

INFORMATION TO USERS

This material was produced from a microfilm copy of the original document. While the most advanced technological means to photograph and reproduce this document have been used, the quality is heavily dependent upon the quality of the original submitted.

The following explanation of techniques is provided to help you understand markings or patterns which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting thru an image and duplicating adjacent pages to insure you complete continuity.
2. When an image on the film is obliterated with a large round black mark, it is an indication that the photographer suspected that the copy may have moved during exposure and thus cause a blurred image. You will find a good image of the page in the adjacent frame.
3. When a map, drawing or chart, etc., was part of the material being photographed the photographer followed a definite method in "sectioning" the material. It is customary to begin photoing at the upper left hand corner of a large sheet and to continue photoing from left to right in equal sections with a small overlap. If necessary, sectioning is continued again — beginning below the first row and continuing on until complete.
4. The majority of users indicate that the textual content is of greatest value, however, a somewhat higher quality reproduction could be made from "photographs" if essential to the understanding of the dissertation. Silver prints of "photographs" may be ordered at additional charge by writing the Order Department, giving the catalog number, title, author and specific pages you wish reproduced.
5. PLEASE NOTE: Some pages may have indistinct print. Filmed as received.

Xerox University Microfilms

300 North Zeeb Road
Ann Arbor, Michigan 48106

75-6542

NATION, Jack Randall, 1948-
CONTRAST EFFECTS WITH SHIFTS IN PUNISHMENT
LEVEL.

The University of Oklahoma, Ph.D., 1974
Psychology, experimental

Xerox University Microfilms, Ann Arbor, Michigan 48106

THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

CONTRAST EFFECTS WITH SHIFTS IN PUNISHMENT LEVEL

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

by

JACK R. NATION

Norman, Oklahoma

1974

CONTRAST EFFECTS WITH SHIFTS IN PUNISHMENT LEVEL

A DISSERTATION

APPROVED FOR THE DEPARTMENT OF PSYCHOLOGY

By

Roger L. Meltzer
R. F. Wain
Charles L. Fergus
James E. Fergus
William H. Alexander

ACKNOWLEDGMENTS

I would first like to thank the members of my advisory committee, Dr. Roger Mellgren, Dr. R. F. Weiss, Dr. Larry Toothaker, Dr. Alan Nicewander, and Dr. Roger Fouts for their careful consideration and advice throughout my graduate career. I would particularly like to thank Dr. Mellgren who has been largely responsible for the cultivation of the few abilities I do possess.

Most of all I would like to thank my wife, Patricia, who has not only given me strong support over the years but has also been a continual source of inspiration and motivation.

TABLE OF CONTENTS

	Page
Manuscript to be submitted for publication	
INTRODUCTION	1
METHOD	3
RESULTS.	5
DISCUSSION	7
REFERENCES11
APPENDIX A . . .Literature Review.15
APPENDIX B . . .Statistical Tests.95

Contrast Effects With Shifts in Punishment Level

Jack R. Nation

University of Oklahoma

Abstract

The present experiment was designed to investigate the effects of shifts in punishment level using a successive shift procedure. Rats were given a constant reward (2 pellets) throughout training but received varying intensities of brief electric shock (punishment) in the goal box. During preshift subjects ran for 40 trials to either .1, .4, or .8 mA shocks in the goal box. All subjects were then shifted to .4mA in the goalbox for 40 trials. The results showed that subjects shifted to a higher intensity shock ran slower than subjects originally trained on that higher intensity shock (negative contrast). There was no evidence of a corresponding positive contrast effect. The data were discussed with respect to their implications for theories that attempt to treat reward and punishment in comparable theoretical fashion.

Contrast Effects With Shifts in Punishment Level

Jack R. Nation

University of Oklahoma

Since the original work by Crespi (1942), contrast effects have been the subject of intensive empirical and theoretical investigation. Positive contrast effects are said to occur when subjects shifted from a small magnitude of reward to a large magnitude run faster than subjects which have received only the large magnitude of reward. The converse situation (where subjects shifted from large to small magnitude of reward run slower than subjects which have received only the small reward magnitude) would imply negative contrast effects.

Evidence for a positive contrast effect is equivocal although it has been obtained under a number of experimental conditions (Mellgren, 1971, 1972; Nation, Wrather, and Mellgren, 1974; Shanab and Ferrell, 1970; Shanab, Sanders, and Premack, 1969). But while positive contrast effects have been relatively difficult to obtain, negative contrast effects have occurred with great regularity (cf. Black, 1968).

The failure to obtain positive contrast has been attributed to a possible ceiling effect for the large reward control (unshifted) group inherent in the running response (Bower, 1961). In a recent test of the ceiling effect hypothesis, Mellgren, Nation, Wrather,

and Jobe (1974) administered punishment on 100% of the reward trials in an effort to reduce rapid running speeds. Under these experimental conditions, subjects shifted from small reward (1 pellet) to large reward (8 pellets) ran faster than subjects which received the large reward throughout training (positive contrast). A corresponding negative contrast effect was also shown to occur (i.e., subjects shifted from 8 pellets to 1 pellet showed depressed running speeds relative to control subjects receiving only 1 pellet during training).

While there are functional and theoretical precedents for treating punishment and reward as joint determinants of the same theoretical construct (e.g., Logan, 1969), the effects of increases and decreases in punishment have apparently received little attention in recent years. In fact, other than a few conceptually related punishment studies (e.g., Church, 1969) there do not appear to be any available punishment studies specifically relevant to contrast effects except the experiment by Mellgren, et. al., (1974) which held punishment level constant and manipulated reward magnitude.

The present study was an attempt to provide further information regarding the effects of shifts in punishment and reward events. Specifically, three 100% punishment groups were used in a traditional successive nondifferential procedure as characterized by Dunham (1968) i.e., two groups were shifted, and one group was continued at the same shock intensity. One shifted group received .1mA shock in the goalbox during phase 1, then .4mA during phase 2 while the other shifted group received .8mA shock during phase 1 followed by .4mA in the second phase. The control group received .4mA punishment

throughout training. All groups received a constant reward consisting of 2 food pellets on each trial throughout the experiment.

Method

Subjects. The subjects were 30 male albino rats of the Sprague-Dawley strain purchased from the Holtzman Company. They were approximately 100 days old at the start of the experiment and were randomly assigned to one of three groups ($N = 10/\text{group}$). All subjects were housed individually with water continuously available.

Apparatus. The apparatus consisted of a commercially made straight alley runway manufactured by the Hunter Company. The alley was constructed of clear Plexiglas with a grid floor and was 150 cm long X 15 cm high X 9 cm wide. It was divided into a 30 cm start section, a 90 cm run section, and a 30 cm goal section; all sections were separated by guillotine doors. The subject's progress in the alley was measured by three .01 sec Standard timers; the first timer which measured start time, was started by a microswitch at the start box and stopped by a photocell 11 cm into the alley; the second timer, which measured run time, was started by the first photocell and stopped by a second photocell located 11 cm in front of the goalbox; the third timer, which measured goal time, was started by the second photocell and stopped by a third photocell located 9 cm inside the goalbox. A scrambled shock was administered to the goalbox through a model 700 Grayson-Stadler shock generator when the subject broke the third photobeam and entered the goal section of the runway. A teaspoon mounted in the middle of the far end of the goalbox served as the foodcup. The times (for each section) were converted into reciprocals

for each subject on each trial and the results are reported in terms of these speed measures.

Procedure. A 12 gm food deprivation schedule (adjusted for amount of food received in the runway) was established during the 7 days prior to the start of the experiment. During this time all subjects were handled and marked for individual identification.

Preshift Training. The subjects were divided randomly into three groups of 10 in each group. All groups received 40 preshift trials (4 trials per day) with 2 45mg Noyes food pellets in the food-cup. While the amount of food reward was held constant for all groups during training the three groups differed with regard to the intensity of shock experienced in the goalbox, i.e., subjects within a group received either .1, .4, or .8 mA shock (1 sec duration) in the goal section of the runway. The procedure was identical for all groups in the preshift and postshift phases of the experiment (with the exception of the differing shock intensities). The subject was placed in the startbox facing the startbox door. Three sec later the door was opened and the subject was allowed to traverse the runway and enter the goalbox. After the subject entered the goalbox the door was immediately closed to prevent retracing and a shock (either .1, .4, or .8 mA) was delivered to the goal section. The subject was then given time to consume the two pellets in the food cup. Subjects were run in squads of 6 (2 from each group) thus creating an intertrial interval (ITI) of 4-5 min.

Postshift Training. The group running to .4mA shock in the goalbox during preshift was maintained at this shock level throughout

the postshift phase of the experiment (.4-.4). The group that received .1mA in preshift was shifted to .4mA in postshift (.1-.4). This shift was directed toward a demonstration of a negative contrast effect since a shift from .1 to .4mA is analogous to a shift from high to low reward. Similarly, the group receiving .8mA shock in preshift was shifted to .4mA in postshift in an effort to show a positive contrast effect (.8-.4). In postshift, as in preshift, all subjects were given 2 45 mg Noyes pellets on each trial. The postshift phase of the experiment lasted 10 days (4 trials per day) for a total of 40 postshift trials.

Results

Preshift. Clear preshift differences due to differential shock levels in the goalbox developed over the 40 preshift trials. An analysis of variance on the last 4 days of preshift for total speeds revealed a highly significant main effect for preshift shock level ($F = 24.38$, $df = 2/27$, $p < .001$), with each group differing from the others ($p < .01$ in all cases). The same result was evident in the fractioned speed measures ($F_s = 19.14, 11.75, 19.12$ for start, run, and goal, respectively; $df = 2,27$, $p < .01$ in all cases). Both the Days main effect and the Preshift shock level X Days interaction failed to reach significance in any of the measures thus indicating that all groups were relatively stable at the end of preshift.

Postshift. The running speeds for the total measure are shown in Figure 1 and a negative contrast effect is graphically indicated. In order to investigate the statistical reliability of this effect, a 3×10 analysis of variance was performed on the postshift data

Insert Figure 1 about here

with Preshift shock level and Days (Blocks of 4 trials) being the variables. The analysis revealed a nonsignificant main effect of preshift shock level ($F = 1.64$, $df = 2/27$, $p > .10$) but showed a significant Preshift shock level X Days interaction ($F = 2.14$, $df = 18/243$, $p < .005$). The Days main effect was also shown to be significant ($F = 2.54$, $df = 9/243$, $p < .01$) but the finding of a significant interaction makes this result unimportant. Post hoc analyses (via Tukey's procedure) were performed on the interaction means. The results indicated that Group .1-.4 ran significantly slower than Group .4-.4 on all postshift days except Day 11 (all $ps < .05$). This finding indicates a negative contrast effect occurred after the first postshift day and remained throughout the experiment. The interaction results also indicated that while Group .8-.4 was significantly below Group .4-.4 in the early stages of postshift ($ps < .05$ for Days 11 and 12) the difference between the two groups at the end of postshift was nonsignificant ($ps > .05$ for Days 17-20). These findings statistically demonstrate a rather obvious failure to show a positive contrast effect.

The fractioned speed measures revealed further information concerning the effects of shifts in different shock intensities. The analysis of goal speed showed essentially the same result as that for total speeds. The main effect for Groups was significant ($F = 3.99$, $df = 2/27$, $p < .05$) with Group .1-.4 running significantly slower than Group .4-.4 (negative contrast). The other possible comparisons on the preshift shock level main effect failed to reach an acceptable level of significance (all $ps > .05$). The Days main effect was shown to be nonsignificant ($F = 1.27$, $df = 9/243$, $p > .05$) but the

finding of a significant Preshift shock level X Days interaction ($F = 2.33$, $df = 18/243$, $p < .01$) further supports the presence of a negative contrast effect, i.e., post hoc comparisons indicated Group .1-.4 was significantly below .4-.4 on Days 12-20 (all $ps < .01$). The analysis on start and run speeds failed to reach acceptable levels of significance on either the main effect or interaction comparisons (all $ps > .05$). These findings indicate that the difference in total speed between Groups .1-.4 and .4-.4 (negative contrast) was entirely a result of goal performance. As in the case of the total speed measure, positive contrast effects were not obtained in the start, run, or goal measures ($ps > .10$ for all comparisons). In fact, there was only one occasion (goal speed on Day 14) where Group .8-.4 was above Group .4-.4 and this difference was slight (means for Group .4-.4 and .8-.4 were 2.364 and 2.595, respectively).

In summary, a negative contrast effect appeared early in postshift and was shown to be primarily a result of goal speed differences. There was no evidence, in any measure, of a corresponding positive contrast effect. The negative contrast effect was shown to be relatively durable and in that respect is consistent with some previous data (e.g., Collier and Marx, 1959; Mellgren, 1971; Nation, et al., 1974), but not consistent with other studies (Dunham, 1968).

Discussion

The present results clearly demonstrate that increases in intensity of shock depress performance relative to that displayed by subjects trained and maintained on the higher intensity of shock, i.e., negative contrast effects occur following shifts in punishment

level. There was no evidence of a corresponding positive contrast effect with shifts in punishment level.

The findings of this study in combination with previous research have implications for theoretical formulation which treat punishment and amount of reward in a comparable theoretical fashion (e.g., Logan, 1960; Logan and Wagner, 1965; Millenson & deVilliers, 1972). These investigators suggest that punishment of a given magnitude can be conceptualized to subtract a constant amount of excitation regardless of the magnitude of positive reinforcement, i.e., punishment and reward are assumed to combine algebraically. It would be predicted that the same behavioral consequences would occur following changes in punishment with reward held constant as occur following changes in reward with punishment maintained at a constant level. The present data are not totally consistent with such a prediction. In a previous experiment (Mellgren, et. al., 1974) both positive and negative contrast effects were shown to occur following shifts in positive reinforcement with punishment maintained at a constant intensity. However, in the present experiment which manipulated magnitude of punishment while holding positive reinforcement constant, asymmetrical contrast effects emerged, i.e., negative contrast was obtained but there was no indication of a positive contrast effect. Thus, it appears that shifts in magnitude of reward and punishment produce performance changes which are only partially consistent with predictions derived from an algebraic incentive theory (e.g., Logan, 1969; Logan and Wagner, 1965; Millenson and deVilliers, 1972).

Another theoretical position relevant to the present experiment is the "incomplete shift" or "inertia" hypothesis (Church, 1969). The inertia hypothesis states that if a subject has learned to perform

in a certain manner in the presence of one stimulus configuration, it will perform in a similar manner in the presence of other similar stimuli. This seems to be particularly true in situations involving the presence of a second intensity shock, where it has been shown that subjects tend to persist in the performance learned in the context of the first intensity shock (Raymond, 1968). In the present study, the failure to find a positive contrast effect is consistent with the inertia hypothesis, but the fact that negative contrast was found would seem to demand an alternative explanation or at least a modified version of the original position.

In explaining the present data, one potentially useful hypothesis concerns the inherent relationship between punishment and response events. It is logical to assume that the introduction of punishment is disrupting and, in fact, such findings have been thoroughly documented in the punishment literature (Church, 1969). The effects of the termination or reduction in punishment are less well understood. When a punishment event is either introduced for the first time or is intensified, the effect is to produce certain unlearned responses (e.g., crouching, jumping, etc.) that are incompatible with an instrumentally reinforced running response. However, there do not appear to be any corresponding unlearned reactions to the termination of punishment which might serve to facilitate performance. Thus, response disruption following an increase in punishment intensity might be expected to occur more readily than response facilitation following a decrease in punishment intensity. The present results are certainly in accord with this line of thinking.

At an empirical level the increase in shock intensity in the present experiment responsible for the production of negative contrast effects had the greatest influence in that part of the runway most proximal to the source of aversive stimulation. That is, negative contrast effects were found in goal speed but not in either the start or run speed measures. This finding agrees with that of Vogel, Mikulka, and Spear (1966) with respect to negative contrast following reward reduction.

Finally, the result of a negative contrast effect in the present study cannot be explained away on the basis of differential adaptation to shock since Group .1-.4 remained below Group .4-.4 throughout postshift training. Had the depression effect observed early in postshift been a result of differential adaptation to shock, one would have expected the two groups to be interlaced at the end of training. Although difficult to interpret theoretically, there can be little doubt that the negative contrast effect obtained in the present study is a reliable behavioral phenomenon.

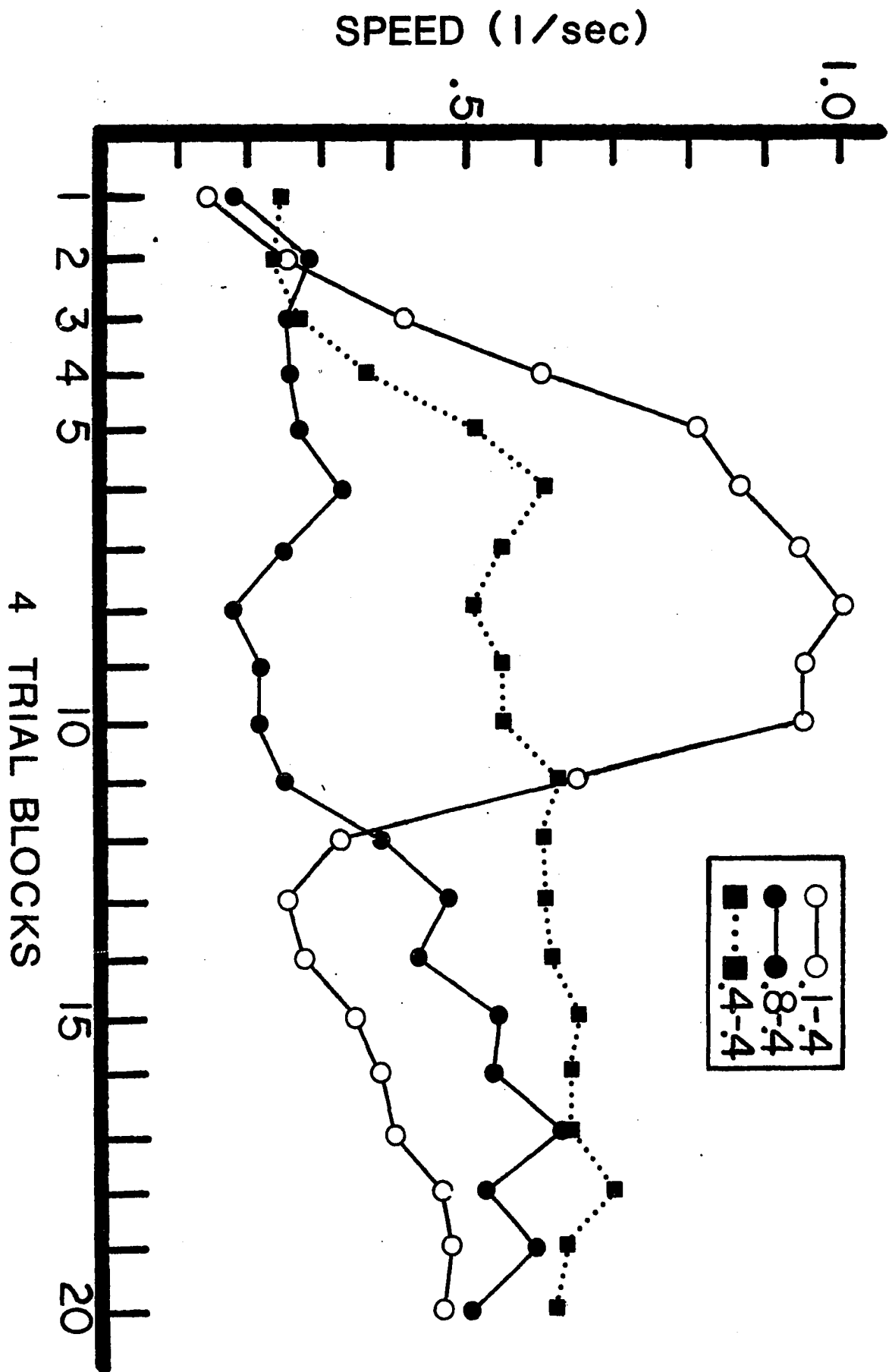
References

- Black, R. W. Shifts in magnitude of reward and contrast effects in instrumental and selective learning: A reinterpretation. Psychological Review, 1968, 75, 114-126.
- Bower, G. H. A contrast effect in differential conditioning. Journal of Experimental Psychology, 1961, 62, 196-199.
- Church, R. M. Response suppression. In B.A. Campbell and R. M. Church (Eds.). Punishment and Aversive Behavior. New York: Appleton-Century-Crofts, 1960, Pp. 111-156.
- Collier, G., and Marx, M. H. Changes in performance as a function of shifts in the magnitude of reinforcement. Journal of Experimental Psychology, 1959, 57, 305-309.
- Crespi, L. P. Quantitative variations of incentive and performance in the white rat. American Journal of Psychology, 1942, 55, 467-517.
- Dunham, P. J. Contrasted conditions of reinforcement: A selective critique. Psychological Bulletin, 1968, 69, 295-315.
- Logan, F. A. Incentive: How the condition of reinforcement affect the performance of rats. New Haven: Yale University Press, 1960.
- Logan, F. A. The negative incentive value of punishment. In B.A. Campbell and R. M. Church (Eds.), Punishment and Aversive Behavior, New York: Appleton-Century-Crofts, 1969, Pp. 443-454.
- Logan, F. A., and Wagner, A. R. Reward and Punishment. Boston: Allyn and Bacon, Inc., 1965.

- Mellgren, R. L. Positive contrast in the rat as a function of the number of preshift trials in the runway. Journal of Comparative and Physiological Psychology, 1971, 77(2), 329-336.
- Mellgren, R. L. Positive and negative contrast using delay reinforcement. Learning and Motivation, 1972, 3, 185-193.
- Mellgren, R. L., Nation, J. R., Wrather, D. M., and Jobe, J. Contrast effects: Artifact or reality? Unpublished manuscript. University of Oklahoma, 1974.
- Millenson, J. R., and deVilliers, P. A. Motivational properties of conditioned suppression. Learning and Motivation, 1972, 3, 125-137.
- Nation, J. R., Wrather, D. M., and Mellgren, R. L. Contrast effects in escape conditioning of rats. Journal of Comparative and Physiological Psychology, 1974, 86(1), 69-73.
- Raymond, G. A. Accentuation and attenuation of punishment by prior exposure to aversive stimulation. Unpublished doctoral dissertation, Brown University, 1968.
- Shanab, M. E., and Ferrell, H. J. Positive contrast obtained in the Lashley Maze under different drive conditions. Psychonomic Science, 1970, 20, 31-32.
- Shanab, M. E., Sanders, R., and Premack, D. Positive contrast in the runway obtained with delay of reward. Science, 1969, 164, 724-725.
- Vogel, J. R., Mikulka, P. J., and Spear, N. E. Effect of interpolated extinction and level of training on the "depression effect." Journal of Experimental Psychology, 1966, 72, 51-60.

Figure Caption

Fig. 1 Mean total running speeds for preshift (first 10 days) and postshift (last 10 days).



APPENDIX A

PROSPECTUS

Contrast Effects With Shifts in Punishment Level

Jack R. Nation

University of Oklahoma

Recently, Dunham (1968) reviewed the animal data on contrast effects and concluded that negative contrast (subjects shifted from a large magnitude of reward to a small magnitude run slower than comparable subjects which have received only the small magnitude of reward) was a reliable phenomenon, but positive contrast (subjects shifted from a small magnitude of reward to a large magnitude run faster than subjects which have received only the large magnitude of reward) failed to occur with any degree of regularity. The present review is intended to examine the appetitive and aversive instrumental conditioning data on contrast effects since Dunham's review and thus provide a more comprehensive analysis of the phenomenon as it occurs in subhuman species. In addition a section is included on human contrast in an effort to show some of the fundamental similarities between humans and lower organisms. The present review is broadly categorized according to the stimulus condition used to produce the effects.

Appetitive Incentive Shifts

The "Ceiling Effect" Issue and Related Problems

Delay of reinforcement as a control for rapid running speeds.

Bower (1961) pointed out that rats running to a large magnitude of reward throughout training (the control group for positive contrast studies) may be at the upper limit of running speed, which would

prohibit the observation of positive contrast. This "ceiling effect" problem has been the source of several recent investigations in the animal learning literature. Shanab, Sanders, and Premack (1969) used an approach that involved the introduction of an aversive condition to hold down speed of running, i.e., subjects received simultaneous shifts in magnitude of reinforcement and delay of reinforcement. It was shown that subjects shifted to the large incentive slowed-down less than subjects which had been running to the large incentive prior to the introduction of delay. Although this is not the traditional form of positive contrast (Crespi, 1942), it clearly indicates that positive contrast effects emerge when running speeds are not at a physiological ceiling.

In a more conventional successive-nondifferential design (see Dunham (1968) for a description of terms), Mellgren (1972) used a constant 20 sec delay of reinforcement to hold down response speeds. In this study, subjects shifted from low magnitude of reward (2 pellets) to high magnitude (22 pellets) clearly ran faster than a control that received the higher magnitude throughout training (positive contrast). Also, negative (22 pellets-2 pellets) was shown to occur. As Mellgren (1972) points out, however, it is possible that these data using delay of reward may have only minimal implications for data obtained with nondelay procedures. The reason being that delay introduces a factor (i.e., inhibition) that is either not present in nondelay studies or is only present to a small degree.

Shanab and McCuistion (1970) shifted magnitude and delay of reinforcement in an effort to determine the effects of shifts on

performance in a straight runway. Rats were trained to receive either 1 or 12 pellets after a delay of 0, 15, or 30 sec in phase 1. In the second phase of the experiment all subjects received 12 pellets under the same delay interval as was used during the first phase of training. In a third phase all subjects were delayed 15 sec before receiving the 12 pellet reward. Notice that the transition from phase 2 to phase 3 represents a shift in a nonmagnitude variable and in that respect is different from the traditional shift design. The results in Phase I showed, as expected, that performance was a positive function of the amount of reward and a negative function of delay. When an upward shift in magnitude of reward was introduced in Phase 2, no elation (positive contrast) effects were observed. This would suggest that delay per se is not a sufficient condition to produce positive contrast effects and in that respect is directly in contradiccion to Mellgren (1972). However, Mellgren (1972) used much greater differences in reward values and that may account for the discrepancy. Consistent with this hypothesis is a later report by Shanab and Biller (1972) which demonstrated that reliable positive contrast effects were obtained when a sufficiently large incentive difference was used i.e., subjects shifted from small reward received after long delay (30 sec) to large reward after intermediate delay (15 sec) showed positive contrast effects. Another reason for the discrepant findings might be the fact that the Mellgren (1972) study was a single trial a day study whereas Shanab and McCuistion (1970) ran subjects 3 trials a day.

The data from Phase 3 of Shanab and McCuistion (1970) indicated that shifts in delay interval prior to receiving a constant reward result in a depression (negative contrast) effect but not an elation effect. This finding is supported by McHose and Tauber (1972) who manipulated preshift and postshift delay of reinforcement. It was shown that subjects shifted from a 10 to a 30 sec delay were inferior to subjects receiving 30 sec delay of reinforcement continuously during training, but shifting from 30 sec to 10 sec did not produce elation effects. While the negative contrast effect reported by Shanab and McCuistion (1970) was only temporary, the data of McHose and Tauber (1972) indicate that the depression effect is relatively durable.

Mellgren, Seybert, Wrather, and Dyck (1973) performed an experiment that used delay to control for the ceiling effect in an investigation of the influence of preshift reward magnitude. Four groups of subjects were run under continuous 20 sec delay to 1, 2, 4, or 8 pellets in the preshift phase of the experiment. Subsequently, all subjects received 8 pellets per trial with a 20 sec delay interval. The data supported the notion that preshift reward magnitude is inversely related to postshift performance i.e., the groups ordered themselves in postshift 1-8, 2-8, 4-8 and 8-8 from fastest to slowest. These data provide even further support for the position that positive contrast is a reliable phenomenon when a ceiling effect does not operate to obscure the observance of positive contrast. It becomes more and more apparent that the absence of the positive contrast effect should not be viewed as a matter of behavioral principle, but rather as an artifact of experimental design.

The effects of delay of reinforcement have also been investigated in differential conditioning paradigms. In this paradigm the experimental subject is presented with two discriminative stimuli associated with two different reward magnitudes, e.g., a black alley leading to 8 food pellets and a white alley leading to 1 food pellet. The experimental subject performance is then compared with that of control subjects that consistently run to either 1 or 8 pellets.

Mellgren, Wrather, and Dyck (1972) have suggested that previous research using a differential conditioning procedure to examine contrast effects may have been inadequate due to the operation of a ceiling effect and/or a decision time problem. Mellgren, et al. (1972) used delay to control for rapid running speeds and multiple, redundant stimuli were associated with the different reward magnitudes to minimize decision time in the alley. The later control was achieved by using runways which were painted black or white in their entirety (unlike Bower, 1961 who used a neutral gray start box in both runways), and by massing large and small reward trials. With both decision time and the ceiling effect controlled, positive contrast effects were demonstrated. While it is impossible to determine which variable made the most significant contribution to performance, the previously mentioned data generated in the context of the "successive nondifferential procedure" (Mellgren, 1972; Shanab and McCuistion, 1970) indicate that delay is a very important consideration in any design that attempts to allow for the occurrence of positive contrast.

Beery (1968) ran rats in a differential conditioning paradigm to assess contrast effects of reward delay. The groups were designated:

1-5, 1-10, 5-10, 1-1, 5-5, and 10-10, where the first numeral in each case indicates the length of delay (sec) in the shorter delay alley (high incentive condition) and the second, the length of the longer delay alley (the low incentive condition). The results on both start and run speed measures closely paralleled the results found in the previously mentioned studies that manipulated delay of reinforcement in the more traditional successive non-differential procedure (e.g., McHose and Tauber, 1972; Shanab and McCuistion, 1970). No evidence was found for a positive contrast effect, while some clear demonstrations of negative contrast effects emerged.

Similarly, Sgro, Glotfelty, and Podlesni (1969) used delay of reward manipulations in a double alleyway (which, as Daly (1968) has suggested is operationally similar to differential conditioning situations). In this study four groups of rats received a factorial arrangement of contrasting rewards in goalbox 1 (2 or 8 pellets) and goalbox 2 (2 or 8 pellets). Each group was divided into two equal subgroups and shifted to either a 15 sec or 0 sec delay of goalbox 1 reward. The major finding, which is consistent with Beery (1968) was that negative contrast effects occurred while positive contrast effects did not obtain.

The results of studies that employ the use of delay of reinforcement, then, appear to be relatively consistent. When delay is held constant and incentives (reward magnitudes) of sufficient differences are shifted, positive and negative contrast effects obtain. When reward magnitude is held constant and the length of the delay interval preceding reinforcement is manipulated, only negative contrast effects are observed.

Punishment as a control for rapid running speeds. Mellgren, Nation, Wrather, and Jobe (1974) conducted two experiments in an effort to determine whether positive contrast effects are artifactual or real phenomenon. The first experiment was designed to take advantage of punishment procedures in investigating contrast effects. Specifically, four groups were used in a traditional successive nondifferential procedure as characterized by Dunham (1968). In an effort to suppress responding, and thus control for the ceiling effect, all subjects received a shock of .6mA in the goalbox on each trial throughout the experiment. The results showed, as predicted, that when punishment is used to suppress running speeds, both positive and negative contrast effects emerge. These data provide more evidence for the argument that positive contrast is a reliable phenomenon when a ceiling effect does not operate to obscure the observance of positive contrast.

In Experiment 2 of Mellgren, et. al. (1974) water deprived rats were run in a straight alley and received differential magnitudes of water reinforcement. It has previously been shown that water deprived rats run slower than food-deprived rats (Logan and Spanier, 1970), and thus ceiling on running speeds should not operate to prevent the occurrence of positive contrast. Accordingly, both positive and negative contrast effects emerged in this experiment that shifted magnitude of water reinforcement.

It is noteworthy that the results of Experiment 1 in the Mellgren et. al., (1974) report bear on the issue of whether or not positive contrast effects are a unique product of inhibition produced by delay and shifts in reward magnitude (Mellgren, 1972). Since Experiment 1 used punishment and the inhibitory effects of punishment are considered

to be independent of the magnitude of positive reinforcement (Millenson and deVilliers, 1972), it does not seem reasonable to assume that positive contrast effects are an artifact of a hypothesized inhibition-excitation interaction effect.

Control via special equipment. Another way to control for the slowing of subjects running speeds is to employ an apparatus that prevents such rapid running speeds. Shanab and Ferrell (1970) ran two groups of subjects one trial a day in a Lashley maze under high deprivation conditions and gave either 1 or 22 pellets of reward (Phase 1). Following asymptote in Phase 1, each group was subdivided into a high and low drive condition, and each subject received 22 pellets (Phase 2). In the comparison of interest it was shown that regardless of drive condition, the subjects that had received small reward in Phase 1 ran faster in Phase 2 than those subjects that had received the large rewards in Phase 1 (positive contrast). In a similar analysis, Seybert and Mellgren (1972) were able to demonstrate positive contrast in an experiment that employed a long U-shaped runway to hold down speeds. These results show that positive contrast based on a speed or latency measure can be obtained when the upward shift is made under conditions that depress performance below some maximal level.

Adamson and Gunn (1969) present a cleverly designed experiment directed toward providing room for positive contrast effects to emerge. In order to place restraints on response rate, these investigators made use of counterweights in a standard bar-pressing situations. Specifically, in a between subjects comparison lever counterweights were shifted from heavy to light and from light to

heavy, with the result that both positive and negative contrast effects were demonstrated. The results support the prediction of a positive contrast effect under circumstances which permit it to be evidenced.

Contrast effects as a function of the number of preshift trials.

The amount of training received before shifting reward magnitude has received considerable attention over the last few years. Since performance early in training should not be at asymptotic levels, then shifts made at pre-asymptotic levels should be more likely to render positive contrast because the ceiling effect variable is controlled. Schier (1967) designed a study to test for a positive reinforcement-contrast effects where the shift in low magnitude reward was made relatively early in training. For 32 days, 2 groups of rats were given 1 trial per day in a straight runway. A control group received 4 pellets in the preshift and postshift periods of the experiment. The shift group received 1 pellet for a brief period (16 trials) and was then shifted to 4 pellets for the remainder of the experiment. Although performance levels shifted commensurate with shifts in reward magnitude, there were no significant differences between the two groups at the end of training. It would seem, at least from this report, that positive contrast can not be demonstrated under conditions which merely prevent asymptotic responding. However, the technique of Schier (1967) is unsatisfactory in that it not only reduces the ceiling effect, but also reduces the magnitude of the increase in positive reinforcement (1-4 pellets is a small increase). Thus, the report is inconclusive.

The effect of the number of preshift trials on postshift performance has also been investigated by Wolach and Seres (1971). In this study rats experienced shifts in reward magnitude after 24, 54, and 108 trials to the first reward magnitude (2 pellets). All subjects were then required to run to large reward (5 pellets) in a two-way runway situation at the rate of 6 trials a day. It was shown that as the days of preshift training increased, the number of trials before postshift performance shifts occurred also increased. Additionally, positive contrast was shown to develop for subjects shifted after receiving 24 training trials. This finding is inconsistent with Schier (1967) and suggest that the number of preshift trials is important in determining positive contrast. In support of this position Mellgren (1971a) demonstrated that positive contrast is a function of the number of preshift trials experienced. In this study subjects were shifted from 1 pellet to 6 pellets after 0, 24, 48 or 72 trials (the 0 condition representing the control group). Additionally, a 20 sec delay was used on all trials as a measure to control for rapid running speeds. It was shown that the rate at which speeds increased was an inverse function of the number of prior training trials. That is, increasing the number of small-reward trials reduced the effectiveness of an increase in reward magnitude, at least in relation to a control group.

Campbell, Crumbaugh, Knouse, and Snodgrass (1970) also attempted to deal with the ceiling effect problem by shifting subjects after relatively few small-reward trials, before the control groups reached asymptote. They were only partially successful in that the control

group appeared to reach an asymptote around the 14th trial of the experiment. The experimental groups were shifted after 5, 10, or 15 trials and may have been subject to the ceiling effect. The group of subjects shifted after 5 trials did appear to show a positive contrast effect, but it failed to reach an acceptable statistical level.

In a related study Mellgren (1971b) ran three groups of subjects to either 0, 2, or 4 trials with small reward (1 pellet) and then shifted to large reward (5 pellets). Although the ceiling effect problem would definitely be controlled using this procedure, no positive contrast effects were obtained. While it is possible that incentive differentials were too small in Campbell, et. al. (1970) and Mellgren (1971b), the only real conclusion that can be made from an examination of these data in combination with previous reports is that the prevention of a ceiling effect is a necessary, but not sufficient condition for the emergence of positive contrast in the straight runway. The lack of positive contrast following limited acquisition may be attributable to the insufficient establishment of differential expectancy of reward magnitude. (Mellgren, 1971b).

The effect of the number of reward training trials preceding a reduction in incentive has also been examined. Davis and North (1968) ran three groups of rats to receive 18 large reward, 108 large reward, or 108 small reward acquisition trials. Following acquisition all subjects received 63 small reward trials. This phase constituted an incentive reduction for all subjects receiving large reward trials in acquisition. Only the group that received 108 large reward trials

in acquisition showed negative contrast effects, and then only in the start measure. These data were interpreted as given support to frustration theory (Amsel, 1958) by suggesting that greater frustration (r_f-s_f) would accompany the stronger conditioning of r_g-s_g in the group that received the greater number of large reward trials before the shift. In a later study Davis and North (1969) demonstrated that disruption of performance also occurred when small reward trials followed a series of goalbox placements with large reward. Again the strongest effects were shown in the start measure.

Contrast Effects in Differential Conditioning Designs

St versus S- depression effects. In the previously defined differential conditioning procedures the finding that the performance of rats receiving differential reward is depressed to the small (S-) reward stimulus relative to that of a condition that receives small reward in both discriminanda is reasonably well documented and has received considerable theoretical attention (cf. Black, 1968; McHose, 1970). The similar observation for performance to the large (S+) reward stimulus, speeds being depressed relative to those of a group receiving large reward in both "S+" and "S-", is only recently receiving much theoretical attention.

Gavelek and McHose (1970) performed an experiment that was concerned with whether differential delay of reward conditioning would also produce contrast effects similar to those obtained with manipulations of differential reward (amount and percentage). Rats received differential conditioning training with different delays correlated with alley brightness. Five groups of subjects were used: 1-1, 1-10, 1-30, 10-30, and 30-30 where the first digit designates

delay, in seconds, received prior to reward in the short-plus (S+) alley and the second digit denotes the length of the delay preceding reward in the long-minus (S-) alley. It was shown in this experiment that the performance levels of the differentially reinforced subjects to both S+ and S- were depressed relative to the performance levels of the appropriate control subjects. Thus depression effect occurred in both the positive contrast comparison and the negative contrast comparison. It is interesting that while the finding of S+ depression is consistent with some previous data in differential conditioning (Matsumoto, 1969), the initial investigation in this area did not obtain statistically reliable S+ depression effects (Bower, 1961).

Support for Gavelek and McHose (1970) comes from a study reported by Chechile and Fowler (1973) where they investigated the mechanism of incentive contrast and the role of cue similarity in differential conditioning. A negative contrast effect in terms of running speeds was found for both a constant-delay-differential-reward magnitude condition and a constant-reward-magnitude-differential delay condition. There was no evidence of a corresponding positive contrast effect. In fact, performance on S+ trials was depressed relative to S+ controls for both conditions. Additionally, it was shown that for both conditions of contrasted reward, cue similarity affected the rate at which the discrimination was formed.

The findings of Chechile and Fowler (1973) create some interesting problems. The report of a significant negative contrast effect in the constant-reward-magnitude-differential delay condition essentially

parallels the report of Gavelek and McHose (1970). However, the finding that depression effects to S+ occurred in the constant-delay-differential-reward condition is grossly inconsistent with the Mellgren, Wrather, and Dyck (1972) study reported in the last section of this review where it was shown that constant delay differential-reward subjects ran faster (elation effect) to S+ than a S+ control. Since "decision time" was controlled in both studies by the use of multiple redundant cues, the data appear to be in conflict. But closer examination of the data of Chechille and Fowler (1973) indicates that their study may have been confounded by a ceiling effect even though these investigators employed a constant delay interval to slow down running speeds. The fact that a control group that received 12 food pellets and 0 sec delay of reward was interlaced throughout training with a control group that received 12 food pellets and a 9 sec delay of reward strongly suggest that 9 sec was not a sufficient delay interval to hold down running speed. Thus, a ceiling problem would be present and positive contrast would not be predicted to occur under such circumstances.

The results of studies examining the effects of incentives shifts in combination with constant delay of reward produce some questions that are of primary theoretical interest. It is possible that in studies where positive contrast (facilitation to S+ relative to a control) does not originally obtain as a result of ceiling effect problems (e.g., Chechile and Fowler, 1973) or other variables (e. g., Matsumoto, 1969), then a depression to S+ occurs, resulting not from any generalized inhibition generated in S-, but from inhibition produced independently of S- depression. When running speeds are held down to a lower level through

the use of delay or some other special procedure, positive contrast effects are free to emerge and thus the independent S+ depression does not obtain. Within the framework of such an "independent S+ depression hypothesis" a group of differential subjects responding to S+ would be expected to show either depression or elation effects, depending on whether or not experimental conditions allow for the observance of positive contrast.

McHewitt (1974) offers some support for the idea of treating S+ depression as a phenomenon independent of S- depression. In a study of differential conditioning it was shown that there was a clear variance difference between S+ and S- depression in the late stages of training. The greater variability between subjects on S- as compared to S+ trials, might be considered to be an indication that depression effects associated with S+ and S- responding derive independently.

Although negative contrast effects in differential conditioning are fairly reliable (Beery, 1968; Gavelek and McHose, 1970; Matsumoto, 1969; Mellgren, et al., 1972) such effects have not always been obtained. Recently, Campbell and Meyer (1971) differentially conditioned two groups of rats in a black-white runway with large (L) and small (S) reward. Group L-S received no daily S-L transitions. Group S-L on the other hand received all its daily S trials first. When subjects were run in their former large runway, only Group L-S demonstrated a negative contrast effect relative to a small reward control group (Group SS). These results suggest that the sequence of rewards administered in studies using differential conditioning procedures is an important consideration. Consistent with this notion are several experiments by Meyer and Campbell (1973) which offer some convincing evidence that sequential manipulations are involved

in determining negative contrast effects. Among their findings is the result that L-S daily transitions are necessary for the occurrence of negative contrast effects regardless of whether or not sequences are regular or irregular. The efficacy of this particular sequence variable is strikingly demonstrated in Experiment II of Meyer and Campbell (1973) where it was shown that a single L-S sequence administered on only 1 of every 4 days was sufficient to produce negative contrast effects.

Large reward alone versus large reward contingent upon runway traversal. In studies of contrast effects involving differential conditioning, the observation that differential conditioning speeds in a 1 pellet alley are depressed relative to that of a control group may simply reflect the fact that subjects in the differential conditioning situation experience relatively large rewards (e.g., 8 pellets) while subjects in the control condition do not. Alternatively, the negative contrast effects may reflect some more specific aspect of the differential treatment of experimental and control conditions, e.g., the administration of relatively large reward contingent upon runway traversal. To help answer this question, Maxwell, Meyer, Calef, and McHewitt (1969) ran a study to determine whether experience with large reward, independent of the conditions under which the reward was obtained, was sufficient to depress runway speeds to a smaller reward magnitude. Specifically, three groups (C, D, and E) each received, during a daily session, two runway trials in one alley of a differential conditioning apparatus to 1 pellet of reward. In addition, Groups C and E received 1 and 12 pellets, respectively, in a placement cage two times during a daily session. Group D received two more training trials to 12 pellet reward in the other half of the differential conditioning apparatus. The results

indicated that the speeds of Group D in the half of the apparatus where 1 pellet was received were significantly below the speeds of Groups C and E in that portion of the apparatus. These findings demonstrate that depression of speeds to a stimulus associated with the smaller of two magnitudes of reward is not due merely to experience with large reward magnitude. Rather, these observations suggest that conditions under which the larger reward is experienced is important in determining negative contrast effects in differential conditioning studies using speed measures. However Harris, Collerain, Wolf, and Ludvigson (1970) indicate that the Maxwell, et. al., data may have been influenced by the trial-initiation procedure employed and for that reason these results must be accepted with caution. In fact, Harris, et. al., did show that mere exposure to large reward was sufficient to produce negative contrast effects in an experiment that controlled for signals (cues) during trial initiation.

The effects of reversal of reward in differential conditioning has been examined by Beery and Black (1968). In this study two groups of rats were given differential conditioning in a pair of straight alleys in which 1 food pellet in one alley and 25 pellets in another alley served as reward. Following 40 training trials, the rewards were reversed for half of the subjects. It was found that subjects did make the appropriate adjustments in terms of changes in performance following changes in reward conditions, however the adjustments of running speed were relatively slow. No reliable evidence of contrast effects (positive or negative) were obtained. The author concluded that these "lack of contrast results" were due to the reduced discriminability of the shift. The relatively gradual changes in performance

following the reversal in reward magnitude in their study suggest they may have been correct in their conclusions.

Differential conditioning and the double-runway situation. Noting the operational similarity between differential conditioning (Bower, 1961) and double-runway situations, Daly (1968) suggested that frustration may occur in the double runway even under nonshift conditions if the rewards in the two goalboxes are not of equal magnitude. A crucial assumption in Daly's (1968) argument is that the type of contrast effect found in differential conditioning should also be found in the double runway. DiLollo and Allison (1971) tested this assumption by comparing a group receiving a small reward in the first and a large reward in second goal box (small-large) with a group receiving the smaller reward in both goal boxes (small-small). If the Daly assumption was correct then performance in the first runway should have been inversely related to the amount of reward in the second goalbox. However all of the relevant evidence reported by DiLollo and Allison was uniformly contrary to the hypothesized similarity between double runway and differential conditioning situations. Instead of getting negative contrast effects in Alley 1, negative contrast effects occurred in Alley 2 (a finding inconsistent with predictions made from frustration theory). So, even though there is some evidence to indicate that frustration variables operate in differential conditioning situations (e.g., Ison, Glass, and Daly, 1969) the weight of experimental evidence indicates that a frustration effect does not occur following incomplete reduction of reward in the double-runway analog of differential conditioning.

Studies using double-runways have an advantage over single alley studies in that the intertrial interval between shifts may be very short.

It is quite possible that the longer intertrial intervals (or events occurring during this interval, e.g., handling) in single alley experiments operate to reduce any facilitative effects that might occur. Accordingly, Meyer and McHose (1968) used a "test" trial condition in which larger reward magnitudes were presented on some trials in the first goal box of a double alley. This procedure allowed several trial-to-trial increases to occur without handling and with a minimum delay after each increase. The results demonstrated that speeds following these increases were faster than the second alley speeds of a group which consistently received the large magnitude of reward in goal box one. Thus, even though this is not a traditional shift procedure, the data clearly indicate that an increase in reward magnitude will enhance the level of a response following a reward increase (i.e., positive contrast will occur).

In summary, the data on contrast effects in differential conditioning appear to have no true consistency and in many cases the presence or absence of positive and negative contrast seems to hinge on methodological considerations.

The Influence of Successive Repeated Shifts in Incentive

Theoretical background. One theoretical account given for double-or multiple-shifts is that by Capaldi and Lynch (1967) who label this procedure the "the transfer shift situation". Crespi (1942) in the original work in contrast effects did use a double shift procedure, however he did not make any theoretical distinctions between single-and double-shift situations. Capaldi and Lynch have proposed a stimulus intensity dynamism (V) modification of Spence's (1956) acquisition formula in

their analysis of contrast effects. They predict that a transfer upward shift should not produce a positive contrast effect and that a transfer downward should not produce a negative contrast effect. In the downward shift condition, it is hypothesized that different reward magnitudes (large, small, etc.) produce distinctive stimuli associated with the respective reward conditions (Capaldi and Lynch, 1967). These stimuli become conditioned to an instrumental approach response. Thus, an animal trained under large reward when shifted to small reward would experience a stimulus generalization decrement. However, in a transfer shift paradigm where subjects receive small-large-small reward shifts, subjects have previously run to small reward and stimuli specific to small reward have been conditioned to the instrumental reaction. Therefore, no generalization decrement (negative contrast) would be predicted when small reward stimuli are encountered in a latter stage of training.

Empirical findings relevant to the transfer shift model. The results relating to the transfer shift model of Capaldi and Lynch (1967) are equivocal. Calef, Hopkins, McHewitt, and Maxwell (1973) found that negative contrast effects occurred following both large reward and small reward trials in a study that varied large and small reward following consistent high-incentive training. This finding is particularly nonsupportive of Capaldi, et. al., which would predict negative contrast only in situations where subjects were shifted to just a small reward, not in situations where subjects were shifted to both large and small rewards simultaneously. However, Godbout (1971) varied reward magnitude training following consistent large reward and was not able to show negative contrast effects, so the results of Calef, et. al., (1973) are inconclusive.

Heirs (1969) gives support to Capaldi and Lynch's analysis in a study that was a direct test of the influence of previous experience with small reward on negative contrast. In this study there were two groups which received three successive shifts in reward magnitude, two groups which received only one shift, and two non-shifted groups. The results showed that while there was evidence of negative contrast effects (and some evidence of positive contrast effects) following the initial shift, there was no evidence of the occurrence of contrast effects following latter shifts in reward. The slight evidence of positive contrast occurring only in the initial shift is supported by Shanab (1971).

Strong support for the position that transfer shifts downward do not produce negative contrast comes from a study by Maxwell (1972) that factorially manipulated the amount of training on small and large reward prior to a shift to small reward. Rats were administered either 0, 6, 14 or 30 trials on small reward during stage 1 followed by 0, 6, 14, or 30 trials on large reward (Stage 2). In Stage 3 all subjects were shifted to a small reward in a straight alley. The results during Stage 3 revealed that the speeds of groups shifted from large to small reward were a function of both the amount of prior large and the amount of prior small reward training such that speeds were below a small reward control (negative contrast) only at high amounts of prior large reward training and low amounts of prior small reward training. These results are consistent with the transfer shift explanation offered by Capaldi and Lynch (1967).

Logan (1968) further indicates that contrast effects do not occur following successive repeated shifts in reward magnitude. In experiment 6 in a series of conceptually related studies, two groups were initially given a large reward in one alley and a small reward in a second alley. Subjects were run for 42 days (6 trials/day) to these contrasting reward values and then one-half of the subjects received large reward in both alleys and the other one-half of the subjects received small reward in both alleys. There was no evidence of a positive or negative contrast effect on either a choice measure or a speed measure. It would appear that the previous exposure to the contrasting reward conditions was sufficient to prevent the occurrence of contrast behavior in the shifted alley. These results are also in accord with Capaldi and Lynch (1967).

The effects of procedural variation on successive contrast effects.

The effects of intertrial interval on successive negative contrast effects has been examined by Capaldi (1972a). This investigation was aimed at showing the differential effects of intertrial interval in transfer and non-transfer shift designs. It was shown that the negative contrast effect is much larger at massed than at spaced trials. Moreover, while a transfer shift training schedule reduced the negative contrast effect at massed trials it eliminated the negative contrast effect at spaced trials. These data constitute more support for the generalization decrement notion of Capaldi and Lynch (1967).

The effects of other variables on successive incentive shifts have been examined. Sayeed and Wolach (1972) designed a study to assess the effects of repeated shifts in reward magnitude on the performance of immature rats relative to the performance of mature rats. The

findings indicated there was no evidence of either a positive or negative contrast effect for either immature or adult subjects. There was evidence of adjustment of running speeds according to the reward magnitude received. The failure to observe depression effects following the second shift was predicted, but the failure to demonstrate negative contrast effects following the initial shift is somewhat surprising considering the multitude of evidence to the contrary. As Huang (1969) has suggested, it may be that in studies where negative contrast effects are not shown, the differences between the two reward magnitudes is so small that the amount of generalization decrement is insufficient to produce noticeable negative contrast effects. Such would appear to be the case in the Sayeed and Wolach (1972) experiment where a very small incentive reduction was made (1 vs 5 pellets).

The effects of large and small magnitude of intertrial reinforcement on successive contrast effects was investigated by Calef (1972). This study tested the hypothesis that an absence of negative contrast should occur in a situation in which subjects receive small magnitude of reward following placement in the goalbox (ITR) and large magnitude of reward following a runway response during preshift training. If subjects emit a fractional running response in the goalbox, then frustration theory would predict that subjects receiving large magnitude of runway reward/small magnitude of ITR during preshift and small magnitude of reward in the runway during postshift should show no negative contrast effects. Alternatively, subjects receiving large magnitude of runway reward/large magnitude of ITR followed by small magnitude of reward in the runway during postshift should show

negative contrast effects. Incidentally, the Calef (1972) study also tested the effects of large and small reward on the elusive positive contrast effect. Consistent with frustration theory, the results revealed that positive and negative contrast effects occurred solely for subjects receiving a large preshift magnitude of ITR.

The extent to which Calef's data contradict current (Capaldi, 1967) stimulus interpretations of the negative contrast effect clearly hinges upon the extent to which an ITR delivered between two training phases regulates the reward-magnitude-related stimuli present during the second phase. If subjects can discriminate between ITR's and long-run trials, then the reward-magnitude-related stimuli present during the second phase would be determined by the regular reward events of the first phase and not by the ITR's. Calef's (1972) findings would thus be consistent with a stimulus interpretation (Capaldi, 1967). Evidence for the ITR discrimination hypothesis comes from an experiment by McHose (1973) where it was shown that both reductions in ITR and runway reward magnitude produced a negative contrast effect when only a minimal number of training trials were given. The McHose (1973) data in conjunction with the Calef (1972) findings thus suggest that either ITR or runway magnitude reductions are sufficient to produce the negative contrast effect after a minimal exposure to these reward events but that, following repeated exposure to these reward events, only a reduction in runway reward produces negative contrast effects. These results are compatible with a stimulus interpretation (Capaldi, 1967) of negative contrast effects.

Another repeated-shift variable that has been examined is preacquisition exploration of the runway. Weinstock (1971) allowed subjects to either explore or not to explore an unbaited runway before training began in a double-shift reward contrast study. During training subjects received one of four sequences: HLH, LHL, HHH or LLL where H indicates 10 pellet rewards and L indicates 1 pellet. Significant positive contrast effects were found following the first shift of reward only, under both explore and nonexplore conditions. No negative contrast effects occurred during the experiment (even following the initial shift), a finding inconsistent with 90% of the contrast literature. One factor that possibly contributed to the lack of negative contrast was the small number of acquisition trials preceeding the initial shift (i.e., only 19). One explanation for the finding of positive contrast is that all subjects were run under relatively mild deprivation levels (88% body weight), and thus acquisition speeds should have been uniformly slowed to allow for the occurrence of positive contrast. That is, under moderate deprivations conditions there is no ceiling effect problem and positive contrast becomes a more likely event.

Shifts in Qualitative Rewards and Sucrose-Saccharin Solutions.

Palatability shifts. Recent investigations involving saccharin drinking in rats have observed immediate and durable elation effects following temporary (time-out) shifts to water (Ashton, Gandelman, and Trowill, 1970a; Gandelman and Trowill, 1969). In an experiment that represented an attempt to extend these findings to sucrose-reward, Ashton, Gandelman, and Trowill, (1970b) ran a series of experiments which demonstrated that elation effects do not occur when subjects

receive sucrose following a temporary shift to water (time-out). It has been hypothesized by Gandelman, et. al., (1969) that shifts in the palatability of given liquids would be sufficient to produce positive contrast but the results of Ashton, et.al., (1970b) do not support such a claim.

In an effort to try to answer questions concerning palatability shifts, Ashton and Trowill (1970) used lick rate as opposed to liquid intake as the dependent measure. It was observed that marked increments in lick rate occurred in saccharin drinking following a temporary shift to water in both deprived and nondeprived rats. Similar increases were not observed when sucrose was used as the reward. These data, for the most part, were found to be consistent with those data reported earlier using intake as the dependent measure (Ashton, et.al., 1970a; Gandelman and Trowill, 1969).

Dube, Ashton, and Trowill (1970) made a systematic manipulation of the duration of time-out (amount of time subjects receives water following training with either a sucrose or saccharin solution, e.g., Gandelman and Trowill, 1969). Nondeprived rats were given a 1-hour exposure to a sodium-saccharin solution for 28 consecutive days. Subsequently, subjects received either a brief (10 min) or lengthy (30 days at the rate of 1hr/ day) exposure to tap water. Results indicated a positive contrast effect emerged following the brief time-out but did not emerge following the longer exposure to tap water. It was suggested that the long time-out may have been so lengthy that subjects forgot the comparison solution (saccharin) or perhaps they may have forgotten the response to that solution.

Contrast effects using licking rate as the dependent measure have also been investigated by Panksepp and Trowill (1971) in a study that examined shifts in sucrose concentration in combination with different levels of food deprivation. Rats under high deprivation (21 hr) or low deprivation (1-hr) were shifted from licking 12 to 32% sucrose or from licking 32 to 12% sucrose. Both positive and negative contrast effects were obtained. A most striking finding of this study was the report that the absolute level of positive contrast was the same regardless of the level of food deprivation. Indeed, the positive contrast effect under low deprivation conditions was all the more striking because of the low level of control licking. It appears that high deprivation levels tend to obscure positive contrast effects because responding is already near ceiling levels. Such a finding is consistent with the analysis of positive contrast given by Weinstock (1971) in an earlier section of this paper, where it was shown that a relatively mild deprivation condition (88% of body weight) lowered running speeds and allowed positive contrast effects to occur.

It is notable that while positive and negative contrast effects occur in licking rate following shifts in sucrose, there appear to be no corresponding contrast effects in studies that use bar-press training and sucrose as reward (Walker, 1971) or sucrose studies that vary response rate up and down simultaneously (Ashton, 1971).

Shifts in quantity and quality. Weinstein (1970a) explored the possibility that negative contrast effects may occur following shifts in concentration of a constant volume of saccharin solution. In a study that compared saccharin vs. sucrose in combination with a partial reinforcement schedule it was revealed that the concentrations

of saccharin and sucrose that produced equivalent levels of performance also produced equivalent negative contrast effects with both continuous and partial reinforcement. This finding is not in agreement with Vogel, Mikulka, and Spear (1968) who decreased the concentration of a constant-volume saccharin solution and failed to obtain negative contrast effects. However, as Weinstein points out, the failure to obtain negative contrast effects in the Vogel, et.al. (1968) study may be because these researchers selected preshift concentration not conducive to the production of negative contrast. Many studies have shown that the magnitude of negative contrast effects is a positive function of the amount of reward reduction (e.g., DiLollo and Beez, 1966). Vogel, et.al. only reduced the concentration of saccharin from .10% to .01% compared to a reduction from 1.5% to .10% in the Weinstein (1970a) experiment. Thus, the relative differences in the concentration selected may account for the discrepant results.

Support for the Weinstein interpretation comes from a study by Cammin (1970) designed to test for negative contrast effects in instrumental conditioning using sucrose as reward. Reinforcement was manipulated in terms of volume ("quantity") and concentration ("quality"). The results indicated a reliable negative contrast effect for shifts downward in either quantity or quality of reward. The finding that disparate qualitative shifts (32% vs 4% sucrose solution) produced negative contrast is consistent with Weinstein (1970a) and at odds with Vogel, et.al., (1968). It is notable that none of the differences among the studies can be explained away on the basis of a saccharin-sucrose dichotomy because one does not appear to exist (Weinstein, 1970a).

Weinstein (1972e) has given an interesting theoretical account of positive contrast effects, at least as far as shifts in saccharin-sucrose incentives are concerned. He posits that an increase in amount of reward results in "an appetitive emotional response, such as happiness or joy, which produces internal cues that energize the instrumental response, thus resulting in an increase in performance (positive contrast) [p. 237]. In accord with such a position, it would be predicted that a neutral stimulus associated with an increase in reward magnitude that produces positive contrast, should subsequently result in a reliably higher level of behavior than a cue initially paired with a control group's higher reward magnitude. Consistent with this prediction Weinstein (1972e) demonstrated that rats ran faster in a straight alley to a tone previously paired with positive incentive contrast effects produced in an operant conditioning chamber than did rats in the control group which ran to a tone initially paired with a higher amount of reward. A similar kind of result was found by Ison and Glass (1969b). Additionally, in the Weinstein (1972e) study it was shown that positive contrast effects which occurred after one increment in reward did not occur following a second increment. This later finding was also interpreted as supporting the notion that positive contrast effects are due to some form of appetitive emotional state.

J. R. Ison and D. H. Glass have conducted a series of investigations on the effects of sucrose rewards on instrumental behavior. Ison and Glass (1968) examined the long-term facilitatory effect of prior high concentration on subsequent postshift instrumental running, although preshift exposure to the initial sucrose solution was confined

to consummatory experience. These investigators found that a high preshift concentration produced rapid running in postshift regardless of the postshift concentration. This result would argue that the occurrence of instrumental behavior, and thus differential habit strength for instrumental behavior, is not crucial. In a follow-up study Ison and Glass (1969a) made a direct comparison of preshift running and drinking vs. merely postshift drinking. In phase 1 of this experiment subjects received either running or goalbox placement trials to one of two levels of sucrose reinforcement. In phase 2 all subjects were given a series of running trials to the low level of reinforcement. The results supported the data of Ison and Glass (1968) in that subjects behaved as if they were still receiving the initial high sucrose concentration and either maintained (in the running group) or acquired (in the placement group) a speed appropriate to that reinforcement level. These results suggest that not only do contrast effects fail to emerge in such situations but the habit-strengths that produced the original high-level of performance are sufficient to sustain high performance even with a lower reward magnitude. Such a finding is consistent with early Hullian study (Hull, 1943).

However, the previously mentioned report by Vogel, Mikulka and Spear (1968) found that shifting to a lower sucrose concentration led to an abrupt undershooting of control group performance (negative contrast effect). Additionally, the magnitude of the negative contrast effect was shown to be increasing with increasing preshift training (licking). The findings of Vogel, et.al., (1968) are thus inconsistent with the reports made by Ison and Glass. There are, however, certain procedural differences in the Vogel, et.al., and Ison and Glass experiments.

Throughout pretraining and postshift testing Ison and Glass required subjects to make a specific number of licks at the tube before being removed from the goalbox. This procedure, important as it may be for control of consummatory behavior, may also have selectively reinforced high rates of licking (i.e., longer bursts). Since Ison and Glass used such short test sessions (20 licks) it could have minimized the occurrence of interburst intervals (a variable shown to be of some importance in determining shift performance, e.g., Collier and Bolles, 1968) and correspondingly minimized the probability of obtaining contrast effects. The experiments of Vogel, et.al., (1968) did not have the same problems concerning selectively reinforcing high rates of licking.

Some years ago, Collier and Marx (1959) allowed rats to find sucrose solutions during magazine training in a lever box with different groups of animals getting low, medium, or high concentrations of the substance. These subjects were subsequently required to lever press for the middle concentration with the result that positive and negative contrast effects occurred. However, Dunham (1968) concluded on the basis of a survey of the literature that the data of Collier and Marx (1959) was unique. The matter seemed settled when Dunham and Kilps (1969) found evidence that the Collier and Marx data were not, in fact, due to changes in reinforcement at all; instead they were due to different degrees of hunger at the beginning of the lever press phase of the experiment.

Recently, Hulse (1973) used a special discrimination control method in an effort to clear up the discrepancy. Rats were magazine trained under 1 of 3 basic conditions: a 3000-Hz. tone followed by

(a) 1 pellet (B) 10 pellets or (c) a quasi-random mixture of both 1 and 10 food pellets. The rats then learned to press a lever for either a 1 pellet or a 10 pellet reward with the result that a long-lasting negative contrast effect emerged. No positive contrast effects were shown. Under conditions where experimental methods did not lead to differential deprivation and different degrees of hunger--conditions which satisfy the objections raised by Dunham and Kilps (1969)--a strong contrast effect emerged. Similar results have been reported by Bevan, Bell, and Lankford (1968) and Marx (1971). The research thus reaffirms the findings of Collier and Marx (1959).

Although Hulse (1973) failed to observe reliable positive contrast effects with incentive-shift using a lever press, Marx (1969) did demonstrate a positive contrast effect using disparate sucrose differences as reinforcers in leverpress learning. The positive contrast result can not be interpreted as an artifact of differential weight loss, as suggested by Dunham and Kilps (1969), because not only were the slight weight differences unreliable, they were in the direction opposite from that required by this interpretation with the positive contrast group showing more rather than less weight gain. It thus appears that both negative and positive contrast are reliable phenomenon in lever press situations, at least when experimental conditions are arranged to allow for their occurrence.

Shifts in sucrose in the double-runway. A recent series of studies have found that shifts in liquid sucrose incentives in a straight, double-runway lead to rapid performance changes (Prytula, 1969; Prytula and Braud, 1970a). While reliable differential speeds were obtained there was no evidence of either a positive contrast or a negative

contrast effect. Similarly, Prytula and Braud (1970b) were unable to demonstrate contrast effects when solid, rather than liquid, sucrose incentives were used as rewards for a running response in the double runway. But, Wookey and Strongman (1972) observed a positive contrast effect in the double runway when subjects were shifted from Noyes pellets (food) to sucrose (a more preferred food). It may very well be that previous failures to demonstrate positive contrast using sucrose reward in the double runway (i.e., Prytula, 1969; Prytula and Braud, 1970a,b) are the result of a ceiling effect produced by a high concentration of preferred food (sucrose). This explanation can not, however, account for the previous failures to observe negative contrast in the double runway when sucrose is used as reward (Prytula and Braud, 1970a,b).

In summary, the data relating to shifts in sucrose and saccharin seem to point toward the conclusion that positive and negative contrast effects both occur with regularity when proper precautions are taken to allow for their occurrence. However, it is difficult to arrive at anything definite because of the tremendous variability in research instrumentation and design in studies that use sucrose-saccharin solutions as rewards.

Appetitive Incentive Shifts: Special Cases

Design variables. The effect of the amount of time between pre-shift and postshift has been investigated by Gonzalez, Fernhoff, and David (1973). It had been shown in a previous experiment by Gleitman and Steinman (1964) that animals that experienced a 68 day interval between preshift and postshift failed to evidence a negative contrast effect. But this report is suspect since only 12 trials were given in the preshift phase. In the experiment by Gonzalez, et.al. (1973)

negative contrast was studied after considerably more preshift training than that given by Gleitman and Steinman (1964) and over several retention intervals. In all, there were 8 groups of rats (4 experimental and 4 control) given 48 preshift trials and then tested for contrast after either 1, 26, 42, or 68 trials (1 trial/day). The results confirmed those of Gleitman and Steinman (1964) showing no evidence of a negative contrast effect with a 68-day interval between pre-and post-shift. Furthermore, Gonzalez, et.al. (1973) indicated that the negative contrast effect diminished in an orderly fashion with negative contrast still occurring following the 26-day interval. This indicates that negative contrast effects do occur across surprisingly long interpolated retention intervals.

Davis and Ludvigson (1969) investigated the possibility that contrast effects are produced because subjects are responding to distinctive odor cues exuded on previous trials. Despite careful and controlled swabbing after each trial, contrast effects occurred. It would appear that contrast occurs in spite of odor not because of it. However, Davis and Ludvigson point out that the pattern of results they obtained could have only occurred if the swabbing had been ineffective. That is, their results indicated that swabbing did not eliminate odor but rather spread it more homogeneously throughout the apparatus. Thus, the question "of odor produced contrast effects" has not been totally answered.

Rosen and Tessel (1968) attempted to determine whether post-reinforcement-delay would act to impede the occurrence of contrast effects. Food-deprived subjects received 55 straight runway trials for 1 or 12 pellet rewards combined factorially with 0-or 20 sec

post-reinforcement delay intervals. (Notice the delay used here is grossly different from the pre-reinforcement delay procedures used by investigators in earlier sections of this paper, e.g., Mellgren, 1972; Shanab and McCuistion, 1970). The 12-pellet groups were then run for an additional 55 trials at 1 pellet while the 1-pellet groups were run for 86 trials, and then shifted to 12 pellets for an additional 24 trials. The results revealed that post-reinforcement-delay produced nondifferential performance relative to no-delay, i.e., negative contrast effects occurred under both conditions. While positive contrast effects did emerge they were not found to be statistically reliable. So, unlike pre-reinforcement-delay procedures, post-reinforcement-delay has little or no influence on contrast phenomenon.

While contrast effects have also been demonstrated in free operant case (Wilson, 1971) and in subjects with hippocampal or neocortical lesions (e.g., Franchina and Brown, 1971), one of the more interesting reports relating to contrast has come from a single experiment by McCain (1969). He ran one group of subjects to a reward of 22 45-mg pellets, then shifted to one 1000-mg pellet. A second group ran the reverse of this reward schedule. (Note: while the total weights of the rewards were not exactly identical they were very close). In general the results revealed that performance shifts, similar to those found in the Crespi effect occurred, although they were not statistically significant. These results pose a problem of interpretation for reward-magnitude studies on incentive shift and suggest a perceptual approach to contrast may be more appropriate.

Leung and Jensen (1968) looked at shifts in percentage of reinforcement as special cases of contrast phenomenon. Subjects given extensive training on low percentages of reinforcement (0-67%) were shifted to

continuous reinforcement at the same reward magnitude in an attempt to show positive contrast. Similarly, subjects were shifted from continuous reinforcement to lower schedules of reinforcement ranging from 67% to 0% in an effort to show negative contrast effects. The results showed that all partial groups but one (0% schedule) ran faster than the continuously reinforced control group after the shift to continuous reinforcement. Shifting from a continuous to partial schedule resulted in little or no reduction in speed, i.e., no negative contrast effects occurred. These results suggest contrast effects occur following incentive shifts whether or not the incentive shifts is based on reward magnitude or change in reinforcement frequency.

It is worth noting that the data of Leung and Jensen (1968) might be understood from within the framework of behavioral contrast (see a later section of this paper for a detailed description of behavioral contrast methodology). Shifting from a continuous to a partial schedule (or vice versa) in many respects is analogous to altering the schedule of reinforcement on one component of a multiple schedule. Behavioral contrast research based on changes in reinforcement frequencies in multiple schedules (cf., Freeman, 1971) indicates that positive contrast is a reliable phenomenon but negative contrast is less well established. Thus, the results of Leung and Jensen (1968) seem to be consistent with other studies that have employed shifts in density of reinforcement.

There have been applications of contrast phenomenon to other areas of research (e.g., Gonzalez and Bitterman, 1969, have indicated that the mechanism for the spaced trials partial reinforcement effect is negative contrast or the lack of negative contrast) however a review of that literature seems outside the scope of the present analysis.

Now let us examine another special case. But this time we will be concerned with subject differences as opposed to procedural differences.

Subject variables. Fish, apparently, do not show the same behavior following reward shifts as rats. Lowes and Bitterman (1967) trained goldfish to respond to an illuminated target for high and low rewards. After the fish had reached asymptotic performance, the reward values were reversed. Interestingly, the fish did not show postshift behavior that was at all consistent with rats given food reward. First, their response time were modified only when magnitude of reward was increased but not when it was decreased. Second, the single instance of a change in response time could be characterized as a gradual one. And third, no overshooting or undershooting was observed.

It is important to note that Lowes and Bitterman (1967) used a response that was quite different from a runway response. The required task was similar to a lever pressing task that is frequently used with rats. However, Lowes and Bitterman (1967) discount the possibility that this task per se could account for the failure to replicate Crespi (1942). They assert that species differences rather than task differences account for the discrepancies in the rat and goldfish literature. The authors present two major reasons for this interpretation. First, the similar performance for rats and goldfish during preshift training was taken as an indication that postshift differences should reflect species differences. Second, a series of earlier goldfish studies seemed consistent with the authors species-difference interpretation. Their earlier studies, however, were also performed with a non-runway task. Raymond, Aderman, and Wolach (1972) attempted to provide an empirical answer to the problem as they failed to demonstrate contrast effects

in a study where the procedure provided an apparatus similar to the apparatus used in earlier studies with rats.

Unfortunately the results of Raymond, et.al. are uninterpretable because of several serious deficiencies. The most obvious, perhaps, is that the stimulus properties of food were confounded with its reinforcing properties--the food used on each trial was at the end of the runway when the trial began and clearly visible to the animal before the completion of the measured response.

These results show that the magnitude of reinforcement is a more potent variable for the fish than for the rat, and that reinforcement is capable of sustaining learned behavior independently and in spite of sequential reward contingencies in fish but not in rats. Additional support for this idea comes from a study by Gonzalez and Bitterman (1967), in which fish were trained to press a target for either high or low food reward. After training both groups were subjected to experimental extinction, and it was found that resistance to extinction was greater for the high reward group. Just the opposite occurs with rats (Hulse, 1958; Wagner, 1961). Again it seems that large rewards sustain learned behavior in the fish but provide the opportunity for contrast effects in the rat. It is interesting to note that, in this instance, fish behavior follows straight S-R (habit) theoretical predictions but rat behavior does not. However, before suggesting that the fish is strictly an S-R organism, there must be more systematic variation. These experiments alone can not support such a claim. Nevertheless, it is difficult to escape the impression that the associative processes of fish and rat are different in some fundamental respect.

The Effect of Deprivation on Contrast Effects

High drive versus low drive conditions. It has been only in recent years that serious investigations have emerged concerning the influence of food deprivation (Drive) on contrast effects. Aside from having empirical relevance a study of contrast effects in relation to drive level has definite theoretical implications. According to frustration theory (Amsel, 1958), negative contrast effects occur in the following way. A decrement in reward in the presence of r_g is held to evoke a primary frustration response (R_F), which, in its anticipatory form, r_f , interferes with the ongoing instrumental approach response and determines the observed negative contrast effect. Since the strength of r_f is said to be a function of the vigor of r_g , it could be stated, that, following a given amount of reward, the magnitude of the negative contrast effect should be greater under conditions which enhance the vigor of r_g ; notably a high as opposed to a low level of drive (Spence, 1956).

Cleland, Williams, and DiLollo (1969) performed an experiment that examined the magnitude of negative contrast effects in relation to drive level. It was expected that the magnitude of negative contrast, as determined by comparison of nonshifted controls, would be greater following a reward shift at a high level than at a low level of drive. Consistent with this expectation, a negative contrast effect was obtained only in the goal section of a straight alleyway and under conditions of high drive. Similar results were reported by Ehrenfreund (1971) in a study that tested for both positive and negative contrast under high and low deprivation conditions. Only negative contrast was shown to occur and then only under high drive. These results support a frustration interpretation of negative contrast effects.

However, Capaldi and Singh (1973) ran two experiments that found that the size of the negative contrast effect was independent of drive level, i.e., high vs. low body weight. These results are in obvious contrast to the previous experiments in which the negative contrast effect occurred only under low body weight (Cleland, et.al., 1969; Enrenfreund, 1971). Thus it would seem that body weight (drive level) influences the size of contrast effects only under certain experimental conditions, conditions which were present in the Cleland, et.al. and Ehrenfreund investigations, and which were not present in the Capaldi, et.al. (1973) study. The main difference between Capaldi, et.al., (1973) and Cleland, et.al., (1969) is that the ITI used in the later experiment was much longer (25 min) than the ITI used in the Capaldi, et.al., (1973) experiments. Also, there were differences in the number of preshift training trial that could account for the discrepant results. Similarly, distinctions can be made between the procedures of Capaldi, et.al., and Enrenfreund. Whereas Ehrenfreund employed a large number of preshift trials (135) and a relatively short ITI (4-5 min), a small difference in reward magnitudes was employed (6 vs. 1 pellets). In the Capaldi, et.al., experiments a much larger difference in reward magnitudes was used (20 vs. 2 pellets). It appears then that drive level may have an influence on negative contrast effects, but only under conditions that are minimal or near minimal for the production of negative contrast effects (i.e., as in the Cleland, et.al., and Enrenfreund investigations).

Shifts in appetitive drive level. One of the more exciting areas of research in contrast effects has been studies that are

concerned with shifts in drive level. One of the first reports in this area is provided by Mollenauer (1971a). She trained rats to run in a straight alleyway, half of which were under high deprivation and half of which were under low deprivation. At 23, 75, and 105 trials one-third of the animals from the original groups were shifted to the other deprivation level. At the two later shifts both positive and negative contrast effects appeared, while the early shift (trial 23) merely produced performance change in the expected direction. These deprivation results are consistent with those of Logan and Wagner (1965) who used incentive shifts and observed that shifts in reward magnitude early in training result in stimulus generalization or delayed behavioral adjustment whereas shifts late in training result in incentive contrast.

But the effect of shifting drive level became a confused issue with a report by Capaldi (1971) where a downward shift in drive level not only failed to produce negative contrast effects, but failed to significantly alter the previous high performance level associated with high drive. That these differences are not a function of differential methods of weight maintenance (i.e., adjusted percentage vs. fixed percentage) was shown in a latter report (Capaldi, 1972b). At this point, the effects of shifts in drive level remained one of the many enigmatic areas of research in contrast effects.

A well conceived article by Capaldi (1973) seems to point toward a path leading out of the wilderness. Capaldi observed that the primary differences between her own reports and that of Mollenauer (1971a) were the number of preshift training trials (only a few preshift trials were given in the earlier mentioned reports by Capaldi) and reward magnitude (Mollenauer used much larger rewards than Capaldi). In an

empirical test of the influence of these variables, Capaldi (1973) trained rats with either a small or large reward, and body weight (Drive) was shifted after extended training. The effect of shifting body weight from 75% to 90% following extended training was shown to vary as a function of reward magnitude. Animals trained with a large reward decreased in speed rapidly to a level below that of the 90% large reward control group, whereas animals trained with a small reward decreased in speed to the level of the 90% small reward control group. Thus, the difference between Mollenauer (1971a) and other reports (e.g., Capaldi, 1971; 1972b) appears to be attributable to the different reward magnitudes employed.

At a general level, then, the effects of shifts in deprivation level are similar to the effects of shifts in reward magnitude, i.e., both positive and negative contrast effects emerge under adequate experimental conditions. Whether this similarity is coincidental or reflects common underlying mechanisms remains a matter for future research.

The effect of shifting drive level has also been examined in differential conditioning experiments. Mollenauer (1971b) used repeated shifts in drive level analogous to the procedure of Bower (1961) which employed simultaneous shifts in reward magnitude. While true positive and negative contrast effects did not obtain, there were some parallels shown between the data of Mollenauer and Bower. For instance, in both studies varying group differences late in training were increased relative to control group differences. Bower has suggested, as has Logan and Wagner (1965), that this type of increased separation of the varying group, is an instance of contrast effects. It is noteworthy that Eisenberger, Myers, and Kaplan (1973) failed to demonstrate any evidence

of contrast effects in a differential conditioning study that varied drive level. But, unlike Mollenauer (1971b), they used small reward magnitudes and as shown in an earlier report (Capaldi, 1973), small reward magnitudes should not be expected to generate contrast effects.

Thus, while contrast effects with shifts in drive level appear to be more pronounced in successive shift paradigms (Capaldi, 1973; Mollenauer, 1971a), there is some evidence of their occurrence in differential conditioning experiments (Mollenauer, 1971b). Clearly, more research needs to be done along these lines.

Summary

A review of the literature concerning shifts in appetitive reward can only lead to the conclusion that both positive and negative contrast effects occur with great regularity when experimental conditions are arranged as to allow for their occurrence. The presence or absence of contrast effects with appetitive incentive shifts appears to be more a question of experimental design than a matter of behavioral principle. However, only through more careful and selective experimental analysis can it be demonstrated that positive and negative contrast are truly reliable phenomena.

Contrast Effects in Escape Conditioning

Shifts in negative reinforcement magnitude. While the literature is replete with contrast studies manipulating appetitive variables there is a paucity of research concerning contrast effects in escape conditioning. One of the early experiments was that of Bower, Fowler, and Trapold (1959) which shifted subjects receiving large reinforcement (200v. shock reduction) to small reinforcement (50-v. shock reduction)

and vice versa. Bower, et.al., found that although subjects quickly adjusted running speeds to the new reinforcement magnitude, there was no evidence of either positive or negative contrast. However, since subjects experienced several transitions during training from small to large reinforcement, and from large to small reinforcement, contrast effects could have been obscured. Although these results were replicated by Howe (1961) in a similar study, quite different results were found by Braud (1968). In an escape experiment that actually suffers from the same criticisms just directed toward Bower, et.al. (1959), Braud found both positive and negative contrast effects when the amount of shock reduction in a runway was shifted from large to small (negative contrast) or from small to large (positive contrast). Consistent with Braud (1968) but at odds with Bower, Fowler, and Trapold (1959) is a report by McAllister, McAllister, Brooks and Goldman (1972). Subjects were first given classical fear-conditioning trials in one side of a two-way shuttle box. They were then allowed to jump a hurdle to the adjacent box and escape the fear-eliciting stimuli. Reinforcement magnitude (defined in terms of fear reduction) during the hurdle jumping phase was either large or small throughout (two control groups) or it was increased for one group while it was decreased for another group. Although there was no evidence of positive contrast, there was a clear demonstration of negative contrast using this procedure. Negative reinforcement contrast effects also appear in studies that employ intracranial stimulation (shock) as the aversive stimulus (e.g., Atrens, VonViethinghoff-Riesch, and Der-Karabetian, 1973). The shock-escape data relevant to incentive shift thus appears to be in a considerable state of conflict.

Woods (1967) used the water runway procedure to investigate the effects of shifts in negative reinforcement magnitude. The alley temperature was maintained at 25°C throughout the experiment while one of two reinforcement magnitudes was employed in the goal section: small (a 2° increase) or large (a 16° increase). Woods used the traditional successive non-differential paradigm with two control groups (constant high and constant low reinforcement) vs. an upshifted group and a downshifted group. It was shown that the different reinforcement magnitudes produced differential speeds during the pre-shift phase of the experiment and in postshift the shifted subjects gradually approached the response levels of the unshifted controls early in postshift with negative (but not positive) contrast effects observed late in postshift. The negative contrast portion of this experiment was replicated again by Woods (1973), using 15°C in the alleyway, and 4° and 24°C increases as small and large reinforcement, respectively. Thus the negative-incentive-shift investigations that employ temperature as the primary aversive stimulus, reliably report negative contrast but not positive. However, it is difficult for the present author to accept that an increase of only 2°C is actually a reinforcing state of affairs. If an increase in temperature of 2°C is not perceived as reinforcement then these experiments do not qualify as studies of traditional incentive contrast. In addition, subjects in both experiments (Woods, 1967; 1973) had to be removed from the alley and placed in the goalbox. Thus, the criticism directed toward Bower, et. al., (1959) concerning subjects experience with reward also applies to the Woods experiments.

Shifts in aversive drive level. There have been several studies that have examined the effects of shifts in aversive drive level. Nation, Wrather, and Mellgren (1974) reported two experiments, both using the shock-escape procedure in a straight runway. Experiment I employed a successive nondifferential procedure with three groups (.2-.4, .4-.4, .8-.4) where the first number indicates the shock in mA that subjects received in the start and runway sections of a straight alley during preshift and the second number represents the level of shock received in postshift. The shock was reduced to 0 in the goalbox for all subjects. The results revealed that both positive and negative contrast effects occurred under this procedure. Although shifts in aversive drive level and shifts in negative reinforcement were confounded in the Nation, et.al. study, the finding that the positive and negative contrast effects occurred on the first trial of postshift implicates an unlearned source of motivation, i.e., drive. Experiment II obtained similar positive and negative contrast effects in a differential conditioning paradigm. Similar results were independently found by Black, Adamson and Bevan (1961) in an early shuttle-box experiment.

Woods and Schutz (1965) ran an experiment that tested the effect of aversive drive shifts in the water runway. Subjects received two drive levels in the alley: 12°C (high drive) and 30°C (low drive). The goalboxes were always 10°C warmer than the alley temperature. Two control groups received high and low drive respectively throughout the experiment while an upshifted experimental group received low drive during preshift and high drive during postshift. Correspondingly, a group receiving high drive during the preshift phase of the experiment

received low drive during the postshift phase of the experiment. The results demonstrated both positive and negative contrast effects following shifts in aversive drive level and in that respect are consistent with the shock-escape data of Nation, et.al., (1974). There would thus seem to be substantial agreement in escape studies involving shifts in aversive drive level as opposed to shifts in magnitude of negative reinforcement.

In summary, the few studies available in the escape literature provide some interesting parallels to the appetitive situation but as yet nothing truly concrete has developed. The main thrust of the literature dictates the message that positive and negative contrast occur in escape conditioning (e.g., McAllister, et.al., 1972; Nation, et.al., 1974; Woods and Schutz, 1965) but there are a number of failures to report contrast effects (e.g., Bower, et.al., 1959; Howe, 1961). Because of the disagreements in the escape literature concerning the effects of reinforcement shifts and drive shifts, nothing conclusive can be stated. Hopefully, further research will help free these confusing results.

Behavioral Contrast

The area of behavioral contrast has been and continues to be one of the more prolific areas of contrast research. It is not within the scope of the present analysis to attempt a review of all of the relevant literature in behavioral contrast. Such a review would doubtless be a major undertaking in and of itself. If the reader desires more comprehensive coverage of this literature, there are several recent reviews available (e.g., Freeman, 1971; Rachlin, 1973).

Presently, the examination of behavioral contrast will be limited to the relationship between behavioral contrast and incentive contrast.

A multiple schedule is one in which two or more schedules of reinforcement are alternated with a different exteroceptive stimulus associated with each. This provides a technique for bringing various behaviors within a single organism under stimulus control (Ferster and Skinner, 1957). Interactions among components of a multiple schedule may be described in terms of the direction of the rate change (Reynolds, 1961). In the typical behavioral contrast experiment, a base line of responding on a single variable interval (VI) schedule in both S_1 and S_2 is first established. Then the schedule of reinforcement in S_2 is altered (either increased or decreased), and changes in S_1 response rates are recorded. When this procedure is followed there are a number of possible results. Rate in the changed component (S_2) may either increase or decrease. At the same time, rate in the unchanged component may increase, decrease, or remain unaffected. If the rate in the unchanged component increases and the rate in the changed component decreases; a positive contrast effect is said to occur (Skinner, 1938). On the other hand, if the rate in the unchanged component decreases while the rate in the changed component increases then negative contrast is said to occur (Skinner, 1938). A rate increase in both the changed and unchanged component is referred to as a positive induction effect, while a rate decrease in both components is referred to as a negative induction effect (Skinner, 1938).

Unlike the difficulty of finding positive incentive contrast, positive behavioral contrast has been reliably obtained by a number of

investigators (e.g., Topping and Larmi, 1972; Sadowsky, 1973). However, of major interest has been the apparent difficulty of obtaining negative behavioral contrast (e.g., Weissman, 1969). So in behavioral contrast the results show asymmetrical contrast effects but in a direction opposite the asymmetrical contrast effect often reported in the incentive contrast literature.

Until an ingenious study by Padilla (1971) emerged, experimentally little concern had been given to the problem of relating incentive and behavioral contrast. In the Padilla study, a procedure was employed which eliminated discrete trials, programmed varying magnitudes of reinforcement on a VI schedule, and employed dependent measures based on both response latency and the rate of shuttling responses. All of these variables previously had been classified as distinctively operant or as distinctively discrete trials and therefore a comparison of the two procedures was prevented. But with the design of Padilla the relationship of incentive contrast and behavioral contrast could finally be examined free from procedure-specific limitation.

In the Padilla experiment subjects were trained to shuttle freely in two parallel runways, being reinforced in both runways on one of two VI schedules of reinforcement (i.e., VI 1.5 min or VI 3.75 min) with either two or five food pellets. After performance had stabilized, the VI schedule in one of the runways was shifted to the other schedule for a time period of eight 30-min. sessions, after which the baseline schedule was given again for another twelve sessions. Following this reinstatement of base-line conditions, the magnitude of reinforcement received was shifted in one of the alleys. The results showed that both positive and negative contrast effects occurred

in response rate and latency when the schedule or magnitude of reinforcement was shifted. These results suggest that incentive contrast and behavioral contrast are not different phenomena, and that little if anything is gained by distinguishing between the two.

Padilla proposes a perceptual-motivational interpretation. It is argued that rewards, in addition to their reinforcing properties, are effective stimuli which function in much the same way as do other stimuli. Any discriminable shift in the reward stimuli (e.g., in magnitude) is hypothesized to result in one of two emotional reactions. For example, if the reward magnitude is increased an "elation" reaction occurs which becomes associated with the new reward magnitude. A decrease in magnitude of reward, likewise, results in a reaction similar to "depression" which lowers performance. With respect to schedules, it is suggested by Padilla that subjects behave as if schedules are complex stimuli consisting of varying interreinforcement intervals. If the schedule is then markedly changed, the subject is thought to undergo an emotional reaction which either enhances or depresses performance, depending on the direction of the shift in schedules.

The notion that contrast effects are a function of the change in the discriminable properties of specific stimuli provides the basis for an enormous number of research projects. For example, Coates (1972) ran a traditional behavioral contrast study where the changed component of a VI schedule was shifted to extinction in one instance and punished-extinction in another instance. The results of the Coates (1972) study revealed that reliable behavioral contrast effects were produced in both the punished-extinction and extinction

conditions, with the reinforcement component following punished-extinction producing significantly more positive contrast than the reinforcement component following extinction. According to a discriminative change notion such as that of Padilla (1971) parallel results should obtain in a discrete trials instrumental conditioning paradigm that employs punished and unpunished extinction in the changed alley. Such a finding would be counter-intuitive considering the response measured in the constant alley (i.e., where positive contrast should occur) would be identical to the response punished in the changed alley. This particular issue is an empirical question and as yet remains unanswered. This is just one illustration of the kind of research that might come out of a discriminative position such as that of Padilla (1971). The demonstration that the differences between discrete-trials instrumental conditioning and free operant conditioning can be bridged can only mean that we are one step closer to a true understanding of all contrast phenomenon.

Contrast Effects with Human Subjects

Attraction related research. It has only been in the last few years that information has been made available regarding contrast effects in humans. But what has appeared in the attraction literature is encouraging considering some of the close parallels found between humans and animals. This particular area of investigation may prove to be one of the more fruitful areas of learning research, demonstrating a close similarity between human and infrahuman behavior. There are certain procedural differences between contrast studies using human vs. animal subjects. For example, contrast effects in interpersonal attraction are said to occur when an agreeing stranger is evaluated

more positively when presented in the context of a disagreeing rather than another agreeing stranger (positive contrast). Similarly, a disagreeer presented with an agreeer should be evaluated more negatively than if both are disagreeers (negative contrast). Griffitt (1971) ran a number of human contrast experiments and maintains that contrast effects result from shifts in the rated values of target stimuli away from contextual values. Griffitt provided support for such a doctrine in that he demonstrated subjects produce contrast effects when making judgements of stimulus persons in "context," i.e., where the subject is simultaneously exposed to the stimulus person and various other persons. This report of contrast effects in an attraction study is consistent with one earlier report by Worchel and Schuster (1966). These findings agree with those of Stapert and Clore (1969) who found similar contrast effects when subjects were exposed to successive persons. In each of the two procedures (simultaneous and successive) the crucial event is that a context is established before an evaluation is made. A person sees an agreeer or disagreeer before evaluating anyone, thus setting an agreeing or disagreeing context, to which the stranger can be compared.

The basic conception of Griffitt (1971) was tested by Padd (1974) in a study that examined the influence of context effects on the perception of a stranger as well as the evaluation of a stranger. The results not only support Griffitt's interpretation of contrast effects but actually add to it. In the Padd experiment, a consistent context was established along with an inconsistent context. A contrast effect was exhibited in that the agreeer in the inconsistent context was rated higher than an agreeer in the same sequential position in a consistent context (positive contrast), and a disagreeer was rated

more negatively in the inconsistent than in the consistent context (negative contrast). Additionally, contrast effects were shown to emerge in terms of perceived similarity (a finding consistent with data reported by Mascaro and Graves, 1973). These results thus extend Griffitt's (1971) explanation of contrast effects to include perceptual as well as response (attraction) variables.

Another attraction related study is that of Lamberth and Craig (1970). These researchers used differential magnitude of reward and magnitude shifts in an experiment specifically designed to show the close similarity between the effects of attitudinal stimuli and other more traditional reinforcers. Although the results of this experiment must be accepted with caution since the usual forced-trial procedure for selective learning was not employed to control for differential number of trials, the study nevertheless may offer some useful information. When shifts were made in small reward (neutral statements) and large reward (personal evaluations) performance levels changed according to reward conditions but there was no report of an overshooting or undershooting. However, close inspection of the graphs of Lamberth and Craig reveal that the experiment may have been prematurely terminated. While the present author can only speculate as to what might have happened, it does appear that if the experiment had been continued that both positive and negative contrast would have been obtained. The data of Lombardo, Tator, and Weiss (1972) provide some support for such a claim since they obtained negative contrast effects in an escape-conditioning study that shifted magnitude of attitudinal reinforcement. As seen previously, there is a fairly close correspondence between escape contrast and appetitive contrast studies and therefore contrast

effects would be expected to occur in the appetitive case (Lamberth and Craig) as well as in the escape case (Lombardo, et.al.).

In another attraction related experiment, Lombardo, Weiss, and Buchanan (1972) examined the effects of shifting to an extinction schedule following training with either high magnitude of negative reinforcement or low magnitude of negative reinforcement. Since extinction can be considered to be the limiting case of the low reward condition in studies of contrast effects, subjects shifted from high magnitude of negative reinforcement to extinction should demonstrate inferior responding relative to low reinforcement subjects shifted to extinction (see Dilollo and Beez, 1966, for a description of magnitude effects in contrast studies). The results, however, indicated that extinction for the different magnitude conditions occurred at approximately the same rate. Thus, depression effects as they appear in escape conditioning studies using human subjects do not seem to be a function of magnitude of negative reinforcement reduction. It would be interesting to see if comparable results occur in escape training with rats.

Haller and Lamberth (1973) used a functional analog to attitudes, i.e., room density. If the analogy holds between room density and attitudes, in terms of the way they function as reinforcing stimuli, then room density should also produce contrast effects. In other words, if room density is assumed to function like disagreeing attitudes (i.e., high room density) or agreeing attitudes (i.e., low room density), then contrast effects would be predicted. Accordingly, the results demonstrated that switching from a crowded to an uncrowded room

produced positive contrast in both an affect and an attraction measure. However, switching from an uncrowded to a crowded room did not result in negative contrast. The lack of a negative contrast effect in this study might be attributed to the time factor employed or subjects may have simply viewed the high density condition as novel. At any rate, these data show contrast effects occur to changes in density conditions and therefore provide some support for the conceptualization of room density (or crowding) as a reinforcing stimulus.

Contrast effects in human probability learning studies. There have been at least two attempts to show incentive contrast effects in human probability learning studies. Schnorr and Myers (1967) ran 6 groups of college students in a 2 choice situation under two levels of risk, the groups differing in the pair of risk levels they experienced. In this study that was analogous to a differential conditioning paradigm, negative contrast effects were shown both in terms of predictive behavior and subjects estimates of event probabilities. Halpern, Schwartz, and Chapman (1968) performed two related human probability learning experiments which were designed to assess contrast effects in a successive as well as a simultaneous (differential) situation. Negative contrast effects were noted with two non-zero incentive values in both the simultaneous and successive conditions. These effects were not obtained, however, when zero and non-zero incentive levels were paired. It appears that zero reward in studies of probability learning produces "floor" performance levels which prevent the occurrence of negative contrast.

Contrast effects with shifts in verbal reinforcement. There have been several experiments conducted which have employed shifts in verbal reinforcers. Bevan and Turner (1966) examined the effect of a qualitative shift in verbal reinforcement. Subjects were given either the word "Right" for correct responses or the word "Wrong" for errors in a signal detection task. Subsequently, subjects were shifted from one qualitative type of reinforcement to the other. The results indicated a qualitative contrast effect. These data suggest that a change in the quality of a reinforcer produces the same behavioral consequences as a change in reinforcer magnitude.

The most prolific person investigating contrast effects with verbal reinforcement has been Lawrence Weinstein. He and his colleagues have performed a series of human contrast experiments with different types of verbal reinforcement. Weinstein and Colucci (1970a) awarded points to college students for working multiplication problems. Two groups received either high (3 points) or low (1 point) verbal reward throughout the experiment while an experimental group was shifted from large to small verbal reward. The results indicated a negative contrast effect occurred following the decrease in reinforcement. Weinstein and Colucci (1970b) ran a similar experiment except that the shifted group was switched from small (1 point) to large (3 points) verbal reinforcement in an effort to show positive incentive contrast. While the increase in the amount of verbal reinforcement resulted in a gradual increase in behavior, there was no evidence of a positive contrast effect.

The failure of Weinstein and Colucci (1970b) to obtain positive contrast effects may have been due to the small reinforcement differential used in the study. Weinstein (1970b) provides substantial support for this notion in a study that investigated the magnitude of positive and negative incentive contrast as a function of the amount of verbal reward change. Both positive and negative contrast effects were shown to be a positive function of the amount of verbal reward shift. Such findings are consistent with studies using infrahuman subjects (e.g., Dilollo and Beez, 1966; Mellgren, et.al., 1973).

More recently, verbal reinforcement has been used to investigate magnitude of human incentive contrast as a function of amount of training and age (Weinstein, 1972a). In the first of three experiments, it was demonstrated that increased amounts of preshift training produced larger negative contrast effects. This result is in accord with most studies with infrahuman organisms (e.g., Vogel, et.al., 1968). Experiment 2 clearly demonstrated that positive contrast effects in humans are a monotonic function of the amount of preshift training. This result is at odds with some studies using rats (e.g., Mellgren, 1971a). Finally, in the third experiment it was shown that younger subjects (age 18) unlike older subjects (age 21) did not evince either positive or negative contrast. Unfortunately, Weinstein did not provide a logical explanation of the later results and none is readily apparent to the present author.

Monetary reward shifts and other special cases. In further research, Weinstein (1971a) investigated the effects of increments in monetary reward and repeated increases in reward magnitude in humans. In the first of two experiments, subjects displayed reliably higher

performance levels for a tone previously paired with an increase in monetary incentive (2-20 cents) and consequent positive contrast effects than did a control group that had previously had the tone paired with only the large monetary incentive magnitude (20 cents). Experiment 2 showed that these effects were eliminated by repeated increases in the reward magnitude. It is noteworthy that a negative contrast counterpart to Experiment 1 was found in a follow-up study (Weinstein, 1971b). It thus appears that both positive and negative contrast effects occur in human subjects when shifts are made in monetary incentive magnitudes.

The effects of sudden monetary incentive shifts have also been examined in a study that used children as subjects. Berkowitz (1973) trained first-graders under low reward (one gray cardboard disk) or high reward (five pennies). After 15 trials, half of the subjects from each group were switched to the other reward magnitude. A significant positive contrast effect was found but no corresponding negative contrast effect was reported. The lack of negative contrast using children, while difficult to explain, is consistent with at least one other report of human contrast (i.e., Haller and Lamberth, 1973).

Successive contrast effects in humans was the focus of a study by Weinstein (1972b). Two experiments examined the effects of a decrease in incentive size subsequent to a downshift in magnitude of reward. The results revealed that while negative contrast effects occurred following a single shift downward, such effects did not obtain following multiple shifts downward. These data are in accord with many related animal studies (e.g., Capaldi and Lynch, 1967).

One of the more compelling studies of human contrast comes from Obrien (1968). This investigation was based on the sequential contrast study of Terrace (1966) where pigeons were presented a multiple schedule of reinforcement in which S+ and S- were presented in a random as opposed to an alternated order. This schedule programmed S+ components to occur after both S- and other S+ components. It was shown that response rates during S+ components that followed S- components (S+/S-) were greater than response rates during S+ components that followed other S+ components (S+/S+). The purpose of the Obrien study was to demonstrate similar sequential contrast effects in humans. Besides demonstrating stimulus control, the results revealed that transient, but reliable, sequential contrast effects did occur in a group of institutionalized retardates. The Obrien experiment clearly illustrates the fact that there is a high correlation between human data and infrahuman data, at least regarding contrast effects. However, the mere close correspondence in data does not in itself, contribute to a better understanding of the phenomenon (Strongman, Wookey, and Remington, 1971).

Concluding remarks. So even though the human literature is marked with frequent demonstrations of upward and downward incentive contrast with appropriate controls (e.g., Haller, et.al., 1973; Padd, et.al., 1974; Weinstein, 1971a,b), it is still not entirely clear what mechanism regulates these behaviors. One potentially useful theoretical interpretation of human negative contrast is that of Weinstein (1972c) which implicates an emotionality variable, i.e., frustration. It is suggested that downward shifts in reward magnitude produce frustration responses which in turn compete with ongoing instrumental responses

and therefore negative contrast effects obtain. If such is really the case, one might expect that individuals who are more sensitive to the effects of frustration (i.e., more emotional) would exhibit larger negative incentive contrast effects than less emotional people. Weinstein (1972d) examined this issue in an experiment that reduced the amount of reward in high and low emotional subjects. Consistent with prediction, negative contrast effects were found in the high emotionality group but no such contrast occurred in the low emotionality group. But even though this position seems to handle negative contrast fairly well, it can not account for positive contrast.

Thus, extant theoretical positions do not seem to be sufficient to account for contrast effects in humans (or animals). The area remains as vague and unrefined as it did several years ago. The discipline might be wise to expend more effort in theory construction and less effort in gathering unrelated facts.

General Summary

As regards the effects of the various experimental procedures that we have gathered together under the heading of contrast, all the sources of evidence add up to equivocation. No longer can positive incentive contrast be summarily dismissed. There presently exist reliable evidence that positive incentive contrast occurs under a variety of experimental conditions, e.g., delay, punishment, low body weight, etc. Yet, much of the appetitive literature continues to report failures to demonstrate positive contrast, with some studies actually showing depressed responding when subjects are

shifted from low to high reward (e.g., Chechile and Fowler, 1973; McHose, 1970). Findings such as these lead to some unfortunately all too common possibilities for future appetitive contrast investigations. It appears that studies attempting to show both positive and negative contrast will have to be delicately designed to control for factors (e.g., ceiling effect, decision time, etc.) that might prevent the occurrence of contrast effects.

The effects of shifts in drive level in appetitive situations has not been extensively investigated but the data that does exist seems to be fairly consistent. When a sufficient number of training trials are given in combination with large reward, the literature uniformly reveals positive and negative contrast. Such consistency does not exist in the escape literature with either shifts in drive or negative reinforcement magnitude. That this confusing area is badly in need of further empirical investigation and clarification goes without saying.

The behavioral contrast results present some interesting problems in view of the fact that asymmetrical contrast effects occur but in a direction opposite to that in incentive contrast, i.e., positive contrast occurs with great regularity in behavioral contrast while negative contrast is difficult to demonstrate. The recent article by Padilla (1971), which indicates that the distinction between incentive contrast and behavioral contrast is largely arbitrary, represents a significant first-step in achieving a better understanding of this area. Up until this point investigators in free-operant and discrete-trial instrumental conditioning areas had maintained a status of casual disregard. Hopefully, the paper by Padilla will result

in a proliferation of related experiments designed to show the fundamental similarities between incentive and behavioral contrast. This, in itself, would be a significant contribution toward establishing a genuine comprehension of contrast phenomenon.

In human contrast, the limited number of reports that do exist are contradictory. The results which are available from such studies range from attraction studies with college students to simple motor responses with children and neither positive or negative contrast effects are well documented. The single greatest limitation of human contrast research (and infrahuman contrast research for that matter) is the lack of adequate theory to guide and direct analysis. Without the integrating force of meaningful theory, the literature relevant to contrast has been and will continue to be an aggregation of seemingly unrelated facts.

In closing, the mechanisms that are responsible for the production of positive and negative contrast remain obscure. While there are some legitimate explanations of negative contrast effects (e.g., frustration, generalization decrement) and other reasonable accounts of positive contrast (e.g., Weinstein's appetitive-emotional-state position), there does not seem to be any satisfactory description of both. This conclusion, as ever, calls for extensive parametric investigation. The present review and analysis may be of some help in considering and designing such investigations.

References

- Adamson, R., and Gunn, D. Contrast effects with a shift in work load. Psychonomic Science, 1969, 14, 11-12.
- Amsel, A. The role of frustrative non-reward in non-continuous reward situations. Psychological Bulletin, 1958, 55, 102-119.
- Ashton, A. B. The effects of sequential fluid concentration shifts upon short term ingestive behavior in the rat. Dissertation Abstracts, 1971, 31, 5012.
- Ashton, A., Gandelman, R., and Trowill, J. A. Effects of food deprivation upon elation of saccharin drinking following a temporary shift to water. Psychonomic Science, 1970, 21, 5-6.(a)
- Ashton, A., Gandelman, R. J., and Trowill, J. A. Effects of reinforcement shifts upon subsequent sucrose consumption. Psychonomic Science, 1970, 21, 7-8.(b)
- Ashton, A. B., and Trowill, J. A. Effects of reinforcement shifts upon lick rate. Psychonomic Science, 1970, 21, 8-10.
- Atrens, D. M., VonViethinghoff, F., and Der-Karabetian, A. Reinforcement contrast effects on the rewarding and aversive components of intracranial stimulation. Learning and Motivation, 1973, 4, 397-404.
- Beery, R. G. A negative contrast effect of reward delay in differential conditioning. Journal of Experimental Psychology, 1968, 77, 429-434.

- Beery, R. G., and Black, R. W. Reversal of magnitude of reward in differential conditioning. Psychological Record, 1968, 18, 179-183.
- Berkowitz, B. P. The effects of sudden incentive shifts on children's performance of a simple psychomotor task. Dissertation Abstracts, 1973, 33, 3926.
- Bevan, W., Bell, R. A., and Langford, H. G. Bar-pressing with a qualitative change in liquid reinforcement. The Journal of Genetic Psychology, 1968, 113, 109-116.
- Bevan, W., and Turner, E. D. Vigilance performance with a qualitative shift in verbal reinforcers. Journal of Experimental Psychology, 1966, 71, 467-468.
- Black, R. W. Shifts in magnitude of reward and contrast effects in instrumental and selective learning: A reinterpretation. Psychological Review, 1968, 75, 114-126.
- Black, R., Adamson, R., and Bevan, W. Runway behavior as a function of apparent intensity of shock. Journal of Comparative and Physiological Psychology, 1961, 54, 270-274.
- Bower, G. H. A contrast effect in differential conditioning. Journal of Experimental Psychology, 1961, 62, 196-199.
- Bower, G. H., Fowler, H., and Tapold, M. A. Escape learning as a function of amount of shock reduction. Journal of Experimental Psychology, 1959, 58, 482-484.
- Braud, W. G. Effects of shifts in shock-and-fear reduction in instrumental escape conditioning. Dissertation Abstracts, 1968, 28, 3486.

- Calef, R. S. The effect of large and small magnitude of intertrial reinforcement on successive contrast effects. Psychonomic Science, 1972, 29, 309-311.
- Calef, R. S., Hopkins, D. C., McHewitt, E. R., and Maxwell, F. R. Performance to varied reward following continuous reward training in the runway. Bulletin of the Psychonomic Society, 1973, 2, 103-104.
- Cammin, W. B. An investigation of contrast effects in reward magnitude employing sucrose solution as reward in instrumental conditioning. Dissertation Abstracts, 1970, 31, 2298-2299.
- Campbell, E. M., and Meyer, P. A. Effects of daily reward sequence on simultaneous and successive negative contrast in rats. Journal of Comparative and Physiological Psychology, 1971, 74, 434-440.
- Campbell, P., Crumbaugh, C. M., Knouse, S. B., and Snodgrass, M. E. A test of the "ceiling effect" hypothesis of positive contrast. Psychonomic Science, 1970, 20, 17-18.
- Capaldi, E. D. Simultaneous shifts in reward magnitude and level of food deprivation. Psychonomic Science, 1971, 23, 357-358.
- Capaldi, E. J. Successive negative contrast effects: Intertrial interval, type of shift, and four sources of generalization decrement. Journal of Experimental Psychology, 1972, 96, 433-438.(a)
- Capaldi, E. D. Effect on rats' straight alley performance of shifts in body weight as a function of method of weight maintenance. Psychonomic Science, 1972, 28, 44-46.(b)

- Capaldi, E. D. Effect of shifts in body weight on rats straight alley performance as a function of reward magnitude. Learning and Motivation, 1973, 4, 229-235.
- Capaldi, E. J. and Lynch, D. Repeated shifts in reward magnitude: Evidence in favor of an associational and absolute (noncontextual) interpretation. Journal of Experimental Psychology, 1967, 75, 226-235.
- Capaldi, E. J., and Singh, R. Percentage body weight and the successive negative contrast effect in rats. Learning and Motivation, 1973, 4, 405-416.
- Chechile, R., and Fowler, H. Primary and secondary negative incentive contrast in differential conditioning. Journal of Experimental Psychology, 1973, 97(2), 189-197.
- Cleland, E. A., Williams, M. Y., and Dilollo, V. Magnitude of negative contrast effect in relation to drive level. Psychonomic Science, 1969, 15, 121-122.
- Coates, T. J. The differential effects of punishment and extinction on behavioral contrast. Psychonomic Science, 1972, 27, 146-148.
- Collier, G. H., and Bolles, R. Some determinants of the intake of sucrose solutions. Journal of Comparative and Physiological Psychology, 1968, 65, 379-383.
- Collier, G., and Marx, M. H. Changes in performance as a function of shifts in the magnitude of reinforcement. Journal of Experimental Psychology, 1959, 57, 305-309.

- Crespi, L. P. Quantitative variations of incentive and performance in the white rat. American Journal of Psychology, 1942, 55, 467-517.
- Daly, H. B. Excitatory and inhibitory effects of complete and incomplete reward reduction in the double runway. Journal of Experimental Psychology, 1968, 76, 430-438.
- Davis, S. F., and Ludvigson, H. W. The "depression effect" and the problem of odor control. Psychonomic Science, 1969, 14, 93-94.
- Davis, S. F., and North, A. J. The effect of number of large reward training trials on behavior following incentive reduction. Psychonomic Science, 1968, 13, 311-312.
- Davis, S. F., and North, A. J. The effect of prior rewarded goal-box placements on incentive reduction behavior. Psychonomic Science, 1969, 16, 147-148.
- Dilollo, V., and Allison, J. Relative magnitude of end-box reward: Effects upon performance throughout the double runway. Journal of Experimental Psychology, 1971, 87, 248-254.
- Dilollo, V. D., and Beez, V. Negative contrast effect as a function of magnitude of reward decrement. Psychonomic Science, 1966, 5, 99-100.
- Dube, R., Ashton, A., and Trowill, J. A. Responses to palatibility shift: Effects of varying the retention level. Psychonomic Science, 1970, 21, 10-11.
- Dunham, P. J. Contrasted conditions of reinforcement: A selective critique. Psychological Bulletin, 1968, 69, 295-315.

Dunham, P. J., and Kilps, B. Shifts in magnitude of reinforcement:

Confounded factors or contrast effects? Journal of Experimental Psychology, 1969, 79, 373-374.

Ehrenfreund, D. Effect of drive on successive magnitude shifts in rats. Journal of Comparative and Physiological Psychology, 1971, 76, 418-423.

Eisenberger, R., Myers, P.A., and Kaplan, R. M. Persistent deprivation-shift effect opposite in direction to incentive contrast. Journal of Experimental Psychology, 1973, 99, 400-404.

Gandleman, R., and Trowill, J. A. Effects of reinforcement shifts upon subsequent saccharin consumption. Psychonomic Science, 1969, 15, 25.

Gavelek, J. R., and McHose, J. H. Contrast effects in differential delay of reward conditioning. Journal of Experimental Psychology, 1970, 72, 454-456.

Gleitman, H., and Steinman, F. Depression effects as a function of retention interval before and after shift in reward magnitude. Journal of Comparative and Physiological Psychology, 1964, 57, 158-160.

Godbout, R. C. The influence of preliminary training of the negative contrast effect in differential conditioning. Dissertation Abstracts, 1971, 31, 6933-6934.

Gonzalez, R. C., and Bitterman, M. E. Partial reinforcement effect in the goldfish as a function of amount of reward. Journal of Comparative and Physiological Psychology, 1967, 64, 163-167.

- Gonzalez, R. C., and Bitterman, M. E. Spaced-trials partial reinforcement effect as a function of contrast. Journal of Comparative and Physiological Psychology, 1969, 67, 94-103.
- Gonzalez, R. C., Fernhoff, D., and David, F. G. Contrast resistance to extinction, and forgetting in rats. Journal of Comparative and Physiological Psychology, 1973, 84, 562-571.
- Griffitt, W. Context effects in response to affective stimuli. Personality: An International Journal, 1971, 2, 23-33.
- Haller, J., and Lamberth, J. Room density as a determinant of affect and attraction. Paper presented at the annual meeting of the Southwestern Psychological Association, Dallas, 1973.
- Halpern, J., Schwartz, J. A., and Chapman, R. Simultaneous and successive contrast effects in human probability learning. Journal of Experimental Psychology, 1968, 77, 581-586.
- Harris, D. R., Collerain, I., Woff, J. C., and Ludvigson, H. W. Negative S- contrast with minimally contingent large reward as a function of trial initiation procedure. Psychonomic Science, 1970, 19, 189-190.
- Hiers, J. M. An investigation of the persistence of contrast effects in reward magnitude in instrumental conditioning. Dissertation Abstracts, 1969, 29(7-B), 2617-2618.
- Howe, E. S. The effects of an increased versus a decreased reduction in shock used as incentive. American Journal of Psychology, 1961, 74, 462-466.
- Huang, I. N. Successive contrast effects as a function of type and magnitude of reward. Dissertation Abstracts, 1969, 29, 3941.

Hull, C. L. Principles of behavior. New York: Appleton-Century-Crofts, 1943.

Hulse, S. H. Amount and percentage of reinforcement and duration of goal confinement in conditioning and extinction. Journal of Experimental Psychology, 1958, 56, 48-57.

Hulse, S. H. Reinforcement contrast effects in rats following experimental definition of a dimension of reinforcement magnitude. Journal of Comparative and Physiological Psychology, 1973, 85, 160-170.

Ison, J. R., and Glass, D. H. Long term consequences of differential reinforcement magnitudes. Journal of Comparative and Physiological Psychology, 1968, 65, 524-525.

Ison, J. R., and Glass, D.H. "Classical" vs. "Instrumental" exposure to sucrose rewards and later instrumental behavior following a shift in incentive value. Journal of Experimental Psychology, 1969, 79, 582-583.

Ison, J. R., and Glass, D. H. Effects of concurrent exposure to different food and sucrose rewards in differential conditioning. Psychonomic Science, 1969, 15, 149-150.

Ison, J. R., Glass, D. H., and Daly, H. B. Reward magnitude changes following differential conditioning and partial reinforcement. Journal of Experimental Psychology, 1969, 81, 81-88.

Lamberth, J., and Craig, L. Differential magnitude of reward and magnitude shifts using attitudinal stimuli. Journal of Experimental Research in Personality, 1970, 4, 281-285.

- Leung, C. M., and Jensen, G. D. Shifts in percentage of reinforcement viewed as changes in incentive. Journal of Experimental Psychology, 1968, 76, 291-296.
- Logan, F. A. Incentive theory and changes in reward. In K. W. Spence and J. T. Spence (Eds). The Psychology of Learning and Motivation. Vol. 2. New York: Academic Press, 1968, Pp. 1-30.
- Logan, F. A., and Spanier, D. Relative effects of delay of food and water reward. Journal of Comparative and Physiological Psychology, 1970, 72, 102-104.
- Logan, F. A., and Wagner, A. R. Reward and Punishment. Boston: Allyn and Bacon, Inc., 1965.
- Lombardo, J. P., Tator, G. D., and Weiss, R. F. Performance changes in human conditioning as a function of shifts in the magnitude of attitudinal reinforcement. Psychonomic Science, 1972, 28, 215-218.
- Lombardo, J. P., Weiss, R. F., and Buchanan, W. Reinforcing and attracting functions of yielding. Journal of Personality and Social Psychology, 1972, 21, 359-368.
- Lowes, G., and Bitterman, M. E. Reward and learning in the goldfish. Science, 1967, 157, 455-457.
- Marx, M. H. Positive contrast in instrumental learning for qualitative shift in incentive. Psychonomic Science, 1969, 16, 254-255.
- Marx, M. H. Resistance to extinction as a function of shifts in incentive. Psychological Reports, 1971, 29, 175-179.
- Mascaro, G. F., and Graves, W. Contrast effects of background factors on the similarity-attraction relationship. Journal of Personality and Social Psychology, 1973, 25, 346-350.

- Matsumoto, R. T. Relative reward effects in differential conditioning. Journal of Comparative and Physiological Psychology, 1969, 68, 589-592.
- Maxwell, F. R. Effects of magnitude and number of prior reward experiences on a subsequent shift in reward. Dissertation Abstracts, 1972, 32, 5490.
- Maxwell, F. R., Meyer, P. A., Calef, R. S., and McHewitt, E. R. Discrimination contrast: Speeds to small reward as a function of locus and amount of interpolated reinforcement. Psychonomic Science, 1969, 14, 35-36.
- McAllister, D. E., McAllister, W. R., Brooks, C. I., and Goldman, J. A. Magnitude and shift of reward in instrumental aversive learning. Journal of Comparative and Physiological Psychology, 1972, 80, 490-501.
- McCain, G. Different levels of performance with equivalent weights of reward. Psychonomic Science, 1969, 14, 2-3.
- McHewitt, E. R. A comparison of S+ and S- depression effects in differential conditioning. Bulletin of the Psychonomic Society, 1974, 3, 4.
- McHose, J. H. Relative reinforcement effects: S_1/S_2 and S_1/S_1 paradigms in instrumental conditioning. Psychological Review, 1970, 77, 135-146.
- McHose, J. H. Stimuli and incentives as determinants of the successive negative contrast effect. Bulletin of the Psychonomic Society, 1973, 1, 4.
- McHose, J. H., and Tauber, L. Changes in delay of reinforcement in simple instrumental conditioning. Psychonomic Science, 1972, 27, 291-292.

- Meyer, P. A., and Campbell, E. A. Role of daily reward sequences on S- discrimination contrast in rats. Journal of Comparative and Physiological Psychology, 1973, 82, 426-433.
- Meyer, P. A., and McHose, J. H. Facilitative effects of reward increase: An apparent "elation effect". Psychonomic Science, 1968, 13, 165-166.
- Mellgren, R. L. Positive contrast in the rat as a function of number of preshift trials in the runway. Journal of Comparative and Physiological Psychology, 1971, 77, 329-336. (a).
- Mellgren, R. L. Shift in magnitude of reward after minimal acquisition. Psychonomic Science, 1971, 23, 243-244. (b)
- Mellgren, R. L. Positive and negative contrast effects using delayed reinforcement. Learning and Motivation, 1972, 3, 185-193.
- Mellgren, R. L., Nation, J. R., Wrather, D. M. and Jobe, J. Contrast effects: Artifact or Reality? Unpublished manuscript. University of Oklahoma, 1974.
- Mellgren, R. L., Seybert, J. A., Wrather, D. M., and Dyck, D. G. Postshift reward magnitude and positive contrast in the rat. American Journal of Psychology, 1973, 86, 383-387.
- Mellgren, R. L., Wrather, D. M., and Dyck, D. G. Differential conditioning and contrast effects in rats. Journal of Comparative and Physiological Psychology, 1972, 80, 478-482.
- Mollenaur, S. O. Shifts in deprivation level: Different effects depending on amount of preshift training. Learning and Motivation, 1971, 2, 58-66. (a)

- Mollenaur, S. O. Repeated variations in deprivation level: different effects depending on amount of training. Journal of Comparative and Physiological Psychology, 1971, 77, 318-322. (b)
- Nation, J. R., Wrather, D. M., and Mellgren, R. L. Contrast effects in escape conditioning in rats. Journal of Comparative and Physiological Psychology, 1974, 86, 69-73.
- O'Brien, F. Sequential contrast effects with human subjects. Journal of the Experimental Analysis of Behavior, 1968, 11, 537-542.
- Padd, W., and Lamberth, J. Perceived similarity as a determinant of contrast effects in interpersonal attraction. Unpublished manuscript, University of Oklahoma, 1974.
- Padilla, A. M. Analysis of incentive and behavioral contrast in the rat. Journal of Comparative and Physiological Psychology, 1971, 75, 464-470.
- Panksepp, J., and Trowill, J. A. Positive and negative contrast in licking with shifts in sucrose concentration as a function of food deprivation. Learning and Motivation, 1971, 2, 49-57.
- Prytula, R. E. Incentive reduction-quality, quantity, in relation to the frustration effect. Dissertation Abstracts, 1969, 3401.
- Prytula, R. E., and Braud, W. G. Sucrose-pellet incentive shifts in the double alley. Psychological Reports, 1970, 27, 391-397. (a)
- Prytula, R. W., and Braud, W. G. Consequences of absolute and relative qualitative and quantitative sucrose-incentive reductions in the albino rat. Psychological Reports, 1970, 26, 843-853. (b)

- Rachlin, H. Contrast and Matching. Psychological Review, 1973, 80, 217-234.
- Raymond, B., Aderman, M., and Wolach, A. H. Incentive shifts in the goldfish. Journal of Comparative and Physiological Psychology, 1972, 78, 10-13.
- Reynolds, G. S. Behavioral contrast. Journal of the Experimental Analysis of Behavior, 1961, 4, 57-71.
- Rossen, A. J., and Gessel, R. E. Incentive shift and post-reinforcement delay in the runway. Psychological Reports, 1968, 23, 107-110.
- Sadowsky, S. Behavioral contrast with time out, blackout, or extinction as the negative condition. Journal of Experimental Analysis of Behavior, 1973, 19, 499-507.
- Sayeed, H., and Wolack, A. H. Successive incentive shifts with immature and mature rats. Japanese Psychological Research, 1972, 14, 54-60.
- Schier, A. M. Effects of an upward shift in amount of reinforcer on runway performance of rats. Journal of Comparative and Physiological Psychology, 1967, 64, 490-492.
- Schnerr, J. A., and Myers, J. L. Negative contrast in human probability learning as a function of incentive magnitudes. Journal of Experimental Psychology, 1967, 75, 492-499.
- Seybert, J. A., and Mellgren, R. L. Positive contrast: A control of ceiling effect using a long runway. Psychological Reports, 1972, 31, 14.
- Sgro, J. A., Glotfelty, R., and Podlesni, J. A. Contrast effects and delay of reward in the double alleyway. Psychonomic Science, 1969, 16, 29-31.

- Shanab, M. E. Sustained positive contrast in the Skinner Box following extended intermittent reinforcement training in the runway. Dissertation Abstracts, 1971, 31, 6958.
- Shanab, M. E., and Biller, J. D. Positive contrast in the runway obtained following a shift in both delay and magnitude of reward. Learning and Motivation, 1972, 3, 179-184.
- Shanab, M. E., and Ferrell, H. J. Positive contrast obtained in the Lashley maze under different drive conditions. Psychonomic Science, 1970, 20, 31-32.
- Shanab, M. E., and McCuistion, S. Effects of shifts in magnitude and delay of reward upon runway performance in the rat. Psychonomic Science, 1970, 21, 264-266.
- Shanab, M. E., Sanders, R., and Premack, D. Positive contrast in the runway obtained with delay of reward. Science, 1969, 164, 724-725.
- Skinner, B. F. The behavior of organisms. New York: Appleton-Century-Crofts, 1938.
- Spence, K. W. Behavior theory and conditioning. New Haven: Yale University Press, 1956.
- Stapert, J. C., and Clore, G. I. Attraction and disagreement-produced arousal. Journal of Personality and Social Psychology, 1969, 13, 64-69.
- Strongman, K. T., Wookey, P. E., and Remington, R. E. Elation. British Journal of Psychology, 1971, 62, 481-492.
- Terrace, H. S. Stimulus control. In W. K. Honig (Ed.), Operant behavior: Areas of research and application. New York: Appleton-Century-Crofts, 1966.

- Topping, J. S., and Larimi, O. K. Behavioral contrast as a function of changes in reinforcement frequency. Psychological Reports, 1972, 30, 583-587.
- Vogel, J. R., Mikulka, P. J., and Spear, N. Effects of shifts in sucrose and saccharine concentration on licking behavior in the rat. Journal of Comparative and Physiological Psychology, 1968, 66, 661-666.
- Wagner, A. R. Effects of amounts of percentage reinforcement and number of acquisition trials on conditioning and extinction. Journal of Experimental Psychology, 1961, 62, 234-242.
- Walker, J. L. A close temporal analysis of incentive contrast effects at two levels of training. Dissertation Abstracts, 1971, 32, 2419-2420.
- Weinstein, L. Negative incentive contrast effects with saccharin vs. sucrose and partial reinforcement. Psychonomic Science, 1970, 21, 277-278. (a).
- Weinstein, L. Magnitude of incentive contrast as a function of amount of verbal reward change. Psychonomic Science, 1970, 21, 65-66. (b)
- Weinstein, L. Effects of an increment in monetary incentive magnitude on instrumental responding and repeated increases in reward magnitude in humans. Psychonomic Science, 1971, 25, 235-236. (a)
- Weinstein, L. Effects of a reduction in reward magnitude on active avoidance behavior in humans. Psychonomic Science, 1971, 25, 205-206. (b)
- Weinstein, L. Magnitude of human incentive contrast as a function of amount of training and age. Psychonomic Science, 1972, 26, 91-94. (a)

- Weinstein, L. Negative incentive contrast in humans with partial versus continuous reinforcement and repeated reductions in reward. Journal of Experimental Psychology, 1972, 94, 210-215. (b)
- Weinstein, L. Contrast effects in animal and human learning: Recent results and interpretations. The Journal of Psychology, 1972, 81, 235-237. (c)
- Weinstein, L. Negative contrast with humans as a function of emotionality. The Journal of Psychology, 1972, 80, 161-165. (d)
- Weinstein, L. Positive contrast with saccharine and repeated increments in reward magnitude in the rat. The Journal of Psychology, 1972, 80, 237-245. (e)
- Weinstein, L., and Colucci, M. Negative incentive contrast effects with verbal reinforcement. Psychonomic Science, 1970, 18, 318. (a)
- Weinstein, L., and Colucci, V. M. Increase in incentive amount with verbal reinforcement. Psychonomic Science, 1970, 21, 83-84. (b)
- Weinstock, R. B. Preacquisition exploration of the runway in the determination of contrast effects in the rat. Journal of Comparative and Physiological Psychology, 1971, 75, 107-115.
- Weissman, R. G. Some determinants of inhibitory stimulus control. Journal of the Experimental Analysis of Behavior, 1969, 12, 443-450.
- Wilson, H. K. Contrast effects and reinforcement magnitude: The free operant case. Dissertation Abstracts, 1971, 31, 6250.
- Wolach, A. H., and Seres, M. Changes in running speeds after incentive shifts. Psychonomic Science, 1971, 23, 238-240.

- Woods, P. J. Adaptation to the drive stimulus in instrumental escape conditioning. Psychological Reports, 1967, 20, 787-793.
- Woods, P. J. The effects of sudden reduction in anticipated "relief". Bulletin of the Psychonomic Society, 1973, 1, 5-8.
- Woods, P. J., and Schutz, L. J. Performance in instrumental escape conditioning following a shift in drive stimulus intensity. Proceedings of the 73rd Annual Convention of the American Psychological Association, 1965, 23-24.
- Wookey, P. E., and Strongman, K. T. Qualitative reward shift in the double runway. British Journal of Psychology, 1972, 28, 44-46.
- Worschel, P., and Schuster, S. Attraction as a function of the drive state. Journal of Experimental Research in Personality, 1966, 1, 277-281.

APPENDIX B
STATISTICAL TESTS

SUMMARY TABLE FOR 3 (GROUPS) X 4 (DAYS) ANALYSIS OF VARIANCE
ON START SPEEDS DURING PRESHIFT TRAINING

Source	MS	df	F
Total	18.074	119	
Between	59.511	29	
A(Groups)	505.972	2	19.14**
Error	26.440	27	
Within	4.722	90	
B(Days)	2.519	3	0.53
AB	5.605	6	1.18
Error	4.738	81	

**p < .01

SUMMARY TABLE FOR 3 (GROUPS) X 4 (DAYS) ANALYSIS OF VARIANCE
ON RUN SPEEDS DURING PRESIFT TRAINING

Source	MS	df	F
Total	0.615	119	
Between	2.059	29	
A(Groups)	13.899	2	11.75**
Error	1.182	27	
Within	0.149	90	
B(Days)	0.055	3	0.38
AB	0.246	6	1.68
Error	0.146	81	

**p < .01

SUMMARY TABLE FOR 3 (GROUPS) X 4 (DAYS) ANALYSIS OF VARIANCE
ON GOAL SPEEDS DURING PRESHIFT TRAINING

Source	MS	df	F
Total	1.848	119	
Between	6.748	29	
A(Groups)	57.368	2	19.12**
Error	2.999	27	
Within	0.270	90	
B(Days)	0.509	3	1.95
AB	0.276	6	1.05
Error	0.260	81	

**p < .01

SUMMARY TABLE FOR 3 (GROUPS) X 4 (DAYS) ANALYSIS OF VARIANCE
ON TOTAL SPEEDS DURING PRESIFT TRAINING

Source	MS	df	F
Total	0.178	119	
Between	0.690	29	
A(Groups)	6.440	2	24.38**
Errors	0.264	27	
Within	0.013	90	
B(Days)	0.026	3	2.13
AB	0.018	6	1.47
Error	0.012	81	

** $p < .01$

SUMMARY TABLE FOR 3 (GROUPS) X 10 (DAYS) ANALYSIS OF VARIANCE
ON START SPEEDS DURING POSTSHIFT TRAINING

Source	MS	df	F
Total	19. 081	299	
Between	89.524	29	
A(Groups)	25.889	2	0.26
Error	94.236	27	
Within	11.515	270	
B(Days)	17.897	9	1.66
AB	18.308	18	1.70*
Error	10.775	243	

* $p < .05$

SUMMARY TABLE FOR 3 (GROUPS) X 10 (DAYS) ANALYSIS OF VARIANCE
ON RUN SPEEDS DURING POSTSHIFT TRAINING

Source	MS	df	F
Total	0.549	299	
Between	4.394	29	
A(Groups)	1.204	2	0.26
Error	4.631	27	
Within	0.136	270	
B(Days)	0.189	9	1.52
AB	0.273	18	2.19**
Error	0.124	243	

**p < .01

SUMMARY TABLE FOR 3 (GROUPS) X 10 (DAYS) ANALYSIS OF VARIANCE
ON GOAL SPEEDS DURING POSTSHIFT TRAINING

Source	MF	df	F
Total	2.577	299	
Between	19.506	29	
A(Groups)	64.541	2	3.99*
Error	16.172	27	
Within	0.758	270	
B(Days)	0.879	9	1.27
AB	1.611	18	2.33**
Error	0.069	243	

* $p < .05$

** $p < .01$

SUMMARY TABLE FOR 3 (GROUPS) X 10 (DAYS) ANALYSIS OF VARIANCE
ON TOTAL SPEEDS DURING POSTSHIFT TRAINING

Source	MS	df	F
Total	0.166	299	
Between	1.336	29	
A(Groups)	2.090	2	1.64
Error	1.282	27	
Within	0.041	270	
B(Days)	0.093	9	2.54**
AB	0.073	18	2.14**
Error	0.036	243	

** $p < .01$