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Transfer of training from an established operant to a subsequently acquired Pavlovian response.

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Transfer of Training from an Established

Operant to a Subsequently Acquired

Pavlovian Response

A Thesis Presented

by

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Abstract

Transfer of training was observed between
an established operant appetitive discrimination
and a subsequently acquired differential Pavlovian
response, the nictitating membrane response,
using 23 New Zealand White rabbits as $\underline{S}$s. Pure
tones served as discriminative stimuli in both
phases of the experiment. The results indicated
negative transfer in the Experimental Group when
compared with operant control conditions of food
alone and tones alone but slightly positive
transfer when compared to a random tone plus food
group.

September, 1968

TRANSFER OF TRAINING FROM AN ESTABLISHED

OPERANT TO A SUBSEQUENTLY ACQUIRED
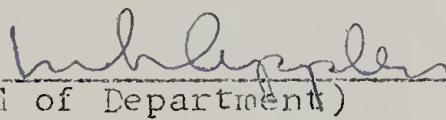
PAVLOVIAN RESPONSE

A thesis Presented

by

Alan B. Ashton

Approved as to style and content by:

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(Chairman of Committee)

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(Head of Department)

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September, 1968

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Two process learning theory, as outlined by
Rescorla and Solomon (1967), identifies Pavlovian
conditioned responses as important mediators of
instrumental behavior. As an animal learns to
press a lever for a food reward there exist suf-
ficient conditions for the establishment of con-
ditioned cardiac and cardiovascular changes, con-
ditioned gastrointestinal reactions, conditioned
glandular reflexes, and so forth. The central
representations of these varied conditioned re-
flexes plus their resultant feedback may logically
be assumed to create a "central state" within the
organism which might then mediate further instrument-
al behavior. Thus, experiments which manipulate
Pavlovian conditioned reflexes prior to the learning
of a relevant, or perhaps even an "irrelevant",
instrumental task should demonstrate differential
effects dependent on the direction of the condition-
ing.

For example, Bower and Grusec (1964) paired
water with a discriminative CS+ and the absence
of water with a CS- using thirsty rats as subjects.
Prior to this the animals had been trained to bar
press for water--without any tonal stimuli.
Finally the subjects were required to learn an S^D--

S^Δ discrimination, half of the group experiencing the previous CS+ as the S^D and the other half finding the positive CS as an S^Δ. It was found that the consistent group (CS+ to S^D) learned the discrimination faster than the inconsistent group presumably because of the facilitory effects of appetitive Pavlovian conditioned CRs.

A number of investigators have employed such transfer paradigms to study the effects of Pavlovian conditioning upon a subsequently acquired instrumental response. Transfer, positive and/or negative, has been demonstrated within a discriminative appetitive situation (Bower & Grusec, 1964), a non-discriminative aversive situation (Rescorla & LoLordo, 1965), and a discrimination reversal (Trapold, 1966). The sum of these experiments has been used as support for the two process approach to learning theory (cf. Rescorla & Solomon, 1967).

Although two process theory does not deny the possibility of transfer from an established operant response to a subsequently acquired classically conditioned response no study to date has attempted to demonstrate such a phenomenon. Experiments of this sort would serve to focus attention on the "order effects" in the interaction of the two processes

(Rescorla & Solomon, 1967, page 177). It might
be assumed, for example, that an S^D establishes a
motivational or "excitatory" state within the
organism, mediated by Pavlovian conditioned re-
flexes, which modulates any subsequently learned
(or conditioned) response whether or not that
response is compatible or in the least way similar
to that in the original learning situation.

If this is true then it would be expected
that an animal which received consistent operant
appetitive discrimination training would show
savings in a classical aversive differential para-
digm over an animal that did not receive such
operant training. It is the purpose of the pre-
sent investigation to test this prediction.

The New Zealand White rabbit meets a require-
ment of versatility in that it is easily adapted
to both the operant learning situation and the
classical conditioning paradigm. In the present
investigation one group of rabbits (Discrimination
Group, D) received operant discrimination training
prior to differential conditioning sessions of the
nictitating membrane response. The S^D in the
instrumental phase became the CS+ in the classical
conditioning phase for all the subjects in that

group. Thus, the experimental design involved two presumably independent response systems and two widely different test situations; the only common factors being the organism and the discriminative stimuli.

Three control groups were run to assess the transfer effects in the experimental manipulation. In Group CTF (control: tones and food) Ss received operant bar press training and were reinforced according to the same schedule as the experimental subjects, the only difference being that the tonal stimuli used as discriminative cues for the former group did not reliably reflect S^D or S^{Δ}; each stimulus was reinforced 50% of the time. In this way the effects of the learned discrimination on the subsequent classical conditioned response could be evaluated separately from those of "adventitious" classically conditioned responses to the tonal stimuli.

Second, to evaluate any other effects of the pattern of conditioned reflexes established during the learning of the instrumental response, eg. glandular reflexes, conditioned cardiovascular changes, and the like, Group CF (control: food) learned to bar press for food according to the same

reinforcement schedule as for the first two groups but without the tonal cues.

Finally, as a test for the effects of mere experience with the discriminative stimuli Group CT (control: tones) received the same pattern of of pure tones as the experimental group but was not trained to bar press for food.

The experimental group, then, was expected to differentiate better in the Pavlovian conditioning phase than the subjects in the three control conditions.

Method

Subjects

Subjects (Ss) in the present investigation were 28 naive New Zealand White rabbits, 90-120 days old at the outset of the experiment, divided equally into four groups. All Ss were placed on a 23 hour deprivation schedule two weeks prior to the beginning of training. Throughout the experiment Ss were run on alternate days with the exception that once per week an extra day was skipped so that a given group would be trained on the same days each week (ie. Monday, Wednesday, Friday). Pellets earned during training sufficed for feeding and no additional food was given on

those days Ss were run with the exception of Ss in Group CT which were given compensatory feedings approximately equivalent to that earned by the other groups. All Ss were allowed access to food for one hour on days that they were not run.

Apparatus, Operant

The operant test chamber consisted of a plexiglas box, 24 in. long by 20 in. high by 15 in. wide, with two audio speakers on the rear wall to deliver masking noise and the tonal stimuli. The front wall contained a food magazine (4 in. wide, 3-1/2 in. long, 1-1/4 in. deep) and a Lehigh Valley, model 1405 M, retractable lever; the lever being 2-1/2 in. from the floor of the chamber. The floor of the operant chamber consisted of 1/4 in. stainless steel rods 3/4 in. apart (center to center). A modified Davis model PD-104 feeder delivered single pellets of standard Purina rabbit lab chow to the food magazine.

House lighing was provided by a 15-watt incandescent light source suspended centrally above the test chamber. Tonal stimuli were supplied by two Hewlett-Packard signal generators (75 dB SPL at the center of the chamber). White noise (70 dB SPL) masked extraneous auditory stimuli throughout

operant training.

Procedure, Operant

Subjects in three of the groups were given bar press training for food reward in the absence of any discriminative cues to be used later in the experiment. Subjects in the experimental group (D) were then given discrimination training with a 400 Hz. tone serving as the S^D and a 1000 Hz. tone serving as the S^Δ. The first control group (CTF) also received food for bar pressing but the tonal stimuli did not reliably signal S^D or S^Δ; tones were randomly reinforced with the restriction that responses to both tones be equally rewarded (50% reinforcement on each). A second control (CF) did not experience the tones but was allowed to bar press for food according to the same schedule as Groups D and CTF. Finally, the third control (CT) did not receive bar press training but was merely allowed to experience the tonal stimuli to the same extent as Groups D and CTF.

Operant training lasted for a total of 21 sessions. Each session consisted of 30 trials with an average intertrial-interval of 30 seconds. For the two groups that experienced tones and food (D and CTF) the tone onset preceded the appearance

of the bar by 5 sec. and terminated as the lever was removed. This same arrangement followed for Group CT except that a lever press did not cause a food pellet to be delivered. The bar appeared at the same intervals for Group CF but there was no tonal signal. During the first four sessions the lever was present in the chamber for 20 sec., during sessions 5 through 8, 10 sec., and, finally, in sessions 9 through 21 the animal had only 5 sec. in which to respond. On reinforced trials each depression of the response lever caused one food pellet to be delivered. Through the use of a discrete-trial operant it was hoped that the temporal similarities of the two experimental situations would be increased.

Subsequent to the 20th training session each S was prepared for the classical conditioning phase of the experiment. At that time a nylon loop was sutured into the nictitating membrane of the right eye and two stainless steel wound clips were attached, one just below and the other just posterior to the same eye. In order to minimize the possibility of injury to the animals during the surgical preparation 1 c.c. of chlorpromazine (Thorazine) was administered intraperitoneally 15 minutes prior to the operation. All Ss were habit-

uated to the restraining boxes and the experimental chamber (see below) for one hour after the surgical preparation was completed.

The 21st operant training session served as a post-operative test to indicate any disruption of performance resulting from the surgical preparation; none was observed.

Apparatus, Pavlovian

A detailed description of the apparatus and techniques used in conditioning the rabbit's nictitating membrane may be found elsewhere (Gormezano, in Sidowski, 1966, Pp. 405-410). Four Ss were run concurrently in a 4-drawer, ventilated file cabinet. Each drawer was front illuminated and had a compliment of three audio speakers to deliver tonal stimuli and masking noise. Each S was placed in a plexiglas restraining box identical to those described by Gormezano. A rotary Minitorque potentiometer (Giannini no. 85153) was attached to an earbar style headmount and further connected to the nylon suture such that the lateral movement of the membrane could be monitored. Amplification and recording was done by a 4-channel Grass ink writing oscillograph at a paper speed of 100 mm./sec.

Procedure, Pavlovian

Six sessions of differential conditioning followed operant training. Each session consisted of 120 trials with an average intertrial-interval of 30 sec. A 400 Hz. tone (70dB SPL at the position of S's head) served as the CS+ for all Ss while a 1000 Hz. tone (70 dB SPL) was the CS-. CS+ and CS-trials were equated in blocks of 20 trials for purposes of analysis. The UCS was a 2 mA. ac shock of 50 msec. duration delivered to the S via the stainless steel wound clips attached near the right eye. The interstimulus-interval was 630 msec. The CS+ terminated with the UCS so that its total duration was 680 msec.; CS- was maintained for a like duration.

A conditioned response (CR) was defined as a positive deflection of the recording pen greater than 1 mm. within the CS-UCS interval.

Results

Operant

Figure 1 depicts operant performance attained by Groups D and CTF for session 9 through 21. An analysis of variance performed on the data (sessions 9 through 20) indicated that Group D responded differentially to the stimuli ($F=19.45$, $df=1/12$,
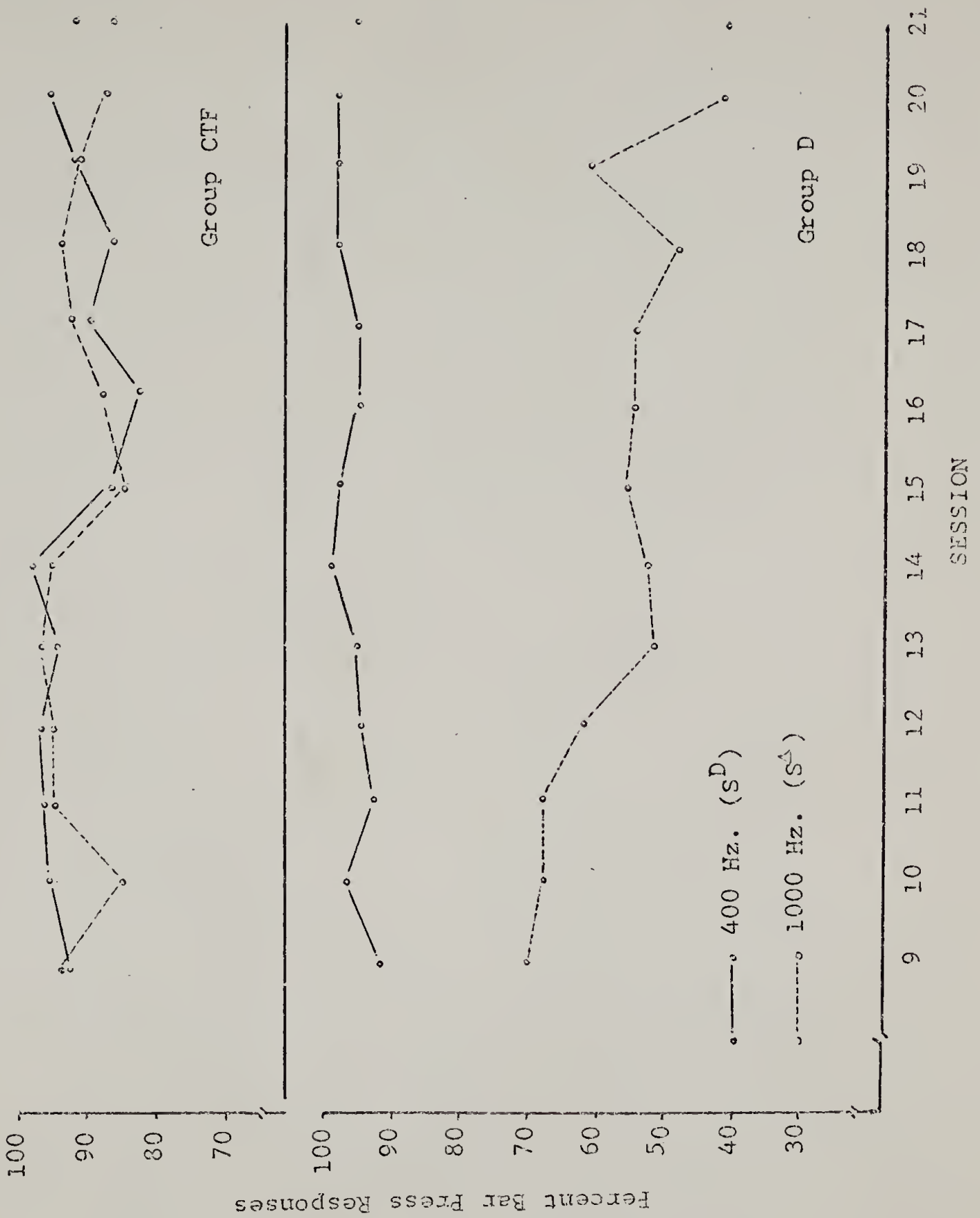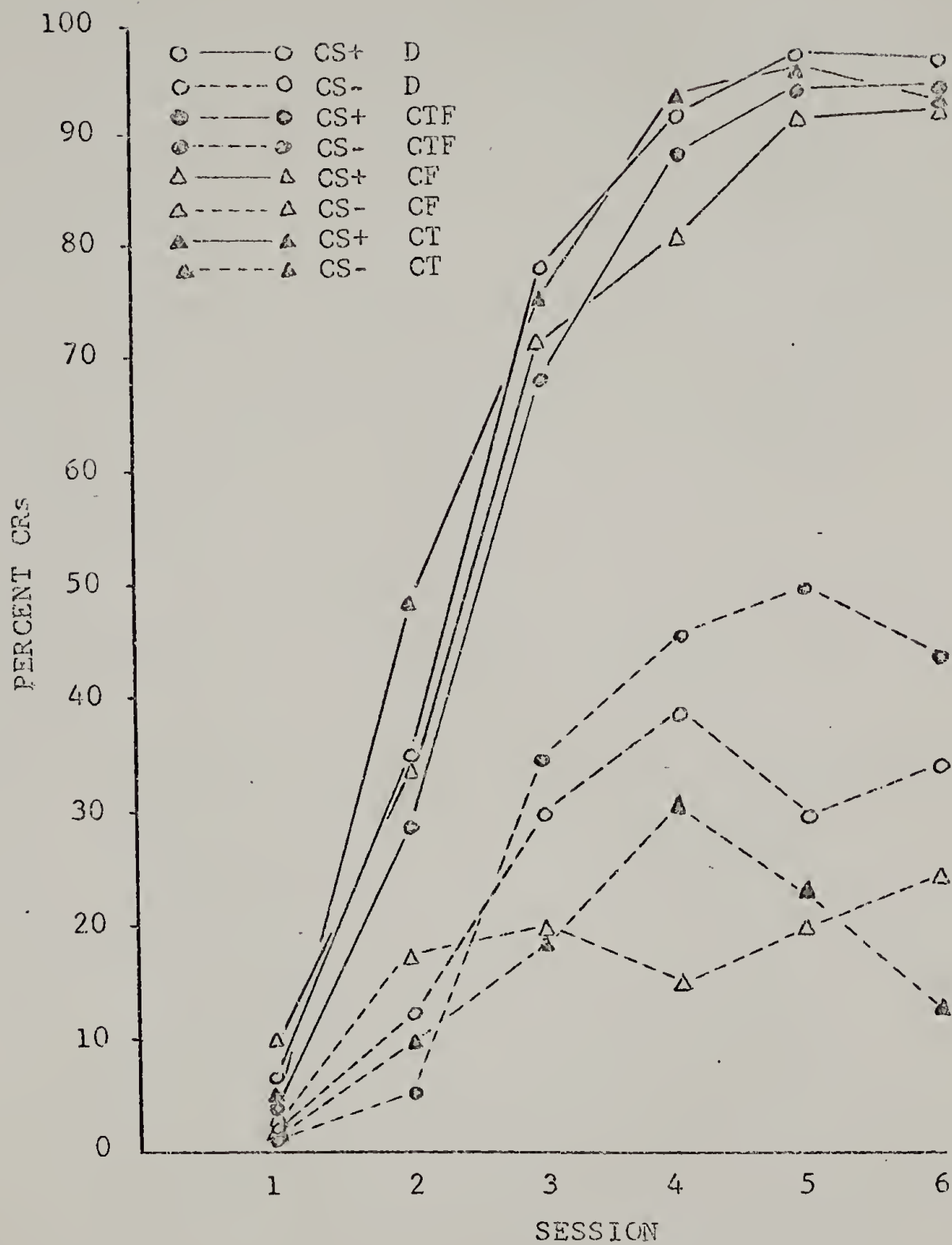
Figure 1

Figure 2

$p<.001$) and that discrimination performance had
increased over sessions ($F=2.12$, $df=11/132$, $p<.025$).
In addition, an analysis involving the mean total
number of bar presses over sessions 9 through 20 for
Groups D, CTF, and CF showed no significant differ-
ences ($F=1.27$, $df=2/18$, $p>.10$). Although no
statistical tests were performed on the performance
during the post-operative test session no aberrant
behavior was observed among any of the subjects.
On the average, however, responding was slightly
lower and discrimination slightly poorer--this
probably being a result of drug aftereffects.

Pavlovian

Percent CRs to CS+ and to CS- are plotted in
Figure 2 for all groups. An analysis of variance
performed on the data yielded a significant Groups
by Differentiation interaction, $F=3.59$, $df=3/24$,
$p<.03$, indicating that the preconditioning manipu-
lations did exert differential effects on condition-
ing performance. A visual inspection of the data
revealed that the two groups which had experienced
tones and food were similar as to classical dif-
ferential performance and that both were different
from the remaining two groups. If the difference
proved to be significant it could be argued that

Table 1

Conditioning Session

1	2	3	4	5	6
-.47	-.56	+.47	+.02	-.70*	-.41

* p<.05

Correlation coefficients comparing
operant and Pavlovian conditioning

Table 1

classical appetitive conditioning, common to Groups
D and CTF, rather than instrumental learning was
responsible for the observed effects. A further
analysis of the Groups by Differentiation inter-
action, however, failed to show a significant dif-
ference between Groups D and CTF when compared to
Groups CT and CF ($F<1$).

Because it appeared that prior instrumental
training involving the same stimuli as used in
the classical conditioning phase had had a detri-
mental effect on the degree of differentiation,
(see Figure 2, Groups D and CTF) a correlation
was computed compairing instrumental performance
(an average of sessions 15 through 20) and each
day of classical conditioning for Group D. In
order to make such a comparison discrimination
performance, instrumental and classical, was first
expressed in terms of a ratio, the index of relative
differentiation (Restle & Beecroft, 1955).[1]
Correlation coefficients are shown in table 1.
With the exception of days 3 and 4 all correlations
were negative suggesting that the better the
performance in the instrumental phase the poorer
the performance in the classical phase.

Discussion

The significance of the Groups by Differentiation interaction in the analysis of the classical conditioning phase of the experiment indicates that the pre-conditioning manipulations did exert differential effects on later conditioning performance. Contrary to expectations, however, the differential performance was poorest for Groups D and CTF. It would seem that the prior pairing of a primary reinforcing stimulus (ie. food) with stimuli which are to become aversive conditioned stimuli results in a decrement of conditioning performance--this, at least, in a differential paradigm. Although it would be tempting to generalize this statement to include simple non-differential conditioning such an extention would not be supported by the present results for the positive stimulus.

Since Groups D and CTF differ in Pavlovian differential performance from Groups CT and CF (albeit not significantly) it would appear that it is not the instrumental learning, per se, but rather the concurrently established positive, classical conditioned responses and their resultant feedback which exert an influence on later aversive conditioning. To the extent that these responses are

elicited by an external stimulus (ie. the S^D-CS+)
they should be expected to influence ongoing behav-
ior. The present experimental design, unfortunately,
does not permit an adequate test of this supposition
although some support may be found in the correla-
tions of instrumental and classical performance.
If one entertains the belief that good operant
discrimination performance reflects well defined
mediating conditioned reflexes then the negative
correlation obtained for Group D could be inter-
preted as representing the decremental effects of
that set of positive appetitive reflexes upon
conditioning performance. A more adequate test of
this supposition would be to vary classical condi-
tioned appetitive responses in a restrained animal
through the use of an intraoral fistula or another
similar procedure.

If the animal who discriminates well in the
operant phase of the experiment has well established
conditioned "excitatory" and "inhibitory" states,
it seems curious that there should be a net negative
transfer in subsequently acquired classical per-
formance. Pairing tonal stimuli with food rein-
forcement in the instrumental portion might increase
the signal value of both stimuli through mediating

reflexes thus increasing the probability of a conditioned response to both CS+ and to CS-. But unless other factors were to act upon the system this would tend merely to raise the acquisistion rates for Groups D and CTF in relation to Groups CT and CF. It appears from the plotted response curves (Figure 2) that this is not the case. Differences in differentiation performance between groups was a result of differences in responding to the CS- rather than to CS+ or to both. Subjects in Groups D and CTF show a higher response rate to CS- than do Ss in Groups CT and CF although acquisition rates to the CS+ are similar for all groups. From this it might be concluded that the increased signal value of the stimuli did not aid different- iation but rather tended to confuse the subject and add noise to the situation.

A second, alternative explanation is also possible. If acquisition responding to the CS+ was at or near maximal physiological limits or if responding was strongly bound to the conditioning parameters employed, the acquisition of CRs to CS+ would be insensitive to pre-experimental manipula- tions which would attempt to increase those rates. Provided that the instrumental manipulations

would act to elevate responding to both CS+ and CS-,
as was suggested above, the observed effect would
be poorer differential performance. This would
not be a valid test of transfer phenomena. There
is nothing in this explanation of the results that
would demand positive transfer although the differ-
ential elevation of the CS- curves for D versus CTF
(Figure 2), possibly due to differing reinforcement
schedules, could lead one to expect such an effect.

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Footnotes

1. (Percent CRs to CS+)-(percent CRs to CS-)/
   (percent CRs to CS+)+(percent CRs to CS-).

22

APPENDIX A

F-Ratios: Operant discrimination, Groups D and CTF; percent bar presses to S^D--percent bar presses to S^Δ (sessions 9 through 21).

Source of Variance	SS	df	MS	F
Between S	5.95	13	.	
Groups (G)	2.86	1	2.86	11.10*
S/G	3.09	12	0.26	
Within S	15.11	322	.	
GxDiscrim (D)	4.02	1	4.02	19.45***
DxDays (J)	0.30	11	0.03	2.45**
DS/G	2.48	12	0.21	
DSJ/G	1.45	132	0.01	

* $p<.01$

** $p<.005$

*** $p<.001$

APPENDIX B

F-Ratios: Total daily bar presses, Groups D, CTF
and CF (sessions 9 through 21).

Source of Variance	SS	df	MS	F
Between S	591764.60	20		
Groups (G)	73270.17	2	36635.08	1.27 (ns)
S/G	518494.43	18	28805.25	
Within S	101124.08	231		
Days (D)	5277.54	11	479.78	1.16 (ns)
GXD	13901.83	22	631.90	1.53 *
SD/G	81944.71	198	413.86	

* p<.05

APPENDIX C

F-Ratios: Pavlovian conditioning, all Groups (% CRs).

Source of Variance	SS	df	MS	F
Between S	23.53	27		
Groups (G)	1.10	3	0.37	0.39 (ns)
S/G	22.43	24	0.93	
Within S	332.69	1988		
GxDiscrim (T)	2.47	3	0.82	3.59 *
ST/G	5.51	24	0.23	
GxT Days (D)	1.40	15	0.09	0.77 (ns)
SDT/G	14.47	120	0.12	

* $p < .03$