2

CONDITIONING TO THE ELEMENTS OF A COMPOUND STIMULUS

CONDITIONING TO THE ELEMENTS OF A COMPOUND STIMULUS AS A FUNCTION OF THE INTENSITY OF ONE OF THE ELEMENTS

By

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SCOPE AND CONTENTS:

This thesis is concerned with the effects of varying the intensity of one element of a compound stimulus while holding the other constant in an experiment employing Kamin's (1964) design for showing the "perceptual or associative block" in the conditioned emotional response situation. The question of whether Pavlovian "overshadowing" or Hullian "summation" usually obtains during classical compound conditioning is examined.

The major findings were (1) that the degree of blocking is a monotonic function of the intensity of the first conditioned element; (2) that rate of conditioning to a compound stimulus is a monotonic function of the intensity of the varied element; and (3) that Hullian summation is the usual case in compound conditioning but that Pavlovian overshadowing occurs when one element is relatively much weaker than the other in terms of speed of conditioning.

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CONTENTS

INTRODUCTION AND HISTORY

Kamin (1964) has reported an experiment describing what he has termed a "blocking effect". He has demonstrated that rats in an Estes - Skinner conditioned emotional response (CER) situation (1941) react differently when tested to the elements of a compound stimulus depending on whether conditioning with one of the elements of the compound came before or after conditioning to the compound as a whole. If rats were first trained to a conditioned stimulus (CS) composed of light (L) and white noise (N), and then given further trails to only one of the elements, upon testing each element was capable of eliciting a CER. If, however, training was given to the single element first, and then to the compound, upon subsequent testing it was found that only the previously conditioned element was capable of eliciting a CER. The second element of the compound failed to acquire the ability to do so, although, of course, it had been paired with the unconditioned stimulus (UCS) the same number of times, and in the same way, as in the case first described. This "blocking" occurred independently of whether N or L was the first trained element. Kamin (1965) has argued that the block can be interpreted as either perceptual or associative in nature. He first suggested that previous learning to one element might "so engage the animal's attention" that when the new element was superimposed on the old, the new element was not perceived, and thus no association involving it could be formed. Subsequent analysis indicated, however, that after training to a single element, there was a detectable attenuation of suppression on the first trial during which the new element was superimposed. Thus it was clear that the animal did perceive the superimposed stimulus on at least the first trial of compound training. But, it could still be argued that once the reinforcement of the first compound trial proved the new element to be redundant, some sort of "sensory gating" mechanism came into play such that on subsequent compound trials the animal did not perceive the superimposed element. An associative interpretation, on the other hand, would maintain that the animal perceived the superimposed stimulus on all trials in a normal fashion, but that prior training to one element produced, in some unspecified way, a "failure of association".

Initially the impetus for the present investigation came from the consideration that if the block was of a perceptual nature its magnitude might be affected by varying the physical intensity (and presumably the "perceptual vividness") of the first trained element, with which a constant superimposed element would have to "compete" for attention. The weaker the first element trained, the more easily should the constant superimposed element be conditioned. It became clear that this type of experiment was also intimately related to the question of whether "overshadowing of one stimulus element by another" (Pavlov, 1927) or summation of response strengths (Hull, 1943) is the general case in compound conditioning. We turn now to a review of that problem.

Pavlov summed up his position in the following way:

> "When the stimuli making up the compound act upon different analyzers the effect of one of them when tested singly was found very commonly to overshadow the effect of the others almost completely, and this independently of the number of reinforcements." (Pavlov, 1927, p.141).

Pavlov cited the experiments of Palladin and Zeliony as support for this conclusion. Palladin established a salivary conditioned response to a compound CS consisting of a cold thermal element and a tactile element, employing acid as the UCS. Upon testing he found that the tactile element alone was capable of eliciting salivation but that the thermal stimulus alone was not. Zeliony conditioned an alimentary conditioned response to a compound of a tone and three lights. Upon testing he found that the lights alone were incapable of eliciting a conditioned response while the tone could. It must be pointed out that in both cases the overshadowed elements were known to be independently conditionable.

Pavlov reported further that if a compound CS is made up of two different tones of equal intensity, after conditioning, each tone will have acquired approximately the same ability to elicit a conditioned response. If, however, the tones are of different intensities as well, only the more intense of the two will acquire the ability to elicit a conditioned response. Pavlov concluded, "...that the obscuring of one stimulus by another is determined by differences in their strength, and it is only natural to assume that this explanation can be applied also to compound stimuli, the components of which belong to different analyzers." (1927, p.143).

While pointing out that the role of the weaker stimulus is not apparent if it does not acquire the ability to elicit a conditioned response by itself, Pavlov cites an experiment by Palladin which demenstrates a function of the weaker element. After conditioning to a compound CS Palladin extinguished the responses elicited by the stronger element while he continued reinforcing the compound. Under these conditions the element was extinguished but the compound did not lose strength, thus demonstrating the role of the weaker stimulus.

Pavlov also discussed the case where two previously onditioned CS's are combined to form a compound CS. He stated that under these conditions overshadowing does not occur. He argued that in the previously discussed cases the natural overshadowing of the weaker stimulus by the stronger stimulus had prohibited the formation of an association between the weaker stimulus and the UCS. In discussing the present case Pavlov is inconsistent. In two places he has explicitly denied the occurence of summation of eliciting abilities (1927, p.144; 1928, p.110). However in another place he holds that under certain conditions, namely the combination of two weak CS's, "...exact arithmetic summation of effect can be observed." (1928, p.310). It should be noted that, when talking about summation, Pavlov is referring to the procedure in which two previously conditioned stimuli, each different, are combined within the same subject. He never employed a between-groups design which might compare conditioning to a single element in one group with conditioning to a compound in another.

Hull derived a very explicit theory of the dynamics of compound stimulus conditioning. His basic statement was:

> "...that stimulus aggregates conditioned to the same reaction possess, irrespective of whether the stimulus aggregates were conditioned to the reaction as seperate entities or as a stimulus compound, (1) a smaller power of reaction evocation when presented jointly that when presented seperately, but (2) a larger joint power of reaction evocation than does any single component when the latter is presented singly." (Hull, 1943, p.212)

Essentially Hull said that given elements A and B, regardless of how conditioned, the following relations should obtain:

R_A or R_B is less than R_{AB} which is less than $R_A + R_B$.

Hull based his generalization on data he obtained during an experiment (1938) concerned with the compound conditioning of the galvanic skin response (GSR). Each observation in the following table, reproduced from Hull (1943), is the mean GSR for eight undergraduate male subjects. The compound stimulus was composed of a light (l) and a tactile vibrating stimulus (v).

(Insert Table I here)

Hull used the index $\frac{Rl + v}{Rl + Rv}$ as his major evidence. He pointed out that some summation does occur, and that it seems always to approximate 66% of what one would expect on the basis of strict arithmetic summation. Further he stressed that in all but one case the response to the compound was greater than that to either element, and thus he concluded that a non-arithmetic summation was the general rule.

A more detailed examination of his data, however, reveals that Hull has, perhaps, over stated his case. This is most clearly revealed in rows two and four of Table I. If in each case we calculate the percentage of the response to the compound that can be accounted for by the response to the vibrator alone, we find that for the data in row two it is 95% and for row four 100%. Thus it seems certain that in both these cases the response to the compound was not significantly greater than to the vibrator alond. While it is true that there is, even in row four, some response to light alone when it is eventually tested, a comparison of this response to that of the sensitization control group indicates at once that we might regard much of Hull's data as evidence for overshadowing rather than summation.

Hull disregarded this evidence for an overshadowing effect for two reasons. The first is his theoretical supposition that all of the stimulus elements in any situation are, to some extent, conditioned; the second, to which he makes explicit reference, is the possibility of experimental error due to the small size of his samples. Hull did not want to

Table I - Hull's GSR Conditioning Data
Each observation is the mean
GSR of a group of eight subjects.
(Hull, 1943, p.210, p.211)

Conditioning Procedure	Rl	Rv	Rl+v	$\frac{Rl+v}{Rl + Rv}$
Train Rl, Train Rv, test Rl+v.	3.5	3.6	4.4	.62-
Train Rl, Train Rv, test Rl+v.	2.2	3.7	3.91	.66+
Train Rl+ v, test Rl, test Rv.	2.5	2.9	3.3	.61+
Train Rl +v, test Rl, test Rv.	1.4	2.8	2.8	.66+
Sensitization Control	2.2	2.9	3.2	.63+

admit the possibility of the occurrence of Pavlovian overshadowing due to the fact that for him it implied some sort of attentional mechanism with which he was unprepared to deal theoretically.

Much more recent work seems to have provided clear evidence that summation, although not strictly arithmetic summation, does occur in the operant conditioning situation. Wolf (1963) used albino rats on a multiple schedule consisting of five minutes on a 30 second variable interval (VI) schedule of reinforcement in the presence of one discriminative stimulus (SD; analogous to a CS in classical conditioning), five minutes of S delta (no stimuli, no reinforcements), five minutes of 30 second VI in the presence of another SD, and five minutes of S delta. The subjects were run until a discrimination criterion of $\frac{\text{S delta}}{\text{SD}}$ of less than .10 was reached. During testing, each component of the multiple schedule was one minute long and an additional component during which both SDs were presented in compound was added. Wolf found that in all cases more responses were emitted during the compound SD than during either of its components presented seperately. Weiss (1964) also reports summation in a similiar experiment. He found summation of response to the original SDs and to generalized SDs. There appears to be no operant work in which a compound SD is first trained, and then the elements tested, with an aim toward trying to quanify summation or overshadowing effects. The operant work like the classical work described earlier employs within-subject rather than between-groups tests of summation effects.

The experiement described in the following chapter was aimed both at providing evidence relevant to the perceptual or associative interpretation of the blocking effect described by Kamin, and at providing evidence about the conditions under which overshadowing and/or summation occur in compound conditioning. Both between-group and within-subject comparisons are utilized.

METHOD

Subjects and Apparatus

The Ss were 56 experimentally naive, male, hooded rats purchased from Canadian Research Animal Farms, Bradford, Ontario. They were from three to five months of age at the start of the experiment and their ad libitum weights ranged from 225 to 350 grams. Over a period of seven days, after their arrival at the laboratory, all Ss were reduced to 75% of their ad libitum weights and then allowed three days to stabilize at that weight before the beginning of actual experimentation. The Ss were maintained on a 24 hour feeding rhythm, and were 22 hours hungry at the start of each experimental session. The Ss were randomly assigned to six groups: two of N = 11, three of N = 9, and one of N = 7.

The experimental chambers were eight standard Grason-Stadler operant conditioning units housed in wooden chests with sand-filled walls in order to attenuate external noise. Each chest was equipped with an exhaust blower and a fresh air intake in order to provide adequate ventilation. In each chest, attached to the internal food cup of each chamber, there was an automatic feeder which allowed presentation of standard 45 milligram Laboratory Rat Food Tablets (P.J. Noyes Co.). On the same wall of the chamber as the food cup a metal lever protruded into the chamber. A speaker was also mounted behind this wall. A frosted 7.5 watt bulb was mounted over each chamber, the plexiglass top of which was covered with a piece of translucent, milk white, plastic (Perspex 404, opal, 1/8 inch) which served to diffuse the light over the area of the experimental chamber.

All programming and recording equipment was housed in an adjacent room. Programming of all phases of the experimental procedurewas automatically controlled by standard relay and timer switching circuits. Recording was carried out by means of digital and print-out counters and cumulative recorders.

Unconditioned Stimulus

The UCS was an electric shock delivered to the feet of the S through the steel grid floor of the experimental chamber. The shock source for each chamber was a separate Grason-Stadler Model E1064GS Shock Generator. This shock generator is equipped with a grid scrambler which makes it impossible for the S to avoid shock by standing on two grids of like charge. Thus the animal received shock as long as it was in contact with the floors, the walls or the lever in the chamber. The shock circuit is of the constant current type (high voltage, high resisitance) in order to minimize the effects of the S's changing resistance on the current.

The UCS was of .5 second duration and was set at a nominal intensity of "1 ma.". In order to minimize attenuation of the shock by the accumulation of feces on the grid floors, the grids were washed with very hot water at the end of each session.

<u>Conditioned Stimuli</u>

The CS was, depending on the phase of the experiment, either a three minute white noise (of varying intensity for the different groups), or a compound, also of three minute duration, of the white noise of appropriate intensity plus the diffuse light of the 7.5 watt frosted bulb. The three noise intensities employed were 80, 60, and 50 decibels.

The source of the 80 db CS was a Grason-Stadler Model 901B Noise Generator connected to an <u>Electra</u> Custom Laboratory Apparatus eight channel Audic Splitter (Ashman Electronics) which allowed the CS to be programmed independently to each box. The source of the 50 and 60 db CS's was a Grason-Stadler Model E5539AGS Noise Generator also connected to an <u>Electra</u> Custom Laboratory Apparatus eight channel Audio Splitter. In order to obtain two CS intensities from one generator and audio splitter the output level of this generator was set at 60 db and by means of a variable resistor in series with the output of each channel, each channel's output could be independently attenuated to 50 db by adding resistance. Thus it was possible to program either a 50, 60, or 80 db CS into each experimental chamber independently of the other.

Adjustment of the CS sound level in each chamber was carried out before each session with the exhaust blowers in all chests disconnected. This was necessary because the ambient noise level with the blowers on was about 62 db.

The white noise CS is, however, discriminably different from the ambient noise level. Adjustment was carried out with the aid of a Type 1551 C Sound Level Meter (General Radio Co.; range 24-150 db; re.0002 μ bar at 1000 cps) which was calibrated daily using a Type 1307A Transistor Oscillator and a Type 1552B Calibrator (both General Radio Co.).

Procedure

The general procedure involved four phases: preliminary training, during which the S learned to press the bar for food reinforcement; pretesting, during which the noise which was to serve as the CS for each S and the light which was to serve as an element of the compound CS were presented without shock; CER training, during which the CS-UCS pairings occurred: and finally one day of testing to the light stimulus alone. The preliminary training phase was identical for all groups.

Preliminary Training This phase lasted four days. On the first day each S was put into an experimental chamber with the house lights on and presented with 40 "free" food pellets on a one minute variable interval schedule; if at any time during this period S happened to press the lever a food pellet was delivered. After the first 40 pellets S could only obtain pellets by lever pressing. Each lever press produced one pellet of food. After 80 lever presses on this continuous reinforcement schedule S was removed from the experimental chamber, terminating the first session.

The second day the animals were put on a 2.5 minute variable interval schedule of reinforcement (VI 2.5) for lever pressing, (with the house lights still on) for a two hour session. All subsequent daily sessions were on a VI 2.5 schedule, and were also two hours long. The third and fourth days were identical to the second except that from the third day on the house lights were always off.

Pretesting This phase lasted two days. Four times during the two hour session (at 21.5, 56.5, 95, and 112.5 minutes after the beginning of the session) either a noise of the intensity assigned to that S or the 7.5 watt bulb came on for three minutes. The first pretest day half the S's in each group received a light stimulus first and half received a noise stimulus first. The stimuli then alternated regularly. On the second pretest day those Ss which had received the light first on the first day received a noise first, and those which had received noise first now received light first. Thus each animal received a total of four noise trials and four light trials during the two days of pretesting.

CER Training This phase lasted six days, and differed between the experimental and the control groups. For the experimental groups a noise CS came on four times during each session for the first four days of this phase. The CS came on at 21.5, 56.5, 95, and 112.5 minutes after the beginning of the session, lasted for 3 minutes and its termination was continuous with the UCS. For the last two days conditions remained exactly the same as for the first four days except that the CS now consisted of noise plus light acting simultaneously for 3 minutes. For the control groups, trials occurred at the same times as for the experimental groups and the CS's were of the same type except that the control animals received the compound light plus noise CS on the first two days, and the noise CS for the last four days of this phase.

Testing to Light This phase lasted one day. All trials occurred at the usual times, but consisted only of a 3 minute presentation of the light stimulus alone, which was not followed by shock.

Measures As an index of the amount of CER conditioning on each trial the "suppression ratio" (Kamin, 1961) was computed. This ratio is $\frac{B}{A+B}$ where A is equal to the number of lever presses in the three-minute period immediately preceding the CS period, and B is equal to the number of lever presses during the three-minute CS period. Thus the ratio is .00 when lever pressing is completely suppressed during the CS period, .50 when the CS has no effect on lever pressing, and 1.00 if no lever presses are made during the pre-CS period and one or more are made during the CS. Normally at the beginning of conditioning the suppression ratio is about .50 and decreases as conditioning proceeds.

Suppression ratios were calculated for each trial using data obtained from the print-out counters. A daily ratio was also computed for each S by summing the number of responses made during the four pre-CS periods and the four CS periods of a single day's session.

Occasionally no responses were made by an S in either period. In that case the standard procedure has been to assign that trial an estimated suppression ratio. The estimate is simply the mean of the ratios computed for the trials immediately preceding and following the responseless trials.

Experimental Design

The experiment involved six groups, three experimental groups and three control groups. The independent variables manipulated in this experiement were the intensity of the white noise CS (and the intensity of the white noise component of the compound CS), and the order in which compound and noise-alone training was given. There were three levels of white noise intensity employed, 80, 60, and 50 db. For each level of white noise intensity there was an experimental and a control group. The experimental and control groups differed from each other in the order in which they received the two CS's employed during CER training. The experimental group at each intensity received sixteen trials (four days at four trials per day) of noise-shock pairings followed by eight trials (two days at four trials per day) of light noise-shock pairings. The control groups received the eight light noise-shock pairings first, followed by the sixteen noise-shock pairings. Table II illustrates the experimental design and the number (N) of Ss in each group.

(Insert Table II here)

Table II

Experimental Design

80 db Experimental Group	(N= 11) :	16 Noise Trials - 8 Light Noise Trials - Test to Light
80 db Control Group	(N= 9) :	8 Light Noise Trials - 16 Noise Trials - Test to Light
60 db Experimental Group	(N= 9) :	16 Noise Trials - 8 Light Noise Trials- Test to Light
60 db Control Group	(N= 7) :	8 Light Noise Trials - 16 Noise Trials - Test to Light
50 db Experimental Group	(N= 11) :	16 Noise Trials - 8 Light Noise Trials - Test to Light
50 db Control Group	(N= 9) :	8 Light Noise Trials - 16 Noise Trials - Test to Light

It will be noted that this design constitutes Kamin's standard design (1964, 1965) for demonstrating what he has termed "the perceptual or associative block". In essence the 80 db groups represent an attempt to replicate Kamin's previous research, while the 50 and 60 db groups represent a parametric extension of that research along the parameter of blocking stimulus intensity. It should be noted that the present design does not include a control for the effects of time elapsin between last exposure to light and the light test, Kamin (1964) has already provided such controls, and has demonstrated that the blocking effect cannot be attributed to this difference between the experimental and control groups.

The design sketched in Table II suggests several comparisons of interest. We can compare the light test data for the three experimental groups, and observe whether the amount of conditioning is a function of the variable intensity of the "blocking" noise element. Within each pair of experimental and control groups, we can ask whether prior training to the noise element has "blocked" conditioning to the light element. We can contrast the rate of acquisition during the first eight trials of training of the experimental and control groups, asking whether acquisition is more rapid to a compound than acquisition to a single element. The ninth training trial of the control groups, finally, should provide within-subject evidence as to whether, at some levels of intensity, the noise has been overshadowed by the light; the first eight training trials of the experimental groups will indicate whether each intensity of noise is independently conditionable.

RESULTS

The results will be presented in three subsections. The first will be concerned with the pretest data, the second with CER training, and the third with the test to light.

Pretest

The results of the pretests are summarized in Table III. Since there was no difference in treatment between the experimental and control groups up to or during pretesting, the noise pretest data of the experimental and control groups at each level of noise intensity were pooled. Furthermore, since the light intensity was the same for <u>all</u> groups regardless of noise intensity, the light pretest data of all 56 <u>S</u>s were pooled.

(Insert Table III here)

The most obvious effect seen in the Table III is the tendency for the light stimulus to inhibit ongoing behaviour substantially on its first presentation. There is, however, at least a partial tendency for this effect to attenuate with repeated trials. Whatever tendency the noise stimulus might have to inhibit bar pressing on its first presentation does not vary with the intensity of the noise; on the first pretest trial, the three noise groups do not differ significantly (Kruskal-Wallis Ranked Analysis of Variance). There is no sign of significant inhibition after the first noise trial.

Table III

Summary of Pretest Suppression Ratios

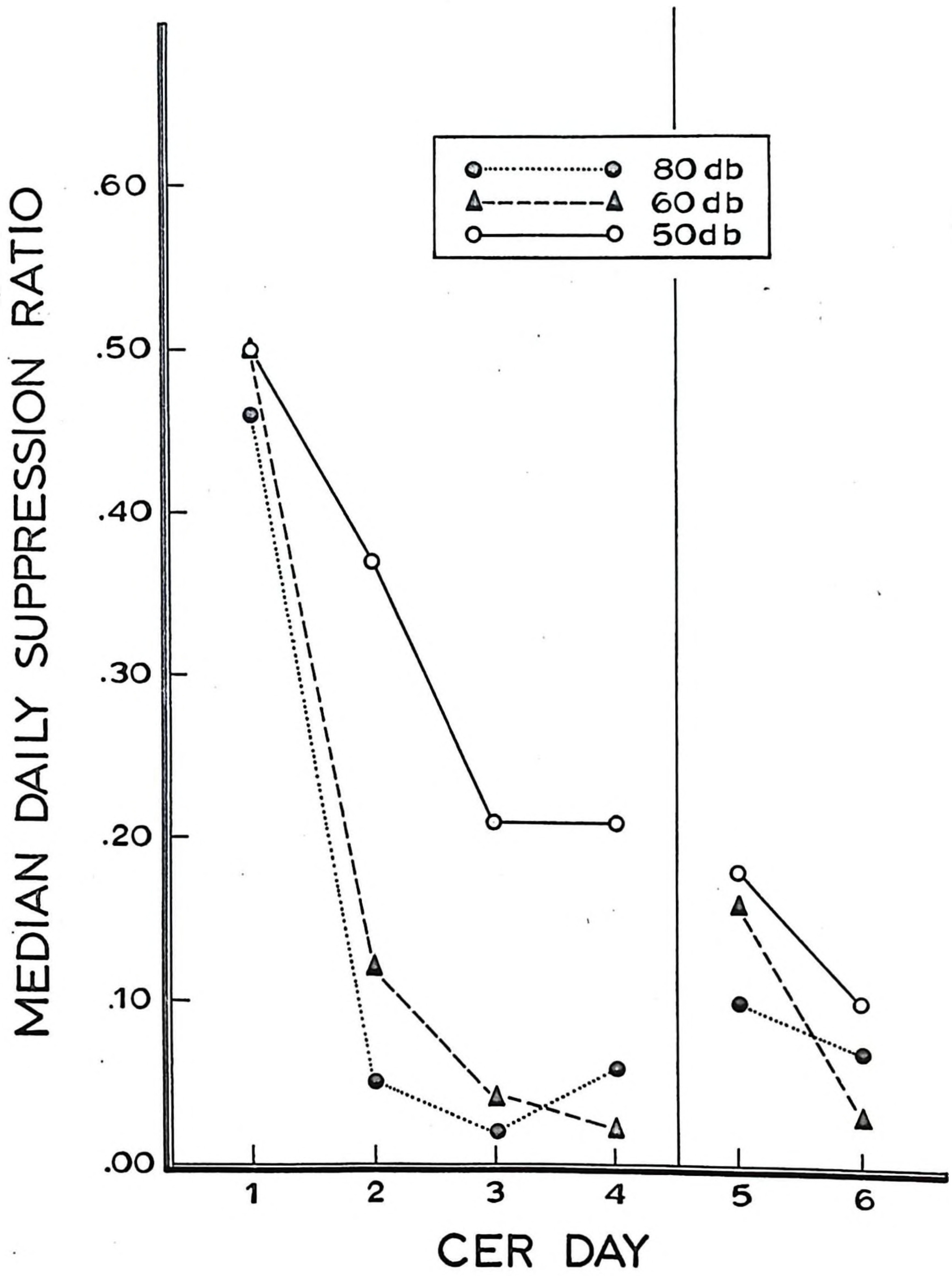
Stimulus	Measure	Pretest Trial			
		N1	N2	N3	N4
50 db (N=20)	Median	.44	.49	.51	.53
	Mean	.44	.48	.50	.54
	Range	.16-.75	.32-.89	.23-.89	.30-1.00
60 db (N=16)	Median	.50	.53	.47	.54
	Mean	.49	.53	.48	.50
	Range	.33-.63	.43-.66	.32-.58	.24-.62
80 db (N=20)	Median	.45	.49	.51	.48
	Mean	.45	.51	.50	.47
	Range	.30-.60	.36-.70	.36-.68	.00-.59
		L1	L2	L3	L4
Light (N=56)	Median	.34	.41	.42	.42
	Mean	.32	.40	.42	.43
	Range	.16-.75	.10-.60	.05-.69	.10-1.00

CER Acquisition

Figures 1 and 2 present CER acquisition curves for the experimental groups. Figure 1 shows the median daily suppression ratio for each day of CER training for each of the three experimental groups. Figure 2 shows the individual trial data for the same three groups. The figures indicate that all groups acquire suppression during the first four days of training to the noise stimulus, though it appears that rate of acquisition is inversely related to the intensity of the noise stimulus. The groups are clearly separated on Trial 5 and Whitney's Extension of the Mann-Whitney U test (Bush and Mosteller, 1954) performed on the ratios of that trial revealed that the expected monotonic trend was significant at the .01 level. By the final trial of training to the noise element (Trial 16) the magnitude of the differences between groups had diminished, but Whitney's test revealed that the monotonic trend was still significant at the .05 level. Multiple U tests (Siegel, 1956) revealed that the difference between the 50 and the 80 db groups was significant at the .05 level, while the other differences were not significant.

The trial on which the CS is changed by the addition of light for the experimental groups (or by its subtraction for the control groups) can be called a "transitional" trial. Examination of Figure 2 suggests that the data of the transitional trial for the experimental groups (Trial 17) indicate

FIGURE 1. EXPERIMENTAL GROUPS. Median daily suppression ratio as a function of CER training day. Note that CS is noise on Days 1 - 4, but light plus noise on Days 5 - 6.



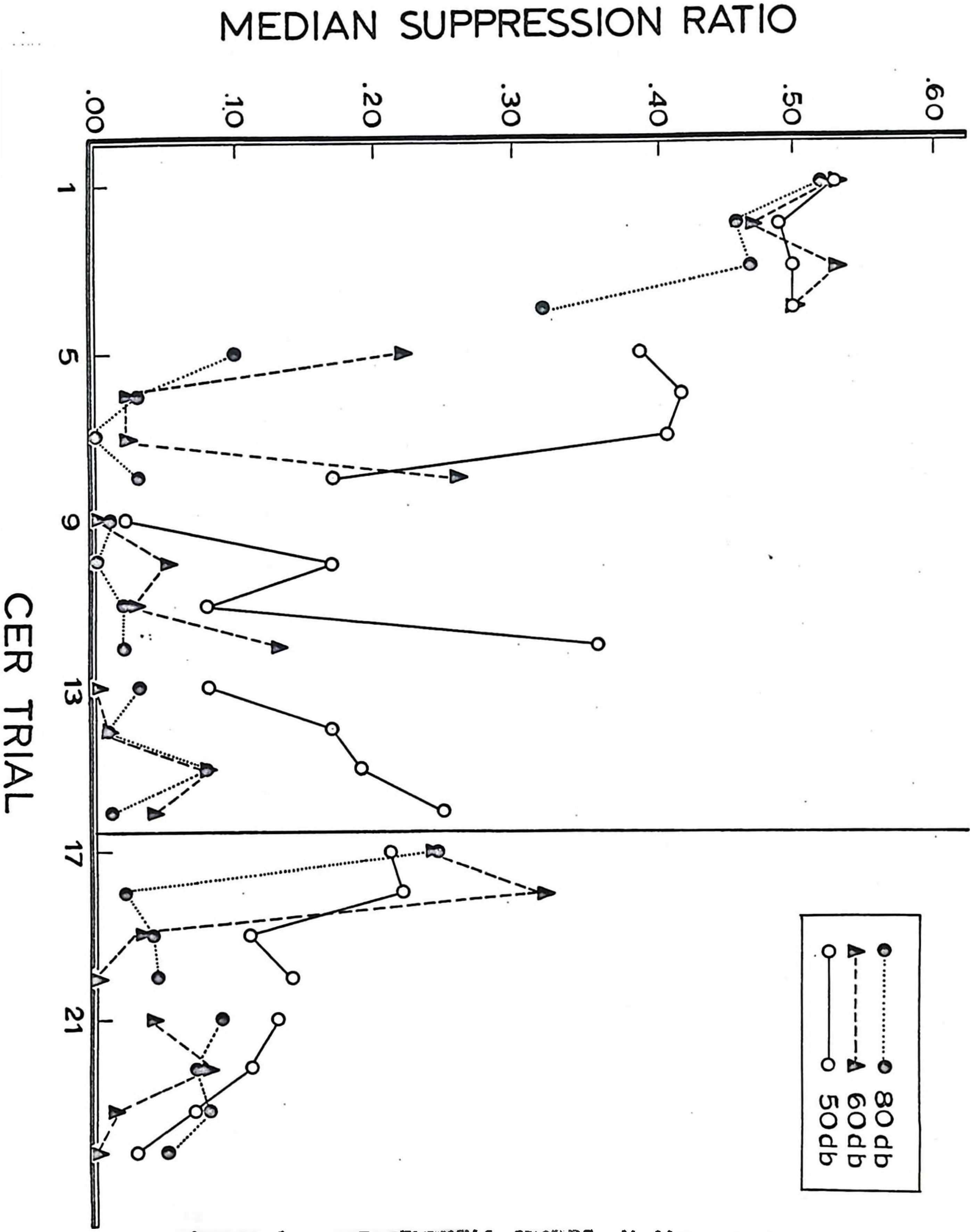


FIGURE 2. EXPERIMENTAL GROUPS. Median suppression ratio as a function of trial of CER training. Note that CS is noise on Trials 1 - 16, but light plus noise on Trials 17 - 24.

a partial loss of suppression on that trial. While it might seem reasonable to test statistically for this loss by comparing the suppression ratios of the transitional trial with those of the trial immediately preceding it, further examination of Figure 2 will reveal that once the CER has been acquired there is a substantial within-session decrement in the magnitude of the CER shown by the 50 db group. This decrement with a low intensity CS has been observed before by Zielinski (1964) and by Theodor (1964). Because of this within-session decrement it appears that a more sensitive test of the effect of adding the light can be made by comparing the transitional trial (Trial 17) with the first trial of the preceding day (Trial 13). The comparison was made by means of the Wilcoxin Matched Pairs Signed Ranks test (Siegel, 1956), and showed that in each group the suppression ratios on the transitional trial were significantly larger than those on the comparison trial ($p < .05$).

The attenuated suppression produced by the addition of the light on Trial 17 is, in the case of the 80 db group no longer observable on Trial 18. For this group the median ratio on Trial 18 was .02. However, as Figure 2 indicates, suppression remained quite moderate on Trial 18 for both the 50 and 60 db groups (median ratios of .22 and .32, respectively). Suppression was virtually complete on Trial 19 for the 60 db group (median = .03), while the 50 db group more gradually approached asymptotic suppression, reaching a median ratio of

.03 on Trial 24. By this final trial of acquisition training all groups were well suppressed and did not differ significantly.

Figures 3 and 4 present CER acquisition curves for the control groups. Figure 3 shows the median daily suppression ratio for each day of CER training for each control group. Figure 4 shows the individual trial data for the same groups. The figures clearly indicate that acquisition to the compound varies with the intensity of the noise element. The daily ratios for Day 2 and the ratios for the final trial of compound training (Trial 8) were subjected to multiple U tests. In each case the 50 db group differed significantly ($p < .05$) from the 60 and the 80 db groups, which did not themselves differ.

In the case of the control groups, in analyzing the attenuation of suppression on the transitional trial the comparison made was between the last trial of compound stimulation (Trial 8) and the transitional trial (Trial 9). This type of analysis differs somewhat from that carried out on the experimental groups, but was necessary because on the first trial of the day preceding transition (Trial 5) many of the Ss in the 50 db control group were still acquiring the CER.

The analysis of the transitional data for the 80 and the 60 db groups showed much the same result as had that for the experimental groups, namely, a significant loss of suppression ($p < .05$). (In the case of the control groups, of course, the loss was produced by removing the light component from a previously trained compound; in the case of the experimental groups, a similiar loss was produced by adding a light component to a previously trained noise stimulus.) The 50 db control group showed a particularly marked effect. The subtraction of the light component from the compound CS resulted in practically no suppression on Trial 9. From this point on the 50 db control group seems to exhibit an almost a complete new acquisition curve to the 50 db stimulus; the other two control groups show only a transitory and moderate loss of suppression on the transitional trial. The positive transfer from compound to noise element is readily apparent on Trial 9 for both the 60 and 80 db groups.

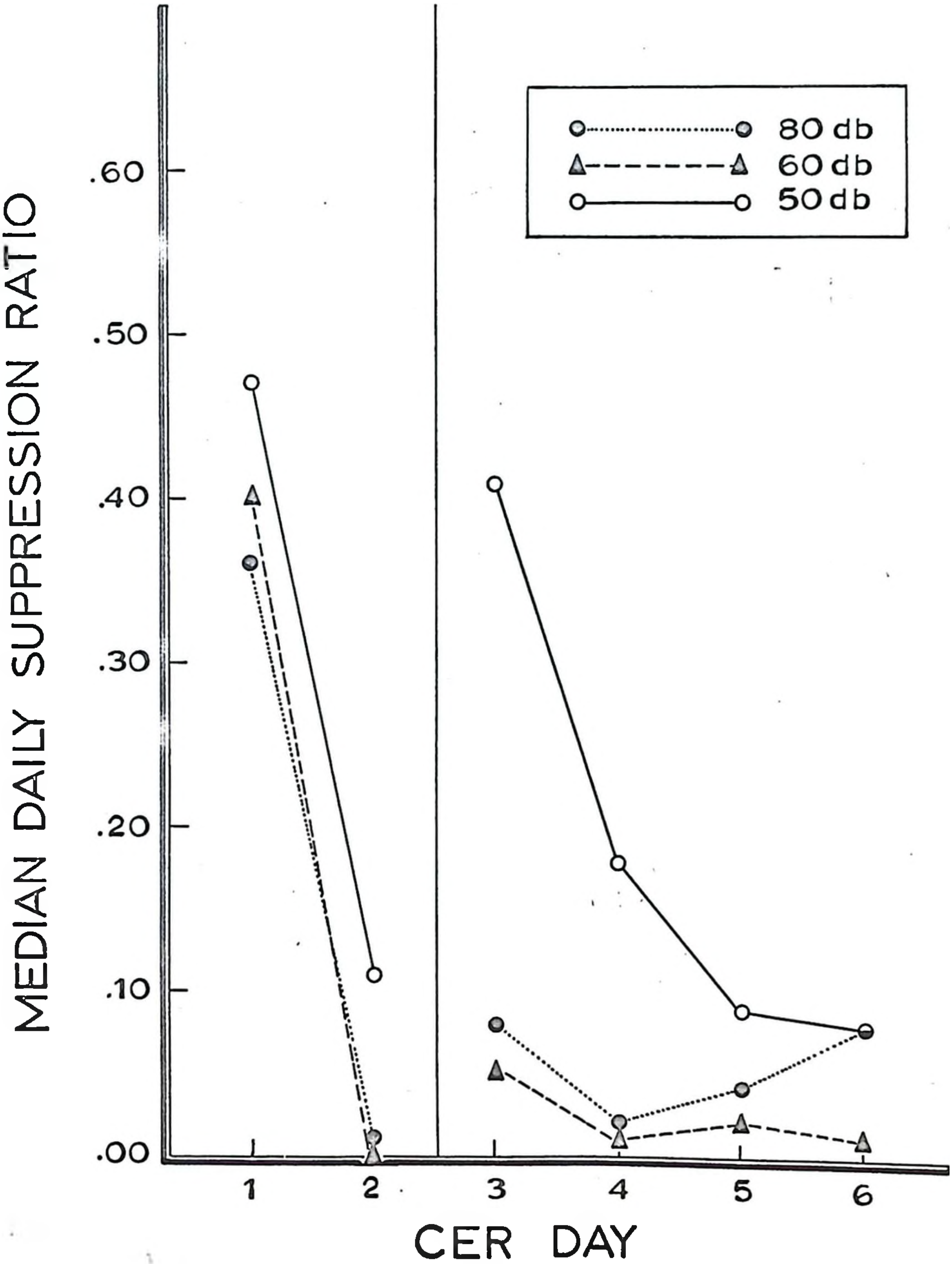
By the end of training to the noise element , all control groups were well suppressed. There were no significant differences among the control groups on Trial 24.

In order to compare rates of acquisition between a compound CS and a noise CS alone, each experimental group was compared with its control group on Trial 5. In all cases the control group manifested significantly lower suppression ratios ($p < .05$). Thus in all cases the compound stimulus was more rapidly conditioned in the same number of trials than was the noise stimulus by itself.

<u>Test to Light</u>

Figure 5 presents the median suppression ratio on each of the four trials of the test to light for each experimental group. Figure 6 presents the comparable data for the three

FIGURE 3. CONTROL GROUPS. Median daily suppression ratio as a function of CER training day. Note that CS is light plus noise on Day 1 - 2, but noise on Day 3 - 6.



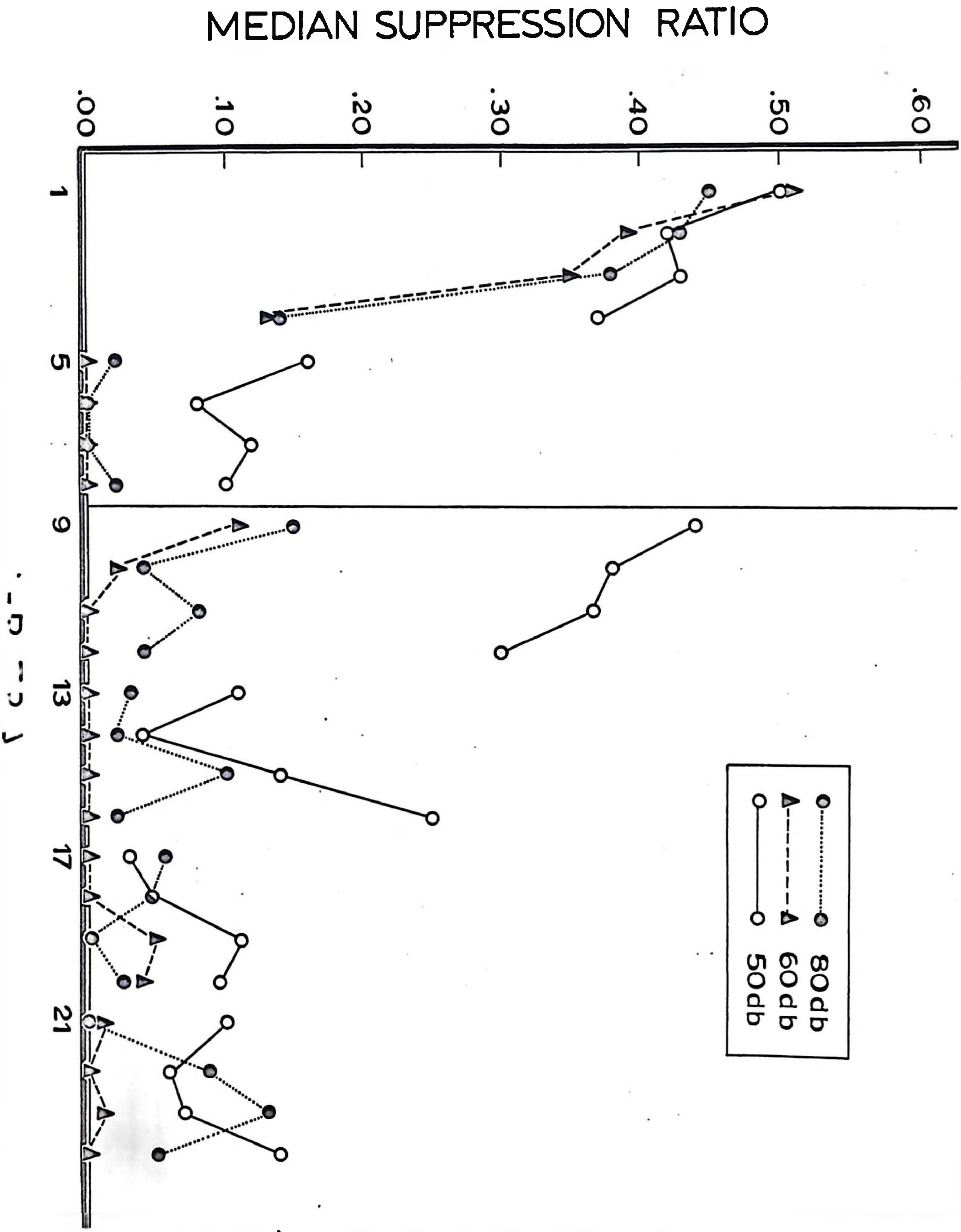


FIGURE 4. CONTROL GROUPS. Median suppression ratio as a function of trial of CER training. Note that CS is light plus noise on Trials 1 - 8, but noise on Trials 9 - 24.

control groups. These data are the primary focus of the present experiment. Table IV and Table V present summary data for the first trial of the light test. It is clear that the magnitude of the suppression ratios, for the experimental groups, varies with the intensity of the noise CS, but these differences between groups tend to diminish as repeated test trials are given without shock reinforcement. Thus the data for test Trial 1 were submitted to analysis by Whitney's Extension of the Mann-Whitney U test. The analysis confirms that the expected monotonic trend is significant across noise intensities for the experimental groups ($p < .01$).

(Insert Tables IV and V here)

While the light test ratios for the control groups also appear to be a function of noise intensity, it is the 80 db group which stands out from the other two (cf. Figure 6, Table V). Mann-Whitney U tests revealed that the 50 and 60 db groups did not differ significantly from each other and that the 50 and 60 db groups each differed significantly from the 80 db group ($p < .05$).

The question of whether a block in acquiring suppression to the light occurred at each level of noise intensity can be answered by comparing the Trial 1 light test ratio of each pair of experimental and control groups. The block, of course, is manifested by significantly larger ratios shown by the experimental group. The 50 db experimental group has a significantly higher ratio than the 50 db control group ($p < .02$). Likewise

FIGURE 5. EXPERIMENTAL GROUPS. Median suppression ratio as a function of light test trial.

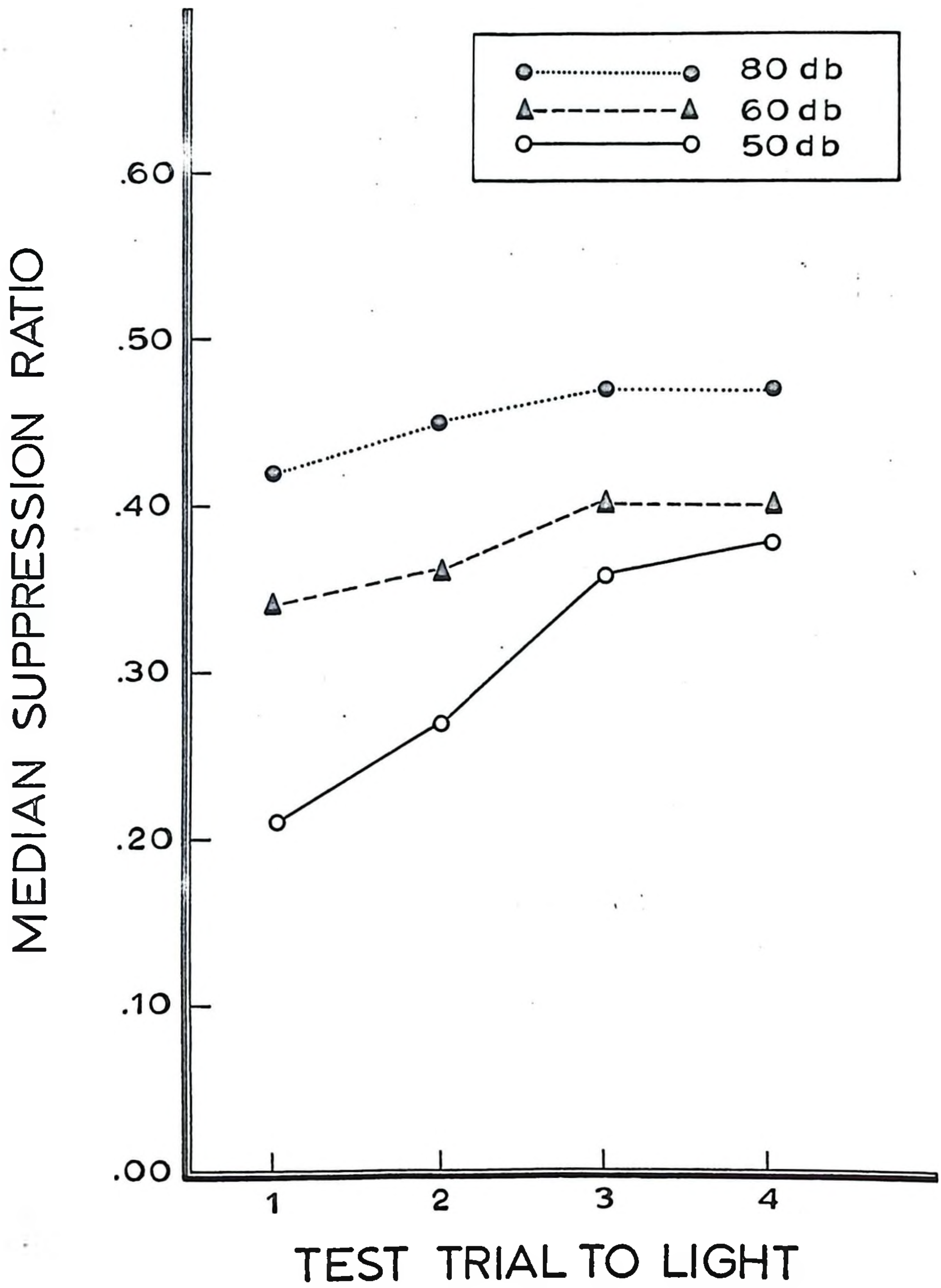


FIGURE 6. CONTROL GROUPS. Median Suppression ratio as a function of light test trial.

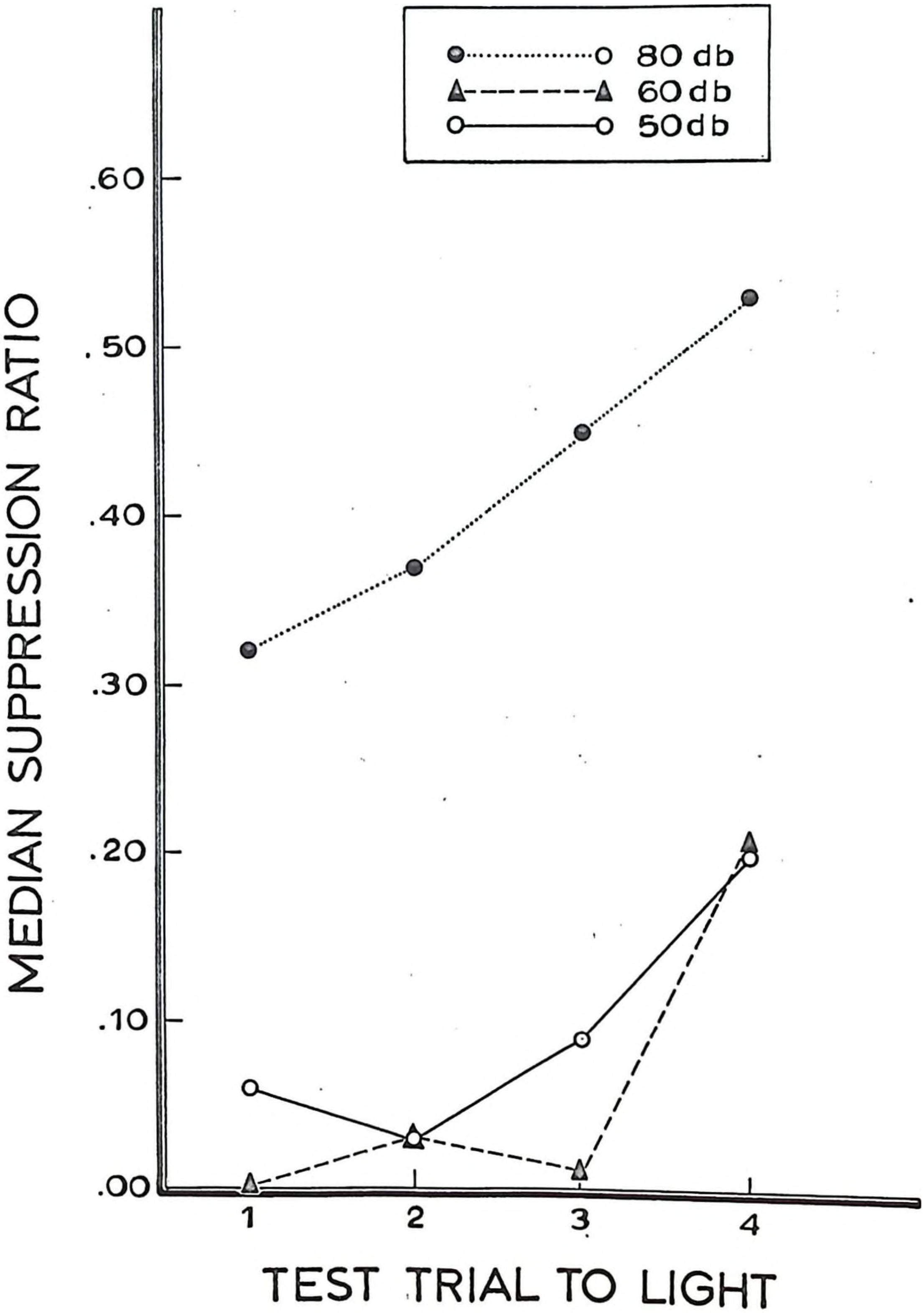


Table IV

Summary Data for Light Test Trial 1, Experimental Groups

Measure	Noise Intensity		
	50 db	60 db	80 db
Median	.21	.34	.42
Mean	.24	.31	.44
Range	.04-.47	.01-.55	.37-.61

Table V

Summary Data for Light Test Trial 1, Control Groups

Measure	Noise Intensity		
	50 db	60 db	80 db
Median	.06	.00	.32
Mean	.09	.01	.27
Range	.00-.33	.00-.05	.00-.46

the 60 db experimental group was significantly higher than its control group ($p < .002$). The same was also true in the case of the two 80 db groups ($p < .02$).

Though the preceding analysis indicates that each experimental group, when compared to its control group, showed a significant degree of block in acquiring suppression to the light, it is obvious that the block in the case of the weaker noise intensities is not complete. That is, some suppression does occur to the light during the light test. The block in the case of the 80 db experimental group, however, can be regarded as complete. Our own pretest data indicate that, by the fourth trial to light during pretest a fairly stable suppression ratio of about .42 is obtained. Kamin (1965) has also demonstrated that animals who have received 24 noise-shock pairings, and are than presented with a light which has never been reinforced, give a median suppression ratio of .42 to the light. Thus the minimal disruption of bar-pressing produced in our 80 db experimental group is of precisely the magnitude which would have been observed had no light been present during reinforced Trials 17-24.

DISCUSSION

The Blocking Effect: Perceptual or Associative?

The present experiment has replicated the block phenomenon reported by Kamin (1964, 1965). The block found when comparing the 80 db experimental group with the 80 db dontrol group is of comparable magnitude to that reported by Kamin. This block may be considered total, for reasons discussed in the final paragraph of the preceding chapter. The present experiment has extended the work of Kamin by showing that there is a significant, though partial, block when the same constant light stimulus is superimposed on a previously conditioned noise stimulus of less intensity than that habitually used by Kamin (1964, 1965). These blocks, demonstrated by comparing experimental and control groups at the 50 db and 60 db noise level on the first light test trial, are considered partial because, though the experimental groups show less suppression than their controls, they clearly do show suppression when tested with light. Finally, we also noted that, when the three experimental groups were compared, the amount of suppression shown to the light alone was a monotonic function of the intensity of the blocking noise stimulus.

It will be recalled that we began with two alternative interpretations of the nature of the blocking effect. The first interpretation is of a perceptual nature, and states that once a superimposed stimulus is proven redundant, some sort of sensory gating mechanism comes into play such that the animal no longer perceives the superimposed stimulus. The alternative interpretation is that the block is the result of a purely associative failure, that is, that the animal perceives the superimposed stimulus, but, for unspecified reasons, no "associative bond" is formed between the superimposed stimulus and the UCS. While it seems difficult to frame clear experimental tests of these alternative interpretations, the original impetus for the present investigation came from consideration of some of the implications of a perceptual interpretation. Put very simply, if the block is due to S's failure to perceive the superimposed stimulus, the more intense or "vivid" the superimposed stimulus is, relative to the first trained element, the more likely should S be to perceive it.

The clear finding that the amount of suppression on the light test is a monotonic function of the intensity of the previously conditioned noise stimulus seems at first to support interpreting the block in perceptual terms. There are, however, a number of aspects of the data which tend to argue against interpreting the block in perceptual terms. If we examine the acquisition data of the three experimental groups for the first 16 trials we find that the level of suppression attained at the end of 16 trials is a significant monotonic function of the intensity of the noise CS. Kamin and Schaub (1963) have already demonstrated that the rate of acquisition of the CER is a monotonic function of the intensity of a noise CS. Their groups, however, converged to a common asymptote of virtually complete suppression. Our experimental groups, after 16 trials of acquisition, still differed considerably in level of suppression. So far as supporting a perceptual interpretation of the block is concerned, this is unfortunate, since Kamin (1965) has demonstrated that it is possible to produce a partial block with an 80 db noise by conditioning it for only 4 trials before superimposing the light. After 4 trials with an 80 db CS his animals were not completely suppressed to the CS, and he proposed thatthis was the cause of the partial, rather than complete, block he obtained. The partial block obtained in the present experiment might be accounted for by the fact that when the light was first superimposed on the noise CS in the 50 db group the animals were not completely suppressed to the noise. Thus, in the present study, the degree of block produced by a given CS intensity could reasonably be attributed to the amount of suppression controlled by that CS, rather than to the CS intensity *per se*.

Closely related to the above, if we examine the effect of the transition from the noise CS to the compound L+N CS we find more data to confound a simple-minded interpretation of the degree of block being attributable to the "perceptual intensity" of the blocking CS. The 80 db group shows less than asymptotic suppression only on the first compound trial (Trial 17), the 60 db group shows less than asymptotic suppression on both Trials 17 and 18, and the 50 db group shows less than asymptotic suppression for a considerable number of trials. Thus, the degree of blocking during the test to light is also a montonic function of the number of training trials during which the superimposed light is presented when suppression is less than asymptotic. Thus it might be argued that in order for a stimulus to acquire the ability to elicit a CER, it not only needs to be temporally contiguous with the UCS, but also it must be present for a number of trials during which suppression is less than complete and during which a learning process can, therefore, take place. This kind of interpretation, of course, moves very far from the perceptual notions with which we began, and is associative in nature.

Future research might help to clarify the present ambiguity in the following way. To separate the effects of intensity of the blocking CS *per se* from the effects of the amount of suppression which it controls, we would like a weak CS to control a great deal of suppression. If we were to train a group with 50 db CS, but a very strong UCS, it might well be the case (Kamin, 1965), that the suppression controlled by the 50 db CS is at least as great as that controlled by an 80 db CS which has been paired with a 1 ma. shock. If it was also the case that when the light was superimposed on the 50 db CS, there was little attenuation of suppression, and if light tested alone finally produced considerable suppression, we would have evidence that it is the weakness of the CS per se which results in a less than total block. This, of course, would support a perceptual interpretation.

Overshadowing versus Summation

The comparison at each level of noise intensity, of original acquisition to noise alone versus original acquisition to light plus noise, provided data that bear upon the controversy of overshadowing (Pavlov, 1927) versus summation (Hull, 1943) during compound conditioning. We have already indicated that, in each possible comparison within our three sets of experimental and control groups, acquisition is more rapid to light plus noise than to noise alone. This, however, is not necessarily evidence for summation. In order to demonstrate summation, the response must be learned faster to the compound than to either one of its elements singly. The present experimental design does not include a group trained to light alone. However, Kamin has trained animals in the same apparatus, under identical conditions, to light alone, and we can utilize his data for the necessary comparisons. In Table VI we present median suppression ratios for the first five trials of acquisition for all of our own groups, for a group trained by Kamin to light alone, and for two groups trained by Kamin with treatments identical to two of our own groups. As can be seen in the cases where direct comparison is possible, Kamin's data agree very closely with our own. We are thus confident in comparing Kamin's light alone group to our groups.

(Insert Table VI here)

Inspection of the right-hand side of Table VI indicates that the acquisition to light plus 80 db noise is more rapid than either, to light alone, or to 80 db noise alone, with the maximal difference observable on Trial 4. Kamin has already shown this effect to be highly significant, and our own data clearly duplicate the difference between the L+80 db group and the 80 db group. When our L+60 db group is compared with our 60 db group and with Kamin's L group, it is again evident that acquisition to the compound is more rapid than is acquisition to either on of its elements alone. Thus, when light is combined with either 80 or 60 db noise, we have clear evidence for summation. In the case of 50 db, however, while it is true that the L+50 group does acquire significantly more rapidly than does our 50 db group, the L+50 group definitely does not acquire any more rapidly than Kamin's L group. These latter two groups do not differ significantly. Thus, the light seems to "overshadow" the 50 db noise element completely. This is also apparent if we look at the behavior of our control groups during the transitional trial when the light is removed. In both the 80 and the 60 db control groups there is high positive transfer, on the transitional trial, from the compound to the noise element alone. In the 50 db control group there is almost no transfer. (For the 80 db group the median suppression ratio on Trial 8, the last compound

Table VI

Comparison of rates of acquisition between present study and previous work of Kamin (1964, 1965). Data are median suppression ratios for the first five trials of acquisition.

CS	Present Study Trial 1	2	3	4	5		Kamin Trial 1	2	3	4	5	
Light (L)							.42	.38	.39	.30	.06	(N=69)
L + 50	.50	.42	.43	.37	.16	(N=9)						
L + 60	.51	.39	.35	.13	.00	(N=7)						
L + 80	.45	.43	.38	.14	.02	(N=9)	.47	.41	.30	.11	.02	(N=77)
50	.53	.49	.50	.50	.39	(N=11)						
60	.53	.47	.53	.50	.22	(N=9)						
80	.52	.46	.47	.32	.10	(N=11)	.51	.50	.45	.33	.05	(N=285)

trial, was .02, on the transitional trial (Trial 9) it was .15; for the 60 db group it was .00 on Trial 8 and .11 on Trial 9; for the 50 db group, however, it was .10 on Trial 8 and .44 on Trial 9.) This within-subject analysis points to the same conclusion as the previous between-groups comparisons do. This, then, is clearly a case of Pavlovian overshadowing. The overshadowing effect seems to occur, as Pavlov (1927) suggested, when one stimulus is very intense relative to the other.

It should be stressed that the overshadowing, or failure of summation, occurs even though 50 db noise is clearly a conditionable stimulus by itself, and even though summation of the same light with other more intense noise stimuli can easily be demonstrated. It is not that the 50 db noise by itself is too weak, or the light itself too strong, for summation to occur. It is the relation between them that is critical.

Relation Between the Block Effect and Overshadowing

The blocking effect reported by Kamin, and the overshadowing described by Pavlov, are clearly real phenomena, and each has been demonstrated in this study. The question now arises as to whether the two effects are independent, or whether they are closely related.

There is at least one obvious way to relate the two phenomena. Kamin has shown that previous conditioning of element A precludes the formation of an association between a later superimposed element B and the UCS. We have shown, as did Pavlov, that when a strong element A is presented in compound with a weak element B, no association is formed between B and the UCS, and that the rate of acquisition to the A+ B compound is no faster than the rate of acquisition to element A in a control group. We can try to piece together what happens when an animal is trained to the A + B compound by considering what happens when other animals are trained with either element A or element B alone. The rate of acquisition to element A (light, e.g.) is much more rapid than the rate of acquisition to element B (50 db noise, e.g.). Perhaps, when an animal is being trained with the A + B compound, he is forming separate associations between the A element and the UCS and the B element and the UCS. If this is so, then the formation of the association between element A and the UCS will be very much advanced before any appreciable association between element B and the UCS has occurred (cf. Table VI). Thus, training to a compound of a strong plus a weak element becomes only a special case of Kamin's blocking phenomenon. In each case, the <u>earlier</u> formation of an association between A and the UCS precludes formation of an association between B and the UCS. In the overshadowing case, the earlier formation of an association to one stimulus is mediated by the relative intensities of the two stimuli. In the blocking case, the weaker of the two stimuli may be deliberately trained first, and may thus be made to block, at least partially, formation of an association to the stronger stimulus.

In the overshadowing case, as in the blocking case, the relative intensities of the two stimuli are completely confounded with the rates of acquisition which they independently control. Thus, again, it would be foolhardy to assume that overshadowing occurs because the more "vivid" stimulus monopolizes "attention" or impedes perception of the less vivid. Again, however, future research might clarify the problem by varying the intensity of the UCS. We know that, with a 1 ma. UCS, light overshadows 50 db noise. What would happen if animals were trained with the same L 50 db compound, but with, e.g., a 4 ma. UCS? When the UCS is very strong, rates of acquisition to CS's of very different intensities are quite similiar. Thus, the interpretation outlined above suggests that, with a 4 ma. UCS, there should be much less overshadowing of 50 db noise by light. If this prediction is correct, there would be little support for a perceptual interpretation of overshadowing, or, in general, for any interpretation which stresses the relative intensities of the CS elements *per se*.

REFERENCES

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

Kamin, L.J. Trace conditioning of the conditioned emotional response. *J. comp. physiol. Psychol.*, 1961, *54*, 149-153.

________. Conditioning to the elements of a compound stimulus, Paper read at Psychonomic Society, Niagara Falls, October 1964.

________. Personal communication, 1965.

Kamin, L.J. and Schaub, R.E. Effects of conditioned stimulus intensity on the conditioned emotional response. *J. comp. physiol. Psychol.*, 1963, *56*, 502-507.

Mosteller, F. and Bush, R.R. Some selected quantitative methods in *Handbook of social psychology*, Lindzey, G. (Ed.) Cambridge, Mass.: Addison-Wesley, 1954.

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

________. *Lectures on conditioned reflexes*. (Trans. by Gantt, W.H.) New York: International Publishers, 1928.

Siegel, S. *Nonparametric statistics for the behavioral sciences*. New York: McGraw-Hill, 1956.

Theodor, L.H. Unpublished data. Mc Master University, 1964.

Weiss, S.J. Summation of response strengths instrumentally conditioned to stimuli in different sensory modalities. *J. exp. Psychol.*, 1964, *68*, 151-155.

Wolf, M.M. Some properties of combined SDs. *J. exp. anal. beh.*, 1963, *6*, 343-347.

Zielinski, K. Personal communication, 1964.

APPENDIX

RAW DATA: SUPPRESSION RATIOS

For each trial of Pretest, for each trial of CER training and for each trial of Test to Light. During Pretest _S_s designated with an A received noise first; _S_s designated with a B received light first. An E after a ratio designates an estimated ratio.

PRETEST

50 db Control Group

S	N1	N2	N3	N4	L1	L2	L3	L4
1 B	.45	.89	.23	.67	.42	.32	.54	.40
2 B	.49	.50	.64	.52	.30	.52	.52	.56
3 A	.16	.35	.45	.55	.27	.29	.36	.33
4 B	.42	.53	.48	.40	.40	.43	.42	.52
5 B	.49	.51	.57	.49	.36	.42	.48	.55
6 A	.39	.48	.51	.58	.37	.44	.55	.42
7 A	.62	.52	.54	.47	.31	.50	.51	.50
8 A	.75	.48	.56	.72	.54	.48	.69	.80
9 B	.22	.40	.89	1.00	.39	.51	.57	.67

50 db Experimental Group

S	N1	N2	N3	N4	L1	L2	L3	L4
1 A	.49	.43	.42	.57	.34	.41	.45	.35
2 B	.30	.32	.51	.37	.33	.28	.40	.38
3 A	.43	.50	.47	.54	.35	.41	.45	.38
4 B	.52	.44	.43	.30	.19	.38	.31	.51
5 A	.37	.42	.39	.55	.16	.50	.48	.33
6 B	.47	.55	.47	.51	.22	.33	.32	.46
7 A	.59	.38	.37	.58	.42	.58	.27	.39
8 B	.38	.52	.41	.57	.30	.29	.38	.56
9 A	.39	.39	.56	.44	.37	.48	.47	.42
10 A	.43	.49	.54	.43	.40	.42	.40	.42
11 B	.44	.52	.56	.46	.41	.46	.56	.54

80 db Control Group

S	N1	N2	N3	N4	L1	L2	L3	L4
1 A	.49	.49	.54	.47	.47	.54	.44	.47
2 B	.50	.70	.47	.48	.61	.50	.30	.38
3 A	.60	.45	.50	.48	.36	.47	.62	.38
4 B	.34	.59	.57	.47	.21	.31	.44	.53
5 A	.42	.47	.36	.48	.18	.22	.45	.45
6 B	.52	.59	.52	.58	.32	.33	.36	.42
7 A	.55	.57	.54	.47	.43	.48	.51	.50
8 B	.39	.49	.54	.51	.26	.33	.37	.43
9 A	.51	.48	.47	.43	.36	.43	.54	.48

80 db Experimental Group

S	N1	N2	N3	N4	L1	L2	L3	L4
1 A	.39	.47	.68	.39	.02	.17	.39	.31
2 B	.37	.53	.55	.50	.17	.35	.30	.46
3 A	.42	.42	.41	.55	.19	.36	.54	.34
4 B	.38	.36	.49	.44	.30	.36	.51	.40
5 A	.48	.53	.46	.59	.23	.52	.39	.32
6 B	.30	.52	.54	.53	.34	.41	.51	.45
7 A	.47	.68	.43	.00	.17	.20	.41	1.00
8 B	.35	.45	.48	.49	.36	.23	.24	.26
9 A	.43	.49	.44	.52	.41	.49	.47	.51
10 B	.49	.41	.55	.47	.45	.60	.49	.51
11 A	.51	.50	.54	.55	.32	.44	.36	.41

50 db Experimental Group

S	CER 1				S	CER 2			
1	.58	.52	.55	.40	1	.46	.41	.41	.37
2	.39	.31	.40	.00	2	.33	.42	.54	.47
3	.54	.51	.52	.50	3	.39	.29	.15	.02
4	.30	.62	.38	.43	4	.20	.43	.40	.16
5	.45	.39	.55	.51	5	.26	.37	.69	1.00
6	.53	.49	.52	.52	6	.57E	.61	.06	.00
7	.59	.60	.40	.55	7	.38	.34	.48	.17
8	.58	.45	.51	.52	8	.35	.46	.27	.08
9	.51	.45	.50	.61	9	.45	.42	.42	.36
10	.43	.52	.47	.45	10	.44	.48	.22	.07
11	.56	.47	.46	.31	11	.53	.49	.52	.56

S	CER 3				S	CER 4			
1	.07	1.00	.44	.48	1	.12	.30	.50	.29
2	.14	.21	.08	.47	2	.06	.00	.07	.30
3	.00	.00	.00	.00	3	.00	.00	.00	.00
4	.18	.55	.30	.36	4	.11	.34	.48	.19
5	.00	.36	.00	.36	5	.08	.02	.01	.02
6	.02	.00	.02	.00	6	.00	.00	.00	.00
7	.00	.00	.33	.21	7	.00	.27	.19	.25
8	.00	.00	.00	.00	8	.00	.00	.00	.00
9	.26	.17	.13	.53	9	.20	.39	.49	.44
10	.02	.00	.00	.00	10	.38	.44	.41	.32
11	.41	.47	.30	.36	11	.33	.17	.44	.52

50 db Experimental Group

S	CER 5			
1	.32	.25	.27	.28
2	.18	.22	.34	.28
3	.33	.16	.03	.02
4	.36	.00	.00E	.00
5	.13	.22	.20	.14
6	.00	.00	.00	.00
7	.00	.14	.04	.04
8	.21	.05	.09	.05
9	.38	.68	.24	.55
10	.15	.26	.11	.23
11	.39	.48	.47	.41

S	CER 6			
1	.25	.14	.19	.18
2	.09	.23	.02	.04
3	.00	.00	.00	.00
4	.29	.22	.44	.41
5	.33	.04	.07	.02
6	.27	.21	.00	.00
7	.00	.00	.00	.00
8	.00	.00	.02	.03
9	.14	.08	.37	.48
10	.08	.13	.20	.00
11	.13	.11	.13	.17

S	TD			
1	.29	.20	.36	.34
2	.04	.24	.42	.33
3	.21	.02	.03	.38
4	.34	.41	.50	.44
5	.29	.32	.52	.67
6	.47	.42	.56	.57
7	.15	.48	.44	.56
8	.17	.27	.34	.34
9	.13	.14	.32	.28
10	.33	.30	.36	.50
11	.19	.17	.14	.28

50 db Control Group

S	CER 1			
1	.47	.22	.00	.25
2	.60	.53	.43	.35
3	.59	.42	.23	.39
4	.50	.38	.39	.32
5	.49	.48	.45	.44
6	.41	.36	.18	.29
7	.56	.40	.45	.54
8	.49	.55	.56	.45
9	.50	.49	.57	.37

S	CER 2			
1	1.00	.00	.00	.00
2	.22	.14	.14	.14
3	.02	.01E	.00E	.00E
4	.02	.06	.06	.10
5	.16	.08	.11	.07
6	.09	.08	.27	.21
7	.28	.39	.23	.27
8	.35	.09	.14	.00
9	.00	.00	.12	.33

S	CER 3			
1	.53	.69	.57	.30
2	.40	.44	.37	.48
3	.00	.15	.00	.09E
4	.45	.65	.40	.30
5	.35	.25	.04	.00
6	.47	.54	.55	.29
7	.48	.38	.28	.33
8	.44	.37	.50	.38
9	.21	.14	.00	.00

S	CER 4			
1	.11	.00	.57	.45
2	.03	.00	.14	.20
3	.18	.00	.00	.00
4	.16	.34	.33	.40
5	.24	.12	.04	.28
6	.03	.04	.02	.28
7	.11	.08	.43	.25
8	.21	.38	.32	.09
9	.00	.00E	.00	.15

50 db Control Group

S	CER 5			
1	.10	.00	.11	.10
2	.00	.05	.14	.09
3	.00	.04	.15	.14
4	.05	.09	.08	.07
5	.01	.00	.00	.00
6	-	-	-	-
7	.13	.09	.25	.26
8	.00	.23	.11	.86
9	.33	.03	.00	.00

S	CER 6			
1	.31	.63	.69	.70
2	.10	.02	.07	.14
3	.50	.00	.05	.00
4	.03	.13	.03	.13
5	.02	.00	.01	.00
6	.31	.54	.45	.47
7	.14	.08	.31	.25
8	.08	.06	.17	.32
9	.02	.00	.00	.00

S	TD			
1	.33	.17	.86	.50
2	.09	.05	.09	.15
3	.06	.02	.04	.20
4	.00	.00	.03	.26
5	.00	.00	.09	.11
6	.15	.41	.16	.29
7	.06	.03	.16	.16
8	.11	.00	.00	.08
9	.00	.12	.36	.40

60 db Experimental Group

S	CER 1			
1	.53	.47	.67	.25
2	.46	.60	.52	.37
3	.48	.52	.64	.45
4	.54	.32	.49	.54
5	.47	.59	.55E	.50
6	.61	.39	.44	.54
7	.40	.39	.37	.30
8	.56	.44	.57	.52
9	.65	.61	.53	.51

S	CER 2			
1	.03	.00	.00E	.00E
2	.06	.00	.00	.00
3	.06	.00	.02	.00
4	.22	.02	.00	.00
5	1.00	1.00	.67	.71
6	.42	.52	.43	.37
7	.14	.14	.00	.26
8	.43	.34	.21	.38
9	.22	.00	.22	.29

S	CER 3			
1	.00	.07E	.14	.00
2	.00	.00	.00	.13
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.47	.54	.68
6	.35	.42	.39	.43
7	.02	.06	.00	.00
8	.00	.05	.03	.22
9	.04	.00	.11	.38

S	CER 4			
1	.01	.01	.11	.04
2	.00	.00	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.19	.43	.56	.53
6	.21	.33	.47	.27
7	.00	.00	.00	.00
8	.00	.19	.08	.29
9	.03	.21	.29	.31

60 db Experimental Group

S	CER 5			
1	.31	1.00	.00	.00
2	.00	.03	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.29	.43	.42	.45
6	.31	.32	.25	.28
7	.00	.00	.03	.00
8	.24	.58	.34	.11
9	.40	.34	.33	.33

S	CER 6			
1	.07	.08	.00	.00
2	.00	.00	.01	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.22	.34	.28	.27
6	.10	.08	.31	.26
7	.04	.09	.00	.20
8	.00	.00	.01	.01
9	.17	.19	.17	.17

S	TD			
1	.01	.07	.36	.39
2	.44	.51	.55	.44
3	.41	.36	.49	.34
4	.51	.40	.31	.40
5	.34	.37	.28	.59
6	.16	.25	.40	.31
7	.55	.52	.44	.51
8	.12	.04	.03	.32
9	.20	.31	.42	.47

60 db Control Group

S	CER 1			
1	.51	.46	.40	.20
2	.54	.36	.14	.13
3	.41	.54	.35	.22
4	.54	.54	.58	.08
5	.40	.29	.11	.03
6	.54	.39	.45	.43
7	.25	.09	.12	.00

S	CER 2			
1	.02	.00	.00	.00
2	.00	.12	.33	.00
3	.00	.02	.00	.00
4	.05	.00	.00	.00
5	.00	.00	.00	.02
6	.00	.00	.00	.00
7	.00	.00	.00E	.00

S	CER 3			
1	.11	.02	.00	.00
2	.05	.03	.05	.04
3	.54	.25	.14	.18
4	.00	.06	.00	.00
5	.12	.00	.00	.00
6	.00	.00	.00	.00
7	.55	.00	.00E	.00

S	CER 4			
1	.01	.00	.01	.00
2	.00	.00	.00	.05
3	.00	.00	.00	.00
4	.03	.04	.02	.28
5	.00	.00	.00	.00
6	.02	.01	.00	.00
7	.00	.00	.00E	.00E

60 db Control Group

S	CER 5			
1	.00	.00	.00	.00
2	.00	.16	.10	.14
3	.00	.00	.05	.04
4	.00	.00	.04	.08
5	.00	.00	.09	.00
6	.00	.00	.00	.00
7	.00	.20	.20	.10

S	CER 6			
1	.01	.02	.01	.00
2	.50	.00	.00	.00
3	.01	.01	.02	.09
4	.03	.03	.08	.14
5	.00	.00	.02	.00
6	.00	.00	.00	.00
7	.00	.00	.00	.00

S	TD			
1	.00	.07	.05	.28
2	.00	.03	.00	.16
3	.01	.07	.16	.44
4	.05	.09	.05	.40
5	.01	.01	.01	.21
6	.00	.00	.00	.00
7	.00	.00	.00	.00E

80 db Experimental Group

S	CER 1			
1	.49	.63	.43	.36
2	.52	.40	.49	.07
3	.52	.44	.46	.27
4	.49	.46	.34	.44
5	.51	.51	.43	.38
6	.65	.54	.50	.14
7	.52	.89	1.00	.40
8	.59	.43	.47	.19
9	.48	.42	.39	.27
10	.54	.42	.47	.33
11	.53	.49	.49	.32

S	CER 2			
1	.16	.02	.00	.00
2	.00	.05	.06	.00
3	.26	.22	.19	.11
4	.09	.00	.00	.01
5	.10	.15	.00	.07
6	.10	.00	.00	.05
7	.23	.03	.15	.08
8	.12	.02	.03	.03
9	.03	.06	.00	.00
10	.10	.14	.00	.04
11	.18	.03	.08	.02

S	CER 3			
1	.01	.04	.02	.00
2	.09	.05	.13	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.05
5	.00	.00	.07	.00
6	.01	.00	.00	.02
7	.02	.00	.06	.15
8	.00	.00	.01	.06
9	.00	.00	.00	.00
10	.05	.05	.07	.03
11	.12	.15	.06	.04

S	CER 4			
1	.20	.02	.12	.06
2	.00	.00	.00	.00
3	.02	.01	.00	.00
4	.14	.01	.08	.01
5	.03	.00	.14	.08
6	.00	.00	.00	.00
7	.00	.00	.00	.00
8	.02	.02	.17	.00
9	.09	.04	.12	.08
10	.31	.12	.06	.05
11	.20	.11	.15	.13

80 db Experimental Group

S	CER 5			
1	.40	.19	.42	.33
2	.24	.00	.00	.03
3	.25	.03	.04	.08
4	.27	.03	.02	.02
5	.40	.27	.27	.24
6	.00	.00	.00	.09
7	.00	.00	.00	.00
8	.09	.01	.04	.03
9	.57	.00	.08	.02
10	-	-	-	-
11	.11	.07	.06	.06

S	CER 6			
1	.20	.20	.19	.25
2	.09	.00	.03	.00
3	.07	.04	.00	.00
4	.19	.09	.13	.03
5	.09	.27	.20	.11
6	.02	.00	.01	.01
7	.00	.00	.00	.00
8	.01	.06	.04	.10
9	.06	.07	.08	.05
10	.16	.11	.23	.17
11	.26	.20	.17	.35

S	TD			
1	.37	.33	.42	.34
2	.51	.33	.43	.55
3	.42	.43	.45	.41
4	.41	.27	.26	.61
5	.39	.45	.50	.42
6	.47	.45	.43	.47
7	.37	.45	.52	.51
8	.42	.65	.56	.59
9	.48	.40	.51	.40
10	.61	.57	.61	.43
11	.41	.46	.47	.51

80 db Control Group

S	CER 1			
1	.31	.40	.45	.14
2	.45	.37	.38	.50
3	.46	.50	.05	.00
4	.55	.51	.49	.52
5	.39	.24	.08	.00
6	.51	.56	.13	.00
7	.55	.43	.47	.42
8	.43	.44	.47	.48
9	.33	.12	.03	.04

S	CER 2			
1	.16	.07	.03	.06
2	.00	.04	.00	.02
3	.00	.00	.00	.00
4	.03	.00	.00	.02
5	.02	.00	.00	.04E
6	.00	.00	.00	.00
7	.17	.00	.16	.15
8	.06	.07	.10	.04
9	.01	.01	.00	.00

S	CER 3			
1	.25	.37	.27	.25
2	.71	.00	.00	.00
3	.09	.00	.00	.00
4	.50	.07	.10	.10
5	.07	.00	.00	.00
6	.21	.03	.08	.00
7	.15	.14	.23	.24
8	.07	.04	.14	.15
9	.02	.04	.06	.04

S	CER 4			
1	.37	.26	.35	.33
2	.00	.02	.22	.02
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	.00	.00	.01	.02
6	.03	.03	.10	.04
7	.12	.09	.25	.15
8	.14	.24	.22	.21
9	.03	.00	.02	.01

80 db Control Group

S	CER 5			
1	.38	.24	.17	.23
2	.00	.00	.00	.00
3	.00	.00	.00	.00
4	.00	.00	.00	.00
5	-	-	-	-
6	.11	.13	.00	.05
7	.03	.13	.11	.16
8	.12	.09	.15	.11
9	.08	.00	.00	.00

S	CER 6			
1	.29	.24	.22	.39
2	.00	.01	.02	.05
3	.00	.00	.00	.00
4	.00	.02	.00	.02
5	.00	.00	.02	.00
6	.15	.15	.22	.23
7	.06	.19	.37	.25
8	.21	.09	.15	.10
9	.00	.33	.13	.00

S	TD			
1	.45	.35	.45	.40
2	.22	.37	.57	.55
3	.46	.45	.38	.57
4	.32	.42	.50	.53
5	.16	.51	.45	.76
6	.38	.41	.36	.38
7	.35	.21	.47	.59
8	.08	.08	.15	.26
9	.00	.00	.11	.31