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THE FACTORS OF PLACEMENT AND INTENSITY OF EMPHASIS IN LEARNING

INTRODUCTION

Purpose of the Study

Several recent investigations have been made to determine the relative efficacy of emphasizing the correct as opposed to the incorrect responses in a simple discrimination problem. Although it is not clear in the literature on the subject, the investigations have concerned themselves with two problems in relation to the influence of emphasis in learning.

In general, it has been found that when information of correctness is conveyed to the learner by an emphasizee placed in connection with the correct response better performance will result than when the information of correctness is conveyed to the learner by the same emphasizee placed in connection with the wrong response.

It has also been found that when no information is conveyed by the emphasizee little or no difference will result in the performance regardless of how the emphasizee is employed.

For the most part the procedures have followed one or the other of two methods. One method consists in presenting to the subjects a series of simple discriminations. Some of the subjects in this method receive an emphasize, such as a bell, a light, or a shock accompanying each correct response as a signal when the response just made was correct. Other subjects receive the same emphasize accompanying each incorrect response as a signal that the response just made was wrong. The second method consists in presenting the series of discriminations to all subjects in the same manner. Part of the time the emphasize occurs in connection with the wrong responses, part of the time in connection with the correct responses and part of the time does not occur at all.

One purpose of this thesis will be to clarify the results of previous experimenters in regard to the particular problem investigated and principles discovered.

A second purpose of this thesis is to present new experimental evidence and an explanatory hypothesis for the first mentioned problem, that of the relative efficacy of emphasizes which bear information of correctness and which accompany correct or incorrect responses.

Historical Development

The original study of this series was made by

Tolman, Hall, and Bretnall (1932). These experimenters had subjects learn a 'punchboard' maze under conditions which varied from group to group. The maze consisted of thirty pairs of holes arranged in an irregular spatial order on a board three feet square. One of each of the thirty pairs of holes was connected with an electric circuit so that when the stylus was inserted it rang a buzzer or, for some groups, gave a shock in addition to ringing the buzzer. The Bell-Right group (BR) was instructed to select the holes which caused the buzzer to sound. The Bell-Wrong group (BW) was instructed to avoid those holes. A third group, the Bell-Shock-Right group (BSR) was instructed to select the same holes as for the BR group but in addition a shock accompanied the buzzer. A fourth group was instructed to avoid the holes which sounded the buzzer and brought a shock. This group is called the Bell-Shock-Wrong group (BSW).

Before the subjects were informed as to what to learn they were given a fore-exercise of three trials during which they placed the stylus in each hole of the thirty pairs. Throughout this fore-exercise the emphasizeers, bell or bell-shock, were present according to the condition which would be maintained throughout the learning period for a given subject. At the end of the fore-exercise the subjects were instructed either to select or avoid the emphasized holes. The subjects were stopped at the end of one

errorless performance or at the end of twenty trials.

In Table I is presented a portion of the results.

TABLE I

Comparison of Performance of the Groups

Diff.=difference between means of errors of groups for twenty trials; P.E. diff= probable error of difference; C.R.=critical ratio or difference divided by P.E.diff; P=chances of such a difference, being a true difference and not one due to chance.

Mean of first minus mean of second.	Diff	PEdiff	CR	P
Bell-Wrong minus Bell-Right	13.41	6.88	1.95	.81
Bell-Shock-Wrong minus Bell- Shock-Right	23.11	7.73	2.99	.96
Bell-Shock-Wrong minus Bell- Wrong	11.60	7.19	1.61	.72
Bell-Shock-Right minus Bell- Right	1.90	7.43	.25	.13

These differences, with the exception of that between BR and BSR, are interpreted by the experimenters as probably being significant for the groups involved. The results do suggest that when information is conveyed to the learner by means of a shock or a buzzer sounding in connection with the correct responses the performance is better than when the information is conveyed to the learner by the shock or buzzer in connection with the incorrect responses. The results are not so clear as to whether combining the two emphasizeers will produce greater differences in performance under the same conditions of information-giving.

Tolman, Hall, and Bretnall have formulated the results of their study in three laws, only one of which is of import-

ance in the present investigation. This formulation which is to be considered is the Law of Emphasis. Tolman et al. have stated that "By a Law of Emphasis we would mean the assumption that in a trial and error situation learning consists in building up little patterns or gestalts in which the correct response is set over against the incorrect one or ones and the further assumption that an accent or emphasis (such as a bell or shock) upon the correct responses will tend to favor learning whereas an accent or emphasis upon the wrong responses will tend to hinder learning."

At face value this law may be criticised from several different points. First, in stating that an emphasis on the correct responses favors learning and that an emphasis on the wrong responses hinders learning, the experimenters have apparently assumed some intermediate learning condition which is unaffected by or devoid of emphasizees and which acts as a basis for judging learning which has been favored or hindered. Since there were no groups that did not receive an emphasizee in connection with either the right or wrong responses, it is reasonable to assume that the experimenters meant only to compare the two experimental conditions.

A second criticism of the Law of Emphasis as formulated above is that it does not clearly differentiate between the influence of the informative factor involved in the experimental conditions and the influence of an emphasis as an

intensifier. In failing to make clear this difference a great deal of confusion has arisen. As stated, the Law of Emphasis implies that it is the action of the intensifying influence of the emphasizee that accounts for the differences in performance under the different conditions. Since the experimental conditions were not so organized as to eliminate the informational factor, no such implication is justified. It seems clear, however, that in part this implication was intentional, as will be presently demonstrated.

The third criticism is that the Law of Emphasis does not clearly formulate the one finding for which the results are relatively clear and for which the investigation was apparently designed. What was found was that when information of correctness is given by an emphasis upon the correct responses the performance is better than when information is given by an emphasis upon the wrong responses. While this is certainly not clearly expressed, if it is even implied, in the Law of Emphasis as stated above, it is relatively certain that in a large part this finding is one which was meant to be expressed.

That Tolman et al. meant to imply in the Law of Emphasis that both informational factors and factors of intensification were operative seems clear from the statement regarding the function of the buzzer that "it ((the buzzer))

seems to be a signal or emphasizer. It signals to the subject that the response just made is right (or vice versa that it is wrong) and it thereby also emphasizes the one hole or the other." (1932, p.611) Here the experimenters have, to some extent, differentiated between the two factors and have shown their belief that both are involved. The signaling factor is noted as well as the intensifying factor. It is suggested that hereafter the informational factor receive special designation, its function to be expressed as the Law of Placement of Emphasis and defined as follows: When, in a simple discrimination problem, information of correctness is conveyed to the learner by a "something" happening in connection with the correct response and a lack of anything happening in connection with the incorrect response, better performance will result than when information of correctness is conveyed to the learner by a "something" happening in connection with the incorrect response and a lack of anything happening in connection with the correct response.

Later, in reply to Dr. Goodenough¹, Tolman (1933) redefines the Law of Emphasis. He now states that "This

¹Dr. Goodenough (1933) objected to the interpretation of results in the study made by Tolman, Hall and Bretnall (1932) on two different bases. Since the objections were adequately handled by Tolman and since their discussion would add nothing to the present analysis they are not considered.

law would seem to belong under the head of (i) learning proper and under that of (ii) the utilization of learning in performance. (i) The more 'emphatic' the to-be-expected results of either hole the more readily the expectations as to these results for both holes and the differences between these expectations should be acquired. (ii) Further, however, it also seems that in so far as that hole, which according to the motivating conditions is the one to be positively responded to, happens also to be the one which receives the greater 'emphasis', the more readily the learned difference between the two holes can be utilized in performance."

In item (i), under learning proper, Tolman has given a blanket statement to the effect that the more emphatic the information-bearing emphasizees, the faster will be the learning regardless of where the emphasizee is placed. This means two things. First, by disregarding the placement of the emphasizees, he has denied his original statement that the emphasizees will aid or hinder learning according to their placement on the correct or incorrect response. Second, he has placed an even greater emphasis than before on the role played by the intensifying influence of the emphasizee, a conclusion hardly justifiable on the meagre evidence in the study. (See Table I, particularly ESW-BW and BSR-BR comparisons.)

In item (ii), under utilization in performance, Tolman has accounted for the differences in the performance of the groups under the different experimental conditions not in terms of any difference in amount learned but in terms of factors which influence the performance or utilization of what has been learned. In other words, the results which have been formulated as a Law of Placement of Emphasis he conceives as being a principle of performance and not a principle of learning.

Before passing on to a discussion of subsequent experiments let us summarize the contents of the past several pages. Two distinct problems have been shown to exist in regard to the functioning of emphasizees in simple discrimination problems. One is the problem which has been formulated in the Law of Placement of Emphasis. The second is the problem of the part played by the intensifying influence of the emphasizee. The punchboard maze study made by Tolman, Hall and Bretnall gave evidence for the former but not for the latter. The original formulation of the Law of Emphasis seems to be faulty in one respect by failing to differentiate between the informational factor involved and the intensifying influence of the emphasizee, and in another respect by failing to state clearly what had been found. The second formulation of the Law of Emphasis placed an increased, although unjustified, emphasis on the role played by the

intensifying influence of the emphasizez and also to have accounted for the differences of the experimental groups in terms of performance factors rather than learning factors, as had previously been done.

Before considering the evidence concerning the intensifying influence of the emphasizezs let us consider the further experimental evidence which bears upon our Law of Placement of Emphasis. Muenzinger (1934)¹, Hulin and Katz (1935) and Silleck and Lapha (1937) have all repeated the California experiment under conditions essentially identical with those of the original study.² A summary of the results of these experiments and of the California experiment is presented in Table II. These results are only those for the experiments in which a buzzer was used as the emphasizez.

In four out of five cases it is seen that the Bell-Right groups performed in a manner superior to that of the

¹Since Muenzinger's experiment was primarily directed at the problem of the intensifying influence of the emphasizez, only that portion of his results which bear directly on the Law of Placement of Emphasis will be considered at this point.

²Because of the misunderstanding of just what problems were being investigated, charges have been hurled back and forth between the various investigators. Since the problems have been differentiated in this study it would add nothing to discuss these charges. The reader is referred to Muenzinger (1936) and Hulin and Katz (1936) for more specific information.

TABLE II

Comparisons of Bell-Right and Bell-Wrong for all punch-board experiments
CR=difference divided by P.E. of the difference

Experimenters	Average No. of Errors		Diff.	C.R.
	Bell-Right	Bell-Wrong		
Tolman, Hall & Bretnall	103.81	117.22	13.41	1.95
Muenzinger (Pattern A) ¹	116.1	145.2	29.1	3.3
Muenzinger (Pattern B)	125.5	124.6	0.9	.2
Hulin & Katz	58.2	76.0	17.8	2.3
Silleck & Lapha	64.7	115.3	50.8	5.5

Bell-Wrong groups. Where this was not the case, the difference is of no significance. The most significant difference was reported by Silleck and Lapha (1937) but the size of the difference may be held partly accountable for by the difference in learning ability of the two groups used. In a stylus maze the individuals who composed the Bell-Right group were found to be better than those who composed the Bell-Wrong group. The difference in the mean performance was 2.73 times the P.E. of the difference. In general, then, it may be said that the evidence offered

¹In the California experiment the construction of the punchboard maze was such that the emphasizees occurred always on the same holes. This meant that the groups which received the emphasis on the right responses learned a different set of holes than the groups receiving the emphasis on the wrong responses. Investigation to ascertain a possible difference in the difficulty of the two patterns has shown no reliable differences to exist. See Muenzinger (1934) and Tolman, Hall and Bretnall (1932). With the exception of the cases reported by Muenzinger (1934) the differences are between the performances on the two patterns.

by the punchboard maze experiments tends to support the Law of Placement of Emphasis although the differences are not highly significant and the law cannot be held as conclusively established.

Gurnee (1938) reports the results of an experiment using a bolt-head maze in which the learners had three possible responses to make, only one of which was correct. A red light flashed on with each incorrect response and a white light with each correct response. Four experimental groups were run. One received a moderate shock in connection with the wrong responses. Two other groups received a slight shock, one in connection with the correct responses and one in connection with the wrong responses. A fifth group learned the maze in the absence of shock. In descending order of effectiveness the conditions were: Slight-shock-on-right, Slight-shock-on-wrong, Moderate-shock-on-wrong, No-shock and Moderate-shock-on-right. In no case, however, were the differences significant. Such results would seem not to agree with the previous findings in regard to the Law of Placement of Emphasis, but it must be realized that in each of the previous experiments¹ where

¹See Muenzinger (1934a) (1934b), Culler (1934), Gilbert (1937), and Honzik and Tolman (1937).

shock has been used that special explanations of the results have been introduced because shock not only acts as an emphasisizer but also as a potent motivator, thus complicating the issue.

Hall and Porter (1938) had subjects learn two serial-position habits, each involving twenty irregularly alternated left and right positions. The subjects were instructed to respond by pressing a key to the left or the right according to whichever position was correct. Just above each key was fastened a small radio-panel light. The light which would flash was determined by operation of the circuits by the experimenter. The key pressed by the subject served to close a common circuit, and in addition to signal to the experimenter which key had been pressed. With this apparatus, by having a light flash on, it was possible always to emphasize the correct (or wrong) response no matter which response the subject had made. Two groups of subjects learned both serial position habits. One group learned the first series with the emphasis always on the correct response and the second series with the emphasis always on the wrong response. The second group received the emphasis on the wrong responses for the first series and on the correct responses for the second series. On both the first and second learning series the condition of light-on-right was found superior to the condition of

light-on-wrong. While these differences were not highly significant they were interpreted as supporting the findings which have been formulated in the Law of Placement of Emphasis.

Now let us consider the evidence as to what influence a mere "something" happening in connection with a response has upon the probability that that response will be repeated. In Muenzinger's study (1934) eight groups were run with systematic variations in the placement of the emphasizeers. In Table III are presented the critical ratios of the differences obtained between the groups compared for twenty trials.

TABLE III¹

Comparison of Factors in Colorado Experiment

CR= difference divided by the probable error of the difference.

Factors compared	Placement of Emphasizers	CR
Shock wrong vs. shock right	Bell on right and shock on wrong	1.0
	Bell on right and shock on right	
	Bell on wrong and shock on wrong	.9
	Bell on wrong and shock on right	
Shock wrong vs. no shock	Bell on right and shock on wrong	1.2
	Bell on right	1.9
	Bell on wrong and shock on wrong	
	Bell on wrong	
Shock right vs. no shock	Bell on right and shock on right	.2
	Bell on right	1.3
	Bell on wrong and shock on right	
	Bell on wrong	

¹These results seemingly have some bearing upon that

From the results presented above it seems more or less evident that if shock has any influence upon the performance of subjects learning the punchboard maze it is insignificant.

Stephens (1934) obtained evidence that if "something" happened when a response was made the probability was increased that the response would be repeated. When that "something" informed the subject that he was successful the increase in the probability of repetition was greater and when that "something" informed the subject that he was unsuccessful the probability of repetition was decreased. These results were obtained by having the subjects attempt to place the point of a stylus at a particular spot on a hidden target. Arbitrarily, some of the responses were followed by the flashing of a letter "R" which the subjects had been previously informed meant that their response was correct. Other responses were arbitrarily followed by the

portion of the Law of Emphasis which we have reformulated in the Law of Placement of Emphasis. It would appear that the insignificant differences between the shock-right and shock-wrong groups is contrary to the placement principle. This interpretation cannot be made since the comparisons in Table III are between pairs of groups of which one of each pair has received an emphasis upon both the wrong and the correct responses and the other has received an emphasis upon either the correct or the wrong, but not upon both. The Law of Placement of Emphasis does not cover such situations. What might be said here is that when, in a two-choice discrimination problem, "something" happens in connection with both the correct and incorrect responses, an additional "something" (whose presence or absence con-

flashing of the letter "W" which meant the response just made was wrong. The remainder of the responses were followed by either the flashing of both letters or by nothing at all. The subjects were instructed that this would happen but they were not told whether such occurrences meant that they had been correct or incorrect. After a response followed by the "R" the subjects tended to deviate but little from the point hit in the preceding response. This tendency to deviate was somewhat greater when the preceding response had been followed by the flashing of both letters. The next greater degree of deviation occurred after the flashing of the letter "W". The greatest deviations took place after responses which were followed by no signals at all. From these results Stephens concluded that a mere "something" happening after a response strengthened the underlying connections.

In this experiment of Stephens' there was no attempt to determine what interpretation the subjects placed upon the flashing of both letters. Hall (1935) has shown that in the absence of definite information of success or failure that subjects tend to evaluate their own responses. Stephens' conclusion implies the assumption that no such evaluations were made by his subjects. Courts (1937)

veys information of correctness and which happens in connection with one or the other of the two responses) will result in no significant influence upon the performance.

effected reasonable control over this possibility by eliminating from consideration all subjects who reported an attempt to evaluate an informationless cue used in his experiment. The task set for the subjects was to learn the correct syllables in a series of thirty pairs. When the correct syllables of ten pairs were responded to, a light flashed on. For another ten pairs the light flashed on whenever the incorrect syllable was responded to. The remaining ten pairs were presented without the light. The lights appeared only during practice trials in which the subjects were instructed to respond to both of the syllables in each pair. After each response the subject was told whether that response was right or wrong. The practice trials were alternated with test trials in which the syllables were presented and records kept of the responses. No illumination occurred during the test trials. At no time were the subjects even so much as informed that the light was a part of the experiment. The results yielded no differences of significance between the performances of the subjects on the different groups of syllables. It would seem, then, that when no information of success or failure is conveyed by it, a mere "something" that happens when a response is made does not reliably increase the probability that that response will be repeated.

Courts and Waggoner (1938) have, in a modified

repetition of Stephens' experiment, shown that when direct verbal information of "right" and "wrong" follow a response there is no intensifying effect obtained by the addition of an emphasizez such as light but that when the emphasizez accompanies a response the addition of direct verbal information greatly increases or decreases the probability that the response will be repeated accordingly as the information conveys information of success or failure.

In summarizing the results of the investigations relative to the intensifying effect of emphasizezs it may be stated that when an emphasizez does not play the dual role of informant and emphasizez, it does not produce reliable differences of performance in a learning situation. The results are distinctly contradictory to what would be expected by predictions based on either the first or second formulation of Tolman's Law of Emphasis. In part, however, the Law of Emphasis has been shown to be valid. This part has been formulated in the Law of Placement of Emphasis. The results just presented have, however, shown the Law of Emphasis to be in part invalid. It is suggested that the results regarding the intensifying influence of emphasizezs be generalized and expressed as a Law of Intensity of Emphasis and defined as follows: When a "something" happens in connection with a response, that "something" will have no influence upon the probability that the

response will be repeated unless that "something" acts as a signal of success or failure of the response.

While the evidence for the Law of Intensity of Emphasis seems quite conclusive, the evidence for the Law of Placement of Emphasis yet remains somewhat obscure. Differences in performance have been demonstrated under different conditions of placement, but these differences have not been highly or uniformly significant. Nor has there been any attempt to determine if the Law of Placement of Emphasis is a principle of performance or a principle of learning. It is in regard to this last problem that the present investigation has been undertaken.

Experimental Apparatus and Procedure

The material to be learned consisted of three series of number pairs.¹ Series A was made up of three-digit numbers and was given to all subjects under the same conditions as a standardizing procedure. Series B and C were made of two-digit numbers and were used for the experimental trials.

The apparatus, as viewed by the subjects, consisted of a 22" x 40" panel faced with black cardboard. Centrally

¹The number series are given in the appendix, p. ii and iii. The criteria of selection and the order of presentation are discussed in the appendix, p. i.

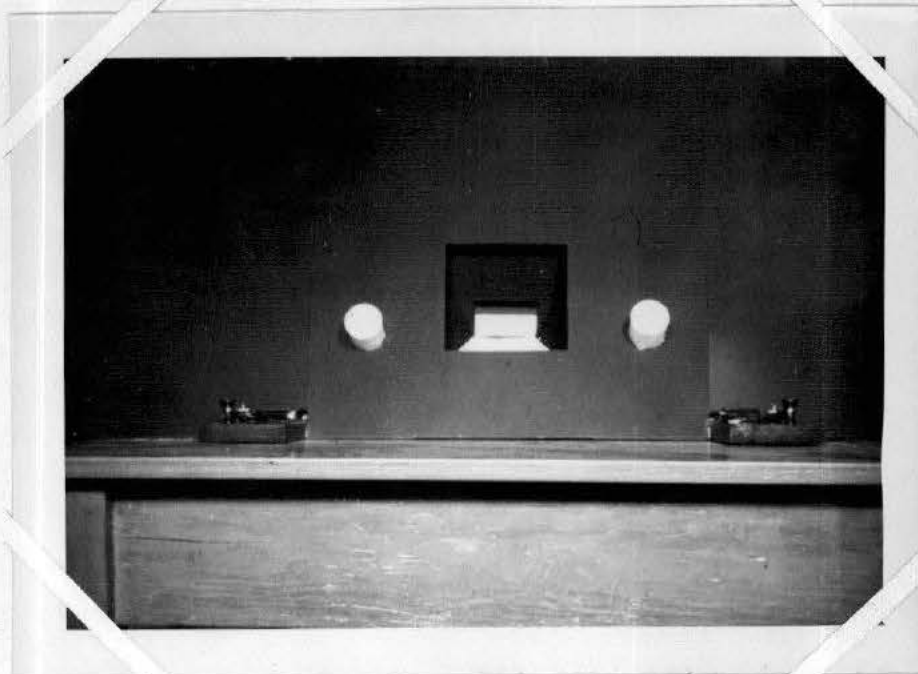


Figure 1. Subject's Position

located and near the base was a 5" square aperture through which the front of the exposure device was visible. Two telegraph keys were attached to the base of the panel, a distance of about 17" between them. Above the keys and more centrally located were two radio-panel lights, 6-8 volts, covered by white paper cylinders. That part of the exposure device visible to the subject consisted of a semi-silvered mirror set at a 45° angle, the upper edge being closer to the subject. From below, a light, not directly visible, was directed into the mirror so as to reflect into subject's eyes and screen from view objects behind the mirror. The number pairs, printed on $1" \times 1 \frac{3}{8}"$ cards, were inserted into position directly behind the mirror. Exposure was effected by turning off the light which re-

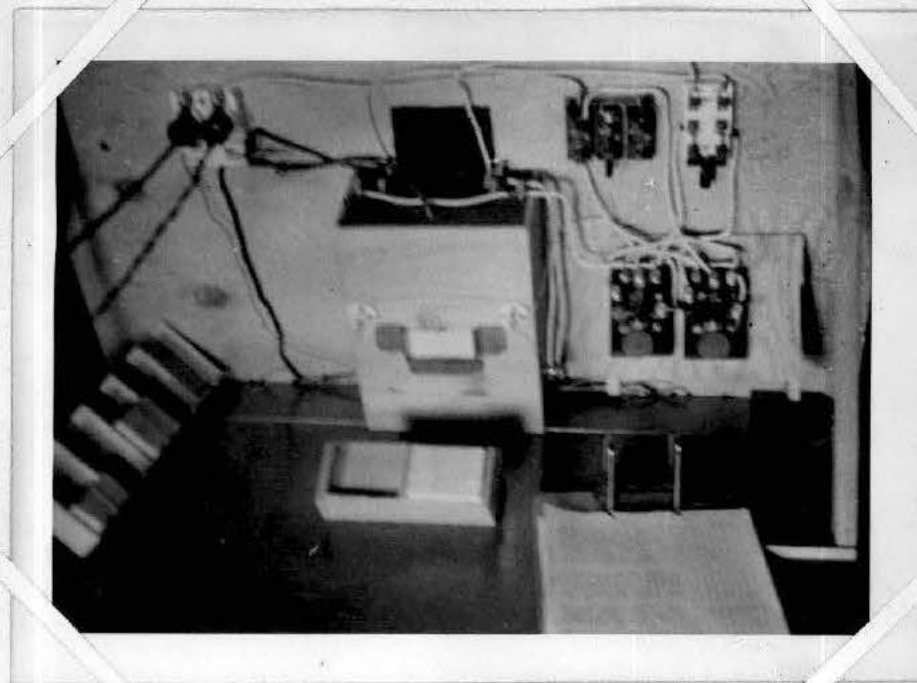


Figure 2. Experimenter's Position

flected into the subject's eyes and turning on another light which illuminated the card behind the mirror.

Two different emphasizeers were used. In one case the radio-panel lights on the face of the apparatus constituted the emphasizeer. In the other case a red light was reflected onto one or the other of the pair of numbers. Control of the emphasizeers was effected by manipulation of circuits from the experimenter's position. Closure of the circuits occurred when the subject pressed either key.

In order to avoid the influence of any differences in difficulty between series B and C, the experimental series, each was placed after series A for half of the cases. Also, to avoid any differences which might arise from the change from one emphasizeer to another the two ex-

perimental series of numbers were accompanied in half of the cases by the red light, "r" and in half of the cases by the white radio-panel lights, "w". The following schedule of combinations was adopted to equate these factors:

Bw-Cr, Cr-Bw, Br-Cw, and Cw-Br.

The subjects were given the following typed instructions.

On the face of the apparatus before you there appears an aperture. Within this aperture there appears a lighted surface. Throughout the experiment you should maintain a position that keeps you directly in front of the lighted surface.

At the top of the lighted area there will appear a series of numbers which you are to learn. These numbers will always be presented in pairs. One of the numbers in each pair is correct and one is incorrect. You are to learn the correct numbers. There will be twelve of these number pairs in a series. These twelve pairs will be presented over and over for several trials. Each time, however, the order will be changed so that you cannot depend upon sequential arrangement in learning. Also, the side upon which the correct one appears will be changed, i.e., for a certain pair of numbers the correct one will be on one side one time and on the other side the next time.

At the base of the apparatus are two telegraph keys. You will indicate which of the numbers in the pair that you choose by pressing one of these keys. When you make a choice, press down on the appropriate key and hold it down until the numbers disappear from view. Between choices do not leave the fingers on the keys.

The operator will give you further instructions verbally as soon as you feel that you understand the directions already given. Ask any questions that you wish.

After the subject had read the instructions he was informed that after the number pair appeared he would be

allowed a period of five seconds in which to make a choice and as soon as a choice was made the experimenter would announce whether the choice was "correct" or "wrong". The subject was further informed that the numbers would not disappear immediately but would continue to be exposed for a short length of time during which he would have the opportunity to study the numbers. Series A, the standardizing series, was then administered.

When ten trials had been completed, regardless of whether a perfect performance had been accomplished, the subject was given instructions appropriate to one of three experimental conditions to be described below.

One of the conditions consisted in having the emphasize occur in connection with the correct number and having the subject press the key which corresponded to the position of the correct number. This condition is known as the Emphasis Right-Press Right (ER-PR) condition. A second condition consisted in presenting the emphasize in connection with the wrong number and having the subject press the key which corresponded to the position of the correct number. This is the Emphasis Wrong-Press Right (EW-PR) condition. A third procedure was to present the emphasis in connection with the correct number and having the subject press the key corresponding in position to the wrong number. This is the Emphasis Right-Press Wrong (ER-PW) condition.

No uniform instructions were given for each condition. The subject was made to understand that the emphazier would give the information as to whether he had made a correct or wrong response. A demonstration was given of what would happen after a response was made and how it should be interpreted. Each subject was made to respond correctly and incorrectly to the trial card and to announce in each case whether his response had been right or wrong. At any point that the subject expressed confusion the experiment was stopped and new instructions given.

When eight trials on each of the experimental series had been completed, the subject was asked to explain just what he had done in learning the series. Following this, the subject was given a sheet of paper to fill out. On this sheet appeared all of the numbers, both correct and incorrect, that were used in the experimental series. In addition were included numbers which had not been used at all. The subjects were instructed to mark the numbers that they could remember as having been correct or incorrect and also to mark any numbers which they felt had not been included in the learning series.¹ They were instructed to guess only when they felt reasonably certain

¹The instruction appeared on the sheet. A replica of the sheet is given in the appendix, p. iii.

that they might be correct.

The subjects, twenty-eight in each of the experimental groups, were for the most part sophomore students who volunteered for the experiment. A few upper-division and graduate students were included, but were distributed among the three groups.

DATA AND RESULTS¹

In Table IV are presented the differences between the performances of the groups on the standardizing series for all but the first trial.

TABLE IV

Group Differences In Errors On Standardizing Series

Group	Mean	σ_{dis}	σ_M
Emphasis Right-Press Right	39.32	10.98	2.07
Emphasis Wrong-Press Right	38.43	8.73	1.65
Emphasis Right-Press Wrong	34.79	9.99	1.88

The significance of these differences is presented in Table V.

TABLE V.

Significance Of Differences on Standardizing Series

Groups compared	Diff.	$\sigma_{diff.}$	CR	P
ER-PR minus EW-PR	.89	2.64	.3	.23
ER-PR minus ER-PW	4.53	2.79	1.6	.89
EW-PR minus ER-PW	3.64	2.49	1.5	.87

¹All of the raw score data are presented in the appendix. See p. iv ff.

Table V shows no reliable differences to exist between the performance records on the standardizing series.

In figure 3 is presented graphically the performance of the groups run under the three experimental conditions.

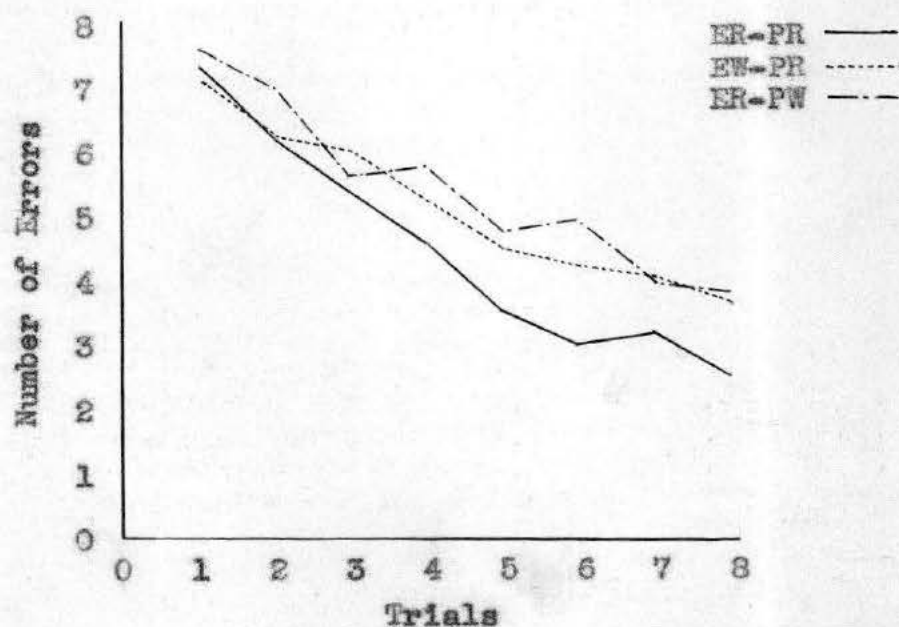


Figure 3. Performance Curves on Experimental Series.

The average number of errors made by each group on the two experimental series is presented in Table VI.¹

¹Because of the large part played by chance in the initial trials, only the last five trials are included in the statistical analyses.

TABLE VI

Average Number of Errors on Experimental Learning Series

Group	Mean	σ_{dis}	σ_M
Emphasis Right-Press Right	16.63	8.08	1.08
Emphasis Wrong-Press Right	21.98	8.89	1.19
Emphasis Right-Press Right	23.50	11.30	1.51

Inspection of Table VI shows the ER-PR group to be superior in performance to both of the other groups and the EW-PR group to be slightly superior to the ER-PW group. The significance of these differences is presented in Table VII.

TABLE VII¹

Comparisons of Groups on Learning Series

Groups compared	Diff.	$\sigma_{diff.}$	CR	P
EW-PR minus ER-PR	5.35	1.08	4.9	1.00
ER-PW minus ER-PR	6.87	1.57	4.3	1.00
ER-PW minus EW-PR	1.62	1.49	1.1	.72

It is demonstrated in Table VII that the differences between ER-PR group and the other two groups are statistically significant as evidenced by the critical ratios of 4.9 and 4.3.

The reliability of the experimental series under

¹A discussion of the statistical procedure used in determining the CR's is discussed in the appendix, p. ix.

the different conditions of performance is given in Table VIII.

TABLE VIII
Reliability of Experimental Series
Under Different Conditions

Conditions	Correlation Between First and Second Series Taken
ER-PR	.721 $\pm$.09
EW-PR	.758 $\pm$.08
ER-PW	.653 $\pm$.10

Table VIII indicates no marked differences in the reliability of the experimental learning series under the different conditions of performance.

The average number of numbers which were correctly marked on the post-test is presented in Table IX.

TABLE IX
Average of Numbers Marked Correctly on Post-Test

Group	Mean	σ_{dis}	σ_{Mean}
ER-PR	23.43	9.69	3.35
EW-PR	21.21	8.85	2.80
ER-PW	19.86	9.21	3.03

The significance of the differences between the groups on the post-test is given in Table X.

TABLE X

Comparison of Groups on Post-Test

Groups Compared	Diff.	$\sigma_{\text{diff.}}$	CR	P
ER-PR minus ER-PW	2.22	2.93	0.7	.52
ER-PR minus EW-PR	3.57	3.54	1.0	.68

It is seen from Table X that there were no reliable differences in the performances upon the post-test.

Discussion of Results

On the basis of the standardizing series the Right-Wrong group was shown to be superior to the other two groups and the Wrong-Right group to be slightly superior to the Right-Right group. The differences in performance were not significant, however. In the experimental learning series, the order of excellence of performance was just reversed. The Right-Right group was shown to be significantly superior to both of the other groups. No significance is to be attached to the differences in performance between the Wrong-Right and the Right-Wrong groups.

The probabilities are about the same from group to group that the obtained means on the experimental learning

series were the true means, in so far as the performance records were influenced by errors of measurement.

On the post-test, although the order of excellence of achievement was in the same direction as for the experimental learning series, there were no reliable differences in performance from group to group.

Interpretation of Results

It was pointed out earlier in this thesis¹ that the evidence for the Law of Placement of Emphasis remains as yet obscure, particularly in regard to whether the law is applicable as a principle of learning or a principle of performance. It was stated at the same time that it was in regard to the problem of identifying the law as a principle of learning or performance that this investigation was undertaken.

Tolman, in his second formulation of the Law of Emphasis, proposed that the differences which arise from the placement of emphasizeers are a function of the conditions of performance rather than the conditions of learning. It is this concept that is put to test. In order to check up on such an hypothesis it is first necessary to demonstrate significant differences in performance under

¹ See p. 19

different conditions in the placement of the emphasizeers. Subsequent to such a demonstration the subjects must be put in a situation where the conditions affecting the performance are the same for all subjects alike. If, under these circumstances, significant differences appear, then it may be said that the placement of the emphasizeers affected the learning and the learning is transferred to the new situation. If no differences of significance appear, it may be concluded that the previous differences of performances were due to factors other than the amount learned.

The evidence presented by the results of the experimental procedures may be interpreted as supporting the hypothesis that the differences of performance under conditions of differential placement of emphasizeers are due to factors which affect the performance in some way without materially affecting the learning under those conditions.

While the results do not bear evidence of what the factors are that influence the performance there are certain explanations which may be offered. These explanations are purely hypothetical and are supported by experimental evidence only indirectly. It may be that experimental tests might be devised to confirm or refute these hypotheses.

In stating that the difference in the performance

curves is due to factors influencing performance rather than learning it has been directly implied that performance curves do not necessarily represent the amount learned nor the rate of acquisition. That such an implication is not unjustifiable is evident from the work of Blodgett (1929), Tolman and Honzik (1930) and others. These investigators demonstrated that rats placed in a maze with no food at the end-box will, after food has been introduced, soon equal in performance a control group which has run to food from the outset. The experimenters argue that rapid increase in excellence of performance and the ultimate equality of the two groups would not be possible had not learning occurred during the period when no food was placed at the end-box. The learning which had occurred during the foodless period did not evidence itself in the performance records. Another line of evidence arises from the facts of over-learning. After a learner is able to perform a task without error, continued performance does result in more learning. The additional amount learned will be evidenced in greater amounts remembered and amounts remembered over longer periods of time. Of this over-learning, however, there is no indication in the original performance records. It has also been suggested by various workers¹

¹See Bryan and Harter (1897), Swift (1903), Batson (1916), and Trow and Sears (1927).

that the plateaus which often appear in "learning" curves are due to inadequacy of measurement of the learning which may be occurring.

Proceeding on the basis that it is not unreasonable to assume that a given performance curve may not be truly representative of the learning which has occurred, there remains the problem of what factors might have affected the performances of the Right-Wrong and Wrong-Right groups during the experimental period. Two factors are suggested as involved. The first factor is that there may be a definite difference in the complexity of response called for by the experimental conditions. The second suggestion is that subliminal cues, cues not yet verbalized as "right" or "wrong", are the ones responded to by the learner, and when these cues are in connection with the correct response a "correct" score is made, but when the cues are in connection with the incorrect response an "error" is made, although in both cases the learning may be at the same level.

The possible difference in complexity of response arises from the fact that wherever a discrimination is to be learned between two things and the information of correctness is conveyed to the learner by means of an emphasis on the correct response in some cases, and the incorrect in other cases both situations demand that the learning be demonstrated by the same overt movement (such as pressing the correct key or punching the correct hole.) As Tolman (1934) has suggested, the learning in such

situations involves the setting-off of one response against another. Where the emphasizee accompanies the correct response the overt movement is directed to the locus of that emphasizee, but where the emphasizee accompanies the incorrect response the overt movement is directed not to the locus of the emphasizee but away from it and to that part of the situation which has been set off as part of the background. In brief, in one case the response is directed to and in the other case opposite to the locus of attention. The second situation is much like asking an individual to nod his head and say "No" or to shake his head and say "Yes". Past habits of pointing and making such responses as just noted are contradictory to the responses called for by the experimental situation; hence they must be inhibited. In only two cases did individuals of the Right-Right group report having pressed the key opposite to the one that they knew to be correct. In the Wrong-Right group ten individuals reported at some point or another during the experiment that they had pressed the wrong key. One individual actually made this confused response sixteen times. Another marked case which demonstrates the habit factor was occasioned when by accident the subject had left his finger on one of the keys. When the next card was exposed the red light immediately turned on. The subject was instructed to go ahead and make the correct response. Despite the

fact that the subject knew which number was correct, a fact established by his subsequent remarks, he nevertheless pressed the wrong key, that which corresponded to the locus of the red light. The incidence of confusion was just as marked in the Right-Wrong group, nine cases reporting. One individual reported that he caught himself at least once on every trial pressing the key he knew to be incorrect. Another subject remarked to the effect that responding to the side opposite of the emphasize was just like looking in one direction and pointing in the opposite, very confusing.

It was predicted before the experiment that the Right-Wrong group would experience much greater confusion and hence show a poorer performance due to the nature of the instructions. This group was instructed that they were to learn the correct numbers but were to press the wrong key, a situation certainly not customarily met. In all but one case, however, the individuals reported that they had changed the directions so that the "correct" numbers were conceived of as the "wrong" numbers. According to the interpretation placed on the numbers, this group was actually receiving the emphasis on what they conceived as the "wrong" numbers. In effect, then, the Right-Wrong group and the Wrong-Right group performed under the same conditions.

The second suggestion, that of the influence of subliminal cues, is purely hypothetical. The argument is that during the course of learning a series of simple discriminations such as is involved in the present investigation or in the punchboard-maze investigations, the learning consists of setting off, one against the other, the two points of discrimination, i.e., the two numbers or the two holes. During the initial stages of learning, before the learner is able to verbalize that "this number is the correct number" and that "this number is the wrong number" he learns that something happens in connection with one number and not the other. As several subjects expressed it, one number seems to 'stand out' although that number is not identified as being right or wrong. The things that can happen in connection with a number are the occurrence of the emphasize and a condition of correctness. For the Right-Right group the emphasize and the condition of "being correct" occur in connection with the same number. However, for the Wrong-Right and Right-Wrong groups the emphasize accompanies one number and the condition of "being correct" accompanies the other. If in some way the placement of the emphasize on a particular number causes it to stand out more than the paired number, it is possible that the subject will, in the absence of definite knowledge

of correctness, respond to the number perceptually more distinct. If this is what actually happens, the differences between the performances of the groups may be accounted for. Under the Right-Right condition the number more perceptually distinct is the correct number and therefore when the subject responds to that number it is recorded as correct although the subject may not have been able to verbalize its correctness beforehand. Under the Wrong-Right and Right-Wrong conditions if the subject responds to the more perceptually distinct number, the response is recorded as an error. In short, the Right-Right subjects are credited for responding to the same cues for which the Wrong-Right and Right-Wrong groups are discredited although all may be said to have learned something about what happens in the situation in connection with one number as opposed to the paired number. Subsequently, if the numbers are presented in a new setting and do not occur in pairs, one number cannot be set off against another so that the basis for one number's being more perceptually distinct than another is removed. Under these conditions it is primarily, if not entirely, the numbers which have been verbalized as right or wrong that will be utilized in the performance. If this statement has basis in fact, the equality of performance between the groups on the post-test is explainable.

In proposing the explanation of how the differences in performance under different placement of emphasisers might be accounted for in terms of factors which influenced the performance rather than the learning, three assumptions have been made. The first assumption is that a "something" which bears information of correctness happens within the locus of one of two discriminanda, one will stand out against the other. The second assumption is that there is a greater tendency to select rather than avoid the one which stands out when no knowledge of correctness is possessed. The third assumption is that the separation of the two discriminanda removes the basis for one's standing out against the other. The final answer to the validity of the explanation awaits the test of these assumptions.

SUMMARY AND CONCLUSIONS

The available experimental evidence concerning the Law of Emphasis was found to be contradictory in part and confirmatory in part. Analysis of the Law of Emphasis showed it to involve two distinct problems rather than one. On this basis the law was divided and substitutes proposed as the Law of Placement of Emphasis and the Law of Intensity of Emphasis. This investigation was conducted to test whether the placement principle was to be identified as a principle of learning or of performance.

To test such a question it is first necessary to demonstrate significant differences in performance under different conditions of placement of emphasis. Subsequent to such a demonstration, if the situation is altered so that the factors affecting the performance are held constant, significant differences in performance would indicate a principle of learning while insignificant differences would indicate a principle of performance.

Three groups of subjects learned series of number pairs. The ER-PR group was instructed to respond to the correct numbers. At each response the correct number was emphasized. The EW-PR group was instructed to respond to

the correct numbers but for this group the wrong number was emphasized at each response. The ER-PW group received the emphasis in connection with the correct number but were instructed to respond to the wrong number. Significant differences were found to exist between the ER-PR group and each of the others. The difference between the EW-PR and ER-PW groups was not significant. In effect, the conditions of learning were the same for these last two groups.

When the groups were presented with a sheet of paper bearing all of the numbers which had appeared in the learning series and in addition some numbers which had not appeared, no one group recalled significantly more of the numbers correctly than any other group. It may be concluded from this that the Law of Placement of Emphasis is a principle of performance rather than a principle of learning.

APPENDIX

The numbers for series A were selected at random from a list of all possible three-digit combinations of the digits from 2 through 9. No progressions such as 234, 246, or 369 were used. No digit occurred twice in a given number and no pair had both numbers starting with the same digit. Half of the larger numbers of the pairs were correct and half of the smaller numbers were correct. Half of the time the correct number was on the left and half of the time on the right.

In order to eliminate the possibility that the subjects would learn the numbers in terms of a serial position habit of left-right responses the cards were arranged in three different orders. While the subjects had been informed that the cards would never be presented in the same order twice, actually the order was repeated every three trials. Another precaution involved the shifting of the numbers from one side of the card to the other.

Learning Series A

763" 952	346 893"	523 687"
453" 362	294 769"	934 548"
874 629"	379" 752	752 379"
637 285"	453" 362	769" 294
294 769"	629" 874	285" 637
687" 523	584 435"	854" 249
249 854"	854" 249	469 954"
548" 934	637 285"	362 453"
347 893"	523 687"	629" 874
584 435"	763" 952	952 763"
954" 469	954" 469	435" 584
379" 752	934 548"	893" 347

"Correct numbers.

Series B and C were selected according to a definite method. Each value in the ninties was matched with some number in the "teens", the twenties, the thirties, etc. The particular value that was matched was determined by chance selection effected by drawing numbers from a hat. In no case, however, were the second digits the same. All of the numbers which ended in "0" were eliminated from the series but were used in the post-test as numbers not included. The pairs obtained were then inspected and in a few cases changed to eliminate easy combinations. The series were presented in four different orders

Learning Series B

61 48"	43 68"	75 28"	32" 58
91" 24	11 85"	82 33"	24 91"
64 29"	12" 79	64 29"	39 54"
73" 98	98 73"	88 65"	21 89"
82 33"	33" 82	54" 39	48" 61

71" 45	28" 75	58 32"	98 73"
58 32"	29" 64	61 48"	43 68"
85" 11	15" 93	89" 21	12" 79
75 28" 45	45 71"	73" 98	28" 75
89" 21	39 54"	79 12"	33" 82
54" 39	24 91"	68" 43	11 85"
88 65"	32" 58	71" 45	45 71"
93 15"	65" 88	85" 11	15" 93
79 12"	48" 61	91" 24	29" 64
68" 43	21 89"	93 15"	65" 88

"Correct numbers.

Learning Series C

42" 13	63" 51	31 78"	19" 84
97" 26	84 19"	27 55"	31 78"
92 41"	66 34"	13 42"	13 42"
95 72"	77 23"	72" 95	34" 66
55" 27	55" 27	23" 77	37" 86
78" 31	78" 31	67 99"	52 81"
86 37"	92 41"	51 63"	16" 49
62" 35	42" 13	26 97"	27 55"
77 23"	97" 26	34" 66	51 63"
63" 51	81" 52	52 81"	67 99"
66 34"	49 16"	37" 86	41" 92
84 19"	62" 35	16" 49	72" 95
81" 52	95 72"	35 62"	26 97"
49 16"	86 37"	41" 92	35 62"
99" 67	99" 67	19" 84	23" 77

"Correct numbers.

Below is given a replica of the post-test.

Name _____

Directions: On this sheet appear all of the numbers both correct and incorrect that were used in the second learning series and in the last learning series. There are also several numbers which did not appear in either of these two learning series. The numbers are arranged in numerical order and segregated according to whether they appeared in the second or last learning series.

You are to go through these numbers marking them in the following way. If a

certain number was a correct number place a "C" on the line provided. If the number was incorrect place an "I" on the line provided. If the number is one that did not appear in the series draw a line through it. When you are not certain about a number but feel that you could make a reasonable guess do so. When you are quite uncertain leave the space blank. Follow these instructions to the best of your ability. Do not feel that you must fill every blank, quality is the thing desired.

"C" means the number was correct.

"I" means the number was incorrect.

___ means the number did not appear.

Numbers which appeared in the second series.

11	21	32	43	53	60	70	80	91
12	24	33	44	54	61	71	82	93
15	25	36	45	56	64	73	88	94
17	28	38	47	58	65	75	85	96
18	29	39	48	59	68	79	89	98

Numbers which appeared in the last series.

10	20	30	40	50	62	72	81	90
13	22	31	41	51	63	74	83	92
14	23	34	42	52	66	76	84	95
16	26	35	46	55	67	77	86	97
19	27	37	49	57	69	78	87	99

Raw Score Data

Below are listed the number of errors on each trial for the standardizing series A. The column of numbers refers to the individual subjects. These numbers correspond throughout all of the tables of raw score data so that the performance of a given individual may be checked throughout. The individuals are grouped under headings which indicate the experimental conditions to which they were subsequently exposed.

Errors on Series A
Emphasis-Right Press-Right

Trials

	1	2	3	4	5	6	7	8	9	10
1.	6	5	8	4	7	2	2	3	3	4
2.	7	6	5	6	6	7	2	4	6	4
3.	7	3	3	2	3	2	1	4	0	1
4.	4	4	5	5	3	5	5	7	5	5
5.	9	5	5	6	5	3	7	5	3	4
6.	6	3	5	2	3	3	5	5	6	6
7.	6	3	3	5	6	3	6	6	5	3
8.	6	3	5	4	3	3	1	1	2	1
9.	7	4	3	3	4	2	2	3	0	1
10.	4	3	3	3	2	4	2	2	2	1
11.	4	4	5	4	4	2	4	3	1	3
12.	3	8	7	7	6	8	8	9	6	3
13.	8	3	6	4	7	5	3	3	3	5
14.	9	7	7	9	7	4	5	4	3	3
15.	8	2	6	5	6	8	7	5	6	2
16.	7	6	4	5	3	5	4	3	2	0
17.	8	5	5	7	5	4	1	3	3	3
18.	9	7	6	7	5	5	2	4	4	6
19.	7	6	7	7	4	9	4	6	7	3
20.	6	4	7	5	7	7	5	5	7	2
21.	5	8	9	7	8	6	5	4	5	7
22.	6	6	10	5	4	6	5	6	5	4
23.	6	5	6	4	4	5	3	4	5	2
24.	6	6	4	3	3	3	2	3	1	1
25.	7	2	3	6	4	8	5	4	3	7
26.	7	4	5	5	5	8	5	4	2	4
27.	9	6	3	7	6	5	5	4	3	2
28.	6	2	5	6	3	3	4	4	5	1

Emphasis-Wrong Press-Right

1.	4	4	5	6	7	6	3	3	4	4
2.	5	4	4	4	2	6	4	4	2	5
3.	6	8	3	2	2	3	3	1	2	1
4.	3	6	7	4	4	6	6	4	5	3
5.	7	7	4	8	2	5	5	3	1	4
6.	8	5	5	2	6	5	2	3	3	4
7.	4	3	1	5	1	4	3	4	2	3
8.	6	7	6	2	6	6	4	2	3	3
9.	6	6	4	3	7	5	3	1	1	2
10.	6	6	6	3	3	5	3	4	2	4

11.	8	1	3	4	4	3	4	3	1	3
12.	4	4	6	5	5	4	5	2	1	3
13.	6	5	5	4	2	2	2	6	6	5
14.	5	6	5	6	7	3	5	4	4	5
15.	6	7	3	5	8	6	3	2	2	4
16.	3	3	6	5	4	4	2	2	4	2
17.	6	4	4	5	4	5	6	5	5	2
18.	5	6	8	6	6	7	5	4	4	2
19.	7	9	10	6	7	7	6	4	6	4
20.	7	4	6	4	4	3	5	4	2	2
21.	7	4	5	3	6	6	2	5	5	7
22.	4	6	7	4	3	5	4	1	5	3
23.	7	4	8	4	9	7	4	5	6	5
24.	5	7	5	6	4	6	4	5	2	6
25.	4	3	1	5	3	3	6	5	3	6
26.	8	8	6	3	7	8	4	9	6	6
27.	9	6	6	3	3	4	1	1	3	6
28.	6	4	5	2	4	2	1	0	2	1

Emphasis-Right Press-Wrong

1.	6	4	6	4	4	4	5	4	3	1
2.	7	7	8	4	7	4	4	3	4	7
3.	8	3	3	5	3	3	3	1	0	4
4.	4	5	5	3	4	2	1	3	4	3
5.	6	3	5	2	3	4	1	1	3	0
6.	5	5	3	2	3	5	2	1	5	3
7.	6	5	6	5	5	1	3	3	7	6
8.	7	3	4	4	3	1	2	3	3	2
9.	6	7	5	7	3	4	2	3	3	2
10.	4	7	6	5	4	3	7	8	7	6
11.	7	4	7	4	7	3	4	5	0	0
12.	6	6	6	7	3	6	8	6	4	5
13.	8	6	3	1	4	0	0	0	0	0
14.	6	6	6	4	5	4	3	3	3	2
15.	6	5	5	5	6	3	6	4	4	3
16.	8	5	4	3	3	3	2	2	3	0
17.	5	7	10	7	4	5	6	4	4	5
18.	7	6	6	3	6	5	4	0	1	0
19.	9	4	5	4	5	3	3	1	1	2
20.	8	4	6	4	4	5	3	4	4	4
21.	2	5	6	3	4	3	2	2	3	2
22.	5	4	4	5	4	2	3	1	5	2
23.	5	3	2	5	4	6	5	3	3	4
24.	4	5	6	8	4	6	4	3	6	2
25.	6	5	6	5	2	3	3	5	1	3
26.	8	6	7	5	4	4	2	0	3	1
27.	5	5	6	4	2	2	3	1	1	1
28.	6	6	7	5	5	8	2	4	7	7

Below are listed the raw score data for the experimental learning series in terms of the number of errors on each trial. The column on the left designates the particular series taken first, on the right the series taken second. In each case the series is labeled as "B" or "C". The "w" and the "r" refer to the white light and red light which were the emphasizeers used. At the extreme left the column of numbers refers to the individual subjects.

Emphasis Right-Press Right

Trials									Trials								
	1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
1.	10	7	5	4	3	4	6	3		6	8	5	7	3	4	0	0
2.	7	8	5	8	7	3	3	3		3	4	4	5	3	0	0	1
3.	12	2	2	2	1	3	2	1		10	5	3	2	0	0	0	0
Bw 4.	5	9	5	6	5	3	4	3	Cr	3	5	4	8	5	5	4	6
5.	7	6	7	6	3	6	2	3		6	5	7	7	5	3	3	2
6.	7	9	5	7	5	3	5	2		5	8	8	4	3	5	3	4
7.	7	8	5	5	5	4	2	2		7	5	3	4	5	6	5	0
8.	8	5	2	2	1	0	1	0		9	8	8	4	3	1	1	2
9.	10	5	5	3	2	1	1	0		8	4	3	4	2	1	4	4
10.	7	8	6	6	6	7	3	0		4	9	5	2	3	5	5	2
Cr 11.	6	8	7	2	2	2	1	1	Bw	9	9	9	5	4	0	4	2
12.	8	2	3	4	2	3	4	3		7	5	5	4	1	0	0	3
13.	7	7	4	3	1	4	4	4		7	6	5	5	4	2	2	1
14.	9	11	6	4	9	5	6	7		5	7	4	4	3	3	6	7
15.	4	5	6	7	8	7	9	4		5	7	7	7	4	5	6	4
16.	5	8	4	4	2	3	1	0		7	7	5	4	1	0	1	0
17.	4	7	6	2	0	1	3	1		7	5	2	4	3	1	2	3
Br 18.	7	5	4	3	2	1	1	2	Cw	6	5	2	0	0	1	0	0
19.	13	6	8	4	7	3	5	2		8	3	5	7	5	2	5	4
20.	4	6	10	7	6	4	7	3		9	4	6	7	5	7	1	5
21.	8	8	6	4	4	6	4	5		8	8	6	6	4	3	0	3
22.	6	4	3	1	1	2	4	3		10	7	7	5	1	0	0	1
23.	5	6	7	5	6	2	6	6		4	8	4	9	7	6	7	5
24.	6	7	7	6	3	2	0	3		8	4	1	1	2	2	1	0
Cw 25.	8	5	7	5	2	4	4	1	Br	11	5	3	1	3	3	3	3
26.	7	7	4	5	4	4	3	5		3	4	5	6	5	2	4	3
27.	8	3	5	7	2	2	2	0		11	5	5	1	0	1	0	0
28.	8	7	6	6	7	5	6	6		10	9	7	7	4	4	6	3

Emphasis Wrong-Press Right

		Trials										Trials							
		1	2	3	4	5	6	7	8			1	2	3	4	5	6	7	8
Bw	1.	4	7	7	7	7	8	6	5	Cr		7	4	6	4	2	3	4	1
	2.	6	7	6	5	5	4	2	1			7	2	6	4	3	2	2	5
	3.	3	7	4	5	4	4	2	3			8	6	6	4	4	3	1	2
	4.	2	5	6	10	8	7	7	3			6	8	7	8	9	3	2	1
	5.	10	7	9	7	7	9	7	7			7	8	7	4	8	6	4	5
	6.	7	4	5	4	7	5	5	3			11	7	8	5	5	3	3	7
	7.	7	5	5	3	2	1	1	0			8	10	4	5	4	2	2	2
Cr	8.	8	6	9	8	6	4	6	3	Bw		8	5	4	5	1	4	3	2
	9.	9	1	7	2	0	1	1	1			7	4	2	1	1	0	1	2
	10.	6	11	7	3	6	1	5	6			4	4	3	3	3	2	4	5
	11.	6	9	4	3	8	2	1	2			5	7	5	4	4	3	2	2
	12.	7	7	7	3	2	0	0	0			6	4	5	1	1	1	0	0
	13.	11	5	10	5	6	5	6	8			9	8	7	7	5	6	5	5
	14.	8	5	8	9	6	10	7	7			8	9	6	7	4	5	6	6
Br	15.	10	7	7	8	6	6	7	5	Cw		6	4	2	5	4	5	6	5
	16.	10	6	6	6	6	5	5	6			8	5	7	2	3	2	7	5
	17.	8	7	5	9	5	6	8	5			7	6	9	5	2	4	5	5
	18.	8	4	4	5	4	3	1	0			8	7	6	6	4	3	3	3
	19.	9	8	8	6	2	4	3	2			9	7	7	4	4	3	6	7
	20.	5	5	6	5	5	6	9	8			6	7	7	6	6	4	1	3
	21.	6	4	8	4	5	4	3	1			10	5	4	2	2	1	4	3
Cw	22.	10	8	4	5	6	2	2	4	Br		6	9	9	6	8	6	2	3
	23.	8	4	5	7	4	4	4	5			8	5	4	6	2	3	8	5
	24.	9	8	7	8	7	7	8	7			6	10	10	8	2	6	4	4
	25.	5	6	6	6	5	5	5	2			6	6	5	4	3	6	5	3
	26.	11	8	4	6	7	8	9	8			2	7	5	8	9	6	8	4
	27.	8	6	3	3	3	5	3	3			10	8	8	5	5	6	2	3
	28.	12	7	4	6	7	3	4	2			8	4	6	9	7	6	3	2

Emphasis Right-Press Wrong

Bw	1.	12	9	7	7	9	11	4	6	Cr	11	7	9	8	5	5	5	3
	2.	6	7	6	9	7	7	6	9		8	8	8	8	9	11	6	5
	3.	11	7	5	5	4	5	3	5		7	6	7	10	6	7	7	7
	4.	7	8	3	4	5	4	5	4		6	5	6	8	4	6	4	3
	5.	8	4	8	3	3	4	4	0		7	1	1	3	0	1	0	0
	6.	6	8	8	9	8	5	6	4		7	7	6	9	7	6	3	5
	7.	7	10	7	8	8	5	7	4		4	7	8	5	4	2	3	6
Cr	8.	8	7	5	4	6	3	4	2	Bw	5	7	9	6	4	5	2	3
	9.	8	6	6	2	2	2	2	2		6	7	3	3	2	3	2	1
	10.	6	6	6	5	7	6	5	5		9	8	8	11	8	9	10	5
	11.	15	6	3	15	4	10	6	10		9	9	5	6	3	5	3	1
	12.	10	7	10	10	9	10	6	7		6	5	6	8	6	6	5	5
	13.	5	7	3	0	0	0	0	0		9	9	5	1	0	0	0	0
	14.	5	4	6	8	4	5	3	4		6	5	6	6	6	5	3	4

15.	11	9	5	8	10	6	7	7	3	11	8	6	4	6	3	3
16.	11	8	3	5	4	3	0	2	9	8	5	1	1	1	0	0
17.	11	9	5	5	6	10	10	9	5	7	4	6	5	7	11	4
Br18.	6	4	7	6	5	3	3	2	Cw	5	4	2	4	3	3	1
19.	10	7	8	4	5	4	0	4	7	7	6	6	6	2	2	2
20.	8	9	3	8	6	5	5	4	10	11	3	4	6	4	4	1
21.	10	9	7	5	3	4	1	4	7	4	6	2	3	3	0	0
22.	6	5	5	4	2	2	3	2	7	3	2	3	0	3	3	3
23.	6	7	7	4	5	8	4	6	6	10	9	7	2	11	10	10
24.	7	5	5	5	6	4	2	1	9	7	3	6	1	3	2	2
Cw25.	10	6	3	5	3	3	3	3	Br	9	7	7	7	8	3	4
26.	10	9	8	8	7	8	7	8	5	11	6	9	7	8	8	7
27.	9	4	3	3	4	1	1	1	8	5	2	9	5	5	2	3
28.	8	8	10	6	7	5	12	8	8	7	5	7	6	6	4	5

In calculating the critical ratios of the differences in performance on the learning series and on the post-test the following formula was used.

$$\sigma_{\text{diff.}} = \sqrt{(\sigma_{M_1}^2 + \sigma_{M_2}^2) - (2r\sigma_{M_1}\sigma_{M_2})}$$

This formula is meant for use where errors of sampling have been reduced by matched groups. In such cases the "r" is coefficient of correlation between the measures of final comparison. The individuals are matched on the basis of identical scores on some original measure. In this study the individuals could not be matched on the basis of identical scores. They were, however, matched on the basis of rank order of performance on the original measure, in this case the rank order of performance on the standardizing series. Where one or more individuals were of the same rank order an average of their measures of final comparison was used. This was done so as not to affect the "r" by

the particular placement of the individuals.

In the tables below are given the data from the post-test.

Emphasis-Right Press-Right

				Bw-Cr						Not Used		
Correct				Incorrect								
C	I	-		C	I	-	C	I	-	C	I	-
1.	12	3	1	3	7	4	15	20	25			
2.	13	3	2	1	5	6	0	0	2			
3.	10	0	0	6	0	1	0	0	2			
4.	21	8	6	0	13	7	9	9	17			
5.	20	7	2	3	7	3	0	2	11			
6.	14	4	2	10	14	6	6	12	22			
7.	12	4	1	4	7	1	3	6	12			
				Cr-Bw								
8.	22	6	2	0	1	0	0	0	0			
9.	18	2	1	1	4	0	0	0	0			
10.	23	12	0	6	9	7	0	7	20			
11.	16	1	1	1	9	0	0	0	0			
12.	17	1	0	3	9	1	0	0	0			
13.	12	2	1	0	6	1	0	1	3			
14.	8	3	1	7	12	14	0	0	0			
				Br-Cw								
15.	16	12	5	9	11	10	5	7	15			
16.	24	2	4	2	23	5	4	5	21			
17.	23	2	5	1	13	3	2	3	13			
18.	18	6	3	3	8	4	1	6	13			
19.	20	4	4	7	8	4	3	9	10			
20.	7	3	0	1	4	2	0	0	0			
21.	16	4	2	0	3	0	0	0	0			
				Cw-Br								
22.	7	0	0	7	6	1	16	25	28			
23.	13	3	2	6	15	5	9	11	18			
24.	16	4	1	3	12	3	2	4	16			
25.	19	10	2	5	13	5	3	6	19			
26.	19	7	4	8	15	7	0	0	0			

27. 13 7 2	3 8 6	1 4 9
28. 10 10 4	9 7 5	11 13 21

Emphasis Wrong-Press Right

Bw-Cr

1. 10 6 0	5 8 0	15 16 30
2. 19 8 3	7 11 5	4 11 22
3. 18 9 3	7 14 6	5 7 21
4. 7 8 0	1 1 0	0 0 0
5. 15 16 8	0 0 0	0 0 0
6. 13 9 8	12 13 5	5 8 17
7. 10 7 0	4 2 2	2 4 13

Cr-Bw

8. 14 8 1	7 9 5	7 12 23
9. 25 2 1	1 11 2	2 5 22
10. 13 8 3	5 7 3	2 4 15
11. 11 1 1	0 6 1	0 0 11
12. 5 1 0	2 21 0	0 0 0
13. 4 4 0	3 5 1	0 0 0
14. 11 3 0	3 3 1	4 7 14

Br-Cw

15. 6 5 1	7 3 6	5 7 13
16. 17 8 4	1 7 3	2 4 16
17. 6 3 1	0 5 2	0 0 0
18. 14 2 0	2 7 3	21 14 27
19. 16 8 6	4 13 4	2 3 14
20. 11 2 0	1 7 1	18 22 28
21. 17 3 3	1 4 1	6 10 18

Cw-Br

22. 19 7 5	3 11 3	0 2 12
23. 12 4 0	3 6 1	1 2 12
24. 16 3 0	0 3 1	1 4 13
25. 15 7 2	9 13 2	0 0 0
26. 8 4 1	2 4 1	22 19 26
27. 12 4 2	1 1 0	0 0 0
28. 11 3 0	1 5 0	1 4 10

Emphasis Right-Press Wrong

Bw-Cr

1. 6 1 1	3 3 0	1 3 10
2. 4 4 0	0 3 0	8 7 16
3. 11 4 3	0 5 3	3 5 11
4. 15 5 0	5 8 5	8 11 22

5. 18	3	0	2	5	0	0	0	10
6. 7	1	0	1	3	0	1	0	4
7. 13	6	0	4	7	3	0	0	0

Cr-Bw

8. 15	11	4	2	2	1	0	0	0
9. 18	4	2	1	10	3	1	5	19
10. 11	15	9	10	9	9	9	12	
11. 5	1	0	1	3	0	2	3	9
12. 13	7	1	4	5	1	3	3	13
13. 15	13	0	6	11	2	3	5	18
14. 23	3	4	1	7	4	1	9	11

Br-Cw

15. 7	8	2	5	10	4	18	12	23
16. 18	2	0	0	9	2	0	0	6
17. 15	12	11	8	9	9	7	9	10
18. 21	1	2	4	12	4	0	5	15
19. 12	5	1	0	7	0	0	1	13
20. 8	5	2	7	5	2	11	11	20
21. 17	9	4	6	15	9	4	6	15

Cw-Br

22. 13	7	4	2	5	2	0	0	0
23. 12	8	6	6	10	5	8	4	15
24. 17	2	4	6	13	2	5	13	22
25. 9	2	0	0	1	0	0	0	0
26. 6	2	2	1	0	0	0	0	0
27. 14	1	0	3	4	1	0	5	17
28. 6	8	2	8	8	2	6	12	20

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