1950

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The ACQUIRED DISTINCTIVENESS of CUES: The ROLE of DISCRIMINATIVE VERBAL RESPONSES in FACILITATING The ACQUISTION of DISCRIMINATIVE MOTOR RESPONSES

ROSSMAN - 1950

The Acquired Distinctiveness of Cues: The Role of Discriminative Verbal Responses in Facilitating the Acquisition of Discriminative Motor Responses

by

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Thesis Submitted for the Degree of Master of Science

University of Massachusetts

June 1950

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I. Theoretical and Experimental Background

The development of an experimentally testable theory of the role of verbal responses in facilitating or inhibiting the acquisition and/or utilization of motor responses is of primary importance for the learning psychologist. Miller (14), extending the earlier work of Miller and Dollard (15), has outlined a stimulus-response analysis of the functional significance of verbal processes in discriminative and generalizing behavior which appears to be among the more promising of such theories. Specifically he has proposed that:

> According to stimulus-response theory, learning to respond with highly distinctive names to similar stimulus situations should tend to lessen the generalization of other responses from one of these situations to another since the stimuli produced by responding with the distinctive name will tend to increase the differences in the stimulus patterns of the two situations. Increased differentiation based on this mechanism has been called acquired distinctiveness of cues.
>
> On the other hand, if the individual learns to respond to two quite different situations with the same verbal response, the stimuli produced by this response will be a common element mediating an increased amount of generalization from one situation to the other. This has been called acquired equivalence of cues, or secondary generalization. (14, p. 174)

It is evident that Miller's hypotheses are related to the more general problem of the experimental investigation and theoretical interpretation of theories of transfer of training. However, reference to standard

secondary sources (7, 13, 20), serious re studies of transfer (4, 17), and to the recent experimental literature dealing only two experimental studies which could be interpreted as direct and adequate tests of the above hypotheses.

Hunter (1) found evidence which supported Müller's hypothesis of the required equivalence of cues. She demonstrated that young children who had learned to give the same name to two stimuli were more likely to transfer a multiplicative response from one stimulus to the other than children who had learned to give different names to the stimuli. The amount of transfer was significantly greater [illegible] than [illegible].

duction was more likely to occur when the two stimuli evoked the same manipulatory responses than when the two stimuli elicited different manipulatory responses.

A third experiment reported by Lawrence (10) was designed to test the hypothesis that transfer will take place between two discriminative problems on the basis of familiarity with the cues. When the male pairs of discriminable cues were present in the successive discrimination, he found evidence of positive transfer from learning one discrimination to the acquisition of new

instrumental responses in a subsequent discrimination. Negative or no transfer effects appeared in groups which were not required to discriminate between the same pair of cues in successive discrimination situations. He concluded that the results supported the hypothesis of a modification of an initial order of distinctiveness of cues based upon changes in the internal response-produced stimulus patterns. However, since rats were used in this study, the results are not directly relevant to the problem of the functional role of verbal mediating processes.

Of further interest to the learning psychologist is the fact that Miller (14) has interpreted the Freudian mechanism of repression within the theoretical framework established by the above hypotheses. Repression, within this framework, is conceived of as the inhibition of verbal responses and specifically as the inhibition of those verbal responses which lead to anxiety. In stating the relation between repression and the acquired distinctiveness (or equivalence) of cues Miller has assumed that:

> The removal of all verbal responses by repression, therefore, will be expected to have a dual effect: (1) in cases where similar objects or situations are labeled differently, repression will remove the basis for acquired distinctiveness

> and increase the amount of primary generalization; and (2) in cases in which different objects or situations are given the same name, repression will remove the basis for acquired equivalence and thus decrease the amount of secondary generalization. In other words, there should be more primary and less secondary generalization in the unconscious (p. 174).

In his summaries of experimental investigations of repression Sears (19) has recognized the necessity for a conceptual framework such as the one proposed by Miller. However, he concluded that while such studies have produced phenomena which correspond, at least in part, to the psychoanalytic conception, "The non-analytic data offers no new refinements of the theory, no addition of relevant new variables, no streamlined techniques that promise eventual solution of the problems posed by Freud (19, p. 120)."

Zeller (21) has proposed that an experimental design for the laboratory study of repression should involve the demonstration of learning, of repression, and of recovery from repression. He concludes that by these criteria none of the relevant experimental work can be considered a conclusive test of repression. However it seems doubtful that the third criterion, recovery from repression, is a crucial step in the demonstration of repression.

Since none of the previous work on repression appears directly relevant to Miller's hypothesis, this work has not been summarized herein. Furthermore, Sears (19) and Zeller (21) have already published detailed reviews and analyses.

II. Statement of Problem

This study was concerned with the experimental investigation of the role of verbal responses in discriminative motor behavior. Specifically, it was designed to investigate the following hypotheses which have emerged from Miller's stimulus-response analysis of the functional significance of mediating verbal processes.

1. The acquired distinctiveness of cues. The acquisition of different verbal responses to similar external stimulus events should, by decreasing the similarity of the resultant stimulus patterns composed of external and response-produced stimuli, facilitate the acquisition of a subsequent discriminative motor response to the same external stimulus events.

2. Inhibition of the acquired distinctiveness of cues (repression). The inhibition of different verbal responses to similar external stimulus events should, by decreasing the distinctiveness of cues based upon verbal responses, retard the acquisition of a subsequent discriminative motor response to the same external stimulus events.

The experimental test of these hypotheses followed the conventional transfer of training procedure in that it was designed to measure the influence of the prior learning

of discriminative verbal responses on the subsequent acquisition of discriminative motor behavior. However, in order to test the second hypothesis it was necessary to carry out a preliminary experiment which had been designed to obtain a direct measure of the decrease in retention of verbal discriminative responses induced by electric shock.

III. Experimental Method:

Subjects

Apparatus and Stimulus Materials

Procedure

Subjects

The subjects were 69 male and 36 female undergraduate students who had been or were currently enrolled in Psychology classes at the University of Massachusetts.

Apparatus and Stimulus Materials

Apparatus

The stimulus materials were presented in the exposure slot of a memory drum at the rate of one stimulus unit every two seconds. The drum, a wood and metal cylinder 12 inches in diameter and 26 inches in length, was driven by a 1/60 H. P. General Electric motor by means of a cam arrangement. It was concealed by a shield and placed on the experimental table. Since the one by one and one-half inch exposure slot was cut in a black cardboard slide, it could be moved to any horizontal position on the shield of the drum. Throughout the training period the experimenter (E) was seated behind the drum out of the direct view of the subject (S).

Additional apparatus consisted of a buzzer, a shocking device, and a motor-response device. The buzzer had a dry cell current source and was concealed behind the shield of the drum. The shocking device was an inductorium with a one and one-half volt dry cell current

source. Shock was administered to the Ss through a small wrist band with metal contacts which served as electrodes on the palmar and outside surfaces of the wrist.

The motor response device, a 6 by 6 by 1 inch box, was constructed to permit the movement of a lever along 5 1/4 inch slots which started from a point near the middle of one side of the top surface and extended diagonally forward toward the right and left corners of the opposite side. Movement of the lever to the end of the diagonal slots closed a circuit which in turn lighted one or the other of two lights arranged behind the drum to inform E of the direction of S's response. The response device was placed in front of the right side of the shield of the drum; movement of the lever was diagonally left or right toward the shield.

Stimulus Materials

Two lists of 16 and 12 paired associate units and a list of 12 nonsense figures were employed as stimulus materials. The stimulus members of the 16 unit list consisted of eight of Gibson's (5) 13 standard figures and the eight corresponding figures of first-degree similarity. The response members of the units were eight pairs of Hull's

(8) nonsense syllables of approximately equal (within ± four percent) and low (mean = 21.2 percent) association values. These syllable pairs were selected so that the muscular movements required for saying one member of each pair would be antagonistic to the movements required for saying the other member. Specifically, the first and last sounds (consonants) of one member of each pair of syllables were stops while those of the other member were continuants. The eight stop syllables were assigned to the standard figures and the eight continuant syllables to the figures of first-degree similarity. Since the 16 unit list proved to be very difficult to learn, six of the original eight pairs of similar figures and their paired syllables were used to construct an easier 12 unit list. The same six pairs of figures without the paired syllables were then employed to make up a nonsense figure list.

In order to minimize serial learning four different sequences of the same units were constructed from the 16 units of the first list. The sequences were randomly determined subject to the restrictions that each unit appear in a different quarter for each of the four sequences and that units containing similar figures did not follow one another. The relative positions of the individual units of

the 12 unit list were the same as in the four sequences of the longer list with the exception that in one list two units were interchanged. The four sequences of the figure stimuli alone were identical with the sequences of the 12 unit paired associates. The four different sequences of both paired associates and figure stimuli, whenever used, were presented to all Ss in the same random order subject to the restriction that each sequence appeared in every block of four sequences.

Since a maximum of eight paired associate units could be presented with one rotation of the drum, it was necessary to divide the 16 and 12 unit lists into equal halves. The equal halves of each of the four sequences were placed in adjacent columns on the tape; columns were numbered from one to eight on the shield of the drum visible to S. The four sequences of the nonsense figures were placed in four adjacent columns on the tape and numbered from nine to 12.

Procedure

Preliminary Experiment: the effects of shock on verbal responses

Determining Ss pain threshold

In order to insure psychological equality of reactions to the noxious stimulus, E, before initiating training, determined each S's pain or discomfort threshold for shock. The sequence of events for each S was as follows: (1) In order to insure the administration of the shock to S's non-preferred hand, information as to handedness was obtained. (2) After this information was secured the wrist band with metal contacts was placed on S's non-preferred wrist, and (3) S was informed that he was to be shocked with an increasingly intense stimulus and that he was to indicate to E at which point the shock became uncomfortable. The following instructions were read to each S:

> What hand do you use for most of your daily activities? (Wait for S's answer). I am going to put this strap around your other wrist. (Secure strap around S's wrist). I am now going to give you a mild electric shock when I turn the switch. At first you may not feel any sensation, but I shall then increase the strength of the stimulus until you tell me that the sensation is definitely uncomfortable. That is, you are to tell me when you are shocked with an intensity that you find hard to tolerate.

Training

The preliminary experiment was designed to determine whether shock would decrease the amount of retention of well-learned verbal responses to pairs of similar stimuli. The training conditions involved (1) acquisition of discriminative verbal responses to the members of pairs of similar nonsense figures, (2) punishment of the verbal responses by means of electric shock, and (3) measurement of the effects of shock upon retention. The details of the training conditions are described below.

1. Acquisition. Thirty-seven Ss were required to learn the 16 unit paired associate list to a criterion of three consecutive errorless trials. Of these 37, seven were eliminated because they did not reach the criterion within a pre-established limit of 45 trials.

Following the conventional paired associate procedure the nonsense-figure stimulus of each figure-syllable unit was presented alone for a two second period. After this period had elapsed, the same figure, in combination with the assigned nonsense syllable, was exposed for two seconds.

Intertrial changes in the position of the exposure slot from behind the drum were inconvenient for E. Therefore, the Ss were instructed to move the slot to the

position designated by E. Since the random sequences were divided into equal halves, S also changed the position of the slot half-way through each trial. Inter-trial and intra-trial intervals of five to 10 seconds were ordinarily required for each change in the position of the slot.

In order to avoid special instructions for the control group and hence a break in the continuity of the Ss' experiences between parts one and two of the training procedure, as well as to equalize possible anxiety in the two groups, all Ss wore the wrist-band shocking apparatus for all trials of the preliminary experiment.

The following instructions were given to each S before the initiation of actual training; S read along with E:

> This is an experiment in learning nonsense syllables.
>
> Shortly after the apparatus starts you will see a figure in the exposure slot. After a few seconds this figure will appear again with a three-letter syllable. You are to say this syllable as clearly as possible. The figure and syllable together represent a pair. You are to learn to associate the two so that when the figure appears you can say the syllable before the figure-syllable pair appears. The pairs will not follow each other in any regular order, but the same figure will always be paired with the same syllable, that is, the two members of the pair will always occur together.
>
> Following the first complete exposure of the entire series of pairs you are to begin to anticipate the syllables of each figure-syllable pair.

In other words, you are to say the syllable of the pair before the figure and syllable appear together, that is, you are to call out the syllable while the figure alone is exposed. If you think you know what the syllable is, but if you are not sure, always guess because it will not hurt your score any more than to say nothing, and if you get it right, it will count as a success. If you anticipate a syllable incorrectly, correct yourself as soon as it appears. Try always to speak the syllables as distinctly as possible.

The lists will appear in different positions on the front of the drum. These positions will be numbered 1,2,3,4,5,6,7,8. After a list ends, you are to move the exposure slot to one of the positions. I will tell you the number of the position to which you are to move the slot. Do not move the slot until I give you the number of the next position.

Remember! You are to anticipate the syllable of each figure-syllable pair by saying the syllable when the figure appears alone and before the pair appear together.

2. Punishment. The 30 Ss who had reached the criterion within the 45 trial limit were divided into matched experimental (PEx) and control (PC) groups. These groups were matched as follows: (1) each S was paired with another S who reached the criterion within two trials, (2) whenever possible Ss were further matched on the basis of sex, and (3) within the preceding limits pairing was continued until two groups of 15 Ss were approximately equal means and variances of trials to criterion had been obtained.

PEx was given one additional trial during which all anticipatory responses whether correct or incorrect were

followed by shock. If S made no anticipatory response, shock was administered after his response to the exposed syllable. In order to insure similar experiences, with the exception of shock for verbal responses, Ss of PC were also given one trial beyond the criterion trials.

3. Retention. Immediately after the shock trial PEx and PC were given two additional non-shock trials.

Questionnaire

Upon completion of the training sequence Ss of PEx were given a short questionnaire (see Appendix A). This questionnaire was designed to elicit additional information about Ss' reactions to the shock and retention trials.

Major Exoeriment: Acquired distinctiveness of cues.

Determining Ss' pain threshold

Following the procedure employed in the preliminary experiment, E, before initiating training, determined each S's pain or discomfort threshold for shock.

Training

The conditions of the major experiment, the acquired distinctiveness of cues, are outlined in Table I. The five groups were included to permit experimental answers to the following problems: (1) the determination of the facilitating

effects of discriminative verbal responses by comparison of the experimental groups, EI and EIII, with the control groups, CI and CII, (2) the determination of the relative effectiveness of overt and covert verbalization by comparison of EI and EIII, (3) the determination of the retarding effects of shock by comparison of EII with EI and EIII, and (4) the determination of the role of intra-list generalization by comparison of CI and CII. The 75 Ss were assigned to these groups by procedures to be described below.

1. Acquisition of discriminative verbal responses.

Sixty-three Ss who were to be assigned to the experimental groups were required to learn a 12 unit paired associate list to a criterion of three consecutive errorless trials. Of these 63 Ss, 17 were eliminated because they did not reach the criterion within a pre-established limit of 40 trials. The control groups, CI and CII, were given one and four trials respectively on the paired associate problem. The temporal sequence of presentation of the figure and figure-syllable combinations, the procedure for changing the position of the exposure slot, and the instructions were the same as in the preliminary experiment. There was an eight second interval between the halves of each paired associate sequence and between successive trials.

Table I

Outline of the Conditions of the Major Experiment

Group	N	Training: Acquisition of Verbal Discrimination	Post-criterion	Acquisition of Motor Discrimination
Experimental I	15	Criterion of 3 errorless trials	1 non-shock trial	20 trials
Experimental II	15	Criterion of 3 errorless trials	1 shock trial	20 trials
Experimental III	15	Criterion of 3 errorless trials	1 non-shock trial	20 trials; overt verbalization
Control I	15	No criterion: 1 trial	None	20 trials
Control II	15	No criterion: 4 trials	None	20 trials

2. Post-criterion. Forty-five of the 46 Ss who reached the criterion were divided into three matched experimental groups. With the exception that three groups instead of two were to be matched, the procedure was the same as that followed in the preliminary experiment. EII was given the same treatment as PEx on the shock trial of the preliminary experiment, that is, on a post-criterion trial, shock was administered after all anticipatory responses whether correct or incorrect. If S failed to make an anticipatory response, shock followed his response to the exposed syllable. Thus all Ss received 12 shocks. In order to insure similar experiences, with the exception of shock for verbal responses, EI and EIII were also given a post-criterion non-shock trial.

3. Acquisition of discriminative motor responses. When EI, EII, and EIII had completed the post-criterion trial, they practiced a motor discrimination for 20 trials. EI and EII received no instructions regarding overt verbalization of the previously learned nonsense syllables to a particular figure before or concomitant with the motor response to that figure. The Ss of EIII were instructed to say the syllable response before or concomitant with the motor response. Following their brief experiences with the paired associate problem, CI and CII also practiced the motor

discrimination for 20 trials. In the motor discrimination situation Ss learned to discriminate, by means of left or right movements of the lever of the motor-response device, between pairs of similar nonsense figures. Specifically, they were to learn movement to the left as the correct response to each of the standard figures. Conversely, movement to the right was designated as the correct response to the corresponding figures of first-degree similarity. Ss were informed of correct responses by means of a buzzer which was sounded by E after S pushed the lever to the end of the correct diagonal slot. No correction of incorrect responses was permitted.

The 12 nonsense figure stimuli were presented one at a time at a two second exposure rate. As in the verbal problem S moved the exposure slot to a designated position during the eight second interval between successive trials.

Ss tested under the CI and CII conditions were paired with the Ss of EI, the group which was expected to learn the most rapidly. The specific procedure was as follows: (1) each S of EI was matched with Ss of CI and CII who were within ± 0.50 mean correct responses for the first block of 4 trials, (2) whenever possible Ss were further matched on the basis of sex, and (3) Ss were run under the CI and CII conditions until the mean numbers of correct responses for

the first four-trial blocks for the three groups were equal. Three Ss were not used in the reported data for the CI and CII conditions because they could not be paired with an S of EI.

An interval of one to two minutes between verbal and motor learning situations was required for reading the following instructions to each S: S read along with E:

> This is a learning experiment. Several figures will appear in the exposure slot one at a time. You are to move the lever in the box in front of you diagonally forward to the left or to the right for each figure. After you reach the end, move the lever back to the starting position. If you move the lever in the proper direction, a buzzer will sound to inform you that you have made a correct guess.
>
> You are not to move the lever diagonally forward more than once for each exposure of a figure. Do not forget to move it back to the starting position as soon as you hear a click.
>
> The figures will not follow one another in any regular order. The lists of figures will appear in different positions on the front of the drum. These positions are numbered 9,10,11,12. After a list ends, you are to move the exposure slot to one of the positions. I will tell you the number of the position to which you are to move the slot.
>
> Remember! A figure will be exposed in the slot. Move the lever to the left if you think that the left side is correct for that figure or to the right if you think that the right side is correct for that figure. As soon as you reach the end of the groove, move the lever back to the starting position. Every correct movement of the lever will be followed by the buzzer.

The Ss of EIII were further instructed to make the previously learned nonsense syllable response to a given figure before or concomitant with making the motor response to that figure.

Questionnaires.

Upon completion of the training sequences the five groups were given short questionnaires (see Appendix A). One questionnaire, given to all groups, was designed to elicit additional information about the method used in the motor discrimination. The Ss of EII filled out another questionnaire on their reactions to the shock trial.

IV. Results

Preliminary Experiment

Table II summarizes the results of the training sequence. Examination of the third and fourth columns reveals that PEx and PC were almost perfectly matched in terms of means and standard deviations of trials to criterion. Of the 15 pairs of matched Ss, eight required the same number of trials to reach criterion, six differed by one trial, and one pair differed by the pre-experimental limit of two trials. It was possible to match 13 of the 15 pairs on the basis of sex.

Comparison of the mean number of correct anticipations made by the two groups on the first post-criterion or shock trial yielded a *t* of correlated measures of 4.23. Since this value is significant beyond the .01 level of confidence the hypothesis that the lower mean score for PEx can be attributed to random errors may be rejected.

Means and variances for each of the two retention trials and for both trials combined are presented in the last six columns. The observed differences between the means of PEx and PC for the first and second retention trials were significant at beyond the 5 per cent and at the 10 per cent levels of confidence respectively. A *t* of related measures of 2.23 was obtained in the comparison of the mean combined or total scores of the two groups. This

value permits the rejection of the null hypothesis at the 5 per cent level of confidence.

Inspection of the individual data for PEx disclosed one apparently atypical S. Since this S failed to make any correct responses during the two retention trials, he contributed disproportionately to the observed differences between means. Accordingly the scores for the atypical S and for the matching S of PC were eliminated and the experimental results recomputed on the basis of 14 Ss. Comparison of the corresponding retention trial scores for 14 pairs, presented in Table III, and for 15 pairs (Table II) reveals that elimination of the atypical S resulted in a considerable reduction in the size of the mean difference. However, elimination of the 15th pair also reduced the error variance of the *t* of related measures. As a consequence the obtained *t* values were larger than the comparable *t*'s based on 15 pairs. Further, even with the loss of one degree of freedom, the *t*'s for differences in group means for the first, second, and total retention scores were significant at the 2, 5, and 1 per cent levels of confidence respectively.

Analysis of the questionnaire data indicated that for the shock trial the Ss of PEx were irritated, puzzled, tense, and fearful in order of decreasing strength and frequency.

Table II

Summary of Results of the Preliminary Experiment

		Trials to Criterion		Post Criterion Trial		Correct Responses during Retention					
	N	M	6	M	6	M	6	M	6	M	6
PEx	15	31.5	7.5	13.0	1.8	12.9	4.1	13.7	3.9	26.5	7.6
PC	15	31.3	7.5	15.2	.7	15.5	.8	15.6	.6	31.1	1.0
Mean difference				2.2		2.6		1.9		4.5	
t				4.23		2.4		1.78		2.23	
p		<.01		.03		.00		.04			
d.f.		14		14		14		14			

Means and standard deviations of correct responses for trials to criterion, the post criterion trial and the retention trials for 15 pairs of Ss

Table III

Summary of Results of the Preliminary Experiment
(one pair of Ss eliminated)

		Trials to Criterion		Correct Responses during Shock		Correct Responses during Retention 1st trial		2nd trial		total	
	N	M	6	M	6	M	6	M	6	M	6
PEx	14	32.1	7.4	12.9	1.8	13.8	2.3	14.6	1.4	28.4	2.8
PC	14	31.9	7.4	15.1	.7	15.5	.8	15.6	.7	31.1	1.1
Mean difference				2.2		1.71		.93		2.64	
t				3.95		2.71		2.11		3.24	
p				.01		.02		.05		<.01	
d.f.		13		13		13		13		13	

Means and standard deviations of correct responses for trials to criterion, the post criterion trial and the retention trials for 14 pairs of Ss

Table IV

Group	N	Acquisition trials of verbal learning: Trials to criterion		Post-criterion trials of verbal learning: Correct Responses		Acquisition trials of motor learning: 1st block		2nd block		3rd block		4th block		5th block		total	
		M	6	M	6	M	6	M	6	M	6	M	6	M	6	M	6
ExI	15	24.0	6.0	12.0	0.0	6.02	.6	6.57	.9	7.28	1.0	8.18	1.7	8.98	1.3	31.0	4.0
ExII	15	24.1	6.0	9.4	1.45	5.88	.7	6.15	1.0	6.37	1.4	7.55	1.7	8.02	1.4	28.1	4.5
ExIII	15	24.5	5.5	11.7	1.00	5.55	1.0	6.00	1.3	6.42	1.1	7.13	1.7	7.63	1.7	27.2	5.0
CI	15					6.02	.6	6.28	.7	6.27	.8	6.47	1.0	6.98	1.2	26.0	2.6
CII	15					6.02	.7	5.87	.9	6.07	1.0	6.55	1.3	6.78	1.6	25.3	3.4

Means and standard deviations for acquisition trials of verbal learning, the post criterion trial of verbal learning and for the acquisition trials of motor learning

Tenseness and anxiety were the strongest reactions during the retention trials. In addition some Ss reported a tendency to hesitate to say the syllables.

Major Experiment

Table IV presents a summary of the results obtained under the various training conditions. The paired associate acquisition performance of EI, EII, and EIII was essentially the same as evidenced by mean and standard deviation values. Of the 15 trios of matched Ss, three required the same number of trials to reach criterion, eight differed by one trial, and four differed by two trials. Three of the trios were matched on the basis of sex.

On the post-criterion or shock trial EI and EIII made more correct anticipations than EII. The t's for EI and EII of 6.67 and for EII and EIII of 4.89 were both significant beyond the one per cent level of confidence. The difference between EI and EIII was not significant.

The acquisition data for the motor discrimination are presented in terms of the means and standard deviations of correct responses made in each of five successive four-trial blocks. Since the first four-trial block was used for matching, the means and variances in the "totals" column

were computed from scores for the last four blocks. Multiplication of the "total" mean values by four will yield the mean number of correct responses for trials five through twenty. In accordance with the pre-experimental criterion EI, CI, and CII have equal first block means. The mean value of 6.02 for these groups did not differ significantly from the somewhat lower means of EII and EIII.

The significance of differences between pairs of "totals" means was tested by means of the t of independent measures, a conservative test for matched groups. Examination of the summary of the obtained t's in Table V reveals that the observed differences between EI and CI and between EI and CII, both in favor of EI would have occurred less than one out of 100 times as the result of random fluctuations. Comparison of EI and EII, and EI and EIII yielded t's which were significant at the eight and four per cent levels of confidence respectively. Random errors would account for the observed differences between EII and CI, and EII and CII 15 and eight per cent of the time respectively. The t's for the remaining comparisons did not reach the 20 per cent level of confidence.

Learning curves for the five groups on the motor discrimination are shown in figure 1. The measure of learning employed is the mean number of correct responses for each of the five four-trial blocks presented in Table IV. Although EI had reached a mean score of only nine of 12 or 75 per cent correct responses by the fifth block, it is apparent that this group was consistently superior to the other groups. EII was learning the motor discrimination at a somewhat lower rate than EI. However, EII was in turn performing at a higher level than the remaining groups. The discrimination problem, as evidenced by the very slow rise of the curves, was much more difficult for CI, CII, and EIII. Although the total scores did not differ significantly, the somewhat steeper trend for EIII suggests that significant differences between this group and the control groups might have been found had more discrimination learning trials been given.

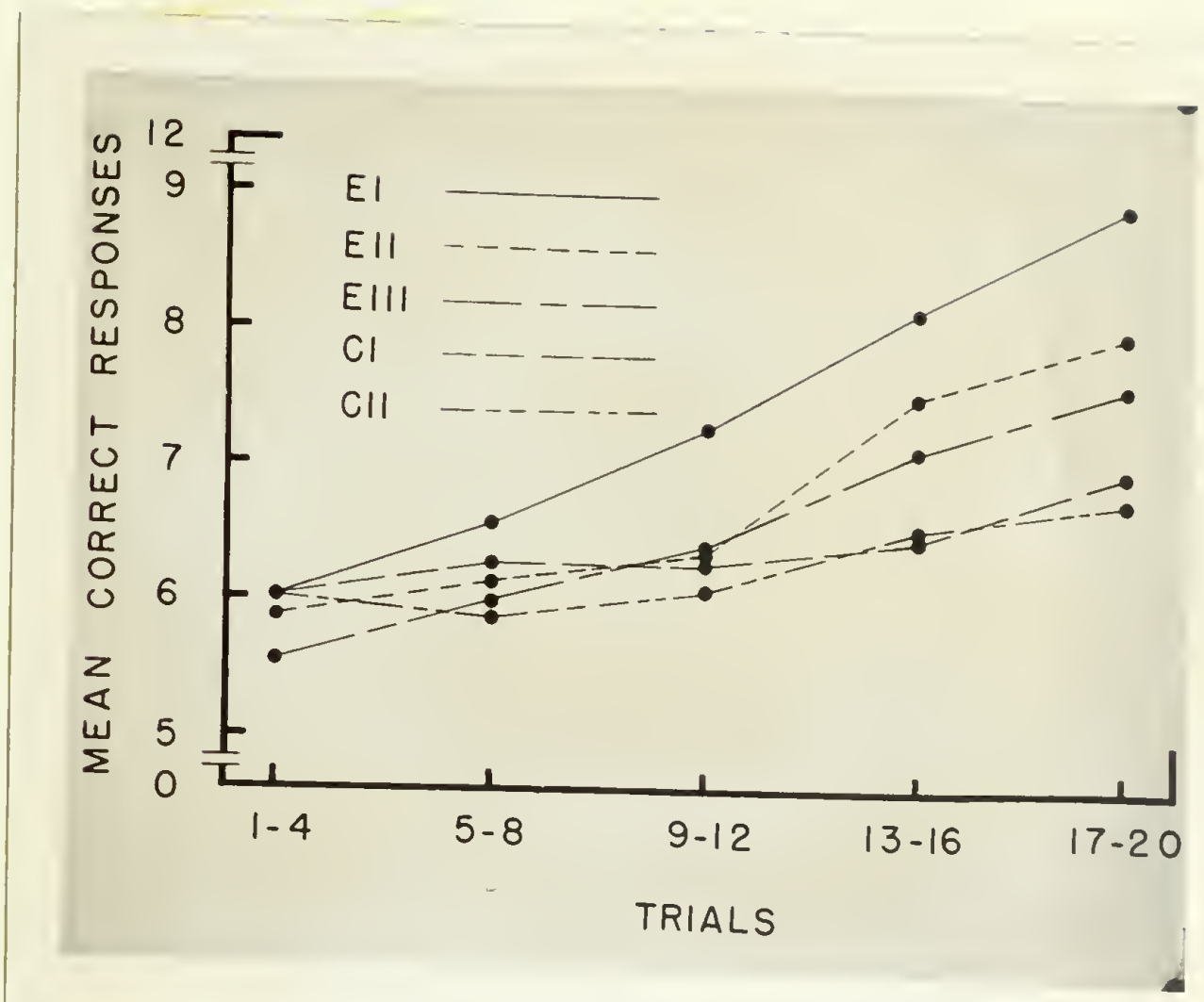

Figure 1

Learning curves for the five groups plotted in terms of mean correct responses for the four-trial blocks

Table V

Groups Compared High	Low	Mean Difference	t	p	d.f.
ExI	CI	5.02	3.86	<.01	28
ExI	CII	5.75	4.11	<.01	28
ExI	ExII	2.94	1.84	.08	28
ExI	ExIII	3.89	2.28	.04	28
ExII	CII	2.81	1.81	.08	28
ExII	CI	2.08	1.5	.15	28
ExII	ExIII	.90	.50	.62	28
ExIII	CI	1.18	.79	.43	28
ExIII	CII	1.91	1.19	.24	28
CI	CII	.73	.54	.60	28

t values for the comparison of mean total scores of pairs of groups on the motor discrimination

Analysis of the questionnaire data concerning reactions to shock for EII indicated that the Ss of that group felt puzzled, irritated, like hesitating to say the syllables and tense in order of decreasing strength and frequency. The groups with verbal learning experience used the syllables as facilitating devices to some degree during the motor learning. However, they reported that looking for identifying parts was more frequently employed and, subjectively evaluated, more valuable. The Ss of CI and CII also reported that they used the identifying parts technique.

V. Discussion and Conclusions

Preliminary Experiment

On the first post-criterion trial the Ss of PEx were shocked for correct and incorrect anticipations. Due to the high initial strength of the anticipatory responses Ss responded correctly on approximately 80 per cent of the paired associate units. Thus shock was a relatively specific consequence of correct anticipations. Under these conditions, according to principles advanced by Mowrer (16), Miller (13), and others (2, 3), internal and overt responses to shock should be conditioned to the cue-pattern of figure plus verbal response-produced stimulation; this conditioned form of the internal response to pain has been termed anxiety or fear. On the next trial, presentation of the figure alone should, (1) by the principle of generalization (6, 9), elicit the internal (anxiety, fear) and overt rèsponses previously aroused by shock, and (2) reinstate the cue-pattern of figure plus response-produced stimulation most strongly conditioned to anxiety. However, the increase in anxiety occasioned by reinstating the cue-pattern could be prevented by failing to respond. Since shock followed both correct and incorrect responses but not failure to anticipate, avoidance of the verbal responses would have the twofold effect of preventing an increase in anxiety and of postponing shock. Behaviorally, the resultant

conflict between the verbal anticipations and the anxiety-motivated avoidance response should be reflected in a decrement in the number of correct anticipations on the subsequent retention trials. The small but statistically significant decrement in the first and combined retention trial scores of PEx represents a tentative confirmation of this expectation.

Major Experiment

On the basis of Miller's analysis of the acquired distinctiveness of cues it was expected that the acquisition of different nonsense syllable responses to the members of pairs of similar nonsense figures should, by decreasing the similarity of the resultant stimulus patterns composed of figure and syllable response-produced stimuli, facilitate the acquisition of subsequent discriminative motor responses to the same pairs of similar nonsense figures. Comparisons of learning curves and of total correct responses indicated that EI was learning the motor discrimination more rapidly than CI or CII. These results represent a clear-cut confirmation of the general hypothesis that learning a verbal discrimination facilitates the acquisition of a motor discrimination to the same stimuli. However, before the results can be interpreted as an unequivocal confirmation of an explanation of the observed positive transfer effect

based on the mechanism of the acquired distinctiveness of cues, the functional contributions of the following additional variables must be determined. First, since the questionnaire results revealed that "looking for identifying parts" was a frequently used and, subjectively evaluated, facilitating technique for all groups, it is possible that the Ss of EI learned more rapidly because of their prior experience in "identifying parts." Second, in learning the verbaldiscrimination the Ss of EI may have also learned that there were pairs of similar figures. This knowledge, in the form "go left for one member of the pair and go right for the other member," may have facilitated motor learning for this group. Finally EI may have been aided by warm-up effects and knowledge of the order of the figures. Within limits set by the possible functional contributions of these factors, the results of the comparisons of EI with CI and CII support Miller's hypothesis of the facilitating effects of discriminative verbal responses.

It will be remembered that Birge (1) found that overt verbalization of the discriminative responses increased positive transfer. On this basis, it was predicted that EIII, the overt verbalization group, would learn the motor discrimination more rapidly than EI or CI and CII. The experimental results did not confirm this prediction.

Comparisons of the performances of EI and EIII revealed a significant difference in total scores and a consistent difference in trend in favor of EI. Further, the total score for EIII, although slightly higher, did not differ significantly from the total scores of CI and CII. However, the learning curve for EIII had a somewhat higher slope than the curves for CI and CII. This suggests the possibility that the difference in curves would have been more pronounced had 40 or 50 motor discrimination trials been given. Reports volunteered by Ss at the conclusion of the motor discrimination test provide the basis for a tentative explanation of the unexpectedly low performance of EIII. In general, Ss found that they did not have enough time to make both responses in the 2-second response interval. Saying the syllables aloud apparently interfered with making the motor response and thus retarded the acquisition of the motor discrimination.

The validity of this interference explanation of the retarded performance of EIII can be tested experimentally by increasing the response interval from two to three or four seconds and/or by decreasing the latencies of the verbal responses by giving Ss a large number of overlearning trials on the paired associate problem. Both procedures,

by providing S with sufficient time to make the verbal and motor responses should minimize interference effects.

Gibson (6) found that during the course of learning 12-unit paired associate lists, intra-list generalization increased to a maximum during the third and fourth tenths of total learning trials and then decreased rapidly during succeeding tenths as generalized responses were differentially reinforced. In the present study the Ss of CII were given four verbal learning trials. On the basis of Gibson's results it was expected that this procedure would retard the subsequent acquisition of the motor discrimination by increasing the generalization of verbal responses between members of pairs of similar figures. However, comparisons of learning curves and total scores of CI and CII revealed no consistent or significant differences in the motor discrimination performance of these groups.

The data do not permit the isolation of the factors which may have accounted for the failure to obtain a significantly retarded performance for CII. It is possible that four trials were not sufficient to produce a high degree of generalization or that any slight generalization was counterbalanced by warm-up effects and increased knowledge of the nature and order of the figures.

The results of the preliminary experiment indicated that shock for correct and incorrect responses produced a small but statistically significant difference in the retention of correct anticipations. Therefore, the motor discrimination performances of EI and EII were compared in order to test the second hypothesis that inhibition of different nonsense syllable responses to pairs of similar nonsense figures should, by increasing the similarity of the resultant stimulus patterns, retard the acquisition of a subsequent discriminative motor response to the same pairs of similar nonsense figures.

The comparison of total score means indicated that the superiority of EI approached a statistically significant level. Likewise the learning curve for EI was consistently higher than and diverged from the curve for EII.

Because of the relatively small decrement in verbal response strength produced by one shock trial, it was expected that the motor performance of EII would be retarded to some degree but not to a degree sufficient to yield a clear-cut statistical difference. Since this was the case, the observed differences in means and trends may be interpreted, with greater confidence, as supporting the hypothesis that inhibition of discriminative verbal responses retards the acquisition of a motor discrimination.

As a concluding remark, it should be noted that the results reported herein are only tentative findings and interpretations. In order to eliminate explanations which have been offered as alternatives to the stated hypotheses, it will be necessary to perform a number of refined experiments. In these experiments several important conditions should be changed. First, the Ss should be given twice as many trials on the motor discrimination problem in order to determine whether the divergence of the several curves would increase. Second, the response interval for the motor discrimination should be lengthened to three or four seconds to permit the overt verbalization group sufficient time to make both verbal and motor responses. Third, and perhaps the most important, two criteria should be used for matching Ss. Ss should be matched on verbal performance, perhaps in terms of the number of trials to learn a four-unit paired associate list containing units similar to those which would be used for the experiment. In addition, they should be matched on motor response reaction times. By these procedures all groups could be perfectly equated for both verbal and motor tasks.

Finally, other variables should be manipulated in accordance with the usual techniques for learning experiments. The following would appear to be among the more important of these variables: degree of massing trials, number of trials, similarity of stimuli, similarity of responses, intensity of and/or number of shock experiences, the interval between verbal and motor discrimination, and type of motor response.

VI. Summary

This study, consisting of two experiments, was designed to test the hypotheses, derived from Miller's S-R analysis of displacement that (1) discriminative verbal responses to similar stimuli facilitate the acquisition of discriminative motor responses to the same similar stimuli, and (2) inhibition of discriminative verbal responses to similar stimuli retards the acquisition of discriminative motor responses to the same similar stimuli.

In the preliminary experiment a 16-unit paired associate list, consisting of pairs of Gibson's standard and first-degree figures as stimuli and nonsense syllables as responses, was presented on a memory drum to two groups of 15 matched Ss who learned the list to a criterion of three consecutive errorless trials. Following the criterion trials the experimental group received one trial, in which all responses were followed by shock, and then two retention trials; the control was given one overlearning trial before two retention trials.

The results were consistent with the hypothesis that one shock trial would produce a statistically significant decrement in the amount of retention.

A 12-unit figure-syllable paired associate list and a list of the same 12 figures alone were employed as stimulus

materials in the second experiment. In addition a motor device, requiring movements of a lever diagonally left or right, was used for the motor discrimination. The five groups of 15 Ss each were treated as follows:

EI: learned paired associates to criterion of three consecutive errorless trials; one overlearning trial; 20 trials to learn discriminative motor responses to the figure stimuli of the paired associate problem.

EII: learned paired associates to criterion; one shock trial; 20 trials to learn motor discrimination.

EIII: learned paired associates to criterion; one overlearning trial; 20 trials to learn motor discrimination with overt verbalization of the previously learned nonsense syllable responses to the figure stimuli.

CI: one trial with paired associates; 20 trials to learn motor discrimination.

CII: four trials with paired associates; 20 trials to learn motor discrimination.

The significant differences in the mean number of correct responses on the motor discrimination found between EI and both CI and CII in favor of EI support Miller's hypothesis that discriminative verbal responses facilitate the acquisition of discriminative motor responses to the same

stimuli. Because overt verbalization of the nonsense syllables apparently interfered with the motor responses of EIII, the differences between this group and the control groups were not significant. Near significant differences in the mean number of correct responses were found between EII and the control groups in favor of EII and between EI and EII in favor of EI. These differences were consistent with the expectation that inhibition of discriminative verbal responses by shock would retard the acquisition of discriminative motor responses to some degree. The failure to obtain a significant difference between the performances of CI and CII indicated that four verbal learning trials may not have been sufficient to increase the intra-list generalization for the latter group.

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Appendix

Name _____

Now that you have completed the experiment we would appreciate your answering a few brief questions to provide us with some additional information. We are interested in your reactions to shock when you were learning the nonsense syllables. Think back to the trial on which you were shocked and try to answer the following questions as adcurately as possible. Circle those terms in the left hand column which best represent your reactions and feelings. For each of these terms which you circle, circle one of the modifying or qualifying words in the middle column. Lastly, look at the right hand column and circle the quarter or quarters (a quarter consists of 3 figure-syllable pairs) during which you reacted or felt in a given way. Further, if the strength of your reactions or feelings changed (for example, from moderately to considerably; considerably to moderately) you should indicate this by circling the appropriate quarter(s) for a given strength of reaction or feeling. Now think back to the shock trial.

Did you react or feel ___?	How strongly ____?	In which quarter ___?
Anxious	Very	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Puzzled	Very	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Irritated	Very	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Tense	Very	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Fearful	Very	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Like giving up	Very much	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Like hesitating to say the syllables even though you knew the correct letters	Very much	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4
Like avoiding or refusing to say the letters of the syllables	Very much	1 2 3 4
	Considerably	1 2 3 4
	Moderately	1 2 3 4
	Just a little	1 2 3 4

Name _____

Now that you have completed the experiment we would appreciate your answering a few brief questions to provide us with some additional important information. We are interested in what you did during the trials in which you had to learn to go to the left or right for each figure. Think back to these trials and try to answer the following questions as accurately as possible. Circle those phrases in the left hand column which best represent what you did. For each of the phrases which you circle, circle one of the qualifying words in the middle column which indicate the relative number of figures for which you did so. Lastly, look at the right hand column and circle the number of trials during which you did so.

What device?	For how many of the figures?	For how many trials?
Did you use the syllables to identify the figures?	3 6 9 all	4 8 12 all
If so, did this device help you to learn? yes no		
Did you try to find other names for the figures?	3 6 9 all	4 8 12 all
If so, did this device help you to learn? yes no		
Did you try to look for identifying parts?	3 6 9 all	4 8 12 all
If so, did this device help you to learn? yes no		

Data for Preliminary Experiment

	Trials to Criterion		Correct Responses Post-Criterion Trial		Correct Responses 1st Retention		Correct Responses 2nd Retention		Total	
	PC	PEx	PC	PEx	PC	PEx	PC	PEx	PC	PEx
1.	15	17	15	7	15	6	16	15	31	21
2.	23	23	16	14	15	0	16	0	31	0
3.	25	25	16	14	15	16	16	15	31	31
4.	25	25	15	14	16	13	16	14	32	27
5.	26	27	15	15	16	14	16	16	32	30
6.	28	28	15	14	15	13	16	15	31	28
7.	30	29	16	12	16	14	14	16	30	30
8.	31	31	15	13	16	14	15	16	31	30
9.	33	33	15	12	16	16	15	16	31	32
10.	35	34	14	14	13	15	15	13	28	28
11.	37	38	15	13	16	15	16	14	32	29
12.	38	38	14	13	15	14	15	12	30	26
13.	39	39	16	14	16	16	16	15	32	31
14.	39	40	15	14	16	13	16	12	32	25
15.	45	46	15	12	16	14	16	16	32	30

Data for Major Experiment

Verbal Learning

	Trials to Criterion			Correct Responses on Post-Criterion Trial		
	EI	EII	EIII	EI	EII	EIII
1.	20	20	21	12	11	12
2.	15	15	16	12	9	12
3.	28	29	28	12	8	12
4.	36	35	35	12	10	12
5.	21	21	21	12	9	12
6.	17	15	18	12	11	12
7.	16	16	16	12	5	12
8.	24	24	25	12	10	12
9.	31	31	29	12	11	12
10.	27	27	28	12	10	11
11.	31	31	32	12	9	11
12.	27	28	27	12	10	11
13.	26	26	26	12	9	12
14.	23	24	25	12	10	12
15.	18	19	20	12	9	11

Motor Learning

Mean Correct Responses in Blocks of Four Trials

EI

	1st	2nd	3rd	4th	5th
1.	5.50	6.75	8.25	11.25	11.75
2.	6.75	6.25	7.00	9.50	9.25
3.	5.25	7.50	7.50	6.00	7.25
4.	6.50	5.75	7.00	6.50	8.50
5.	5.25	6.50	7.50	9.75	9.00
6.	6.25	8.00	8.75	9.50	10.75
7.	5.50	5.75	7.50	9.50	9.75
8.	5.25	8.25	8.50	6.75	8.75
9.	6.75	6.50	6.75	9.00	10.00
10.	5.75	5.25	6.00	8.00	8.75
11.	6.25	7.25	6.00	8.00	7.75
12.	7.50	7.25	8.75	8.50	9.50
13.	5.50	5.75	6.00	5.00	8.00
14.	6.25	5.75	5.75	5.75	6.75
15.	6.00	6.00	8.00	9.75	9.00

Motor Learning

Mean Correct Responses in Blocks of Four Trials

EII

	1st	2nd	3rd	4th	5th
1.	7.75	4.50	5.50	5.75	7.00
2.	6.25	6.00	5.00	6.50	7.75
3.	5.00	6.00	5.75	6.00	7.75
4.	5.25	6.50	6.00	6.00	6.75
5.	6.75	6.50	6.25	4.75	6.50
6.	5.50	7.00	4.75	8.25	7.75
7.	5.25	5.00	7.50	9.00	7.75
8.	5.75	6.50	8.50	8.50	8.75
9.	5.50	6.75	7.00	7.50	7.75
10.	6.75	7.75	7.25	9.00	10.50
11.	6.25	5.25	5.25	6.50	8.75
12.	5.50	6.75	4.50	6.25	5.75
13.	6.25	7.25	8.25	9.50	8.75
14.	5.50	4.00	4.75	8.00	7.25
15.	4.75	6.50	9.25	11.75	11.50

Motor Learning

Mean Correct Responses in Blocks of Four Trials

EIII

	1st	2nd	3rd	4th	5th
1.	6.50	5.50	7.00	6.50	6.75
2.	7.50	8.00	9.00	11.50	12.00
3.	6.00	5.25	6.75	7.75	6.50
4.	4.00	6.25	6.50	6.25	5.75
5.	6.25	6.00	6.00	9.25	8.75
6.	5.75	6.25	4.00	6.00	7.50
7.	3.75	4.50	4.75	4.75	5.75
8.	5.50	4.25	6.00	6.25	8.50
9.	5.75	6.50	6.50	6.75	7.75
10.	4.50	4.00	6.00	5.25	6.25
11.	5.00	5.75	6.00	6.25	6.00
12.	7.75	7.25	8.00	9.00	10.50
13.	4.75	8.25	6.50	7.75	7.50
14.	4.75	7.25	7.00	7.75	8.75
15.	5.50	5.00	6.25	6.00	6.25

Motor Learning

Mean Correct Responses in Blocks of Four Trials

CI

	1st	2nd	3rd	4th	5th
1.	5.50	6.50	6.50	5.75	7.75
2.	6.75	5.50	5.25	8.00	7.00
3.	5.75	6.25	6.25	4.75	9.50
4.	6.50	6.25	6.00	6.75	6.25
5.	5.00	5.75	6.75	6.75	6.25
6.	6.25	6.25	5.75	5.75	6.00
7.	5.50	6.75	6.25	8.00	9.00
8.	5.75	5.25	5.00	6.25	6.50
9.	6.50	7.25	6.75	7.75	7.75
10.	5.75	7.00	6.25	5.00	7.00
11.	6.25	6.75	5.50	8.00	7.25
12.	7.50	5.25	5.50	5.00	5.00
13.	5.50	6.00	7.00	5.50	5.00
14.	5.75	7.25	8.00	7.00	7.50
15.	6.00	6.25	7.25	6.75	7.00

Motor Learning

Mean Correct Responses in Blocks of Four Trials

CII

	1st	2nd	3rd	4th	5th
1.	5.75	5.00	4.75	6.00	5.00
2.	7.00	5.75	7.50	6.25	7.25
3.	5.25	6.50	5.75	5.75	5.75
4.	6.50	5.50	5.00	8.50	8.50
5.	4.75	6.00	5.00	4.25	5.25
6.	6.00	4.00	5.50	5.25	7.50
7.	5.75	5.25	5.00	6.50	5.25
8.	5.25	5.00	6.75	6.25	7.50
9.	6.75	6.75	6.50	7.25	8.50
10.	5.75	6.25	8.25	9.75	10.00
11.	6.75	6.50	5.75	6.50	5.50
12.	7.25	5.75	7.25	7.50	7.75
13.	5.50	7.75	6.50	6.75	6.50
14.	6.25	6.50	6.25	6.25	6.75
15.	5.75	5.50	5.25	5.50	4.75

Acknowledgements

The writer wishes to express her deep appreciation to Dr. Albert E. Goss who suggested the problem for this thesis and guided her throughout the work to its completion.

Appreciation is also expressed to Dr. Claude C. Neet, Dr. J. Harold Smith, and Mr. Charles Oliver for their valuable criticisms and suggestions, and to Mr. Joseph Mach who greatly aided in the design and construction of the apparatus.

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Date June 1, 1950