perhaps most convenient to quote McAllister and McAllister (1963) on this point

> Although the conditioning box was constructed to be a replica of the start-box of the hurdle apparatus, some differences were present. Those discernible to the human observer consisted of the visibility, through the grids, of a gray, wooden support at one end of the start box but not of the conditioning box and some variation in appearance between the guillotine door of the hurdle apparatus and the simulated door in the conditioning box. In addition, since the light sources did not pass through a perfectly diffusing medium, there may have been discriminable differences in the light patterns on the glass, although the illumination measured in each box was approximately the same.(p. 577)

The basic design of the experiment is the same as the Perkins and Weyant (1958) design, and essentially consists of 2 groups that are tested after a delay period--one with and one without changes in the stimulus conditions--, and 2 groups tested immediately after conditioning again one with, and one without changed stimulus conditions.

McAllister and McAllister report no differences in speed of the hurdle response between the 2 groups tested after 24 hours, that is, whether the start-box is the same or different from the conditioning box makes little difference if testing is not begun until after a 24 hour delay. However, if testing is begun 3 minutes after conditioning, a severe decrement in response speed is evident in the group that was conditioned in a box that was

different from the start box of the hurdle jumping apparatus. The effect has been replicated (McAllister and McAllister, 1965), and it is in agreement with the Perkins and Weyant (1958) data. It seems then, that a flattened gradient of generalization is found after a delay period whether the response is positively or negatively motivated. However, in that various investigators have reported data that indicates that a fear or anxiety response may show changes over a time period (Bindra and Cameron, 1953; Kamin, 1957; McMichael, 1966; Gray, 1964) it should be kept in mind that where fear motivated responses are involved, changes in stimulus generalization gradients may be mixed up with changes in fear itself.

In summary: there are a few reports of changes in the shape of generalization gradients over a period of time. The experiments mentioned earlier agreed in finding a sharpening of the gradient over a period of extinction trials which in one case spanned a period of 25 days. It was pointed out then that extinction trials were always confounded with time per se. The studies specifically aimed at showing a change in the gradient over time did not begin the extinction tests until after some delay period. These studies seem to agree that there is a flattening of the generalization gradient over a time period. These findings are at variance with the results outlined above in the introduction to this thesis. Briefly, the data reported in the introduction indicated that there was some sharpening effect over time such that animals tested after a post conditioning delay showed more generalization decrement than animals tested with a changed stimulus

immediately after conditioning. The experiments reported below constitute a further investigation of the phenomenon.

METHOD

Subjects and apparatus

Subjects were 111 experimentally naive male hooded rats about 100 days old and weighing between 250 and 300 gms. when they were received from Quebec Breeding Farms. Seventy-two were used in experiment 1 and 39 in experiment 2.

The apparatus consisted of 8 standard Grason-Stadler conditioning units that were individually housed in sound attenuating sand boxes. The appropriate timers, relays, and counters etc. necessary for automatic control of the eight boxes simultaneously were located in an adjacent room.

Initial training

Over a period of 10 days all animals were food deprived to 75% of their ad. lib. weight and they were maintained on a 24 hour feeding schedule. Preliminary training was the same for all rats and consisted of a "magazine training" day followed by 3 daily 2 hour bar press sessions for food on a 2.5 minute VI schedule. Reinforcements were 0.45mg Noyes lab rat pellets. No light was present during the bar press sessions. The fourth day of bar pressing was a "pre-test" day. During this day's session of bar pressing all rats received 4 presentations of the stimulus that was to be used as a CS in the conditioning phase of the training.

The CS was a 3 minute, 80 db. white noise signal generated by a model 901B Grason-Stadler noise generator. Noise intensity was measured with a General Radio model 1551C sound meter. The readings were taken inside the conditioning unit with the microphone 2" from the speaker. The sound attenuating chamber

door was closed.

Conditioning

All animals were given 4 CS-US pairings on each of 2 consecutive conditioning days. The conditioning days immediately followed the pre-test day described above. On these 2 days CS-US pairings were superimposed on the regular bar pressing session. The first pairing occurred 15 minutes after the start of the 2 hour session and the other 3 at half hour intervals. The CS was the 80 db. white noise that had been used on pre-test day. The US, a 0.5 second, 1 ma. shock presented through the grid floor of the box, was produced by Grason-Stadler Model E1064GS shock generators.

Testing

So far in the procedure all animals were treated exactly the same, however, testing procedures were different for experiment 1 and 2. The test procedure for experiment 1 follows; the design of experiment 2 will be described later.

Experiment 1 involved 4 groups with 18 animals in each group. All animals had the 2 days of fear conditioning (8 CS-US pairings). Two groups of animals began extinction trials the day following conditioning day 2. For one of these groups the CS was the 80 db. white noise that was used in the conditioning phase, but for the other group the CS was a 60 db white noise generated by an identical model noise generator. Two other groups did not begin their extinction trials until 5 days later. During the 4 day waiting period these animals were kept in their home cages on their regular feeding schedule. They were, however,

handled each day. The handling procedure consisted of carrying them from their home cage to the conditioning room in the regular carrying box as though they were going to have a regular session, but they were immediately returned to their home cages. When the extinction tests began for these groups, for one of them the CS was the 80 db noise while for the other it was changed to the 60 db noise. The extinction sessions consisted of 4 CS presentations superimposed on the regular bar press session. Extinction was therefore the same as conditioning except of course that the US was not paired with the CS. The design of experiment 1 in summary is as follows: all animals were treated alike in the conditioning phase; all of them receiving 8 CS-US pairings. Two groups were tested in extinction on the day following conditioning--for one of them the CS was the same as used in conditioning, but for the other the CS intensity was changed. Two further groups were tested in the same way but test sessions did not begin until after a 4 day wait. All groups were given 5 days of testing.

It should be noted that the animals had been assigned to experimental conditions from the beginning of training, and care was taken to counterbalance the groups for time of day at which they were run and for conditioning unit in which they were trained.

Dependent measure

The measure reported is a suppression ratio that compares the animals rate of response during the CS to the rate during an immediately preceding period of equal duration. The ratio is B/A+B where B represents the number of responses during

the CS and A the number during the preceding 3 minute period. The ratio has a lower limit of 0.00 which would indicate that the CS completely suppressed the animals bar pressing, and an upper limit of 1.00 which would represent the theoretically possible case of an animal making some presses during the CS and none during the preceding period. A ratio of 0.50 would indicate that an equal number of presses were made in the CS and the preceding period. Ratios between .00 and .50 therefore represent varying degrees of suppression. The usual procedure is to work out an overall suppression ratio for each conditioning or test day. This ratio is computed from the sum of the "B" and "A" periods from the 4 trials that occur in a daily session.

RESULTS

Figure 1 shows mean daily suppression ratios for the pretest, conditioning, and extinction days. Table 1 shows the mean daily ratios for extinction days 1-5. No differences are evident on pretest or conditioning days, but a difference appears on the first extinction day. It is clear that if the CS used in extinction is the same as that used in conditioning it makes no difference whether the extinction is begun immediately (group 80-1) or after a 4 day wait (group 80-4). The curves for these two groups are almost superimposed. The two groups that get the changed CS do extinguish faster than the no-change groups. The main finding, however, is that the group that does not begin its tests until after a 4 day wait (group 60-4) extinguishes faster than any other group. The mean ratio for this group on extinction day 1 is .29, while the ratios for the other 3 groups are .06, .06, and .09 for groups 80-1, 80-4, and 60-1 respectively.

Table 2 presents the summary of an analysis of variance on the ratios for extinction day 1. The finding of interest is the significant Stimulus X Delay interaction which is due to the fact that the group tested after a 4 day delay, with a changed stimulus shows significantly more attenuation of suppression than any other group. The Scheffé critical value (at the .05 level of significance) for differences between the 4 means is 13; thus the 60-4 group differs from each of the other 3 groups but there are no differences within them.

A similar analysis performed on the day 2 ratios is summarized in table 3. The interaction is no longer significant.

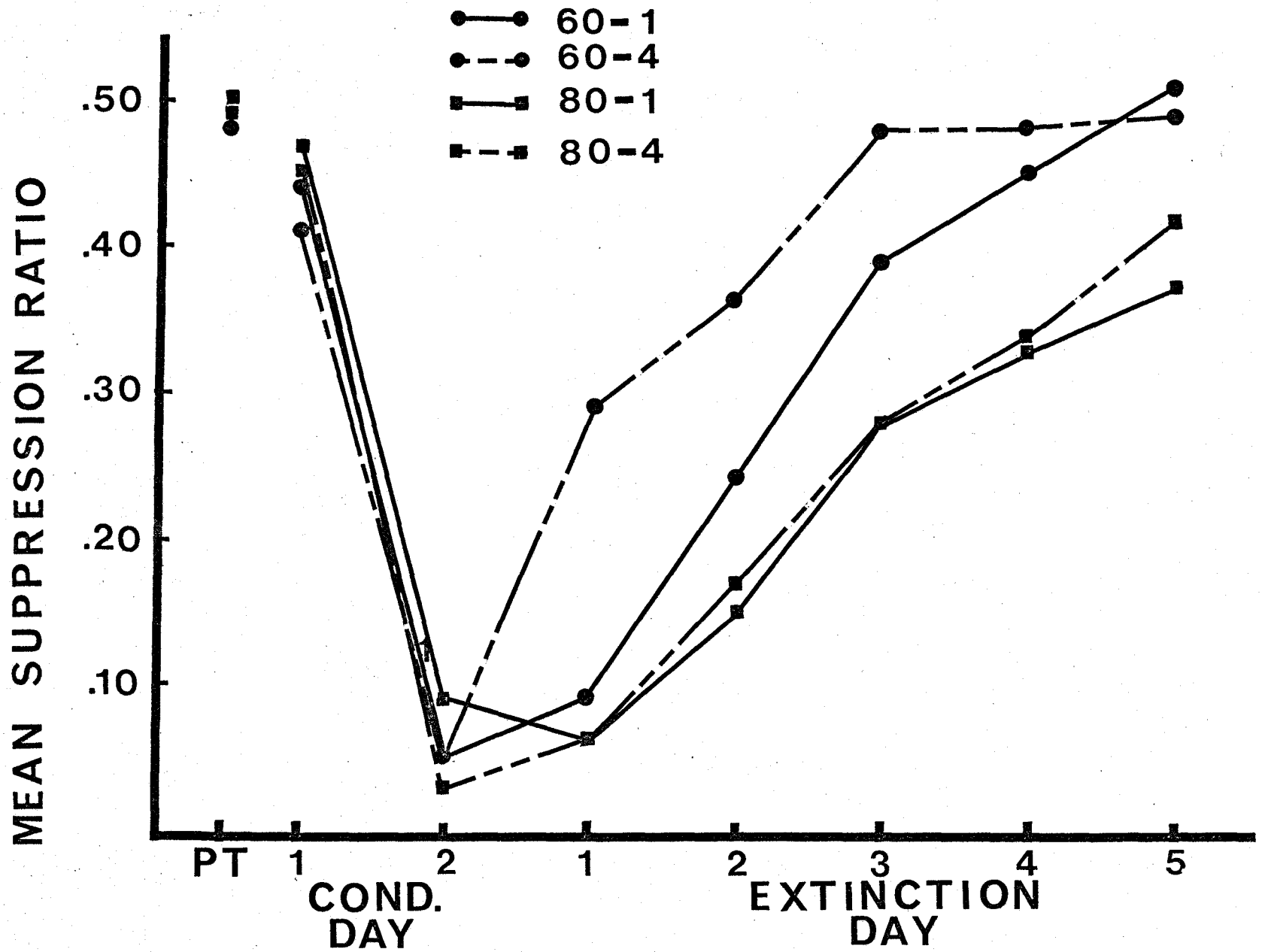

Figure 1. Mean daily suppression ratios for the Pretest, Conditioning and Extinction days for the groups in experiment 1.

Extinction Day

Group	1	2	3	4	5
60-1	.09	.24	.39	.45	.51
60-4	.29	.36	.48	.48	.49
80-1	.06	.15	.28	.33	.37
80-4	.06	.17	.28	.34	.42

Table 1. Mean Daily Ratios for extinction days 1-5 for Experiment 1.

Source	df	MS	F	P
Stimulus (60 or 80)	1	3016.05	16.25	$<.005$
Delay (1 or 4 days)	1	2005.55	10.80	$<.005$
Delay X Stimulus	1	1922.01	10.35	$<.005$
Error	68	185.65		

Table 2. Summary of analysis of variance on mean ratios of extinction day 1.

Source	df	MS	F	P
Stimulus (60 - 80)	1	3683.68	11.36	$<.005$
Delay (1 or 4)	1	793.34	2.44	NS
Delay X Stimulus	1	445.02	1.57	NS
Error	68	324.23		

Table 3. Summary of analysis of variance on mean ratios of extinction day 2.

	Trial (Extinction day 1)			
Group	1	2	3	4
80-1	.04	.05	.08	.09
80-4	.01	.02	.07	.12
60-1	.02	.07	.10	.13
60-4	.09	.29	.34	.39

Table 4. Mean day 1 trial by trial ratios for each of the groups in experiment 1.

This seems due to the fact that group 60-1 no longer shows significantly more suppression than group 60-4. The 4 means are .15, .17, .24 and .36 for groups 80-1, 80-4, 60-1, and 60-4 respectively. The Scheffé critical value here is .17. Thus although the 60-4 group is significantly less suppressed than either of the 80 groups, it is not significantly different from the 60-1 group. The difference between the two 60 groups is, however, still quite large and a Mann-Whitney U test (Siegel, 1956) shows them to be just significantly different at the .05 level with a one-tail test (U=108.5). This last comparison is presented only to indicate that there is still an appreciable difference between the 60-1 and 60-4 groups on the second day of testing.

Figure 2 shows the mean suppression ratios for each of the 4 trials of extinction day 1. Table 4 presents these trial by trial ratios for each of the groups. It is clear that the trial by trial data completely corroborates the findings derived from the analysis of the daily ratios. Although it can be shown that the 60-4 group is significantly less suppressed than the 60-1 group even on trial 1 (Median test, $X^2 = 4.3$, $p < .05$. Siegel, 1956), it is not until trial 2 that a gross difference appears. Figure 3 shows how the gradient of generalization steepens sharply after the 1st extinction trial.

To summarize the results briefly: it is clear that a change in the CS produces considerable attenuation of the suppression only when there is a conditioning-test interval of 4 days. Only the 60-4 group shows rapid extinction of the suppression on the first test day. This apparent sharpening of the generalization

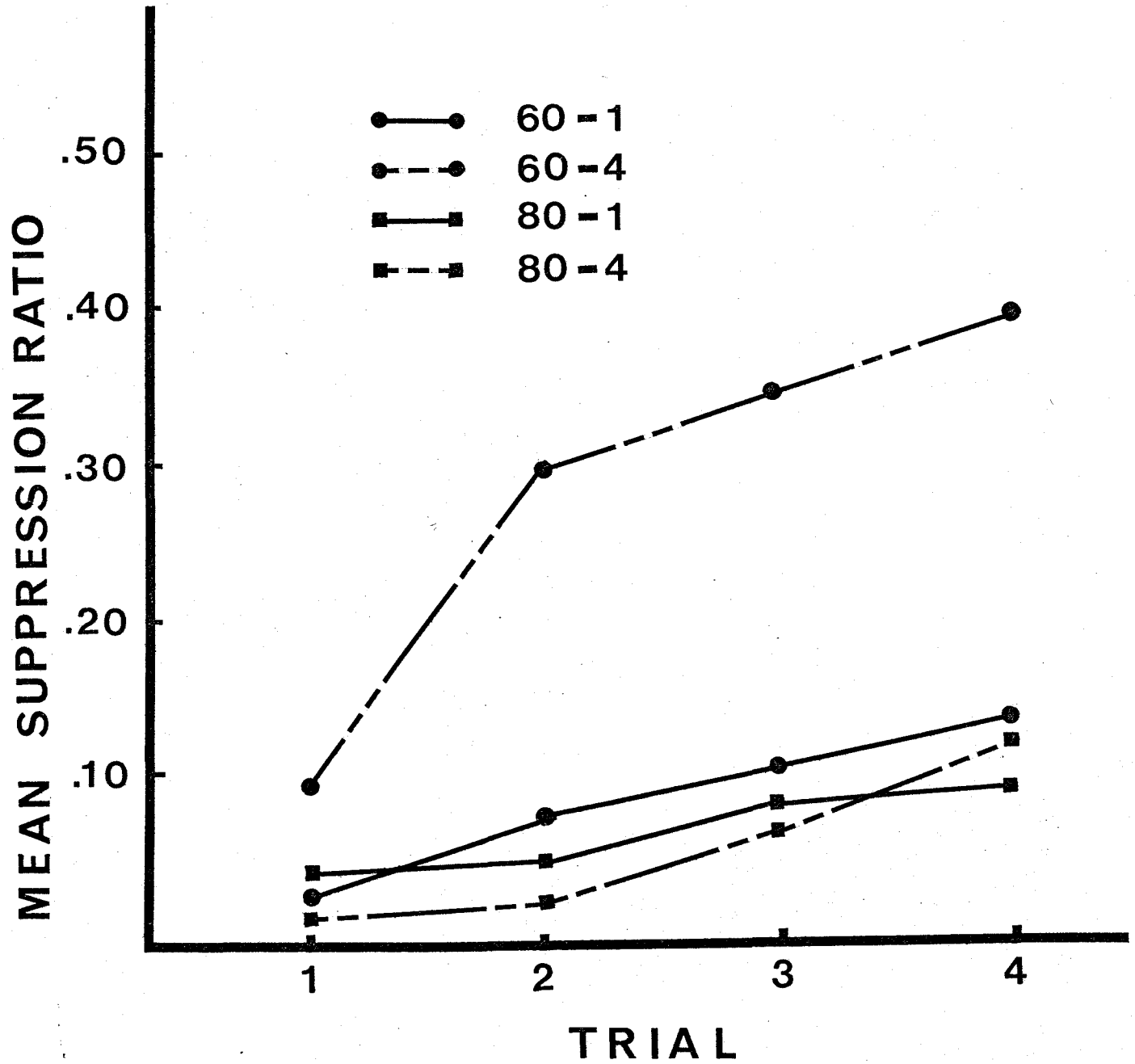

Figure 2. Mean suppression ratios for the separate trials of extinction day 1.

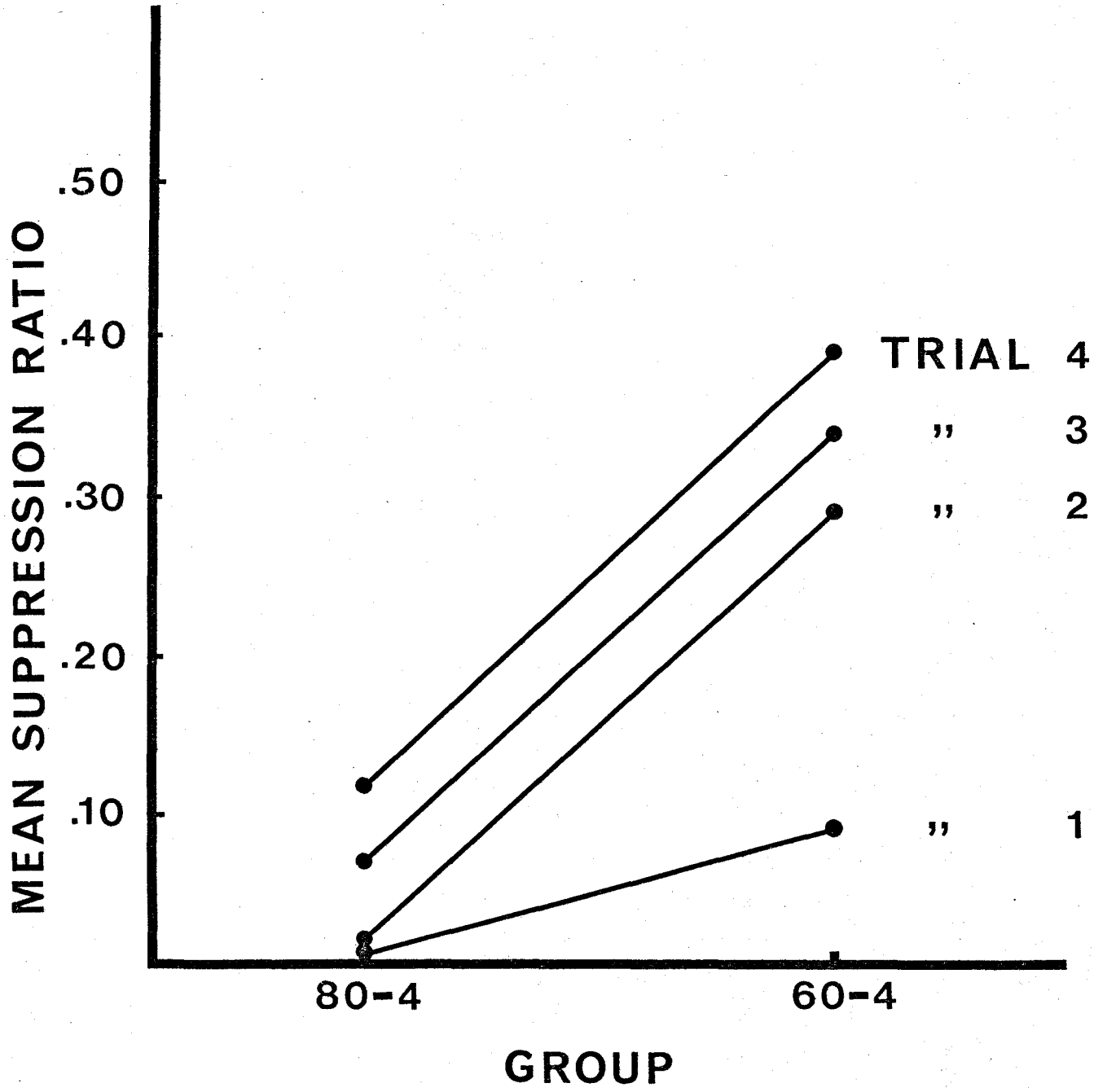

Figure 3. Generalization for each trial of extinction day 1.

gradient--greater generalization decrement after a period of time--is the effect that was predicted on the basis of the results described above in the introduction. In those groups the sharpening effect was found when the stimulus change was produced by adding or subtracting a new stimulus to the CS. The intramodal changes used here were also effective in producing differential amounts of generalization decrement depending on how soon after the conditioning the testing was begun.

Although the animals that were given the delayed test were carried to and from the conditioning apparatus each day, nothing else was done to them during the 4 day interval. One might expect the animals' experience during the waiting period to be of some significance. It might be, for instance, that animals tested only 1 day after conditioning are in a more "emotionally aroused" state since they have only recently been through a fear conditioning experience. The 4 day interval may allow dissipation of emotionality so that animals tested after a delay may be less fearful and hence more likely to show fast extinction of the suppression. Put another way, it might be that the animals tested immediately with the changed CS did not show more attenuation of suppression due to generalization decrement, because they were in a highly fearful state and therefore ready, so to speak, to suppress to anything, that is, the expected generalization decrement could have been to some extent offset by a high level of general emotionality.

If some sort of general fear dissipation takes place during the 4 day interval, the changed CS might lead to greater

attenuation of suppression because the expected generalization decrement is not offset by a high level of fearfulness.

One might expect that allowing animals to bar press each day of the 4 day period would allow for maximum dissipation of any generalized fearfulness. Animals that received further shocks during the 4 days presumably would not have the opportunity to dissipate fear. It might further be expected that animals given unsignalled shocks would be more generally fearful than animals that were fear conditioned with a specific CS. With the above notions in mind, the 3 groups of experiment 2 were tested.

EXPERIMENT 2

Preliminary training and conditioning for the 39 animals was exactly the same as described for those in experiment 1. All three groups (n = 13) were tested on the 60 db CS after a 4 day interval. In this respect they were the same as the 60-4 group of experiment 1, however, they differed from that group in terms of what happened to them during the 4 day interval. The animals in group A had a regular session of bar pressing on each of the 4 days. They were simply allowed to bar press for the 2 hour session. Group B's experience during the 4 days consisted of further conditioning trials. These animals received 4 CS-US pairings each day on the same schedule as in the conditioning phase of their training. The CS for these pairings was the onset of a 7 watt light; the US was the same 1 ma. shock. Group C was given 4 unsignalled shocks during each day's regular session. The rats in group C were prevented from bar pressing by the insertion of a plastic cover over the bar. The bar cover

was made of black plastic that was moulded into a rectangular, dish-like shape that was 3½" wide, 7½" high, and 3/4" deep. This cover, when fitted over the lever, extended from floor to ceiling of the Skinner-box.

RESULTS

Figure 4 plots the mean daily ratios for groups A, B, and C. The 60-4 group from experiment 1 is also included for comparison. Table 5 presents mean ratios for each of the extinction days for the 4 groups. Results are by no means clear cut. It would appear as though the original 60-4 group shows more attenuation of suppression than the other 3 groups, but an analysis of variance of the day 1 means failed to find any significant differences. ($F=1.39$, $p > .25$). Figure 5 plots mean suppression ratios for the separate trials of day 1. The means are presented in table 6. Again it seems as though the original 60-4 group, that received nothing but handling during the 4 day interval, is more extinguished. The day 1 trial by trial data were subjected to a Type I analysis of variance (Lindquist, 1953). Variety of experience during the interval was the "between" factor and trials was the "within". Table 7 gives the summary of the analysis. The only significant effect was the main effect of trials, which indicates simply that the animals were extinguishing over the 4 trials.

Though scarcely legitimate, some statistical support for the appearance of the data is that, on trial 2, the 60-4 group is significantly different from group A. A Mann-Whitney test on those two groups gave a U of 66 which is just significant at the .05 level for a two-tail test. Other than this slight

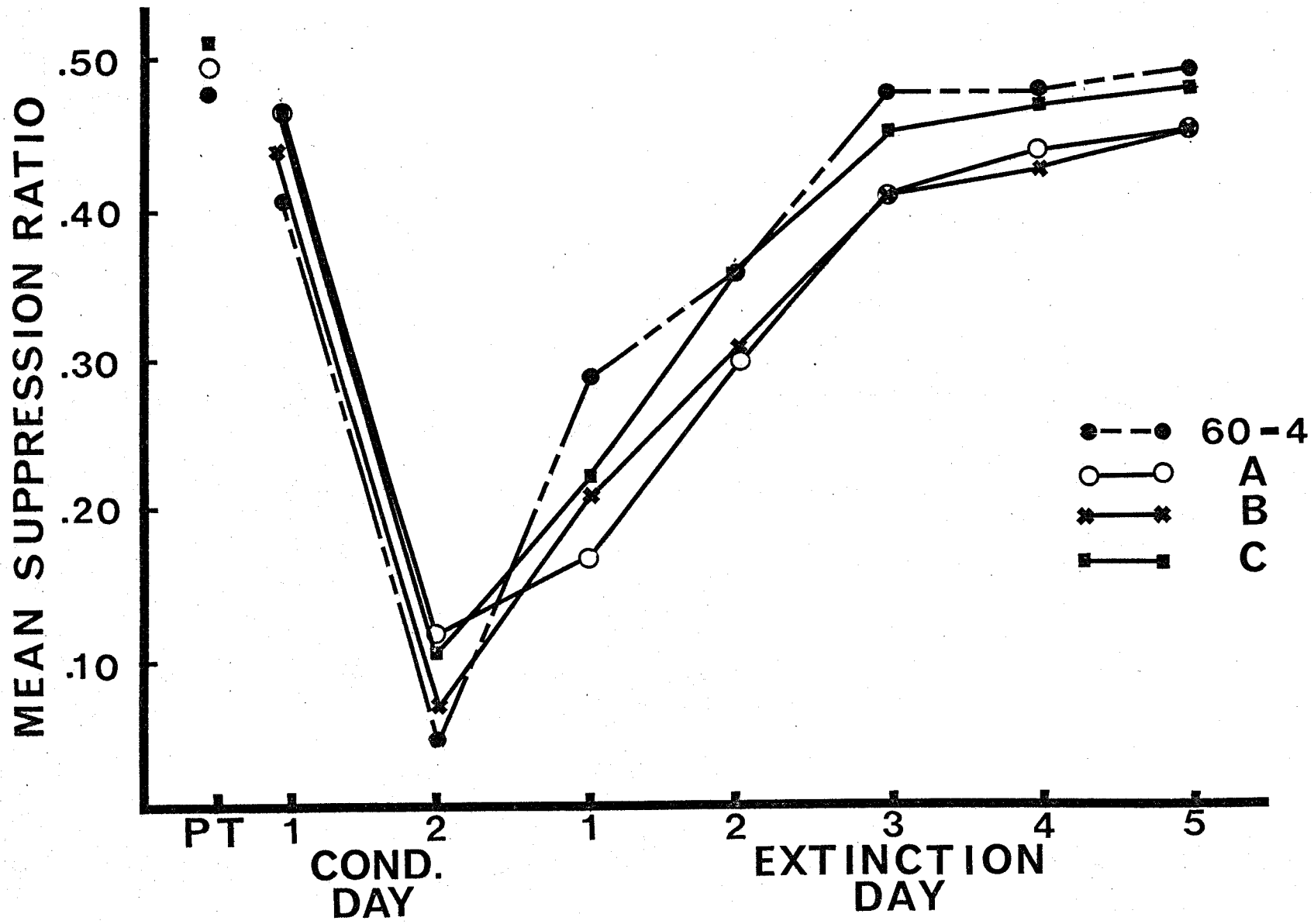

Figure 4. Mean daily ratios for the groups in experimental design 2.

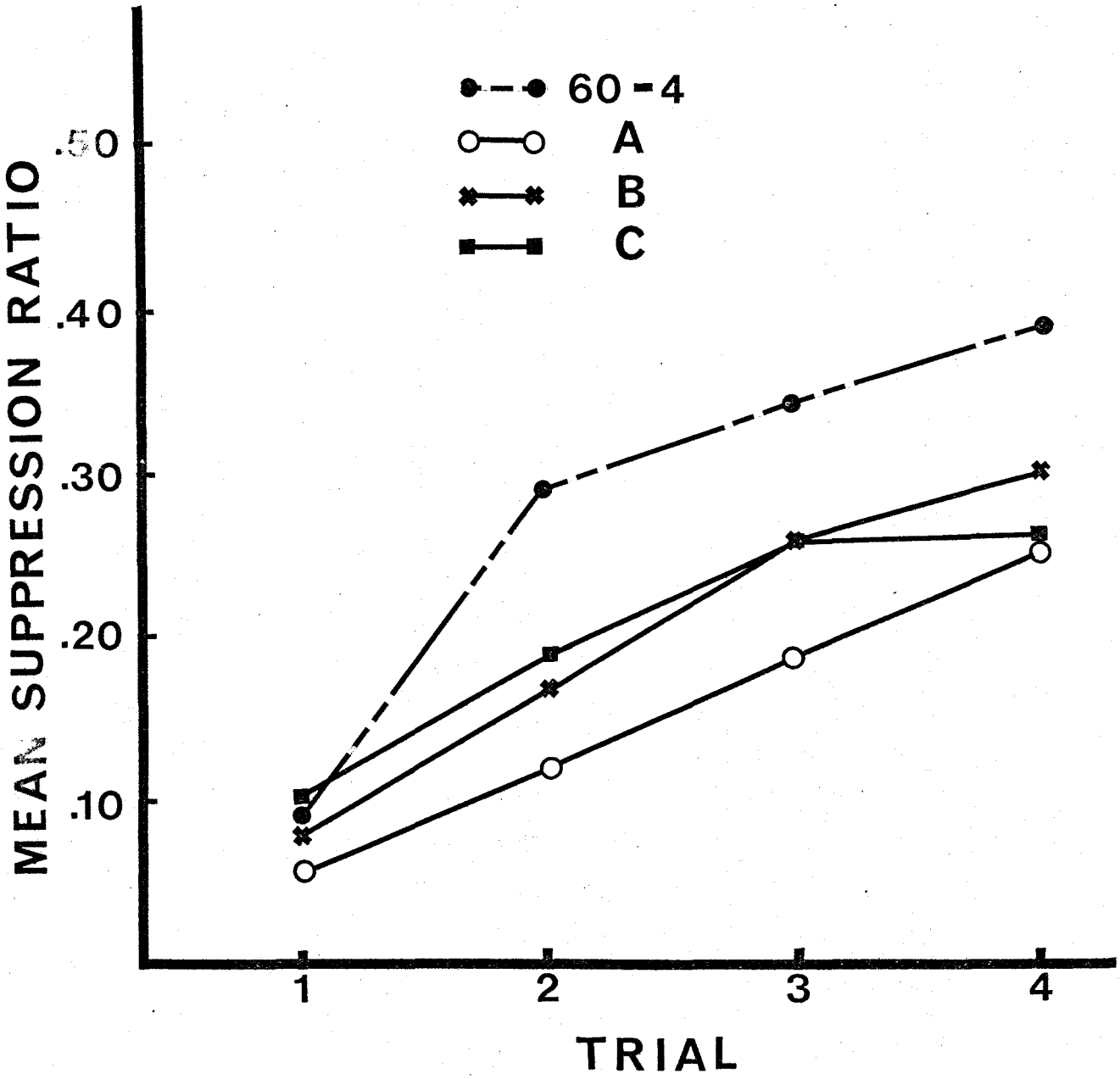

Figure 5. Mean suppression ratios for the separate trials of extinction day 1. (Experiment 2).

Extinction Day

Group	1	2	3	4	5
A	.17	.30	.41	.44	.45
B	.21	.31	.41	.43	.45
C	.22	.36	.45	.47	.48
60-4	.29	.36	.48	.48	.49

Table 5. Mean daily ratios for the 4 groups of experiment 2.

Trial

Group	1	2	3	4
A	.06	.12	.19	.25
B	.08	.17	.26	.30
C	.10	.19	.26	.26
60-4	.09	.29	.34	.39

Table 6. Mean suppression ratios for the 4 trials of day 1 for the 4 groups of experiment 2.

Source	df	MS	F	P
Groups (Treatment during 4 day interval)	3	1412.93	1.36	$<.20$
Error (between)	53	1036.46		
Trials	3	5368.90	36.25	$<.001$
Trials & Groups	9	148.11	1.08	$<.20$
Error (within)	159	137.52		

Table 7. Summary of type I analysis of variance on day 1 trial by trial ratios.

evidence for a between group difference it must be concluded that the different treatments during the 4 day period did not produce significant changes in the amount of generalization decrement.

DISCUSSION

The data of experiment 1 are clearly at variance with the findings outlined above in the historical introduction. Perkins and Weyant, (1958), Thomas and Lopez, (1962), and McAllister and McAllister, (1963, 1965), though using different procedures, all agreed in finding a flattening of the generalization gradient over a period of time. The present results are in line with those reported in the introduction above. In that changing the CS led to severe attenuation of suppression only if a period of 4 days was interposed between the conditioning and test sessions, a sharpening rather than a flattening of the gradient is indicated. Furthermore, this change in the shape of the generalization gradient does not appear until after at least 1 day wait, whereas McAllister and McAllister (1963) and Thomas and Lopez (1962) find a change, although in the opposite direction, after 24 hours.

Perkins and Weyant, and Thomas and Lopez, as an explanation of their results, simply hypothesize that over a period of time the animals forget the exact CS faster than they forget how to perform the conditioned response. This differential forgetting would have the effect of making the generalized stimuli seem more similar to the original CS, thus producing a flatter generalization gradient.

McAllister and McAllister, (1963, 1965) offer an explanation in terms of the number of jnd's that separate stimuli on a physical dimension. They redescribe their data in the following fashion. If two different stimuli from the same stimulus dimension are presented in close temporal contiguity, e.g., the second

being presented only 3 minutes after the first, more jnd's will separate them than if they were presented 24 hours apart. They report (1965) as support for such a mechanism a study with human subjects who more often judged lines of different lengths to be equal if an 8 minute rather than a ½ minute interval was interposed between presentations of the lines that were to be compared.

Both Perkins and Weyant's, and McAllister and McAllister's explanations fit well with what one might hypothesize after a commonsense consideration of the data. It is not unlikely that subjects, either animal or human, would after a period of time become confused about the precise attributes of a CS. One may "remember", for instance, that the CS was a tone but forget whether it was of 1000 or 2000 cps.

As was mentioned in the historical introduction, there have been reports that point to there being an incubation of fear over a time period of about 24 hours. (McMichael, 1966; Gray, 1964). In that the McAllister and McAllister experiments involved fear conditioning and a time interval of 24 hours, it is possible that a fear incubation explanation might be relevant to their data. They briefly consider such a possibility but immediately discard it because "an increased response strength to the original, as well as to the generalized, stimuli would be predicted". (1965, p. 580). It is possible however that the failure to find an increased response strength to the original stimulus was due to a ceiling effect. Keeping in mind also that a reduction in response strength is expected in the groups tested under "different" conditions whether or not the test is immediate or delayed, it may be that the "3 minute-different" group showed such poor performance because the

reduction in response strength due to the change in stimulus conditions was not offset at all by any incubation of fear effect. The changed stimulus conditions would not cause much reduction in response strength after 24 hours because of the prop of fear incubation. If such an explanation could be made more compelling with further evidence, McAllister and McAllister's data need not be at variance with the present results in that the apparent flattening of the generalization gradient could be accounted for in terms of changes in the fear response.[1]

In the present experiment all groups were maximally fear conditioned by the first trial of the second conditioning day. It is likely, especially in the light of McMichael's (1966) findings, that any incubation effect would have reached its asymptote by the beginning of the second conditioning day. He reports an apparent incubation of fear that reaches a maximum between 6 and 24 hours after the original conditioning.

It was, however, considered possible that the after-effects of having only recently been fear conditioned could have made the immediately tested groups more generally fearful and hence more likely to suppress to a changed stimulus. It will be recalled that such a consideration led to the testing of the groups in experiment 2. (page 20). It was thought that the animals in the group tested with a changed CS after a delay might be less generally fearful because there had been a 4 day period for fear or anxiety to dissipate. The results of experiment 2 did not support such a notion in that animals given further fear conditioning

[1]The author would also feel happier about McAllister and McAllister's (1963) results if measures other than latency of response had been presented.

or unsignalled shocks during the 4 day period could not be shown to be different from the 60-4 group of experiment 1 or from a group that had only bar-press sessions during the same interval. There was some slight evidence (page 21) that, if anything, the group allowed to bar press during the 4 days, showed most resistance to extinction of the suppression.

It can be said then that the results do not support an interpretation that would depend heavily on changes over time in the animals general state of fearfulness.

The trial by trial analysis of the first extinction day in experiment 1 revealed that the 60-4 group was significantly less suppressed than the other groups even on the first trial, but the difference was small in comparison to the differences that were evident on the succeeding 3 trials. This finding-- that the generalization gradient steepens dramatically after the first extinction trial-- is in line with the studies mentioned in the historical introduction that reported a sharpening of the generalization gradient over extinction trials. (Desiderato, 1964; Hoffman, 1965).

As a conclusion little more than a restatement of the basic finding can be offered. Whether the extinction tests are begun 1 or 4 days after conditioning makes no difference to the rate of extinction of a conditioned emotional response so long as no change is made in the CS. The conditioned response seems just as stable after a 4 day interval as it is 1 day after conditioning. The rate of extinction of the conditioned suppression to a generalized stimulus, in this case a stimulus 20 db lower in intensity, is,

however, quite different depending on whether the tests are begun 1 or 4 days after conditioning. What happens to the animals during the 4 days seems to make little difference; it is simply as though the generalized conditioned response has in some manner become weaker.

Before an adequate explanation of the phenomenon can be given, further research is clearly called for. It should be established, for instance, what delay interval is crucial for the production of the phenomenon. Also different magnitudes of stimulus change, including changes that involve an increase in intensity, would allow a more precise description of the effect.

SUMMARY

Various reports indicated that the slope of the gradient of generalization changes over a period of time. The experiments reported above investigated the generalization of a conditioned emotional response, originally conditioned to an 80 db white noise, to a 60 db white noise. In different groups the tests for generalization were begun immediately after conditioning or after a 4 day waiting period. Experiment 1 established that the groups tested after the delay period with a changed CS extinguished more rapidly than any other group.

Experiment 2 indicated that what the animals did during the 4 day interval made little if any difference. Three groups were tested, with a changed CS, after a 4 day period that was variously taken up with bar pressing sessions, fear conditioning with a new (light) CS, or unsignalled shocks.

The results were related to other findings and dis-

crepancies were noted. A tentative conclusion was that generalized conditioned responses become weaker over time and are thus more rapidly extinguished.

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APPENDIX

RAW DATA: EXPERIMENT 1 (in all cases the decimal point, which comes before the two digits has been left out).

d

Group 60-1 Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	52	41	00	01	01	28	49	51
2	47	37	00	00	00	20	41	49
3	51	32	00	25	43	60	58	55
4	52	59	08	02	08	12	42	58
5	43	34	02	28	48	52	45	45
6	40	55	35	48	46	49	51	52
7	55	37	00	00	00	00	08	41
8	45	36	03	05	31	43	41	49
9	49	45	01	00	14	47	49	50
10	55	53	08	00	03	20	41	51
11	46	50	00	02	32	47	48	49
12	54	42	01	15	47	53	55	57
13	36	41	20	03	32	38	42	50
14	60	50	01	00	42	52	51	59
15	51	48	04	00	14	42	48	51
16	47	46	01	14	50	53	54	61
17	41	33	02	10	19	53	36	41
18	47	49	01	00	06	32	49	50

Group 60-4 Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	48	39	00	00	14	40	44	43
2	55	36	02	04	29	43	47	46
3	49	41	00	45	50	51	40	48
4	51	49	02	26	38	51	48	44
5	43	43	00	00	02	30	47	50
6	46	45	00	54	34	45	51	50
7	56	49	02	34	50	55	51	53
8	50	35	00	20	23	38	41	51
9	44	43	01	43	40	50	50	48
10	60	37	01	21	56	57	55	55
11	48	47	02	31	36	*	*	*
12	08	13	02	46	52	55	48	52
13	59	53	27	44	34	49	48	53
14	44	36	05	42	40	51	48	49
15	44	37	00	00	00	*	*	*
16	51	32	01	27	43	47	54	49
17	51	51	30	47	56	50	47	50
18	51	50	08	45	48	49	52	49

*These ratios were lost because of experimental error

Group 80-1 Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	43	40	01	01	09	15	27	38
2	43	38	02	00	01	06	12	30
3	59	52	07	05	23	43	51	50
4	41	52	30	43	50	63	56	50
5	48	42	01	00	00	01	09	18
6	43	56	06	07	42	53	43	49
7	48	41	02	02	02	03	03	05
8	59	40	00	00	00	00	00	02
9	48	45	03	00	00	00	00	00
10	46	47	04	11	32	53	43	45
11	54	57	06	00	00	03	23	38
12	49	41	08	00	05	36	45	51
13	46	46	29	30	46	47	51	51
14	67	61	23	03	39	53	47	54
15	51	39	03	02	10	29	39	43
16	63	45	00	00	00	33	46	56
17	42	47	16	01	04	27	38	41
18	46	59	19	01	05	42	53	48

Group 80-4 Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	54	48	04	00	00	02	17	27
2	63	39	00	00	00	02	27	46
3	47	54	03	02	17	36	33	42
4	48	35	01	03	12	23	31	29
5	47	30	03	00	00	04	41	42
6	46	42	06	33	55	59	45	53
7	50	49	01	01	01	04	07	18
8	47	38	00	23	51	50	50	56
9	47	34	02	20	29	*	*	*
10	44	52	01	00	01	12	14	22
11	52	41	00	00	17	22	30	51
12	60	57	02	00	15	57	53	56
13	40	42	06	01	01	*	*	*
14	54	60	05	05	34	47	59	52
15	45	45	16	13	36	47	43	51
16	47	48	04	00	08	33	47	48
17	49	43	02	00	00	00	08	23
18	46	59	03	09	21	48	46	51

*These ratios were lost because of experimental error.

Expt. 1. Trial X Trial Ratios for Extinction Day 1

Group 60-1					Group 80-1				
	Trial					Trial			
Subject	1	2	3	4	Subject	1	2	3	4
1	00	00	00	00	1	00	00	00	00
2	00	00	00	00	2	00	00	00	00
3	00	00	00	00	3	00	00	00	00
4	00	04	04	02	4	02	00	04	02
5	00	01	24	30	5	04	23	30	31
6	01	00	16	35	6	07	00	00	00
7	00	00	01	04	7	00	00	00	00
8	00	00	00	00	8	02	22	51	42
9	00	02	04	26	9	00	01	03	00
10	00	00	00	00	10	02	00	00	00
11	00	02	00	00	11	01	01	02	00
12	00	00	00	00	12	00	00	00	01
13	00	19	24	45	13	02	00	06	13
14	00	00	33	00	14	40	40	45	46
15	03	43	27	27	15	00	00	00	00
16	38	51	51	51	16	00	04	02	19
17	00	00	00	00	17	04	00	00	02
18	00	00	00	15	18	00	00	00	00

Group 60-4					Group 80-4				
	Trial					Trial			
Subject	1	2	3	4	Subject	1	2	3	4
1	09	61	49	48	1	02	15	27	29
2	00	05	29	34	2	00	00	00	00
3	00	04	58	36	3	00	02	00	00
4	34	56	53	36	4	00	00	00	00
5	14	32	48	65	5	00	00	02	02
6	03	51	51	48	6	04	00	04	09
7	00	00	00	00	7	00	00	11	39
8	00	16	34	48	8	00	00	00	00
9	22	53	52	53	9	00	00	00	00
10	14	52	49	54	10	06	03	17	13
11	00	00	00	00	11	01	00	00	00
12	03	00	00	08	12	00	00	00	00
13	27	42	58	48	13	00	00	00	07
14	00	23	36	37	14	03	02	03	08
15	00	00	00	00	15	00	00	00	00
16	30	72	53	46	16	02	04	41	66
17	00	40	20	53	17	00	01	01	01
18	02	17	20	34	18	00	00	26	50

Experiment 2.

Group A (Bar Press Only), Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	46	43	00	01	01	05	11	16
2	58	27	00	00	07	35	46	40
3	49	42	00	04	32	36	52	46
4	50	48	07	12	31	47	48	51
5	45	49	37	30	46	48	48	49
6	49	58	09	00	00	34	40	42
7	55	50	06	32	51	51	51	51
8	50	52	22	33	46	47	46	46
9	43	49	41	37	49	51	51	49
10	52	50	26	00	10	36	47	44
11	51	49	04	21	35	45	47	52
12	54	49	01	10	41	54	49	48
13	45	40	09	42	47	42	36	46

Group B (Further Conditioning With Light CS) Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	54	43	02	01	02	19	24	42
2	50	48	01	00	17	42	52	46
3	49	32	03	00	00	09	08	08
4	57	58	18	24	45	46	47	49
5	51	42	00	00	12	35	44	45
6	47	53	47	50	49	48	56	54
7	49	48	01	14	39	48	52	50
8	48	43	02	20	12	45	42	37
9	43	49	09	29	43	51	50	54
10	51	44	03	28	30	45	39	46
11	26	22	03	39	48	51	40	52
12	47	45	02	38	50	56	49	55
13	51	47	00	35	57	36	50	49

Group C (Unsignalled Shock) Daily Ratios

Subject	Pretest	Conditioning Day 1	Conditioning Day 2	Extinction 1	Extinction 2	Extinction 3	Extinction 4	Extinction 5
1	44	44	01	00	25	30	30	46
2	53	49	23	43	45	52	50	53
3	47	49	02	00	00	25	36	46
4	50	56	03	28	51	45	44	39
5	49	48	15	31	47	50	54	55
6	52	52	22	15	27	47	51	50
7	60	59	46	48	54	58	58	51
8	46	29	01	25	28	42	52	44
9	53	39	00	30	36	49	58	45
10	45	44	03	01	35	48	46	47
11	57	47	05	09	40	53	50	61
12	43	48	14	12	37	46	47	52
13	59	44	02	43	45	43	41	35

Experiment 2.

Trial X Trial Ratios for Extinction Day 1

	Group A				Group B				Group C			
	Trial				Trial				Trial			
Subject	1	2	3	4	1	2	3	4	1	2	3	4
1	00	00	00	02	00	00	00	03	00	00	00	00
2	00	00	00	00	00	00	01	00	39	43	49	41
3	00	00	00	15	00	00	00	00	00	00	00	00
4	00	00	18	24	00	11	33	36	00	33	15	36
5	05	15	35	47	00	00	00	00	00	22	39	43
6	00	01	00	00	51	49	45	56	17	15	12	17
7	02	19	31	52	00	12	16	25	12	46	57	65
8	11	32	39	42	00	00	29	42	07	29	21	29
9	33	42	40	34	04	22	36	44	00	07	45	44
10	00	00	00	00	00	40	35	36	50	00	00	00
11	00	00	26	41	26	30	55	40	00	06	14	08
12	00	03	11	23	03	34	45	48	00	02	25	13
13	29	41	43	47	09	18	40	63	00	46	58	43