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A RE-EXAMINATION OF THE ROLE OF PERCEPTUAL

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A RE-EXAMINATION OF THE ROLE OF PERCEPTUAL CONTRAST IN CS INTENSITY DYNAMISM

Performance is a negatively accelerated increasing function of the intensity of the conditioned stimulus. This relationship has been termed by Hull (1951, 1952) stimulus intensity dynamism (SID).

The stimulus intensity effect appears to be quite weak, in that a large number of studies simply fail to observe it (Carter, 1941; Grant and Schneider, 1948; Heyman, 1957; Kimmel, 1959; Kimmel, Hill, and Morrow, 1962). Gray (1965), in his review of the literature, cites three primary conditions that must be satisfied in order to obtain SID. These are:

1. Behavior should be measured during acquisition, not during extinction.
2. The GSR (as well as other responses of an "orienting nature") should not be used since conditioned and unconditioned aspects of the responses are difficult to separate.
3. Discrimination training is necessary for the appearance of the intensity effect.

Those studies which failed to observe the effect also failed to satisfy one or all of these conditions with only a few exceptions (e.g., Carter, 1941). So although SID has been demonstrated, the strength of the relationship appears to be tenuous.

Three theories have been proposed to account for SID. The dynamogenic model (Hull, 1951, 1952) predicts response strength to vary directly with the <u>absolute</u> energy level of the conditioned stimulus. Perkins (1953) and Logan (1954), on the other hand, would predict, in a differential conditioning model, that CS intensity effects are based upon the relative differences between the energy levels of the CS and the weaker inhibitory intertrial or background stimuli.

The differential conditioning model, in contrast to that of a dynamogenic model, predicts that the offset of stimulus energy is as effective as the onset of stimulus energy in establishing a conditioned response. Thus response strength should vary with the relative intensity, regardless of the direction of the stimulus change.

An additional model, as proposed by Grice and Hunter (1964), based upon Helson's Adaptation Level (AL), also predicts that stimulus change (or perceptual contrast) is an important variable in determining response strength. In addition, a dynamogenic or arousal function of the CS is considered. The CR is formed by the degree to which a CS departs from the AL established during training. The AL is a reference level, a point at which the S has become accustomed or adapted to the previous stimuli at that moment. If the intensity of the eliciting stimulus is above the reference level, the CR magnitude will be greater. Any additional stimulation will increase or decrease the AL with little or no loss in discrimination time.

Reviews (Champion, 1962; Gray, 1965; Marx, 1969) of studies pertinent to the effects of CS intensity on response strength have frequently reported failures to demonstrate SID when an extinction measure has been employed. Studies (e.g., Grant and Schneider, 1948, 1949; Kamin and Schaub, 1963; Kessen, 1953; and Walker, 1964) which employed extinction measures also used a counterbalanced factorial design. The factorial design supposedly provides a means of separating the effects of CS intensity on associative or nonassociative processes. Despite the logic of using a factorial design, several sources of confounding exist and these are: (1) an exaggeration of the CS intensity effects such that within-S CS intensity effects were as much as five times greater than between-S effects (Grice and Hunter, 1964); and (2) a decrement in performance for groups shifted in either direction due to generalization decrement (Kamin and Schaub, 1963).

Levy (1971), in two studies, tested whether or not CS intensity affects learning or performance using a conditioned suppression technique, and then tested such an effect with an extinction measure. A conditioned suppression procedure has the advantage of reliably demonstrating stimulus relationship with a one trial procedure. Along with the use of experimental and pseudoconditioning groups, tests of associative and nonassociative effects of SID can be made without the confounding of within-S shifts. In the first study Ss were trained with 82- or 58-db. white noise CS. In the second study Ss were trained with CS-offset using the same intensity as used in the first study, but there was a failure to include an appropriate control for the CS-offset group. If the CER procedure adequately measures classical conditioning processes, then the failure to find associative properties for SID in Levy's study lends even more support to the notion that CS intensity is a non-associative variable.

Using Levy's procedure, several hypotheses can be tested. With the addition of appropriate pseudoconditioning control groups a comparison between the CS-onset and CS-offset conditions can be made. The addition of a shifting technique, where Ss are trained on one stimulus condition (e.g., CS-onset) and tested with the opposite condition (e.g., CS-offset), will provide a means of testing the various theories of CS intensity. A summary of the various theories of CS intensity and their differential predictions of the use of the shifting procedure are as follows:

1. Hull's stimulus intensity dynamism theory takes into account only the absolute value of the stimulus. Only the onset of the CS is the effective condition. Thus, one would predict that conditioning would not be possible with CS-offset.
2. The Perkins-Logan theory takes into account the generalization gradients of excitation (from the CS) and inhibition (from intertrial or background stimulus). CS intensity effect is said to be the result of discrimination learning. It would be expected that Ss trained originally with CS-onset would acquire a habit strength to respond to a CS and not to respond to the background stimuli. Now, when the Ss are switched to CS-offset, they must relearn this new relationship. Thus a negative transfer would be predicted when groups are trained with one stimulus condition and tested with the opposite condition.
3. The adaptation level theory, as proposed by Grice and Hunter, assumes that Ss respond to the CS in its relationship among a series of stimuli after a reference level (e.g., the adaptation level) has been established. If the stimulus conditions are reversed (i.e., onset to offset), the same reference level is maintained. Thus, with the adaptation level theory, one would assume positive transfer.

Method

Subjects

The Ss were 96, 100-120 day old, male albino rats of the Sprague-Dawley strain.

Apparatus

A conditioning and a separate test chamber were used. The conditioning chamber was a BRS Foringer Skinner Box (Model RC-004) with the lever and food cups removed. The operant chamber was housed in a BRS Foringer ventilated, sound attenuating test cubicle (Model RCH-001). The Skinner Box was continuously illuminated by two 4.75 watt bulbs located on the back panel of the box 22.8 cm. above the stainless steel grid floor. A 9 second white noise CS (59-db. or 82-db.) was produced by means of a noise generator (Grason-Stadler Model 901B) and was delivered to the experimental chamber by means of a 5 cm. 9 ohm speaker located on a panel 25 cm. from the operant chamber. The UCS was a 1 ma. shock (scrambled) of 1 sec. duration produced by a Grason-Stadler Model E6070B shock generator.

The test chamber, which consisted of a galvanized steel box measuring 24 x 18 x 18 cm., with a wire mesh front, a Plexiglas cover, and a brass rod grid floor, was housed in a ventilated sound resistant shell. The light source was provided by two 4.75 watt bulbs positioned on the far end of the Plexiglas cover.

A drinking tube (3 mm. orifice) was located 6 cm. above the grid floor adjacent to the wire mesh front of the test chamber in such a way that the S could contact the solution (20% by weight sucrose) only with its tongue. Each touch of the tongue to the drinking tube was amplified by a drinkometer and recorded on a digital print-out counter (Grason-Stadler, Model 1238).

The ambient noise level, in both the conditioning and test chamber with the exhaust fans operating, was 84-db. as measured by a Realist sound level meter, Model 33-1028. The CS intensity levels were measured with the fans disconnected and had values of 58- and 82-db. for the weak and strong CSs respectively.

The conditioning and test chambers were located in a separate room from that of the automated programming and recording equipment. Stimuli for all phases of the study were programmed with commercially available relay, timing, and counting equipment.

Procedure

The Ss were randomly assigned to 8 groups of six Ss each. The factors in the experimental design were: (a) the presentation of either a 58- or 82-db. white noise CS during training trials; (b) the presentation of the CS-UCS acquisition contingency, i.e., paired (E) versus random (C) presentations of CS-UCS acquisition trials; (c) the presentation of CS-onset or CS-offset conditions in the acquisition phase; and (d) the presentation of the CS-onset or CS-offset conditions in the test phase according to a 2 x 2 factorial design.

CER training. The CER training phase began immediately following four daily 10 min. handling sessions and consisted of 10 delay conditioning trials with a 2 min. variable interval for the four experimental groups (i.e., 82-onset CS or 82-offset CS; 58-onset CS or 58-offset CS). Four control groups (82-onset CS or 82-offset CS; 58-onset CS or 58-offset CS) were administered the CS and UCS variables in random order with a 1 min. average interstimulus interval.

Approach training. Immediately following CER acquisition training trials, all Ss were water deprived for 24 hrs. The Ss received their water ration in 2 sessions, 24 hrs. apart, in the test chamber. Each session lasted for 10 min. following the twentieth lick from the drinking tube.

CER extinction. The strong and weak CS groups were given 4 days of extinction immediately following CER acquisition. The extinction training consisted of four daily CS presentations. The two groups trained with onset and offset conditions were subdivided into groups of 6 *Ss* each, according to a 2 x 2 factorial design. The On-On group received the onset conditions for either intensity in both the acquisition and extinction phases; the Off-Off group received the offset conditions for either intensity in both acquisition and extinction; the On-Off group was trained with CS-onset but tested with CS-offset; the Off-On group was trained with CS-offset but tested with CS-onset. Similarly, the control groups received the same divisions.

If a *S* failed to respond during the allotted time for extinction, an additional 10 min. period was administered; but if the *S* failed to respond during this extended period, the four CS presentations were presented, regardless of the response behavior. The UCS was never administered in the test chamber.

Results and Discussion

1st Trial Data

A 2 x 2 x 2 x 2 analysis of variance (ANOVA) was conducted on licking suppression to the white noise CS on the first extinction trial. This trial served as a test of CS intensity acquisition effects, since no trials at this stage had been received without shock.

In the ANOVA, Factor A corresponds to CER acquisition contingency (e.g., paired versus unpaired), Factor B to CS intensity (i.e., 82- versus 58-db.), Factor C to CS-onset versus CS-offset in training and Factor D to CS-onset versus CS-offset in testing. For future discussion, an example of a possible

TABLE 1

Summary of 2x2x2x2 Analysis of Variance on First Trial Extinction Suppression Ratios

Source	df	MS	F
TOTAL	95.	0.044	--
Between subjects	15.	0.139	--
A (Acquisition contingency)	1.	0.742	28.3137**
B (CS intensity)	1.	0.398	15.1976**
C (Onset-offset in acquisition)	1.	0.002	0.0607
D (Onset-offset in extinction)	1.	0.228	8.7026*
A x B	1.	0.072	2.7299
A x C	1.	0.066	2.5012
A x D	1.	0.042	1.6097
B x C	1.	0.169	6.4449*
B x D	1.	0.199	7.6010*
C x D	1.	0.011	0.4364
A x B x C	1.	0.055	2.0929
A x B x D	1.	0.000	0.0122
A x C x D	1.	0.085	3.2467
B x C x D	1.	0.001	0.0467
A x B x C x D	1.	0.014	0.5339
WITHIN	80.	0.026	0.5339

** $p < .005$

* $p < .025$

group notation would be for Ss trained with paired presentations of CS and UCS, 82-db. CS-onset condition and then tested with 82-db. CS-offset condition - E-82-On-Off. The response measure chosen was a suppression ratio which was calculated by the formula B/A+B where A is the number of licks before CS presentation and B is the number of licks during CS presentation (Kamin, 1965). Any ratio with a value of .50 or higher indicated no suppression while a ratio of .00 indicated complete suppression of responding during CS presentation. A summary of the ANOVA for the first trial data is shown in Table 1.

The analysis of the main effects were significant for CER acquisition contingency (F-28.31, df-1/80, $p < .001$); CS intensity (F-15.20, df=1/80, $p < .001$); and CS-onset and offset in testing (F=8.70, df=1/80, $p < .004$). An Intensity x CS-onset or offset in training was significant (F=6.46, df=1/80, $p < .01$), as well as Intensity x CS-onset or offset in testing (F=7.60, df= 1/80, $p < .01$).

The significant main effects and interactions indicated that there were not equal suppression rates for CS-onset or CS-offset conditions. Therefore, a series of Tukey's tests for differences among treatment means (Kirk, 1968) were conducted on first trial data.

The results of the analysis were as follows: (a) Group E-82-On-On Ss suppressed significantly more than Group E-82-Off-Off Ss (q=.14, df=6/80, $p < .01$); Group E-58-On-On Ss suppressed significantly more than did Group E-58-Off-Off Ss (q=.23, df=6/80, $p < .01$); Group E-82-Off-On Ss suppressed significantly more than did Group E-82-On-Off Ss (q=.32, df=6/80, $p < .01$); and Group C-82-Off-On Ss suppressed significantly more than did Group C-82-On-Off Ss (q=.25, df=6/80, $p < .01$). Thus, it appears that Ss trained and tested with

CS-onset suppressed significantly more than with the CS-offset condition and that *Ss* trained with CS-offset but tested with CS-onset suppressed significantly more than the comparable offset condition.

Support for the assumption that CS intensity influences associative processes in acquisition could only have been obtained by having a significant interaction between acquisition contingency and CS intensity. The failure to find this interaction indicated that while the main effect of CS intensity was significant, the differences were obtained in the pseudoconditioning control groups (C-82-Off-On) as well as in the experimental group. This data, in conjunction with previous reports using factorial designs, fails to support the assumption that CS intensity affects associative processes. The differences found in suppression ratios between groups can be interpreted as nonassociative effects of CS intensity.

Extinction Data Analysis

Another purpose of this investigation was to determine if CS intensity differences observed in acquisition would persist during an extinction procedure. A significant difference in group suppression ratios during extinction sessions, whether supporting an influence of CS intensity on associative or nonassociative processes, would be a contradiction to the findings of previous investigations which have used factorial procedures (e.g., Grant and Schneider, 1948; Kamin and Schaub, 1963; Kessen, 1943; and Walker, 1960).

Mean daily suppression ratios for the paired groups, the unpaired groups, and CS-onset or CS-offset in training and testing were plotted as a function of each daily extinction session in Figures 1-4. A repeated measure ANOVA with the following factors was performed on the suppression ratios: (a) CER acquisition contingency; (b) CS intensity; (c) CS-onset or CS-offset in training; (d) CS-onset or CS-offset in testing; and (e) extinction sessions. A summary of this analysis can be found in Table 2.

The main effects for CER acquisition contingency ($F=333.38$, $df=1/80$, $p < .0001$), CS intensity ($F=103.87$, $df=1/80$, $p < .0001$), and extinction sessions $F=5.84$, $df=3/240$, $p < .001$) were all significant. The effects of CER acquisition contingency x CS intensity level ($F=66.85$, $df=1/80$, $p < .001$) and CS intensity level x CS onset-offset in testing ($F=4.80$, $df=1/80$, $p < .02$) were also significant. Only a CER acquisition contingency x CS intensity x CS onset-offset in testing ($F=6.87$, $df=1/80$, $p < .001$) was significant, while other interactions were insignificant.

The fact that no differences were observed in CS onset-offset in training or testing indicated that there were no differences in suppression for Ss who were trained or tested with CS-onset or CS-offset. However, a CS intensity x CS onset-offset in testing and a CER acquisition contingency x CS intensity x CS onset-offset in training indicated that the results were unequivocal for CS intensities. Therefore, a series of Tukey's tests was conducted on means of daily extinction data. For importance to the discussion, the following analyses will be considered: (a) Group E-82-On-Off Ss suppressed significantly more than did Group E-58-On-Off Ss ($q=.16$, $df=6/80$, $p < .01$); (b) Group E-82-Off-On Ss suppressed significantly more than did Group E-58-Off-On Ss ($q=.19$, $df=6/80$, $p < .01$); (c) Group E-82-On-On Ss suppressed significantly more than did Group E-58-On-On Ss ($q=.16$, $df=6/80$, $p < .01$); and (d) Group E-82-Off-Off Ss suppressed significantly more than did Group E-58-Off-Off Ss ($Q=.26$, $df=6/80$, $p < .01$). None of the control group comparisons were significant. Differences between experimental and control groups were found in all groups trained and tested with an 82-db. CS intensity, but not all of

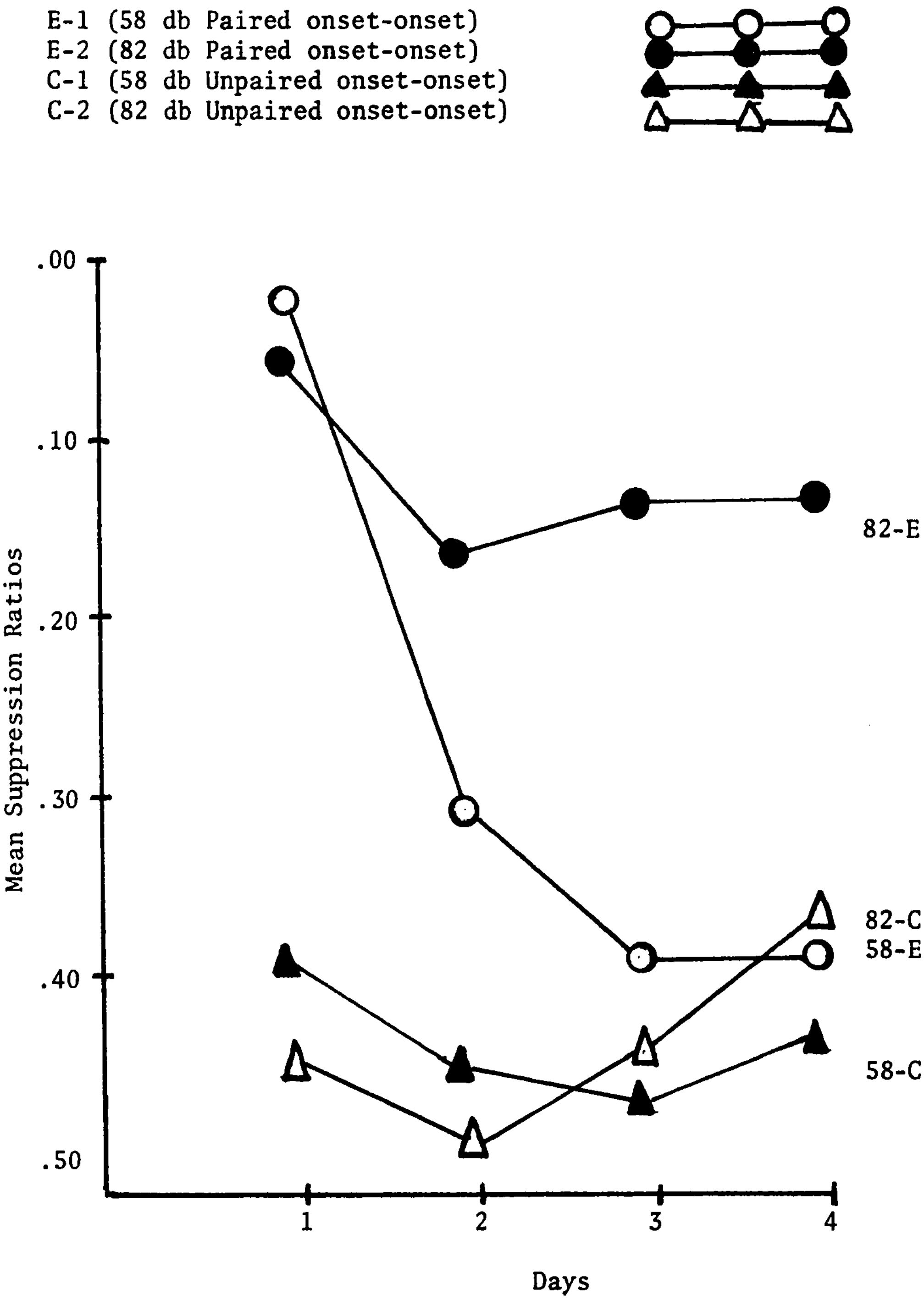

Fig. 1. Group suppression ratios in extinction for 82 onset-onset versus 58 onset-onset conditions.

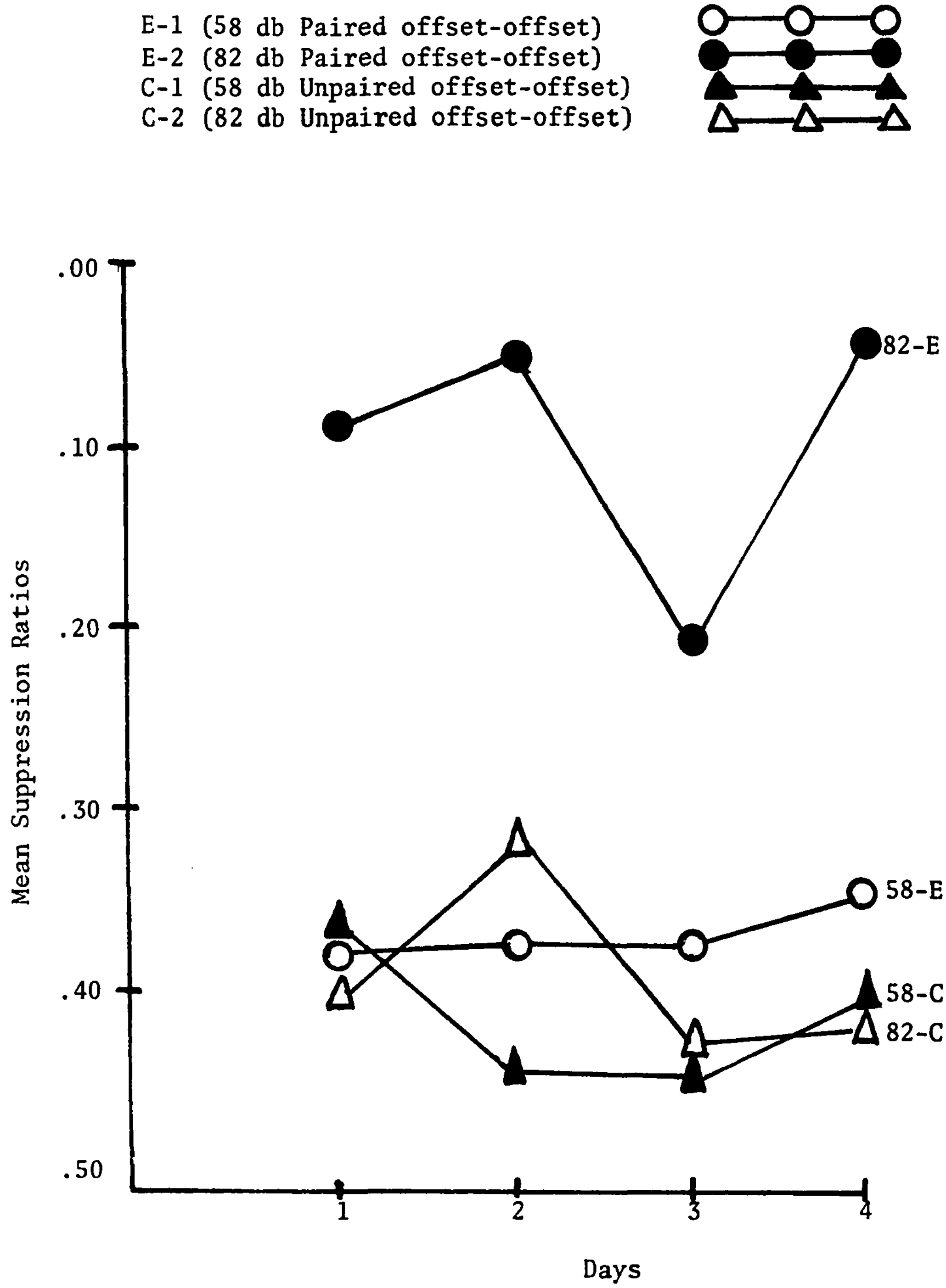

Fig. 2. Group suppression ratios in extinction for 82 offset-offset versus 58 offset-offset conditions.

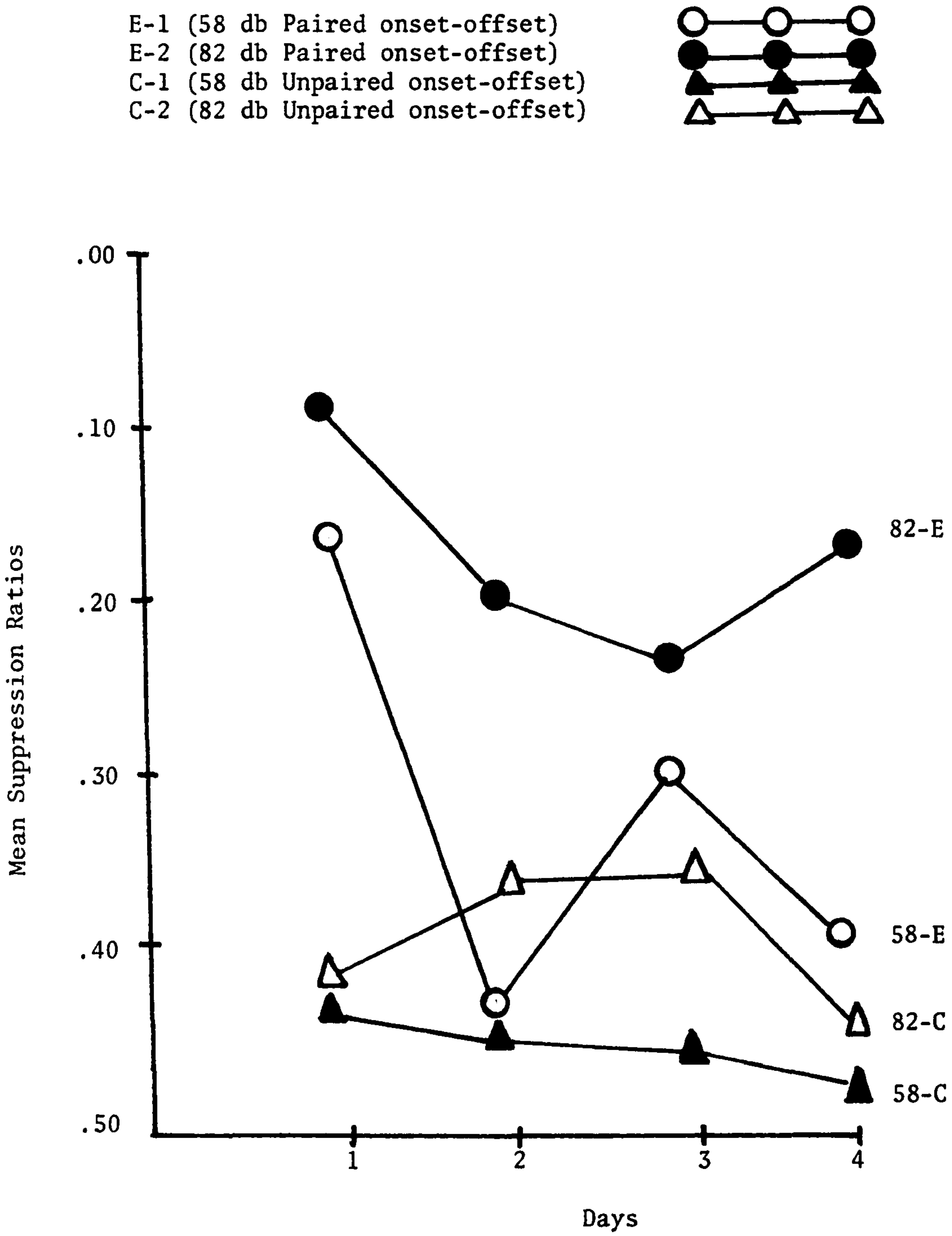

Fig. 3. Group suppression ratios in extinction for 83 onset-offset versus 58 onset-offset conditions.

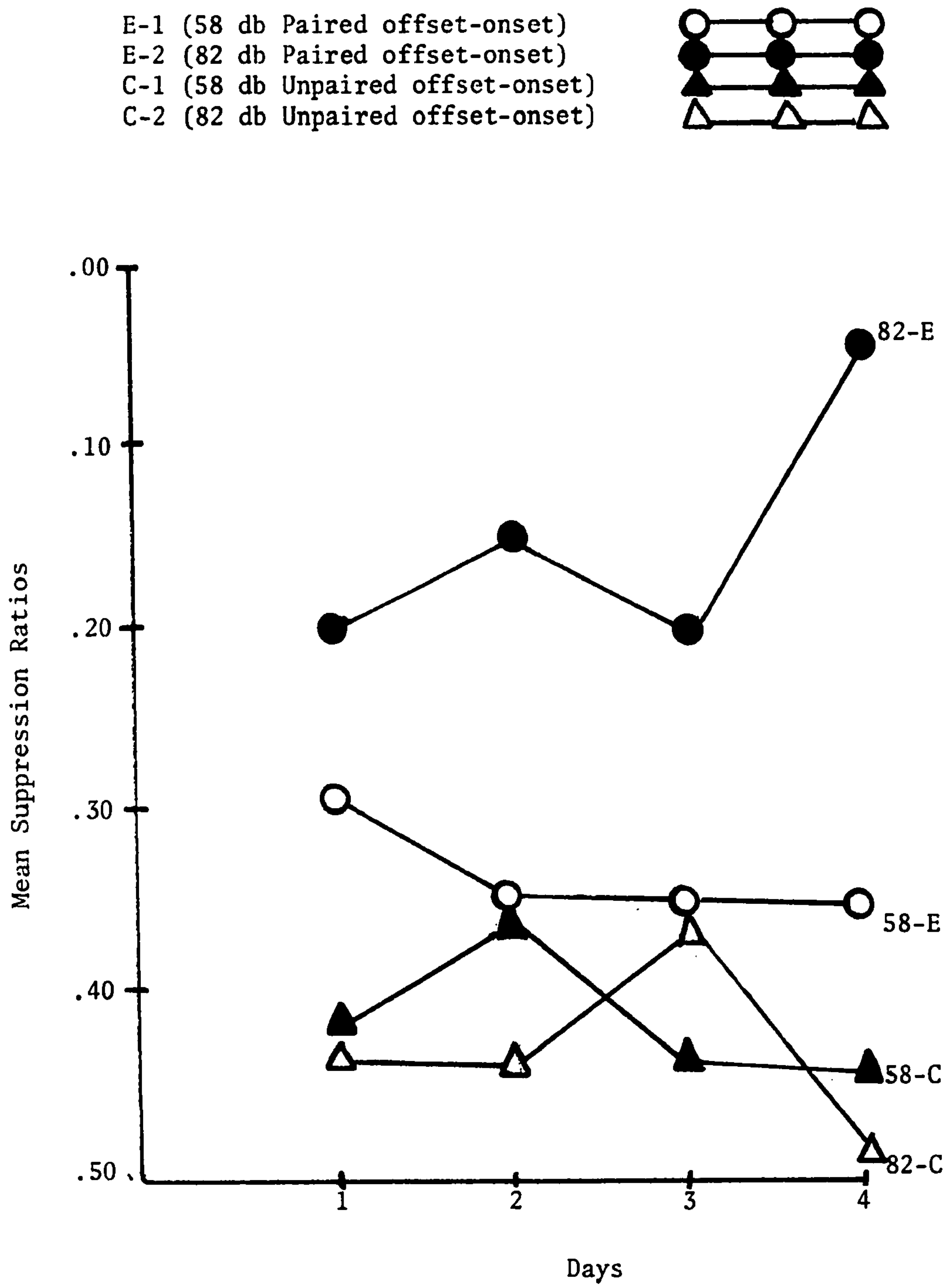

Fig. 4. Group suppression ratios in extinction for 82 offset-onset versus 58 offset-onset conditions.

TABLE 2

Summary of Analysis of Variance on Group Suppression Ratios During Extinction Sessions

Source	df	MS	F
TOTAL	383.	0.027	--
Between Subjects	95.	0.067	--
A (Acquisition contingency)	1.	3.459	333.3826**
B (CS intensity)	1.	1.078	103.8705**
C (Onset-offset in acq.)	1.	0.002	0.1561
D (onset-offset in ext.)	1.	0.001	0.0546
A x B	1.	0.694	66.8454**
A x C	1.	0.020	1.8969
A x D	1.	0.031	3.0367
B x C	1.	0.021	1.2000
B x D	1.	0.050	4.8031*
C x D	1.	0.024	2.3394
A x B x C	1.	0.071	6.8682*
A x B x D	1.	0.003	0.3072
A x C x D	1.	0.013	1.2943
B x C x D	1.	0.007	0.6208
A x B x C x D	1.	0.025	2.3702
% error	80.	0.010	--
Within Subjects	288.	0.014	--
E (Extinction session)	3.	0.069	5.8371*
A x E	3.	0.042	3.6036*
B x E	3.	0.042	3.6007*
C x E	3.	0.065	5.5627*
D x E	3.	0.001	0.0462
A x B x E	3.	0.034	2.0471
A x C x E	3.	0.058	4.9456*
A x D x E	3.	0.002	0.1546
B x C x E	3.	0.014	1.1801
B x D x E	3.	0.042	3.6076*
C x D x E	3.	0.025	2.1523
A x B x C x E	3.	0.006	0.5396
A x B x D x E	3.	0.018	1.4982
A x C x D x E	3.	0.018	1.4868
B x C x D x E	3.	0.001	0.0490
A x B x C x D x E	3.	0.015	1.2538
% error	240.	0.012	1.2538

*p <.05 **p <.025

the group comparisons were significant for 58-db. CS intensity.

The results of the present study appear to be consistent with those obtained by Levy, in that Ss trained and/or tested with an 82-db. CS suppressed significantly more than Ss trained with the 58-db. intensity. Finding a significant CER acquisition contingency x Intensity interaction is also congruent with Levy's results. However, if one were to reanalyze the data in Levy's study for the first four days of extinction, the results of the interaction would not be significant. Thus an apparent contradiction exists. However, the interaction data has been obtained for all conditions combined which should enhance the between-S variance.

Shifting Data Analysis

The final purpose of this investigation was to provide a test of the various theories of CS intensity. An assumption was made that if successful transfer between conditions could be made (i.e., Ss trained with CS-onset, then tested with CS-offset), partial support would be provided for AL theory. On the other hand, if there was interference, as predicted by the differential conditioning hypothesis, this effect would most notably be observed in first trial data.

The analysis of the various group means for first trial data according to the Tukey test indicated that the nonswitched groups suppressed significantly more than did the switched groups. For example, Group E-82-On-On Ss suppressed significantly more than E-82-On-Off Ss ($q=.34$, $df=6/80$, $p<.01$), but group means comparison for Group E-82-On-On and E-82-Off-On were found to be significant ($q=.02$, $df=6/80$, $p<.01$). A failure to find a main effect for onset-offset conditions in the extinction phase would indicate that there were no differences between switched and nonswitched groups. It would appear that switching did have an affect on the S for the first trial data but this interference quickly dissipated in the extinction phase. The Perkins-Logan model would predict such an interference due to the change in stimulus conditions; but since the test CS condition is never reinforced in the extinction phase, the interference would be more enhanced in the switching group than the non-switched group. A failure to find such a difference in the present study creates a problem for the theory.

The presence of this interference and the finding of successful suppression for groups trained and tested with an 82-Onset condition might be interpreted to mean that the CS variable has some arousal function. Such a conclusion is further supported by the finding of successful transfer for the C-82-Off-On group. The Hullian model can be supported with the present data since the CS was shown to have some arousal function and the CS-onset condition was more effective than CS-offset.

The initial arousal property of the CS quickly dissipates in the extinction trials. The adaptation level theory of Grice and Hunter (1969) would predict an initial arousal function of CS, but as soon as the S begins to adapt to the stimulus condition this arousal property should dissipate. Since there was successful transfer of condition, the results appear to be congruent with the AL theory of Grice and Hunter (1964).

References

Carter, L. F. Intensity of conditioned stimulus and rate of conditioning. Journal of Experimental Psychology, 1941, 28, 481-490.

Champion, R. A. Stimulus-intensity effects in response evocation. Psychological Review, 1962, 69, 428-449.

Grant, D. A. & Schneider, D. E. Intensity of the conditioned stimulus and strength of conditioning: I. The conditioned eyelid response to light. Journal of Experimental Psychology, 1948, 38, 690-696.

Gray, J. A. Stimulus intensity dynamism. Psychological Bulletin, 1965, 63, 180-196.

Grice, R. G. & Hunter, J. J. Stimulus intensity effects depend upon the type of experimental design. Psychological Review, 1964, 71, 247-256.

Heymen, W. Certain relationships between stimulus intensity and stimulus generalization. Journal of Experimental Psychology, 1957, 53, 239-248.

Hull, C. L. Essentials of behavior. New Haven: Yale University Press, 1951.

Hull, C. L. A behavior system. New Haven: Yale University Press, 1952.

Kamin, L. J. Temporal and intensity characteristics of the conditioned stimulus. In W. F. Prokasy (Ed.), Classical conditioning: A symposium. New York: Appleton-Century-Crofts, 1965. Pp. 118-147.

Kamin, L. J. & Schaub, R. E. Effects of conditioned stimulus intensity on the conditioned emotional response. Journal of Comparative and Physiological Psychology, 1963, 56, 502-507.

Kessen, W. Response strength and conditioned stimulus intensity. Journal of Experimental Psychology, 1953, 45, 82-86.

Kimmel, H. D. Amount of conditioning and intensity of conditioned stimulus. Journal of Experimental Psychology, 1959, 58, 283-288.

Kimmel, H. D., Hill, F. A., & Morrow, M. C. Strength of GSR and avoidance conditioning as a function of CS intensity. Psychological Reports, 1962, 11, 103-109.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, Calif.: Brooks-Cole, 1968.

Levy, L. CS intensity and extinction of the CER in rats. Dissertation Abstracts, University of Oklahoma, 1971.

Logan, F. A. A note on stimulus intensity dynamism (V). Psychological Review, 1954, 61, 77-80.

Marx, M. H. (Ed.) Learning processes. London: The Macmillan Company, 1969.

Perkins, C. C., Jr. The relation between conditioned stimulus intensity and response strength. Journal of Experimental Psychology, 1953, 46, 225-231.

Walker, E. G. Eyelid conditioning as a function of intensity of conditioned and unconditioned stimuli. Journal of Experimental Psychology, 1960, 59, 303-311.

APPENDICES

Appendix I

Dissertation Prospectus

The observation that response strength varies with the intensity of the conditioned stimulus has been called stimulus intensity dynamism (SID) (Hull, 1951). The effect has been demonstrated in both classical and instrumental paradigms, e.g., Gray (1965), with a variety of response systems and within the range of stimulus intensities from the lower absolute threshold to a level which may cause receptor damage. Despite observations of the CS intensity effect, several problems with regard to the theoretical predictions of the relationship still remain unresolved.

American studies (pre-1960) have frequently reported no relationship between response strength and stimulus intensity; whereas the Russian studies have generally reported both an inverse and a direct relationship between the response and stimulus strengths. As a result of these ambiguities, several theoretical positions have been proposed in order to explain the origin of the CS intensity effect and its effects on learning.

The purpose of this paper is to examine these various inconsistencies. An attempt will be made to present an experimental study which will help to clarify some of these problems.

Theories of CS Intensity

The CS intensity variable has played a rather minor role in learning theory or research. The first emphasis on CS intensity was found in Pavlov's theory of cerebral physiology. Here it would become apparent that the absolute and relative intensity of the CS is theoretically very important in response evocation. Hull (1951, 1952) was the first to consider CS intensity in formal terms by postulating V_1 and V_2 (components of CS intensity that affect either learning or performance, respectively). Hull suggested that a dynamogenic relationship exists between the intensity of the CS and the CR.

Since Hull's postulate, there have been only two major theoretical views of CS intensity, those of Perkins-Logan (1953, 1954) and Grice and Hunter (1964). These theorists explained CS intensity in terms of a discrimination or contrast hypothesis. The difference between the two theories lies specifically in what constitutes discrimination learning.

<u>Pavlov's Law of Strength</u>

The "Law of Strength" (Pavlov, 1927) denotes an inverted U relationship between the intensity of a conditioned stimulus and the magnitude of the resulting conditioned response. The peak of performance is a function of the relative differences between the CS and the UCS. Furthermore, Pavlovian theory is concerned with the variable of stimulus change (i.e., stimulus delivery and/or stimulus removal). The dynamogenic or arousal property of the CS appears to receive less emphasis than the inferred neurological counterparts to the stimulus pair.

Razran's dominance contiguity theory (1957) emphasized the physical properties of the conditioning situation much like those of Pavlov's model. Razran stressed, in his approach, the importance of the relative intensities of the CS, US, CR, and UR. Razran states that the mere occurrence of a UR does not insure conditioning and the pairing of a CS with a UR (contiguity) is a necessary, but not sufficient, condition for acquisition. If the CS intensity reaches a certain level, its neural activity would approach that of the unconditioned stimulus so that the UCS would no longer dominate the CS.

Kamin (1965) criticized the Russian studies for using a within-group design, because the factor of generalization decrement would mitigate the effects of a stronger stimulus. Grice and Hunter (1964) suggest that SID is greatly enhanced by the use of a within-group design.

Hull's Stimulus Intensity Dynamism

Hull (1951) introduced a stimulus intensity component into his theory as an intervening variable (V) which acted multiplicatively with other intervening variables in the determination of reaction potential. He assumed a positive monotonic relationship between response and stimulus strengths naming the effect "stimulus intensity dynamism." Hull postulated both a learning (V_1) and performance (V_2) component for SID, then later abandoned the learning component. Hull limited V to the strength of the signal stimulus trace, a stimulus which is dependent upon the age of the trace instead of the intensity of the stimulus. Specifically, he postulated that the frequency of the neural stimulus trace initiated by the external CS undergoes a relatively rapid phase of recruitment, reaching a maximum frequency at 450 msec., and then subsides. It is at this maximum frequency that UCS presentation is most effective.

Hull concluded that stimulus intensity (a) energizes behavior very much like a drive; (b) depends upon the absolute value of the conditioned stimulus; and (c) is limited to short latency responses.

Various investigators have questioned Hull's reliance on the physical energy of a stimulus. Kish (1955), using a shock avoidance paradigm, tested the relative effectiveness of CS-offset and CS-onset. In the first experiment, two groups (CS-offset and CS-onset) were given fifty avoidance and thirty extinction trials. Kish used a wheel-turning apparatus to condition 72 albino rats. The CS was a light source (28 foot-candles) and the shock was a 480 volt charge to the grid floor. A wheel turn by the rat terminated the shock. In the second study a buzzer was used in place of the light with all other conditions the same as in the first experiment. Kish's results supported Hull's in that both light and buzzer onset were more effective CS's than light or buzzer offset.

Myers (1960) replicated Kish's study, but in addition, included a pseudoconditioning group to control for the unconditionable properties of a buzzer. He varied six conditions: paired versus unpaired CS-UCS conditioning (i.e., the avoidance conditioning group and the pseudoconditioning group - CS and UCS randomly presented); CS quality (tone and buzzer); and CS condition (offset versus onset). Eight groups of rats received 200 massed trials on a wheel-turning avoidance task. For the tone groups, Myers found that in the acquisition phase, CS-onset was just as effective a stimulus as CS-offset; the more intense CS produced the greater response strength. There was no difference between the CS-onset or CS-offset conditions. However, with the buzzer group, for the experimental and the control groups, CS-onset was a more effective CS than CS-offset and CS intensity effects were observed in the pseudoconditioning control group. Observation of the S's behavior during the acquisition phase showed that the rats were exhibiting a startle response to the buzzer in that they hovered over the wheel whenever a buzzer was used as the CS. The startle response caused the wheel to turn, successfully eliminating the possibility of shock. Myers (1959) demonstrated a similar effect when a light was used as a CS. Apparently, the light elicited aversive properties similar in effect to those of the buzzer, bringing to question Kish's findings.

Champion (1962) attempted to test two primary assumptions of Hull's theory that the SID is reserved to short latency CR's, and that the CS-offset condition is an ineffective stimulus for conditioning. He performed a study whereby a long latency GSR as a CR and an auditory stimulus as a CS were used. Ss were conditioned to either an 80- or 60-db. tone as CSs. The stimulus (CS-offset) was terminated with the presentation of a 2.27 milliamp shock as the UCS. Champion's results did not support Hull's theory in that the Ss were successively conditioned to CS-offset with the 80-db. CS-offset condition producing the greatest number of CRs.

In conclusion, the various studies cited fail to support Hull's notion that the stimulus trace was dependent solely upon the energy level or dynamogenic property of the CS. Hull's theory receives some support in those studies that have used eyelid response as a CR. Champion attempted to explain his results by viewing CS intensity in terms of discrimination learning. He states that the contrast hypothesis would predict results which would offer a contradiction to Hull's SID. Apparently, the number of studies which fail to support Hull's theory could now be explained via a different conditioning hypothesis (Champion, 1962).

Perkins-Logan Hypothesis

Perkins (1953) and Logan (1954) presented, independently, theories of CS intensity based on differential conditioning. Their theory assumes that as learning proceeds, the excitatory gradient associated with the reinforcement to the CS exceeds that of the inhibitory gradient, which is a result of any nonreinforced element in the stimulus situation. Specifically, the S discriminates between the relevant CS and its background.

Perkins (1953) provided the first experimental test of the differential conditioning hypothesis. He specifically tested the hypothesis that discrimination training must be employed in order to demonstrate the CS intensity effect. Two types of training were involved: (a) simple positive training, and (b) differential conditioning in which the inhibitory stimulus was considered to be the experimental situation-minus-CS. The first group of rats was given extensive training on a bar pressing apparatus for food reward under a partial reinforcement schedule in the presence of a light of medium intensity. Another group of rats was given differential training in which the medium intensity light was present on reinforced, and absent on nonreinforced, trials. Then both groups were tested under three conditions: (a) with the same light as used during training; (b) with a light of greater intensity; and (c) with a light of lesser intensity. Perkins predicted that the differentially reinforced group should make shorter latency responses when tested with a light of greater, than when tested with one of lesser, intensity and that the partially reinforced group should show no difference in response latency when tested with the two light intensities since no differential training was involved. Both predictions were supported in that there was no difference in response latency for the differential conditioning group.

In Logan's (1954) theoretical paper a special emphasis was placed upon the effectiveness of the offset of a stimulus being used as a CS. Since V is assumed to enter multiplicatively into determining excitatory potential, using offset as a condition would force excitatory potential to zero, and thus one would predict no conditioning. Therefore, the Hullian model would assume that conditioning would not be obtained using CS-offset. However, the Perkins-Logan interpretation would predict that offset should be as effective as onset in eliciting a response. Stimulus intensity effects are ascribed to the relative intensity of a stimulus, rather than being dependent upon the absolute intensity. Instead, the emphasis is placed upon contrast effects.

The Perkins-Logan model predicts that (1) given an intense background or intertrial stimulus, the weakest CS will yield the strongest CR; (2) stimulus offset is just as effective a CS as stimulus onset; and (3) the offset of a strong intertrial stimulus is a more effective CS than offset of a weak one. Basic to these predictions is the assumption that CS intensity is best defined in terms of stimulus change (Marx, 1969).

Various experimenters have subsequently tested the Perkins-Logan theory in order to demonstrate the extension of Hull's dynamogenic hypothesis to that of a discriminatibility hypothesis. In developing his theory, Hull (1951) referred to an experiment by Hays which demonstrated that the latency of rats jumping to a white card was shorter than the latency of rats jumping to a black card on a Lashley jumping stand. Bragiel and Perkins (1954) interchanged figure-ground relationships and found that latencies did not differ for groups that jumped to a white on black card or a black on white card.

In order to test Hull's assumption that CS-onset is the only effective condition, Hansche and Grant (1960) conducted an experiment to determine whether the termination of a visual stimulus had the same effect as the onset in serving as a CS in eyelid conditioning. They also were interested in discovering the optimal inter-stimulus-interval (ISI) for an offset CS condition in comparison to the ISI for an onset condition. They ran eight groups of 10 _Ss_; the onset and offset groups were divided into ISIs of .15, .35, .55, and .75 seconds. They found that termination of a stimulus was as effective a CS as onset; and that both onset and offset ISIs had the same functional relationship to the rate of conditioning (i.e., the most effective ISI was .5 seconds regardless of direction of CS).

Logan and Wagner (1962) found no difference between groups in eyelid conditioning when a light stimulus was either an increase in intensity or a decrease in intensity. Their results support the hypothesis that stimulus change may be an effective stimulus for conditioning, no matter what direction the change. Prior experiments had stressed the termination or delivery of a stimulus.

Champion (1962) tested the effect of CS-onset and offset with a GSR measure. His results demonstrated, in a within-S design, superior conditioning for onset or offset of an 80-db. 2,000 cps. tone over the onset or offset of a 60-db., 2,000 cps. tone. Kamin (1965) reported a monotonic relationship between the magnitude of reduction of white noise as a CS and the magnitude of a conditioned emotional response. Of importance to later discussion was Kamin's use of a between-group design. Prior attempts to demonstrate a CS intensity effect, whether onset or offset, had largely been ineffective with between-group designs.

The stimulus offset studies do not refute the Hullian theory of SID, nor do they offer indisputable support for the Perkins-Logan hypothesis. One can simply redefine V in terms of stimulus change to account for the data. Perkins and Logan merely suggest that stimulus change, rather than absolute intensity, is the more important factor in predicting CS intensity effects without the assumption that CS intensity has any arousal properties.

Very damaging evidence against the Perkins-Logan theory is presented in a study by Grice, Masters, and Kohfeld (1966). The premise that stimulus intensity effects can be obtained only with discrimination conditioning procedures is essential to the Perkins-Logan hypothesis. In the Grice et al. study, human _S_s underwent eyelid conditioning to CSs which consisted merely of a transition in the intensity of a tone from one level to another. The transitions were either up or down in steps of variable size (either 50- or 100-db.). These stimulus conditions were stimulus-off, 50-db., and 100-db; each of these intensity values served as the intertrial background stimulus on the next trial. No constant background or CS was used. Since Perkins-Logan hypothesized the necessity of discrimination between the relevant stimulus and the background stimulus, intensity effects would not be expected where the CS consisted merely of stimulus change. The experimental procedures yielded intensity effects despite the absence of a specific inhibitory gradient. It appears that the important factor for the CS intensity effect is the _amount_ of stimulus change from the background intensity. The more extreme a change from the background, the more effective a CR would be produced.

The Perkins-Logan hypothesis of stimulus contrast appears to be an important factor for explaining the stimulus intensity effects. However, the model may be revised. Grice and Hunter (1964) assumed that the dynamogenic potency of a stimulus depends upon the total number of stimuli contained within an experimental situation. A redefinition of Hull's hypothesis of stimulus change, plus the assumption that the CS actually has certain dynamogenic properties, might more effectively explain the effect.

Adaptation Level Theory

Another theory of CS intensity effect has been proposed by Grice and Hunter (1964). This theory, which used Helson's adaptation level construct, was proposed because a series of experiments conducted in Grice's laboratory demonstrated a heightened effect when a within-S design was used.

In the first of a series of investigations, Beck (1963) tested the effects of the interactions of three variables in eyelid conditioning: CS intensity, UCS intensity, and emotionality. Two groups of subjects were selected on the basis of high and low emotional responsiveness (Taylor Manifest Anxiety Scale) and then presented paired CS-UCS trials under combinations of strong or weak CS and UCS intensity. All Ss were administered both CS intensities in random order during 100 conditioning trials. The results of the study were quite surprising: all three variables were positively related to CS magnitude and the CS intensity effect was much greater than that obtained in previous studies which had used a between-S design. Exposure to the two intensities actually served to increase the magnitude of the stimulus intensity effect.

Grice and Hunter (1964) compared both a between-S design and a within-S design in an eyelid conditioning study. In the experiment, Ss were trained with a CS of 50- or 100-dbs. or with both CSs, plus a 1-psi air puff as a UCS. Another group was administered 50 conditioning trials with each tone presented in random order. The results of the investigation were such that the two groups which had received both CS intensities demonstrated a CS intensity effect which was more than five times the magnitude of the effect for the group which had received only one value of the CS during conditioning trials.

Grice and Hunter concluded that neither Hull's SID theory nor the Perkins-Logan hypothesis could explain the results they obtained. Though they accepted Hull's dynamogenic property of V, they extended the range of the stimuli to which the concept applies to the total stimuli in the environmental situation. They suggested that the Perkins-Logan hypothesis is unable to explain their results, i.e., that the addition of a weak stimulus to a strong stimulus results in an increase, rather than a decrease, in response strength (as the Perkins-Logan model would predict). Grice and Hunter proposed that the use of a within-S design should provide an adequate test of the adaptation level theory.

The AL theory, with regards to CS intensity, suggests a subjective factor (attention or adaptation) which is an integration of both present and residual stimulation. As a S experiences a variety of CS intensities his subjective reference, i.e., the AL, changes. The attainment of this AL also establishes a bipolarity of behavior in such a way that stimuli above the AL tend to elicit one kind of response and those below the AL elicit the opposite type of response. The probability of the CR occurring is dependent upon the distance of a stimulus from the adaptation level. Grice (1968) later adopted a different approach in order to explain CS-intensity effects by replacing the AL model with the decision model of McGill (1963). He points out that the AL theory is difficult to integrate into a behavior theory, due to the fact that the AL theory does not contain a principle of response evocation. McGill's theory is based upon simple reaction time and stimulus intensity effects. Sensory information may be regarded as a series of impulses. When the cumulative count reaches a predetermined number (i.e., the decision criterion or response threshold) the S will respond. The time required for the count to reach this criterion is called the reaction latency. The impulse rate is probabilistic and increases with the intensity of the eliciting stimulus. McGill's premise is that the response criterion is a stable process. Grice's revision of McGill's model is based upon the theory that sensory input is a rather stable process determined by stimulus energy and that the variability found in reaction time experiments resides, not so much in stimulus input rate, as in fluctuations in the criterion of responding.

In order to explain the difference between within-S CS intensity and between-S CS intensity effects with the model, the only assumption needed is that the criterion adopted by the S be determined by the degree of all stimuli to which he is exposed. If a S receives only a series of weak stimuli, he will adopt a lower criterion than one who has received a series of strong stimulus intensities. In a between-S design, only one group of Ss will receive the strong stimulus intensity while another group will receive the weaker stimulus intensity; in a within-S design, a S will receive both weak and strong stimulus values, usually in a random order. He must respond to both stimulus values with a single criterion. Since there are greater contrast effects for those Ss in a within-S design, they will respond with a different latency response than Ss in a between-S design. Therefore, greater intensity effects would be observed in a within-S design. Grice has used his model to explain findings in both reaction time experiments and eyelid conditioning studies, limiting the model to the use of human Ss, but suggesting that its ultimate utility would depend upon further analysis.

Subsequent experiments conducted in Grice's laboratory tested the revised AL theory on CS intensity effects (Grice, Hunter, Kohfeld and Masters, 1967; Grice, Masters and Kohfeld, 1966; Kohfeld, 1968; and Murray and Kohfeld, 1965). For example, Murray and Kohfeld (1965) attempted to alter the AL before conditioning by using a preadaptation period including 90 stimulus presentations in 30 minutes of either "silence," a 40-db. or a 100-db. tone. Reaction time was recorded for each stimulus condition. After this procedure, 48 conditioning trials with the 40-, 60-, 80-,and 100-db. tones were presented in random order. The prediction made by the AL theory would be that the overall reaction time at all intensities combined would be fastest for Ss adapted at 40-db., the test series being at or above the AL; slowest for Ss adapted at the 100-db. level, the test series being at or below the AL; and intermediate for Ss adapted at silence, since they would come to adapt to the mean of the test series. These predictions were upheld.

Birkimer and Drane (1968) sought to hold constant both generalization of inhibition and amount of stimulus change from the background so that if any intensity effect was observed, it could be attributed to the dynamogenic properties of stimulus intensity. Birkimer and Drane assumed that the generalization gradients are symmetrical; so they set an above ambient level intensity as background, with two stimuli equal distance (on a JND or log unit dimension) from that of the background, but one more intense and one less intense in value. They reasoned that the amount of generalized inhibition and stimulus change should be identical for the two stimuli. The procedure used was a discriminated lever press avoidance task. The results of the study revealed that the majority of Ss tested (3 out of 4) demonstrated the SID effect. This information would suggest that a dynamogenic effect of stimulus intensity can be explained without the use of inhibitory gradients, thus supporting the AL theory.

Sources of Confounding

There have been a number of studies which have simply failed to observe a stimulus intensity effect (e.g., Blough, 1959; Carter, 1941; Heyman, 1957; Kimmel, 1959; Kimmel, Hill, and Morrow, 1962; and Passey and Herman, 1955).

Yet, as previously reported, most Russian studies have generally found an inverted U relationship between CS intensity and performance. Razran reviewed 150 Russian studies and found that most have supported the CS intensity effect. However, the full function relating CS intensity to CR magnitude appeared to be an inverted U when a GSR was used as a response measure (Razran, 1957).

The basic empirical question as to what relationship or what variables are involved in CS intensity effects has not been resolved. It can be concluded that the CS intensity effect has been well documented. Empirically, however, the large number of negative instances makes it seem that the effect is somewhat weak; yet the number of positive instances seem to attest to its authenticity. A possible reason for the discrepancy in the empirical data may be that different variables have been operating in different studies (Gray, 1965).

Gray (1965), in an exhaustive review of the literature concerning the SID phenomenon, mentioned several sources of confounding which may account for the complex results found in a number of studies. Only a summary of these boundary conditions can be reported in this study and these are:

1. Stimulus intensity must be defined, not in terms of absolute physical intensity, but as the degree of contrast in intensity between the positive and negative stimuli.

2. If operant behavior is studied, formal discrimination training must be carried out. This condition may perhaps be taken as establishing an operational definition of the term "conditioned stimulus" as applied to operant conditioning situations. This problem does not arise in a classical conditioning situation, which necessarily involves discrimination training.

3. Response strength must be measured during reinforced responding, not during extinction.

4. Care must be taken to sample a sufficiently large portion of the intensity continuum.

5. The GSR does not display the usual relations between stimulus intensity and response strength. Careful evaluation of those responses that make up the "orienting reflex" might reveal that they are affected differently by CS intensity.

Gray's conclusion generally supports the Perkins-Logan model of CS intensity effects. Yet Carter (1941), who did observe the prevailing conditions that Gray mentioned, still failed to observe SID. So it would appear that other variables are operating that are still yet to be found. It may be that CS intensity is a much more complex phenomenon than once believed.

Learning or Performance

Kimble (1961) defines learning as "a more or less permanent change in behavior which occurs as a result of practice." Thus, one can conclude that learning refers to long-term changes within the organism produced by practice. Performance, on the other hand, is viewed as the translation of learning into behavior and refers to a relatively transitory aspect of behavior. One can assume that a performance factor behaves very much like a learning variable; but finding criteria which will allow a distinction to be made between learning and performance, independent of confounding effects, has been difficult.

The most accepted design for separating learning and performance factors is the factorial design (see Cofer and Appley, 1964, p. 520-529 for discussion of the various designs). The primary reason for using the orthogonal or factorial design is that one can control the effects of stimulus generalization.

Factorial Design

In this design, two groups are usually trained under different levels of a variable that has been experimentally shown to influence behavior. Then, each group is factorially divided into similar high and low values and given a test (usually an extinction measure). This procedure results in a 2 x 2 factorial design. Let H and L stand for the high and low intensity values. The main effects of intensity would be found in the row totals and this difference would reflect associative strength which can only develop during training trials. One could assume that the associative strength is at a higher level with the H stimulus than with the L stimulus, since the intensity used during extinction does not enter differentially into the row totals. By the same reasoning, if there are differences in the column totals, it would mean that the intensity of the CS influences response strength; for these sums "neutralize" differences due to CS intensity during the acquisition phase. Thus, significant row totals represent learning factors while significant column factor sums represent performance variables.

Kimble (1961), in his evaluation of the factorial procedure, states that the answer to the question of whether or not a variable is observed to have an effect upon learning or performance is determined by which portion of the performance curve is analyzed. If the section of the function immediately after the shift is selected, the result will indicate that the variable influences both learning and performance. A shift in CS intensity requires several trials in order to reach the same asymptote level as those Ss who retained the same CS level. So the apparent value of using the factorial design is questioned.

Woodard (1966), as reviewed in Levy (1971), adds several additional difficulties and possible sources of confounding which are necessarily included in any factorial design. A brief summary of six possible effects of shifting variable values are summarized below:

1. A stimulus generalization decrement which would cause a performance decrement in groups shifted upward or downward.

2. A contrast effect, which would cause a relatively large transient performance increment in a group shifted upward and a smaller transient performance decrement in a group shifted downward.

3. A CS-UR effect which would cause a long lasting performance increment for a group shifted upward and a corresponding decrement for a group shifted downward, both with respect to pre-shift performance.

4. An OR (i.e., orienting response) effect, which would cause a transient performance increment (or decrement, depending upon the CR) in groups shifted upward or downward.

5. A nonassociative effect exclusive of other shift effects, which would cause a group shifted upward to shift its performance level immediately to a group trained entirely at a high level and a group shifted downward to shift its performance level in the opposite manner.

6. An associative effect, which would cause performance to increase at a higher rate over trials in a group shifted upward and performance to increase at a lower rate over trials in a group shifted downwards.

Grant and Schneider (1948) were the first investigators to use a factorial design to determine whether CS intensity had an effect upon learning or upon performance. Ss were divided into four equal groups which received different CS intensities of light, ranging from 7 to 1,500 millilamberts, during the conditioning of an eyelid response. All Ss received 25 paired trials of light CS and a corneal air puff on each of two acquisition days. Then they were subdivided into four equal groups, which received different CS intensities or the same intensity condition as in acquisition, and given 15 extinction trials following the last acquisition trial on day 2. The primary finding of this study was that the manipulation of CS intensity did not significantly affect either response strength or conditioning. Significant interaction effects indicated generalization effects.

Kessen (1953) employed a 4 x 4 factorial design similar to that used by Grant and Schneider; however, his dependent variable was turning a wheel to avoid the effects of shock. The four CS intensities were light CSs ranging in value from 6 to 150 watts. Training consisted of 42 trials in which a 15 sec. presentation of a light CS was followed immediately by a 90 volt electric grid shock. The criterion was that if a S rotated the wheel during the first 5.8 secs. following the onset of the CS, he avoided shock. Then Ss were given 30 extinction trials of 15 secs. of the CS. A trial was terminated if a response was not made during the CS presentation time. The primary conclusion of the study was that the CS intensity had no effect on response strength during acquisition or extinction. However, other measures taken during extinction demonstrated that CS intensity influenced response strength. Kessen hypothesized that the omission of the UCS during extinction could account for the negative findings obtained with extinction procedures.

Walker (1960) reported that a possible explanation for the failure to observe a CS intensity effect may be due to the omission of the UCS during extinction. She hypothesized that UCS intensity is one of the conditions influencing the relationship between CS intensity and CR strength. Specifically, Walker proposed that CS intensity would have a greater effect upon response strength under a strong UCS than under a weak one. This hypothesis was similar to that reported by Razran (1957). Walker presented the UCS during extinction trials, but with a CS-UCS interval (2.5 secs.) which was known to produce extinction (McAllister, 1953). During acquisition, eight groups of 20 male Ss each received 80 paired CS-UCS trials in a single test session. The stimulus conditions were: Weak CS-weak UCS; strong CS-weak UCS; weak CS-strong UCS; strong CS-strong UCS. The CS was a 1,000 cps. tone (intensities were 30- and 80-db.); the UCS was a .5 lb/sq. in. or 5.0 lb./sq. in. air puff. After acquisition training, Ss were subdivided into groups and received extinction training. Each group received 30 extinction trials with the UCS being the same in extinction as that which they had received in acquisition; however, the CS-UCS interval was shifted from 500 to 2,500 msec. during the extinction trials. The primary results of the study were that the CS intensity did have an effect on performance during training trials. However, the CS x UCS interaction was not significant. Walker did find that the differences between the strong and weak CS intensities were significant under the strong UCS but were not reliably different under the weak UCS. This result partially supports her hypothesis. An additional finding of the study was that no CS intensity effect was observed in either the row or column means in the factorial design in the extinction phase despite the use of the UCS during extinction sessions. Walker suggested that an extinction measure is not a fair test of whether CS intensity affects learning or performance because of a failure to control for stimulus generalization effects when Ss are switched from the acquisition to extinction phase.

Kamin and Schaub (1963) studied the effects of white noise CS (40-, 63-, or 81-db.) on the acquisition of a conditioned emotional response (CER) in rats, using a factorial design, similar to that used by Grant and Schneider (1949), in order to determine whether CS intensity affects learning or performance. The CER technique was chosen because it has been found to be a highly sensitive test of behavior (Kamin, 1965), and such a sensitive test is required to measure the strength of the CS intensity effect. An analysis of the data indicated that within the range of CS intensities explored, CER acquisition varied directly with CS intensity, though all groups achieved the same asymptote at the end of the training phase. An analysis of the extinction data revealed no effect on performance or learning. The only significant effect found was an interaction between training CS and extinction CS, indicating that generalization effects were significant. Kamin and Schaub concluded that a factorial design allows one to evaluate the influences of generalization effects and does not provide a means of determining whether or not a particular variable influences learning or performance.

It can be concluded that the stimulus intensity effect has been adequately demonstrated. The relationship generally reported is that performance is a negatively accelerated increasing function of CS intensity. However, the number of negative instances from studies varying the intensities of the CS would seem to suggest that (1) the effect is quite weak; (2) the confounding caused by the designs of studies masks the strength of the effect; and/or (3) a combination of both exists. Studies which have been cited as having supported a CS intensity effect have been criticized for the use of a within-S design which is known to produce substantially greater intensity effects than a between-S design.

None of the traditional theories adequately explains the effect. Perkins-Logan redefined Hull's SID in terms of stimulus contrast, with SID a subphenomenon of discrimination learning. Grice and Hunter redefine stimulus contrast in terms of departures from an adaptation level. The adaptation level is a subjective reference point which is formed by the S responding to the total range of stimuli present in the experimental situation including the residual presence of stimuli previously presented to the S. Thus the role of adaptation and attention is emphasized within the Grice and Hunter model of CS intensity effects.

Support for the effect has not been duplicated in the few studies which have used extinction measures, a finding which contradicts the expected correlation between acquisition and extinction measures. Most of these studies which failed to observe this correlation used a counterbalanced factorial procedure. Such a design, though directed at providing a distinction between learning and performance, is complicated by the within-S shifts in intensity values which occur between acquisition and extinction sessions.

The Present Experiment

The CER Technique

In 1941 Estes and Skinner introduced the conditioned emotional response (CER) procedure as a technique which could be used to investigate quantitative properties of "anxiety." The technique involves the assessments of the effects of classical conditioning training by the employment of a transfer paradigm. The technique has proven to be a sensitive measure of learning. Relationships that were once very difficult to observe with traditional classical and instrumental procedures are more easily uncovered with the CER procedure. Essentially, the paradigm consists of training a S to perform an operant response (i.e., bar pressing for food) until a stable baseline rate has been established. Once such a stable rate has been established, superimposed paired presentation of a CS and an aversive UCS (usually electric shock) are administered. Suppression of the operant rate during the presence of the CS is considered to be an index of conditioned "anxiety" or "fear" (Marx, 1969). The Estes-Skinner technique has been used to study the effects of several important independent variables upon the conditioning process (i.e., CS intensity, CS duration, UCS intensity, and CS-UCS interval) and with a wide variety of Ss (i.e., rats, pigeons, dogs, monkeys, rats, and humans). Kamin (1965) has adapted the technique to investigate several parameters of classical conditioning, with surprising quantitative sensitivity and accuracy.

A complication of the Estes-Skinner procedure to a research problem is simply the time required to establish a stable operant rate prior to superimposing paired CS-UCS trials. Leaf and Muller (1965) have substituted operant drinking for lever pressing and thus reduced the tedium of shaping an operant response. The procedure consists of a conditioning session and a test session. During the training session, Ss are administered various CS-UCS contingencies followed by a period of water deprivation. The test session (usually in a separate chamber) consists of providing the deprived S access to a drinking tube and then presenting the trials of superimposed CS without UCS. Suppression of licking is analogous to suppression of lever pressing during the presence of the CS. The licking suppression procedure provides an even more stable operant baseline than that obtained with lever pressing schedules.

Associative Versus Nonassociative Effects

Contiguity between CS and UCS has been considered to be a critical variable in the establishment of a conditioned response. Rescorla (1967) has pointed out that a requirement vital to the definition of conditioning is that the presentation of an unconditioned stimulus be contingent upon the occurrence of a conditioned stimulus. He states that changes in behavior not dependent upon this contingency are not considered to be types of "true" conditioning (i.e., associative effects). In order to identify such effects (i.e., nonassociative effects) control groups have been used. Each of the procedures attempting to control associative effects from nonassociative effects has tried to retain some of the features of Pavlovian conditioning, while eliminating the CS-UCS contingency.

The Levy (1971) Procedure

Levy (1971) attempted to test whether or not CS intensity was a learning or performance variable with the use of a CER paradigm. Instead of the typical factorial design, an extinction measure was employed. The addition of a pseudoconditioning control group allowed a test of the associative and nonassociative effects. An assumption was made that another test of associative effects could be made by analyzing the first trial of extinction data since no previous trials had been administered without the use of the UCS.

The task consisted of rats tested with either an 82- or 58-db. white noise superimposed upon a water licking response. These stimuli had previously been presented in conjunction with an UCS (.5 milliamp shock) in a separate chamber. Results of the first trial extinction data indicated, for both the experimental and control groups, a CS intensity effect in that the 82-db. group suppressed more than the 58-db. group. Analysis of the extinction data over days indicated the usual CS intensity effect with no differences observed in the control groups. An additional test was conducted with CS-offset as a variable. Similar results were found in that the 82-db. CS-offset group suppressed more than the 58-db. CS-offset group; but since there was no control group, no conclusions can be drawn. Thus Levy's results are congruent with the notion that CS intensity is a performance variable.

The present experiment was designed to test the various theories of CS intensity. An application of the Levy procedure provides a sensitive test of the CS intensity effect. With the addition of pseudoconditioning control groups, a comparison can be made of the onset and offset conditions. With the use of a shifting technique (i.e., train Ss with one stimulus dimension, e.g., CS-onset, and then test these Ss with CS-offset) a means distinguishing the various variables involved in the CS intensity effect can be made.

The purposes of the present study are: (1) to replicate and extend Levy's study by including pseudoconditioning control groups for the offset dimension; (2) to extend the Perkins-Logan model to include extinction data by comparing onset with that of offset conditions; and (3) to test the various theories of CS intensity effect by including a shifting group whereby Ss are trained with one stimulus condition and then tested with the opposite stimulus condition.

The present study attempts to test various hypotheses. Of primary importance is whether or not Ss who are trained on one stimulus condition, e.g., CS-onset, can successfully transfer their responding when tested with the opposite stimulus dimension, e.g., CS-offset. A summary of the various theories of CS intensity and their differential predictions of the use of the shifting procedure are as follows:

1. Hull's stimulus intensity dynamism theory takes into account only the absolute properties of the stimulus. Only the onset of the CS is the effective condition. Thus, one would predict that conditioning would not be possible with CS-offset.

2. The Perkins-Logan interpretation takes into account the inhibitory properties due to nonreinforcement of the CR which generalizes to the intertrial stimulus or background intensities. CS intensity effect is said to be the result of discrimination learning. It would be expected that Ss trained originally with CS-onset would acquire a habit strength to respond to a CS and not to respond to the background stimuli. Now, when the Ss are switched to CS-offset, they must re-learn this new relationship. Thus, a negative transfer would be predicted when groups are trained with one stimulus condition and then tested with the opposite condition.

3. The adaptation level theory as proposed by Grice and Hunter assumes that Ss respond to the CS in its relationship among a series of stimuli after a reference level (i.e., the adaptation level) has been established. If the stimulus conditions are reversed (i.e., onset to offset), the same reference level is maintained. Thus, with the adaptation level theory, one would assume a positive transfer.

Method

Subjects

Four days prior to the beginning of the experiment, each of the 96, 100-120 day old, male albino rats will be handled for approximately 10 min. each day. The rats will be purchased from the Holtzman lab.

Apparatus

A conditioning and a separate test chamber will be used. The conditioning chamber is a BRS Foringer Skinner box (Model RC-004) with the lever and food cup removed. The operant chamber will be housed in a BRS Foringer ventilated sound attenuating test cubicle (Model RCH-001). The Skinner box will be continuously illuminated by two 4.75 watt bulbs located on the back panel of the box 22.8 cm. above a stainless steel grid floor. The 9 sec. CS will be a white noise of either a 58- or 82-db. intensity produced by means of a Grason-Stadler noise generator (Model 901B). The UCS will be a 1 ma. electric shock of 1 sec. duration, provided by a Grason-Stadler shock generator (Model E6070B).

The Ss will be tested in a galvanized steel box measuring 24 x 18 x 18 cm. The box will have a wire mesh front, a brass rod grid floor, and a Plexiglas cover. The test box will be housed in a ventilated sound resistant shell. The light source will be provided by a 4.75 watt bulb. A drinking tube (3 mm. orifice) will be positioned 6 cm. above the grid floor adjacent to the wire mesh front in such a way that the S can contact the orifice only with its tongue. A 20% by weight sucrose solution will be presented as the water source. Each touch of the tongue to the drinking tube will be measured by a drinkometer and a cumulative digital print-out counter (Grason-Stadler, Model 1238).

The ambient noise level will be measured by a Realist sound level meter, Model 33-1028 and equated for both chambers. With the exhaust fan disconnected, the respective intensities (i.e., 58- or 82-db.), then the ambient noise level plus the respective intensities, will be measured. The weak CS must be detectable over and above that of the ambient noise level.

The conditioning and test chambers will be located in a separate room from that of the automated programming and recording equipment. The programming equipment will present all stimulus sequences for all phases of the experiment. Commercially available relay timing and counting equipment are components of the recording and programming equipment.

Procedure

The Ss will be randomly assigned to 16 groups of six Ss each. The factors in the experimental design will be: (a) the presentation of either a 58- or 82-db. white noise CS during training trials; (b) the presentation of the CS-UCS acquisition contingency (i.e., paired versus random presentation of CS-UCS acquisition trials); and (c) presentation of CS-onset or CS-offset conditions in the acquisition and extinction phase.

CER training. The CER training phase will begin immediately following the last handling session. Ten simple daily paired CS-UCS trials with a 2 min. variable interval for the experimental groups (i.e., CS onset-82 or 58; CS offset-82 or 58) will be administered. Four control groups (CS onset-82 or

58; CS offset-82 or 58) will be administered; however, the CS and UCS variables are presented in a random order with a 1 min. average interstimulus interval during the CER acquisition session.

Approach training. Immediately following CER acquisition training trials, all Ss will be water deprived for 24 hrs. The Ss will receive their water ration in 2 sessions 24 hrs. apart in the test chamber. Each session will last for 10 minutes following the twentieth lick from the drinking tube.

CER extinction. The strong and weak CS groups will be given four days of extinction immediately following CER acquisition. The extinction training will consist of four daily CS presentations. The groups trained with onset and offset conditions will be subdivided into groups of 6 Ss each according to a 2 x 2 factorial design. The On-On group will receive the onset conditions for either intensity in both the acquisition and extinction phases; the OFF-OFF group will receive the offset conditions in both phases; the On-OFF group will be trained with CS-onset but will be tested with CS-offset; and the OFF-On group will be trained with CS-offset but tested with CS-onset. The control groups will be similarily divided. The UCS will never be presented in the test chamber. The first CS presentation will begin immediately following the 100th lick. Each subsequent CS presentation will occur following a 60 sec. intertrial stimulus condition. A typical extinction session should last for 10 minutes. If a S fails to respond during the time period allotted for extinction, an additional 10 minute period will be administered; but if the S fails to respond during this extended period, the four CS presentations will be presented, regardless of the S's behavior.

References

Beck, S. B. Eyelid conditioning as a function of CS intensity, UCS intensity, and manifest anxiety scale score. Journal of Experimental Psychology, 1963, 66, 429-438.

Birkimer, J. C. & Drane, D. L. Stimulus intensity dynamism with stimuli equal decibel distances above and below background. Psychonomic Science, 1968, 12, 213-224.

Blough, D. S. Generalization and preference on a stimulus-intensity continuum. Journal of the Experimental Analysis of Behavior, 1959, 2, 307-317.

Bragiel, R. M. & Perkins, C. C., Jr. Conditioned stimulus intensity and response speed. Journal of Experimental Psychology, 1954, 47, 437-441.

Carter, L. F. Intensity of conditioned stimulus and rate of conditioning. Journal of Experimental Psychology, 1941, 28, 481-490.

Champion, R. A. Stimulus-intensity effects in response evocation. Psychological Review, 1962, 69, 428-449.

Cofer, C. M. & Appley, M. H. Motivation: Theory and Research. New York: John Wiley & Sons, Inc., 1964.

Corbit, J. D. & Luschei, E. Invariance of the rats rate of drinking. Journal of Comparative and Physiological Psychology, 1969, 69, 119-125.

Estes, W. K. & Skinner, B. F. Some quantitative properties of anxiety. Journal of Experimental Psychology, 1941, 29, 390-400.

Grant, D. A. & Schneider, D. E. Intensity of the conditioned stimulus and strength of conditioning: I. The conditioned eyelid response to light. Journal of Experimental Psychology, 1948, 38, 260-696.

Gray, J. A. Stimulus intensity dynamism. Psychological Bulletin, 1965, 63, 180-196.

Grice, G. R. Stimulus intensity and response evocation. Psychological Review, 1968, 75, 359-373.

Grice, G. R. & Hunter, J. J. Stimulus intensity effects depend upon the type of experimental design. Psychological Review, 1964, 71, 247-256.

Grice, G. R., Hunter, J. J., Kohfeld, D. L., & Masters, L. Order of presentation, CS intensity, and response latency. Journal of Experimental Psychology, 1967, 74, 581-585.

Grice, G. R., Masters, L., & Kohfeld, D. L. Classical conditioning without discrimination training: a test of the generalization theory of CS intensity effects. Journal of Experimental Psychology, 1966, 72, 510-513.

Hansche, W. J. & Grant, D. A. Onset versus termination of a stimulus as the CS in eyelid conditioning. Journal of Experimental Psychology, 1960, 59, 19-26.

Heymen, W. Certain relationships between stimulus intensity and stimulus generalization. Journal of Experimental Psychology, 1957, 53, 239-248.

Hull, C. L. Essentials of behavior. New Haven: Yale University Press, 1951.

Hull, C. L. A behavior system. New Haven: Yale University Press, 1952.

Kamin, L. J. Temporal and intensity characteristics of the conditioned stimulus. In W. F. Prokasy (Ed.), Classical conditioning: A symposium. New York: Appleton-Century-Crofts, 1965. Pp. 118-147.

Kamin, L. J. & Schaub, R. E. Effects of conditioned stimulus intensity on the conditioned emotional response. *Journal of Comparative and Physiological Psychology*, 1963, *56*, 502-507.

Kessen, W. Response strength and conditioned stimulus intensity. *Journal of Experimental Psychology*, 1953, *45*, 82-86.

Kimble, G. A. *Conditioning and learning*. New York: Appleton-Century-Crofts, 1961.

Kimmel, H. D. Amount of conditioning and intensity of conditioned stimulus. *Journal of Experimental Psychology*, 1959, *58*, 283-288.

Kimmel, H. D., Hill, F. A., & Morrow, M. C. Strength of GSR and avoidance conditioning as a function of CS intensity. *Psychological Reports*, 1962, *11*, 103-109.

Kish, G. B. Avoidance learning to the onset and cessation of conditioned stimulus energy. *Journal of Experimental Psychology*, 1955, *50*, 31-38.

Kohfeld, D. L. Stimulus intensity and adaptation level as determinants of simple reaction time. *Journal of Experimental Psychology*, 1968, *76*, 468-473.

Leaf, R. C. & Muller, S. A. Simple method for CER conditioning and measurement. *Psychological Reports*, 1965, *17*, 211-215.

Levy, L. CS intensity and extinction of the CER in rats. *Dissertation Abstracts*, University of Oklahoma, 1971.

Logan, F. A. A note on stimulus intensity dynamism (V). *Psychological Review*, 1954, *61*, 77-80.

Logan, F. A. & Wagner, A. R. Direction of change in CS in eyelid conditioning. *Journal of Experimental Psychology*, 1962, *64*, 325-326.

Marx, M. H. (Ed.) Learning processes. London: The Macmillan Company, 1969.

McAllister, W. B. Eyelid conditioning as a function of the CS-UCS interval. Journal of Experimental Psychology, 1953, 45, 417-422.

McGill, W. J. Stochastic latency mechanisms. In R. D. Luce, R. R. Bush, & E. Galanter (Eds.), Handbook of mathematical psychology, Vol. 1. New York: John Wiley & Sons, Inc., 1963.

Murray, H. G. & Kohfeld, D. L. Role of adaptation level in stimulus intensity dynamism. Psychonomic Science, 1965, 3, 439-440.

Myers, A. K. Avoidance learning as a function of several training conditions, and strain differences in rats. Journal of Comparative and Physiological Psychology, 1959, 52, 381-391.

Myers, A. K. Effects of CS intensity and quality in avoidance conditioning. Journal of Comparative and Physiological Psychology, 1960, 55, 57-61.

Passey, G. E. and Herman, P. N. The shape of the discrimination gradient for two intracontinuum stimulus separations. Journal of Experimental Psychology, 1955, 49, 273-277.

Pavlov, I. P. Conditioned reflexes. (Translated by G. V. Anrep). London: Oxford University Press, 1927.

Perkins. C. C., Jr. The relation between conditioned stimulus intensity and response strength. Journal of Experimental Psychology, 1953, 46, 225-231.

Razran, G. The dominance-contiguity theory of the acquisition of classical conditioning. Psychological Bulletin, 1957, 54, 1-46.

Rescorla, R. A. Pavlovian conditioning and its proper control procedure. Psychological Review, 1967, 74, 71-80.

Walker, E. G. Eyelid conditioning as a function of intensity of conditioned and unconditioned stimuli. *Journal of Experimental Psychology*, 1960, *59*, 303-311.

Woodard, W. T. The effect of conditioned stimulus intensity in classical conditioning of the common carp. Doctoral dissertation, University of Hawaii, Ann Arbor, Michigan. *University Microfilms*, 1966, No. 66-73, 716.

Appendix II

Suppression Ratio Across Days for Groups in

Onset-Onset Condition

	Days			
Group	1	2	3	4
E-82-On-On	.04	.03	.27	.08
	.05	.01	.02	.24
	.04	.01	.02	.03
	.07	.45	.27	.05
	.12	.02	.07	.03
	.05	.50	.18	.34
E-58-On-On	.07	.02	.47	.50
	.04	.02	.50	.53
	.05	.27	.49	.24
	.02	.52	.45	.25
	.03	.43	.24	.36
	.05	.43	.24	.40
C-82-On-On	.26	.52	.50	.45
	.40	.52	.50	.50
	.48	.50	.49	.44
	.53	.50	.45	.15
	.47	.49	.40	.25
	.49	.49	.49	.41
C-58-On-On	.42	.48	.50	.46
	.33	.48	.49	.41
	.48	.34	.49	.40
	.27	.50	.54	.50
	.37	.49	.44	.42
	.43	.45	.49	.42

Appendix III

Suppression Ratio Across Days for Groups in

Offset-Offset Condition

	Days			
Group	1	2	3	4
E-82-Off-Off	.14	.01	.27	.02
	.01	.04	.22	.13
	.03	.06	.21	.09
	.05	.02	.14	.30
	.00	.16	.02	.15
	.17	.02	.15	.05
E-58-Off-Off	.40	.43	.48	.26
	.35	.48	.47	.28
	.33	.24	.47	.47
	.41	.33	.44	.47
	.45	.45	.40	.10
	.43	.44	.32	.25
C-82-Off-Off	.36	.36	.46	.45
	.47	.20	.50	.38
	.37	.33	.49	.30
	.40	.40	.41	.39
	.43	.35	.38	.47
	.38	.38	.48	.49
C-58-Off-Off	.48	.46	.44	.36
	.42	.44	.49	.47
	.46	.46	.37	.48
	.11	.46	.50	.36
	.34	.43	.48	.30
	.46	.47	.48	.37

Appendix IV

Suppression Ratio Across Days for Groups in

Onset-Offset Condition

	Days			
Group	1	2	3	4
E-82-On-Off	.05	.05	.18	.04
	.06	.02	.31	.37
	.03	.18	.48	.15
	.01	.30	.37	.11
	.16	.27	.14	.11
	.20	.39	.06	.20
E-58-On-Off	.04	.35	.17	.47
	.10	.50	.02	.48
	.01	.46	.38	.28
	.00	.40	.48	.28
	.35	.38	.31	.50
	.52	.48	.46	.46
C-82-On-Off	.33	.38	.46	.33
	.38	.47	.43	.36
	.45	.39	.38	.40
	.15	.47	.23	.45
	.40	.25	.33	.60
	.50	.40	.04	.56
C-58-On-Off	.46	.38	.50	.47
	.41	.40	.50	.52
	.53	.50	.41	.50
	.42	.49	.41	.49
	.44	.46	.41	.49

Appendix V

Suppression Ratio Across Days for Groups in

Offset-Onset Condition

	Days			
Group	1	2	3	4
E-82-Off-On	.19	.02	.26	.05
	.47	.33	.31	.06
	.14	.16	.46	.01
	.19	.07	.38	.02
	.10	.22	.01	.12
	.23	.08	.02	.06
E-58-Off-On	.24	.52	.48	.47
	.21	.50	.22	.03
	.33	.38	.47	.50
	.26	.16	.40	.13
	.38	.15	.19	.28
	.50	.37	.43	.37
C-82-Off-On	.38	.44	.48	.50
	.50	.43	.48	.49
	.41	.36	.39	.49
	.48	.41	.49	.49
	.47	.48	.32	.50
	.43	.50	.44	.47
C-58-Off-On	.53	.48	.43	.42
	.37	.40	.32	.50
	.49	.30	.50	.49
	.32	.40	.40	.47
	.43	.36	.51	.48
	.46	.30	.48	.33

Appendix VI

Means and Standard Deviations for Groups Across Days

Group		Days 1	2	3	4
E-82-On-On	M	.06	.17	.14	.13
	SD	.19	.21	.11	.13
E-82-On-Off	M	.09	.20	.26	.17
	SD	.07	.15	.15	.11
E-82-Off-On	M	.21	.15	.19	.05
	SD	.12	.10	.18	.03
E-82-Off-Off	M	.06	.11	.21	.06
	SD	.06	.08	.05	.04
E-58-On-On	M	.04	.31	.39	.38
	SD	.14	.23	.11	.11
E-58-On-Off	M	.17	.42	.30	.39
	SD	.20	.05	.16	.10
E-58-Off-On	M	.30	.35	.36	.36
	SD	.10	.15	.13	.13
E-58-Off-Off	M	.40	.38	.38	.35
	SD	.04	.08	.13	.09

Appendix VII

Means and Standard Deviations for Groups Across Days

		Days			
Groups		1	2	3	4
C-82-On-On	M	.44	.47	.47	.36
	SD	.09	.05	.04	.12
C-82-On-Off	M	.42	.36	.35	.43
	SD	.49	.08	.14	.10
C-82-Off-On	M	.44	.44	.37	.50
	SD	.04	.05	.12	.01
C-82-Off-Off	M	.40	.32	.45	.41
	SD	.04	.06	.04	.07
C-58-On-On	M	.38	.45	.47	.44
	SD	.06	.05	.05	.03
C-58-On-Off	M	.44	.45	.47	.49
	SD	.05	.05	.05	.02
C-58-Off-On	M	.43	.37	.44	.45
	SD	.07	.06	.07	.06
C-58-Off-Off	M	.38	.46	.46	.39
	SD	.12	.02	.04	.07

Appendix VIII

Mean Group Suppression Ratios

First Trial

Switched Ss			
E-82-On-Off	E-58-On-Off	C-82-On-Off	C-58-On-Off
.3733	.3062	.4862	.4465
E-82-Off-On	E-58-Off-On	C-82-Off-On	C-58-Off-On
.0588	.4302	.2393	.4615
Nonswitched Ss			
E-82-On-On	E-58-On-On	C-82-On-On	C-58-On-On
.0338	.2042	.3907	*.5063
E-82-Off-Off	E-58-Off-Off	C-82-Off-Off	C-58-Off-Off
.1730	.4320	.4443	.4430

Appendix IX

Mean Group Suppression Ratios

Repeated Measures

Switched Ss			
E-82-On-Off	E-58-On-Off	C-82-On-Off	C-58-On-Off
.1772	.3227	.3878	.4608
E-82-Off-On	E-58-Off-On	C-82-Off-On	C-58-Off-On
.1543	.3424	.4377	.4228
Nonswitched Ss			
E-82-On-On	E-58-On-On	C-82-On-On	C-58-On-On
.1321	.2820	.4366	.4368
E-82-Off-Off	E-58-Off-Off	C-82-Off-Off	C-58-Off-Off
.1046	.3759	.3964	.4219

Appendix X

Abstract

A Re-examination of the Role of Perceptual Contrast In Stimulus Intensity Dynamism

Ninety-six albino rats were divided into eight experimental groups (simple delay) and eight control groups (random unpaired). Ss were further divided according to training sessions (Intensity-82 or 58 db. and CS-onset or CS-offset). Ss were tested with either the same stimulus condition (e.g., CS-onset) or with the opposite condition (CS-offset). Ten acquisition trials (four trials/day for four days) were conducted in a separate chamber with conditioned suppression of licking response measured. Analysis of the first trial of extinction (acquisition test trial) indicated greater suppression for the CS-onset group while the analysis of the repeated extinction measures indicated a correspondence between stimulus conditions (i.e., CS-onset and CS-offset). In addition, when Ss were tested with a different stimulus dimension than used in training, an interference occurred, but quickly dissipated over extinction trials. Two conclusions were drawn: that the CS has some initial arousal function and that Ss can successfully discriminate stimulus conditions.