1-1-1957

The role of stimulus generalization in projective test (Rorschach) behavior.

Joseph J. Moylan
University of Massachusetts Amherst

Recommended Citation
Moylan, Joseph J., "The role of stimulus generalization in projective test (Rorschach) behavior." (1957). *Doctoral Dissertations 1896 - February 2014*. 1679.
https://scholarworks.umass.edu/dissertations_1/1679

THE ROLE OF STIMULUS GENERALIZATION IN PROJECTIVE TEST (RORSCHACH) BEHAVIOR

MOYLAN - 1957

THE ROLE OF STIMULUS GENERALIZATION IN PROJECTIVE TEST (RORSCHACH) BEHAVIOR

JOSEPH J. MOYLAN

Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
Doctor of Philosophy
University of Massachusetts, Amherst
June, 1957

Table of Contents

Page

Introduction 1

Stimulus generalization 1

Projective testing 4

Problem 5

Method 9

Subjects 9

Stimuli, apparatus, and response 9

Procedure 10

Results 15

Strengthening of jex response to incidental stimuli... 15

Strengthening of jex response to training stimuli 20

Test for generalization of jex response 26

Discussion 40

Stimulus generalization from complex, familiar figures 40

Implications for the Rorschach 45

Summary 50

References 53

Appendix 60

A. *Summary of studies of generalization* 60

B. *Ranking of stimuli* 68

C. *Response speeds of individual Ss on four test trials* 70

Acknowledgments 86

Introduction

The study to be reported was concerned with stimulus generalization from complex, familiar visual stimuli along a continuum of similar forms which included a uniformly black version of Card V of the Rorschach series. Data and hypotheses bearing on the problem were drawn from laboratory studies of stimulus generalization as well as from analyses of projective testing. These materials are considered first; then the specific experimental problem is described.

Stimulus generalization.--The empirical phenomenon of stimulus generalization has been described as follows: "An organism that has been trained or instructed to respond to a designated stimulus will also respond, under certain specifiable conditions, to formerly neutral stimuli on which no training has been given (or to stimuli to which responses have been prohibited by instructions)" (14, p. 56). Thus defined, the phenomenon has been obtained or inferred for various attributes of visual, auditory, tactile and other stimulus modalities on the basis of vocal, motor, or visceral responses of humans, dogs, rats, and other organisms in a number of learning and psychophysical situations (28,37,41,44,45,70).[1] Despite this wide range of empirical materials however, forms of empirical generalization gradients

---

[1] The specific stimuli, training procedures, and results of relevant studies are summarized in Appendix A.

for single dimensions of various modalities, parameters which determine gradient forms, and underlying associative or neurophysiological mechanisms are still largely indeterminant in any precise fashion (14,52,63,83).

Shortcomings with respect to forms, parameters, and mechanisms are even more marked in the case of variations in shape or for multidimensional changes in simple and complex forms. Many of the pertinent studies are essentially demonstrations of the phenomenon of stimulus generalization rather than attempts to obtain more adequate quantitative data. Thus generalization of various responses to forms and models of decreasing similarity to male sticklebacks, the English robin, herring gull heads, birds of prey in flight, mosquitoes in flight, female ruffed grouse, and other organisms are reported by Tinbergen (79, pp. 27-46); but little is known of the antecedents of such responses. Miller (60) has trained rats to aggress against other rats; subsequently aggression generalized to a white doll figure.

If a direct relationship between degree of similarity and length of exposure time is assumed, recent studies of recognition thresholds for words can be viewed as demonstrations of generalization from word stimuli (e.g., 68). Also, Lawrence and Coles (51) have reported threshold gradients for black and white pictures of familiar objects. Rubenstein (74) introduced ambiguous figures of increasing similarity to line drawings of familiar figures such as a shoe, fish, and watch. Presumably the increased frequency of occurrence of labels for the familiar figures was due to stimulus generalization. A stimulus generalization interpretation may also be applied to Kraus' (49) observation of differences between responses to a tachistoscopically blurred and a clear presentation of a Rorschach-like stimulus.

Attneave (4) attempted to determine how differences along two dimensions affect judged similarity of stimuli. The figures were parallelograms, squares, and triangles which differed in size and angularity, area and reflectance, and area and angularity, respectively. The resultant judgements were of a form which justified an assumption of linear additivity of distance along two psychological dimensions for only a limited range of conditions. Eriksen and Hake (25) varied size, hue, and/or brightness of squares to find that discrimination of differences along any two or all three dimensions simultaneously could be predicted reasonably well from knowledge of discriminations along single dimensions. Both studies used scaling techniques rather than the procedure of first conditioning or strengthening a response to a stimulus and then testing for generalization to test stimuli. Such post-training generalization gradients for scaled forms or for multidimensional differences between training and test stimuli have yet to be determined.

Intralist and interlist intrusion errors to word and figure stimuli of some original, interpolated, or recall verbal learning tasks have been attributed to stimulus generalization (27,58,63).

Preliminary to such investigations Yum (84), and Gibson (27) had judges scale line-drawing nonsense figures for similarity. After Ss learned nonsense syllable responses to standard stimuli, the same responses were elicited with decreasing frequency by test figures of decreasing rated similarity. Gibson also reported a gradient of generalization in subsequent learning. However, this gradient was an average for three stimuli at each point in which effects of increasing associative strength and discrimination training were confounded with generalization. Therefore, since Miller (60) used only one test stimulus, the only adequate data for generalization to complex visual stimuli following training to respond to one stimulus are for these two sets of line-drawing nonsense figures.

Projective testing.--Although empirical data in the field of projective testing have accumulated rapidly, assimilation of such findings within the framework of more general principles of learning, motivation, and perception has been relatively neglected (1,9,22,48,56). Because of this inadequate theoretical foundation Phillipson (67) has questioned the usefulness of projective techniques in research and in clinical practice, while Rapaport declares that projective test theories, "...have hardly more in common than vague references to psycho-analytic ideas -- but even from among these ideas the different test theories choose different ones" (69, p. 269).

Recently, however, problems of explanation of projective test behavior in terms of concepts and principles of general behavior theory has received greater attention. Thus, in one symposium on projective methods and personality theory, Auld has commented:

> Behavior theory comprises our best organized set of facts and principles about human behavior. There is, I believe, no need to invent a special set of principles for test interpretation; what scientists studying human behavior in other situations have discovered can be used in the testing situation (5, p. 421).

More specifically, he suggested that the principle of stimulus generalization from an "origin situation" was basic to understanding the occurrence of responses in both Thematic Apperception Test and criterion situations. Both McClelland and collaborators (57) and Epstein and Smith (23) have assumed some variation of this principle with thematic apperception pictures and Sears et al (75) introduced generalization gradients to explain relationships between parents' behavior and their childrens' responses in projective doll play. Finally, Goss and Brownell (29) have shown how this principle along with a number of other principles of general behavior theory can be extended to a wide range of projective test stimuli, including inkblots.

Problem.--Studies in which stimulus generalization with complex stimuli has been demonstrated or seems a plausible inference, support the use of this principle, in part, to account for many responses to stimuli of projective tests. That some of these studies have quantitative inadequacies has been noted above, as has the more important shortcoming of lack of information about conditions of acquisition of observed responses. Moreover, the stimuli employed in the investigations in which conditions of acquisition were specified have been dissimilar to those of common projective tests, particularly the Rorschach.

The stimuli and procedures of the present study were developed to reduce, if not eliminate, these shortcomings. First, three test stimuli were developed rather than one or two so that a more adequate gradient might be obtained. Also, the similarity of these stimuli to the training stimuli was predetermined on independent grounds. Second, the test stimuli included a solid black version of Card V of the Rorschach thus assuring greater similarity to one or more stimuli of the most frequently used and investigated projective test. Third, the conditions of acquisition of the criterion response were reasonably well specified. One aspect of this more adequate specification was the use of silhouettes of a "bat" and of a "bird" as training stimuli. These stimuli were selected because they were presumed to be similar to or lie on a continuum with the stimuli from which responses of "bat" or "bird" generalize to Card V with, respectively, high and low frequencies (8).[2] Use of two training stimuli provided for partial replication of findings along with information about the effects of training with two different stimuli from which, because of differences in the frequencies of "bat" and "bird" responses

---

2. Forms of empirical gradients of generalization may be partially dependent on absolute and relative strengths of "approach" (say the name) and avoidance (inhibit the name) responses (28). It was assumed that the training and test stimuli used in this investigation did not arouse any, or very strong, avoidance of the naming response.

to Card V, somewhat different initial generalization gradients could be expected.

The second aspect of this more adequate specification was the introduction of training to two levels of strength of association between training stimuli and the responses to these stimuli (78). Although this variable has been shown to be of considerable importance for generalization with simple stimuli (81) it has apparently not been investigated in connection with more complex visual forms. Control for the strengths of associations between incidental stimuli and the response was introduced as a refinement of procedures of previous studies of relationships between generalization gradients and strengths of the training stimulus-criterion response association. That stimuli in addition to the training stimulus may also be involved in initial strengthening, and influence the course of generalization has been emphasized by Hull (44) who termed them "incidental stimuli." In those studies in which strength of the association between the training stimulus and criterion response has been varied, strength of association between incidental stimuli and that response would also have changed in parallel fashion. Subsequent tests of generalization of the response to decreasingly similar test stimuli, therefore, entailed confounding of strengths of the training stimulus-criterion association with strengths of association between incidental stimuli and that response. In this study the influence of association between incidental stimuli and the response was controlled by bringing those associations to the same asymptotic levels of strength before initiation of training to two levels of strength of association between the "bat" or "bird" training stimuli and the response.

In summary, the experimental problem was that of determining whether or not the empirical phenomenon of stimulus generalization could be demonstrated with this set of stimuli, and would vary with association strength. However, no attempt was made to specify or test all possible mediating cues which might have contributed to the determination of the response (19); nor were underlying associative or neurophysiological processes of concern. Such problems were considered possible avenues of further investigation contingent upon demonstration of stimulus generalization and additional knowledge of effects of parameters such as amount and type of training.

Method

Subjects.--The Ss were 192 undergraduates, 86 men and 106 women, primarily from the introductory psychology courses at the University of Massachusetts. Assignment to 12 training groups of 16 Ss each was random.

Stimuli, apparatus, and response.--Two training stimuli and three test stimuli were constructed on Rorschach-size cards to approximate length-width dimensions and area of the figure on Rorschach Card V. Although it is doubtful that responses to Card V are markedly influenced by shading (7), in order to restrict scaling to similarity and subsequent generalization to the form aspect of training stimuli, all were uniformly black. One training stimulus was a black silhouette of a bat with outspread wings on a white background; the other was a similar silhouette of a bird. The three test stimuli represented a pre-experimentally established continua of decreasing similarity to both training stimuli. These continua were established by having comparable Ss place seven forms, including Card V, in order of decreasing similarity to the training stimuli.[3] Selection of the seven forms was from a much larger number of experimental forms which had been systematically altered until it was possible to obtain at least one form, designated A, which was always placed between

---

[3] The stimuli, procedure, and results of the scaling are described in Appendix B.

the training stimuli and Card V, along with one other form, designated _C_, which was always placed beyond Card V. Thus, the final set of stimuli consisted of the two training stimuli and the three additional test stimuli of decreasing similarity which are labelled _A_, _V_, and _C_ in Appendix B. In addition, a white circle one inch in diameter on a black card served as the stimulus for preliminary strengthening of the verbal response to incidental stimuli.

All stimulus cards were presented to individual _S_s tachistoscopically two sec. (83, p. 30) after a red light-click warning signal. Intervals between stimulus exposure and the beginning of _S_s' responses were obtained by a voice key whose activation stopped a Hunter "Klockounter." Interstimulus intervals were about 10 sec.

The response selected was the nonsense syllable _jex_. This was of 0% association value (38), initially neutral with respect to training and test stimuli, and had no letters in common with responses which might occur to those stimuli.[4]

---

[4] Dr. S. C. Goding kindly pointed out that in French _jex_ was the name for one variety or type of cheese. Not one of an informal sample of _S_s, however, was familiar with this meaning.

Procedure.--Table 1 summarizes the experimental design. The white circle was the stimulus for the first stage of training whose objective was strengthening the associations between incidental stimuli and the _jex_ response to asymptotic levels. The

Table 1

Summary of Experimental Design*

Strengthening of *jex* Response to Incidental Stimuli	Strengthening of *jex* Response to Training Stimuli		Stimuli for Test of Generalization of the *jex* Response		
	Training Stimuli	Association Strengths	Test Stimuli		
			A	*V*	*C*
jex response to white circle strengthened to asymptotic level of response	Bat (*Ba*)** (96)	High (*H*) (48)	(16)	(16)	(16)
		Low (*L*) (48)	(16)	(16)	(16)
	Bird (*Bi*) (96)	High (*H*) (48)	(16)	(16)	(16)
		Low (*L*) (48)	(16)	(16)	(16)

*The numbers in parentheses indicate the number of *S*s administered the particular condition.

**Henceforth, each one of the 12 training groups will be designated by combinations of the symbols in parentheses and a letter for one of the test stimuli. Thus, *Ba-H-A* refers to the group trained on the bat (*Ba*) stimulus to a high (*H*) level of association strength and tested with test stimulus *A*.

bat or bird stimuli were then introduced and the *jex* response to those stimuli was trained to either low or high (asymptotic) levels of association strength. Generalization to test stimuli was then tested by substituting cards *A*, *V*, or *C* for the training stimuli on four additional trials.

As noted above, previous studies of stimulus generalization in relation to response strength failed to control for a common level of strength of associations between incidental stimuli and the criterion response (44). It was assumed that when the *jex* response to the white circle stimulus had reached asymptotic levels, associations between both the circle and incidental stimuli would be at asymptotic values. The asymptote was defined as five successive responses all within a range of response speeds of 0.25 with no evidence of an upward trend between the first and fifth trials. Reciprocals of response latencies (response speed) were used to facilitate comparisons with other learning measures (59). Since "thoughts," or subvocal activity, might differ both within and between *Ss*, all were required to repeat the sound (/m/) in a continuous fashion except when the circle or training stimuli were presented to elicit the *jex* response.

The bat and/or bird training stimuli were introduced immediately after each *S* had reached his asymptote for the *jex* response to the circle and accompanying incidental stimuli. Since the same incidental stimuli were presumably present during this second stage, any further strengthening should have been limited to the training stimuli-nonsense syllable associations. Because of the marked dissimilarity of the small white circle-black background stimulus and the training stimuli, no transfer was expected. High (asymptotic) association strength of the *jex* response to the bat or bird stimuli was again defined as five successive responses with a response speed range of 0.25 with no apparent upward trend between the first and last of those trials. Four trials with the bat or bird stimuli constituted the low strength condition.

At the conclusion of training to high or low levels of association strength, one-third of the *S*s in each condition were then given test stimulus *A*, another third *V*, and the remainder *C* for four successive trials. Since instructions were to make the *jex* response to the specific bird or bat stimulus, the subsequent introduction of test stimuli *A*, *V*, and *C* tested generalization of that response.

All *S*s were brought to the experimental room individually. The instructions to each were as follows:

> This is a study of verbal reaction time. The apparatus before you is equipped with a padded opening through which you may look into the interior of the apparatus. Inside the apparatus is a floodlight which will enable you to see a figure at the far end of the apparatus. As soon as you see the figure you are to respond as rapidly as you can. When you do, your voice will be picked up by the microphone in front of you, the floodlight will go out and one trial will be completed. Let's adjust the apparatus so that you can comfortably keep your forehead in contact with the padded opening.
>
> Specifically now, here is what you are to do. When I tell you to, start making the sound /ʍ/, /ʍ/, /ʍ/ in a soft voice. (*E* demonstrates.) You will then hear a click. This is a warning signal that the floodlight will soon go on. A red light will also go on when you hear the click, but if you are in position you will be unable to see it--all you will see is a red

glow around you--so listen for the click. A short time after the click then, the floodlight will go on and you will see a simple figure, a white circle. As soon as you see this figure, respond JEX. (A card with *jex* printed on it was shown to S.) Your response, *jex*, will turn off the flood and that will be one trial. After you respond, start making the sound /μ/ again, and continue to make this sound until you see the figure.

We shall continue this for a few trials and then you will see the figure of a Bat (Bird). As soon as you see the Bat (Bird) figure, and each time you see it, respond *jex*, as rapidly as you can. Remember, between all trials, make the sound /μ/ right up until the time you see the figure. Any questions?

Results

Strengthening of jex response to incidental stimuli.--The asymptotic level of strengths of associations between incidental stimuli and the *jex* responses was determined individually for each *S* of each of the 12 experimental groups. Shown in the first two columns of Table 2 are means and standard deviations of number of trials required by *S*s of each group to reach the defined asymptote of five successive responses with speeds all within a range of 0.25 and with no apparent upward trend between the first and fifth of those trials.

Table 3 summarizes the analysis of variance test of the hypothesis that differences among the 12 means of trials to asymptotic levels were due to sampling errors. Since the *F* of 1.73 did not reach the .05 level the null hypothesis was not rejected; that is, the observed differences were attributed to chance factors.

Table 2 also shows the means and standard deviations of response speeds for *S*s of each group on each of their five asymptotic trials. These means are all above the mean of 1.80 for all *S*s on the first trial. The first question of interest is whether the definition of asymptotic strength employed actually resulted in differences among means of response speeds on the five asymptotic trials which, for each group separately and over-all groups, differed no more than would be expected on the basis of sampling errors. That this was the case is indicated by the nonsignificant *F*'s for the main effects of trials and the interaction of trials

Table 2

Means and Standard Deviations of Trials to Asymptotic Levels and of Speeds of Responses to Incidental Stimuli on each of the Five Asymptotic Trials and Averaged over the Five Asymptotic Trials

Training Groups	Trials to Asymptote		Asymptotic Trials										Average for Trials 1-5	
			1		2		3		4		5			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Ba-H-A*	3.75	3.23	2.46	0.38	2.48	0.37	2.47	0.42	2.51	0.35	2.54	0.39	2.49	0.38
Ba-H-V	2.69	2.35	2.69	0.30	2.78	0.48	2.67	0.38	2.66	0.48	2.69	0.14	2.70	0.43
Ba-H-C	2.81	2.79	2.35	0.35	2.26	0.34	2.39	0.48	2.37	0.28	2.30	0.38	2.33	0.38
Bi-H-A	5.25	4.25	2.53	0.63	2.47	0.67	2.54	0.60	2.47	0.53	2.49	0.51	2.50	0.59
Bi-H-V	4.13	3.44	2.61	0.41	2.43	0.52	2.61	0.39	2.59	0.36	2.57	0.34	2.58	0.41
Bi-H-C	3.81	3.47	2.57	0.30	2.47	0.26	2.54	0.25	2.63	0.31	2.59	0.32	2.56	0.30
Ba-L-A	5.19	4.60	2.47	0.53	2.40	0.51	2.45	0.49	2.44	0.46	2.42	0.46	2.43	0.49
Ba-L-V	4.25	3.96	2.44	0.34	2.54	0.47	2.51	0.44	2.62	0.45	2.61	0.38	2.54	0.43
Ba-L-C	2.50	2.46	2.34	0.51	2.36	0.56	2.34	0.47	2.33	0.46	2.31	0.47	2.34	0.51
Bi-L-A	4.31	3.31	2.56	0.44	2.59	0.47	2.60	0.51	2.63	0.47	2.56	0.47	2.59	0.47
Bi-L-V	4.56	4.17	2.37	0.51	2.46	0.46	2.54	0.52	2.52	0.59	2.52	0.48	2.48	0.52
Bi-L-C	4.50	4.25	2.19	0.42	2.02	0.36	2.12	0.43	2.11	0.41	2.08	0.31	2.10	0.39

*See Table 1 for explanation of labels.

Table 3

Analysis of Variance of Trials to Asymptotic Speeds of Response to Incidental Stimuli

Source	*df*	*SS*	*ms*	*F*
Groups	11	149.69	13.61	1.73
Within	180	1416.18	1.87	
Total	191	1565.87		

and groups obtained in the Lindquist (53) mixed design (type I) analyses of variance summarized in Table 4. Thus, the asymptote criteria were sufficiently stringent to eliminate any further upward trend in response speeds.

Whether the groups reached the same asymptotic levels is also of concern. In order to show these levels in response speed values comparable to those for each of the five trials separately, asymptotic levels were obtained by averaging Ss response speeds over their last five trials. Means and standard deviations of these values for each group are presented in the last two columns of Table 2. Although based on totals of response speeds on all five trials the F for groups of the analysis of variance of Table 4 provides an appropriate test of the hypothesis of no differences among asymptotic levels of the 12 groups. The obtained value of 2.05 indicates that the observed differences would have occurred by chance about once in 20 times. While some systematic factor may have accounted for these differences, examination of procedures of assignment to the groups and of treatment of Ss during the first stage of their training failed to disclose any such factor(s).

Whatever the bases of the observed differences it seems likely that their effects were primarily on the Bi-L-C (Bird-Low Association-Test Figure C) group whose mean of 2.10 was farthest from the general mean of 2.47 for all groups. Elimination of this group resulted in an F which was no longer significant. Thus the unusually slow speeds of some of the Ss in the Bi-L-C group

Table 4

Analysis of Variance of Speeds of Response to Incidental Stimuli on Asymptotic Trials

Source	df	SS	ms	F
Between Ss	191	190.24		
(B) Conditions	11	21.22	1.93	2.05*
Error (between)	180	169.02	0.94	
Within Ss	768	20.69		
(A) Training Trials	4	0.20	0.050	1.90
A X B	44	1.59	0.036	1.36
Error (within)	720	18.92	0.026	
Total	959	210.93		

*Significant at the .05 level.

were probably the most important source of the significant F for differences among asymptotic levels for all 12 groups. As will be noted below, however, at the termination of the second phase of the experiment this group did not differ from the other five groups given similar treatment in the first two stages. It seems doubtful, therefore, that the slight and barely significant differences among speed of responses to incidental stimuli had any effects on performance during the second and third stages of the experiment.

Strengthening of jex response to training stimuli.--The asymptotic level of strengths of association between training stimuli and the jex responses was determined individually for each S of each of the six high association groups. Shown in the first two columns of Table 5 are means and standard deviations of number of trials required by Ss of each of these groups to reach the defined asymptote of, again, five successive responses with speeds all within a range of 0.25 and with no apparent upward trend between the first and fifth of those trials.

Table 6 summarizes the analysis of variance test of differences among means of trials to asymptotic levels. Since the F of 2.00 was not significant the null hypothesis was not rejected. Thus, the jex response was strengthened at the same rate in all groups.

Means and standard deviations of response speeds on each of the five asymptotic trials for the high association groups are also presented in Table 5. On the fourth trial, mean speeds for

Table 5

Means and Standard Deviations of Trials to Asymptotic Levels and of Speeds of Responses to Training Stimuli on each of the Five Asymptotic or Four Training Trials and Averaged over the Five Asymptotic or Four Training Trials

Training Groups	Trials to Asymptote		Asymptotic Trials										Average for Trials 1-5 or 1-4	
			1		2		3		4		5			
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Ba-H-A	1.81	2.82	2.63	0.23	2.62	0.16	2.57	0.31	2.60	0.40	2.74	0.39	2.63	0.32
Ba-H-V	2.50	2.70	2.78	0.27	2.73	0.21	2.85	0.46	2.82	0.44	2.76	0.41	2.79	0.38
Ba-H-C	3.06	3.82	2.44	0.49	2.56	0.51	2.54	0.52	2.56	0.47	2.53	0.47	2.53	0.49
Bi-H-A	1.94	2.16	2.54	0.62	2.56	0.65	2.58	0.63	2.55	0.63	2.48	0.67	2.54	0.64
Bi-H-V	2.25	2.85	2.74	0.30	2.69	0.28	2.66	0.30	2.65	0.25	2.71	0.33	2.69	0.29
Bi-H-C	4.50	4.45	2.65	0.42	2.73	0.32	2.65	0.30	2.71	0.34	2.71	0.31	2.69	0.36
Ba-L-A	The six low association groups had only four trials with the training stimuli.		2.43	0.55	2.49	0.63	2.53	0.48	2.48	0.52			2.48	0.56
Ba-L-V			2.64	0.63	2.41	0.45	2.61	0.48	2.46	0.47			2.53	0.52
Ba-L-C			2.14	0.68	2.29	0.44	2.26	0.47	2.44	0.56			2.28	0.56
Bi-L-A			2.36	0.75	2.54	0.64	2.58	0.48	2.50	0.51			2.49	0.60
Bi-L-V			2.44	0.64	2.46	0.49	2.56	0.43	2.57	0.48			2.51	0.52
Bi-L-C			2.21	0.57	2.23	0.47	2.27	0.40	2.36	0.47			2.27	0.48

Table 6

Summary of Analysis of Variance of Trials to Asymptotic Speeds of Response to Training Stimuli

Source	*df*	*SS*	*ms*	*F*
Groups	5	79.68	15.94	2.00
Within	90	718.31	7.98	
Total	95	797.99		

the low association groups (Table 5) were still below the asymptotic level.

None of the _F_'s (Table 7) obtained in the Lindquist (53) mixed-design (Type I) analysis of differences among means, for asymptotic trials for the high association groups and training trials for low association groups, was significant. It was concluded therefore, that the six high and six low association conditions formed two homogeneous groups. _Ss_ comprising the six low association conditions, however, were responding more rapidly with each presentation of the stimulus and the response speeds of all groups were increasing at essentially the same rate.

Since there were no differences among the six high and among the six low strength groups their means for the five asymptotic and the four training trials, respectively, have been combined to obtain the two markedly different curves plotted in Fig. 1.

Values for asymptotic levels of the high association groups were obtained by averaging response speeds on the five asymptotic trials. Means and standard deviations of these values are shown in the last two columns of Table 5. The general mean or asymptote of 2.65 for these groups was significantly higher (t - 4.50; $p <.01$ for 190 _df_) than the general asymptotic level of 2.47 for response speeds to incidental stimuli. The t of 4.10 for the difference between the asymptote of 2.65 and the general mean of 2.47 for the last trial of the low association groups was highly significant ($p <.01$ for 190 _df_). Thus, as suggested by

Table 7

Analyses of Variance of Speeds of Responses to Training Stimuli for High (Asymptotic) and Low Association Groups

Source	High Association				Low Association			
	df	*SS*	*ms*	*F*	*df*	*SS*	*ms*	*F*
Between *S*s	95	85.98			95	83.45		
(B) Conditions	5	2.87	0.57	0.63	5	4.44	0.89	1.01
Error (between)	90	83.11	0.92		90	79.01	0.88	
Within *S*s	384	13.09			288	33.76		
(A) Trials	4	0.03	0.007	0.20	3	0.68	0.23	1.92
A X B	20	0.55	0.027	0.77	15	1.60	0.11	0.92
Error (within)	360	12.51	0.035		270	31.48	0.12	
Total	479	99.07			383	117.21		

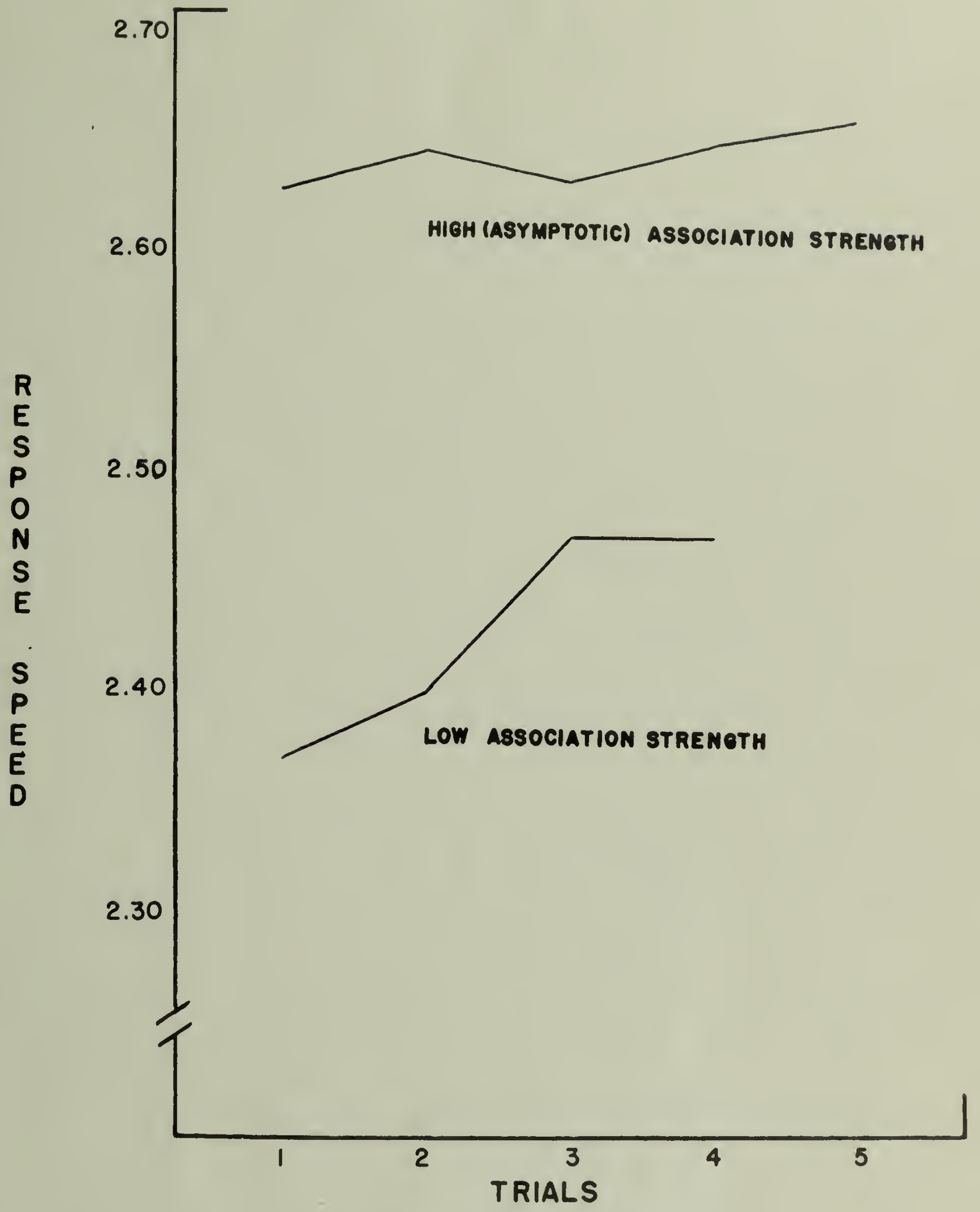

Fig. 1. Means of response speeds for the five asymptotic and four training trials, respectively.

Fig. 1, it can be concluded that the low association level groups had not yet reached the response speed asymptote.

Test for generalization of jex response.--Frequency of occurrence of the trained response to test stimuli on each test trial has often been used as a response measure. However, in this study, response speeds were the measure of primary interest since Ss overwhelmingly generalized the jex response to the test stimuli. Table 8 summarizes responses by type given to the test stimuli over the four test trials. Although none of the Ss gave the response "bird," this category is included because one of the training stimuli was a "bird." On the first test trial then, only two Ss failed to give the jex response. Eighteen Ss failed to give this response on the second trial, seventeen on the third trial, and only nine on the fourth trial. There were no differences in response frequencies among conditions and/or among test trials.

Means and standard deviations of speeds of response on each test trial and averaged over the four test trials are presented in Table 9 for 16 groups.[5] Twelve of these are the groups which were trained to high or low levels of strength of response to the bird or the bat stimulus and then tested on one of the three stimuli of decreasing similarity to the training stimuli. The other four groups, designated by asterisks, are synthetic groups which

---

[5] When responses other than the jex response occurred their latencies were used to compute response speeds. Latencies of five sec. were substituted when a response failed to occur.

Table 8

Type and Frequency of Occurrence of Responses to Test Stimuli on each Test Trial and for all Four Trials

Trial	*jex*	Bat	Bird	Other	No Response
1	190	0	0	0	2
2	174	3	0	3	12
3	175	4	0	10	3
4	183	2	0	5	2
1-4	722	9	0	18	19

Table 9

Means and Standard Deviations of Speeds of Response to Training and Test Stimuli on each Test Trial and Averaged over the Four Test Trials

Training Group	Test Trials								Average for Trials 1-4	
	1		2		3		4			
	M	SD	M	SD	M	SD	M	SD	M	SD
Ba-H-Ba*	2.60	0.36	2.66	0.50	2.67	0.40	2.73	0.45	2.67	0.47
Ba-H-A	2.46	0.40	2.53	0.54	2.55	0.46	2.55	0.41	2.52	0.46
Ba-H-V	2.43	0.65	2.29	0.68	2.55	0.64	2.52	0.65	2.45	0.66
Ba-H-C	2.44	0.58	1.79	0.74	2.13	0.54	2.10	0.51	2.11	0.64
Bi-H-Bi*	2.69	0.58	2.67	0.47	2.64	0.59	2.63	0.57	2.66	0.65
Bi-H-A	2.49	0.67	2.23	0.62	2.49	0.61	2.37	0.43	2.39	0.60
Bi-H-V	2.24	0.76	1.89	0.79	2.13	0.51	2.41	0.64	2.17	0.71
Bi-H-C	2.49	0.40	1.73	1.04	1.86	0.83	1.96	0.75	2.01	0.86
Ba-L-Ba*	2.56	0.54	2.54	0.57	2.67	0.52	2.64	0.52	2.60	0.65
Ba-L-A	2.31	0.49	2.15	0.63	2.41	0.50	2.50	0.47	2.34	0.54
Ba-L-V	2.42	0.74	1.67	0.90	2.09	0.51	2.19	0.69	2.09	0.77
Ba-L-C	2.11	0.74	1.64	0.78	1.74	0.64	2.07	0.55	1.89	0.71
Bi-L-Bi*	2.47	0.43	2.60	0.47	2.70	0.53	2.64	0.46	2.60	0.54
Bi-L-A	2.61	0.51	2.50	0.56	2.45	0.54	2.45	0.58	2.50	0.55
Bi-L-V	2.54	0.64	1.69	0.89	2.03	0.51	2.01	0.71	2.07	0.77
Bi-L-C	2.18	0.47	1.47	0.79	1.77	0.61	1.89	0.77	1.83	0.72

*Synthetic groups, whose basis is explained in the text.

were formed to provide comparison values for response speeds to training stimuli at asymptotic levels and for four training trials beyond those administered to low association groups.

The rationale for their formation and inclusion is as follows. Since the asymptotic level criterion provided reasonable assurance that no further increases in response speed would occur it was unnecessary to include additional bat and bird training groups to which four post-strengthening trials with those same stimuli were administered. Also, response speeds of those same Ss on their fifth, sixth, seventh, and eighth training trials would be equivalent to four trials with the training stimuli beyond the four trials which defined low association strength.

Use of the high strength Ss in this fashion, however, introduces statistical problems. If response speeds for additional trials with the training stimuli are included with those for responses to test stimuli, there will be correlations between response speeds of some cells and not between those of other cells. Unless the effects of these correlations are removed from the error terms the probability of a Type II error will be increased. One way to avoid this difficulty of related and independent measures, however, precludes an over-all analysis of variance involving stimuli, levels of association strength, and test trials. The first step of this alternative approach would be a three-dimensional analysis of the effects of stimuli, strengths of association and test trials factors for the 12 independent experimental groups. Analyses of variance for related measures would be used to compare asymptotic response speeds to the training stimuli with response speeds to test stimuli A, V, and C for Ss trained to high levels of association strength. Response speeds on the fifth, sixth, seventh, and eighth training trials with the bird or bat stimuli would be compared with response speeds to A, V, and C stimuli following low association strength training. Measures in cells for stimuli and response strengths would be independent.

The technique of analysis finally adopted was a compromise which minimized any possible increase in the probability of a Type II error while permitting an analysis of variance involving response speeds to training and test stimuli for high and low association strengths over all four test trials.

The first step consisted of summing response speeds on the fifth, sixth, seventh, and eighth trials for each of the 48 Ss of the three groups learning the jex response to the bat stimulus to a high level of association strength. These totals were arranged in an array from highest to lowest response speeds and then divided into three sub-groups of 16 Ss each by an I, II, III, III, II, I, etc. technique in which all I's were in one subgroup, all II's in a second subgroup, and all III's in the third subgroup. The same technique was used for obtaining three subgroups of 16 Ss each from among Ss whose training was with the bird stimulus. Table 10 shows the means and standard deviations of response speeds for these I, II, and III subgroups of Ss trained with the bat or bird stimuli averaged over trials five, six,

Table 10

Response Speed Means and Standard Deviations of High Association Training Group after Ranking to Obtain Control Conditions

Control Condition	Assignment after Ranking					
	I		II		III	
	M	SD	M	SD	M	SD
Bat-High-Bat	2.64	.65	2.67	.50	2.67	.47
Bird-High-Bird	2.66	.67	2.62	.54	2.64	.45
Bat-Low-Bat	2.60	.65	2.63	.51	2.63	.51
Bird-Low-Bird	2.62	.58	2.60	.54	2.61	.41

seven, and eight and over the last four asymptotic trials. Average response speeds over trials five, six, seven, and eight for the six subgroups are essentially equal as are the average response speeds per trial for the last four asymptotic trials. Subgroup II, composed of Ss trained with the bat stimulus was selected at random to provide response speeds to the bat stimulus for Ss trained to high strength on that stimulus. Subgroup I was then selected to provide values for the fifth, sixth, seventh, and eighth trials with the bat stimulus. In similar fashion, subgroups I and II of Ss trained with the bird stimulus were used as estimates of response speeds to bird stimuli for training to high and low strengths, respectively. Means and standard deviations of the response speeds for these subgroups were then computed for each of the last four asymptotic trials or for trials five, six, seven, and eight separately; these are the values presented in Table 9 for the four synthetic groups.

Since the Ba-H-Ba subgroup consisted of only 16 of the 48 Ss who were trained to high response strength to the bat stimulus, any correlation with response strengths for the Ss of this group would involve only one-third of the measures in the Ba-H-A, Ba-H-V, and Ba-H-C cells. This would also be the case for Ss trained to low strength of response to the bat stimulus and high and low levels of strength for the bird stimulus. Since different subgroups were used to provide values for the last four asymptotic values and for the fifth, sixth, seventh, and eighth trials those cells would be independent. Such drastic reductions in the number of correlated measures should render inconsequential any increase in the probability of a Type II error which might have resulted from failure to allow for related measures.

Table 11 summarizes a mixed-design (53) analysis of variance in which training stimuli, test stimuli, response strengths, and their interactions have been considered "between Ss" sources of variance; trials and interactions involving this factor are the "within Ss" sources of variance. The main effects of association level, test stimuli, response strengths, and trials were significant at from $<.05$ to $<.01$ levels but bat and bird training stimuli had no differential effects. Accordingly, the latter factor was disregarded in obtaining values for Fig. 2 which shows response speeds to the training stimuli and A, V, and C test stimuli for high and low levels of association strength. For both levels the decline in speed from the training stimuli to test stimulus C is regular and all points for the high association strength gradient lie above those for low strength. Because the interaction of these two variables was not significant it can be concluded that, at least for these particular stimuli, when associations to incidental stimuli are brought to asymptotic levels, strength of association between training stimuli and response effects absolute but not relative amounts of generalization.

The significant F's for trials, and particularly for the interaction of trials with stimuli and with both stimuli and strengths of response, suggests a more complex patterning of

Table 11

Lindquist Mixed Design (Type III) Analysis of Variance for Level of Association, Training Stimuli, Test Stimuli, and Test Trials

Source	df	SS	ms	F
Between Ss	255	320.01	1.25	
(B) Association Level	1	4.43	4.43	4.34*
(C) Training Stimuli	1	0.77	0.77	
(D) Test Stimuli	3	65.51	21.84	21.41**
B X C	1	1.38	1.38	
B X D	3	1.84	0.61	
C X D	3	1.14	0.38	
B X C X D	3	0.98	0.33	
Error (between)	240	243.96	1.02	
Within Ss	768	161.92	0.21	
(A) Test Trials	3	12.28	4.09	22.47*
A X B	3	0.41	0.14	
A X C	3	1.03	0.34	
A X D	9	11.22	1.25	6.87**
A X B X C	3	0.45	0.15	
A X B X D	9	3.68	0.41	2.25*
A X C X D	9	0.51	0.06	
A X B X C X D	9	1.47	0.16	
Error (within)	720	130.87	0.18	
Total	1023	481.93		

*Significant at $< .05$

**Significant at $< .01$

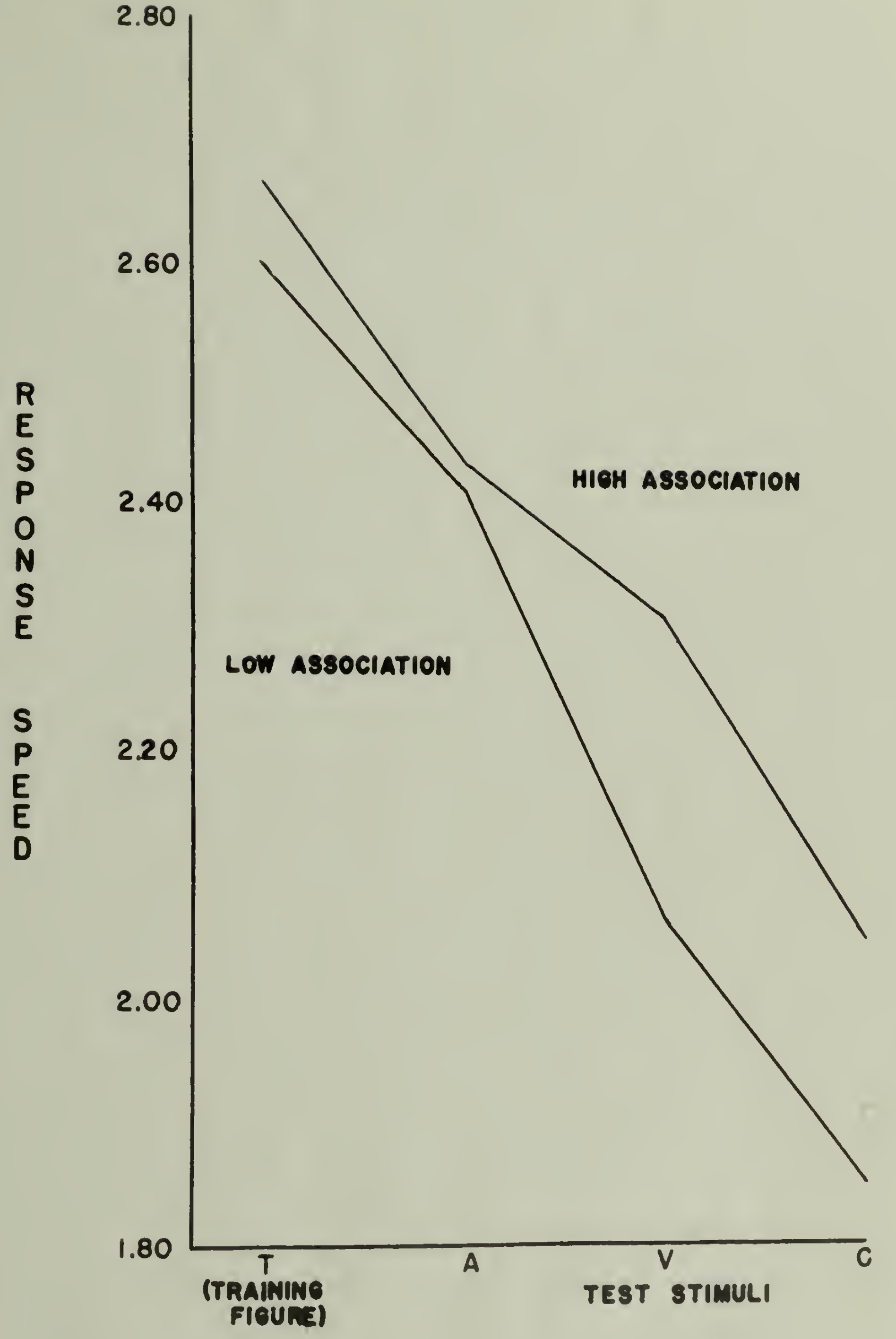

Fig. 2. Generalization of response speeds to test stimuli for high and low association strengths.

relationships between association level, test stimuli and test trials. Figs. 3a and 3b provide a somewhat clearer picture of the nature of these relationships than Table 9. The former figure shows response speeds to training and test stimuli following training to high association levels on each of the four test trials separately. Fig. 3b shows the same relationships for low levels of association strength.

The gradients on trial one for both levels are relatively flat. Table 12 summarizes an analysis of the effects of test stimuli and association strength for only this trial. Neither factor nor their interaction was significant. Thus, on the first test trial, there was not only no decline in response speed as a function of decreasing similarity but the gradients for both levels of association strength were the same.

For both levels of strength the most precipitous decline occurred on the second test trial so that these curves were clearly below the corresponding curves of the first trial. The analysis of variance for only the second trial (Table 12) indicates that the decline due to decreasing similarity of stimuli was highly significant with the gradient for high association strength significantly above, though parallel with, the trend for low association strength. The third trial gradients lie above those for trial two but below those for the first trial. This increase continued for trial four so that the gradient on that trial for the high association level group tended to overlap the first trial gradient. The fourth trial curve for low association strength

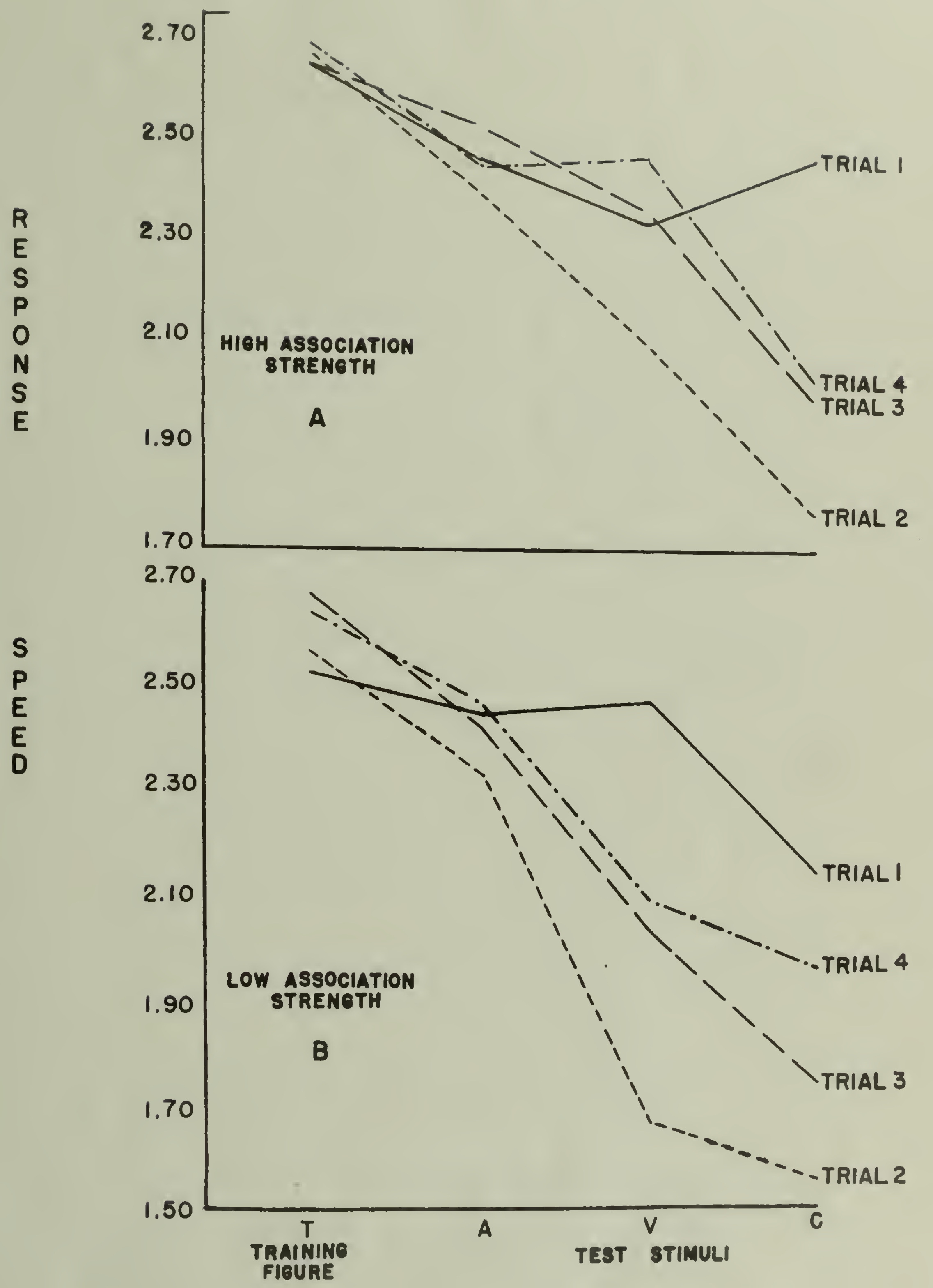

Fig. 3. Generalization of response speeds to test stimuli for high (A) and low (B) association strengths on each test trial.

Table 12

Analyses of Variance of the Effects of Test Stimuli and Strength of Association on the Four Test Trials Separately

	Test Trial 1				Test Trial 2			
Source	df	SS	ms	F	df	SS	ms	F
(D) Test Stimuli	3	2.50	0.83	2.44*	3	36.37	12.12	24.40**
(B) Association	1	0.42	0.42	1.23	1	2.30	2.30	4.63*
D X B	3	1.88	0.63	1.85	3	1.16	0.39	0.79
Error (within)	248	84.81	0.34		248	123.19	0.50	
Total	255	89.61			255	163.02		
	Test Trial 3				Test Trial 4			
(D) Test Stimuli	3	23.12	7.71	23.04**	3	14.78	4.93	13.81**
(B) Association	1	1.35	1.35	4.03*	1	0.76	0.76	2.13
D X B	3	0.99	0.33	0.99	3	1.44	0.48	1.34
Error (within)	248	82.99	0.33		248	88.48	0.36	
Total	255	108.45			255	105.46		

*Significant $<$ .05

**Significant $<$ .01

was still below that for the first trial.

There were significant declines with decreasing similarity on the second and third trials but by trial four the difference between high and low association strengths was no longer significant (Table 12).

The significant main effect of trials reflected the decline in response speeds between the first and second test trials which was reversed for test trials three and four. The interaction of test stimuli and test trials probably arose from the nonsignificant effect of test stimuli on the first test trial, the marked decline associated with test stimuli on the second test trial, and the progressively less steep generalization gradients of the third and fourth test trials.

The significant triple interaction of test stimuli, association strengths, and test trials is due to the interaction of test stimuli and test trials in combination with the lack of significant effects of association strengths on the first and fourth trials and significant effects of that factor on the second and third test trials.

Discussion

Stimulus generalization from complex, familiar figures.--In the present study strength of association between complex, familiar, visual stimuli--silhouettes of a "bat" and a "bird"--and a nonsense syllable response, *jex*, were increased experimentally to two different levels. Following attainment of these levels, three stimuli of decreasing similarity to the training stimuli were introduced for four test trials. The second of the test stimuli was a solid figure version of Card V of the Rorschach. Averaged over the four test trials, response speeds decreased as similarity between training and test stimuli decreased. Bat or bird training stimuli did not influence strengthening of the *jex* response or its generalization to test stimuli. Response speeds for these two stimuli for each association level could therefore be pooled. The gradient for high association strength was significantly above that for low association strength. However, the two gradients were parallel. There was no evidence that frequency of the *jex* response decreased with decreasing similarity of the test stimuli or was affected by training stimuli or association strength. Thus, stimulus generalization occurred with both response speed and frequency measures. However, since differential effects of test stimuli and association strengths were demonstrated only with response speed, this would appear to be the more sensitive and hence the more satisfactory measure.

Previous studies (43,78) of the influence of association strength failed to control for the influence of strength of associations between incidental stimuli and the criterion response. It was inappropriate, therefore, for those investigators to have drawn any conclusions regarding the relationship between association strength and either absolute or relative amounts of generalization. In the present study associations between incidental stimuli and the jex response were brought to asymptotic levels before the introduction of training with the bat or bird figures. Accordingly, any differences obtained on the generalization test trials could be attributed only to differences in association strength with respect to the training stimuli. Since the two gradients were parallel the conclusion can be drawn that, at least for these particular stimuli, association strength influences only the absolute amount of generalization. This is contrary to interpretations advanced by Razran (70), Hovland (39), and Margolis (59).

These conclusions, however, hold only for response speeds averaged over the four test trials. Examination of response speeds on each test trial separately and of changes in response speeds over the four test trials suggests that descriptive or interpretive statements based on averages over the four test trials, as well as for any of these trials considered individually, may embody conclusions which are only approximately correct. Three problems in particular arise from differences between the results for all four trials and those for each trial separately, from differences among the four test trials, and/or from differences between those trials and results of comparable studies of generalization.

The first problem is that raised by the failure to obtain falling gradients on the first test trial along with no difference between those gradients for high and low levels of association strength. The relatively standard procedure of introducing test stimuli without having informed Ss that this would happen was followed here. After the first test trial, however, though the critical cues on that trial are not known, some Ss may have recognized that the stimulus had been changed. This recognition would presumably have taken the form of responses such as "what's happened," "something's changed," "it's not the same," etc. These responses might have had further consequences in the form of shifts in general body posture, receptor orientation, or self-instructions which, despite the precautions employed to keep such responses relatively constant from trial-to-trial, would be discriminably different from the responses made by Ss under training conditions. The incidental stimuli produced by these responses would be new and hence not yet conditioned to the criterion response. The stimulus complex of the second and further test trials would then have differed from that of the training trials with respect to incidental-stimulus as well as test-stimulus components.

Because of the possible introduction of reactions to the first test trial and their further consequences as part of the conditions of subsequent test trials some investigators (e.g. 32) have regarded the first trial as the most important, if not the only one, for ascertaining the form of gradients of generalization for differences between training and test stimuli. Accordingly, the falling gradient which was obtained for all four test trials may have been due to changes which arose as a result of Ss' reactions to the first test trial and also to the second and third of those trials.

Either of two factors might have produced the relatively flat gradients of the first trial. One is that the training and test stimuli were too similar for any marked falling off of response speeds to have occurred. An indirect test of this explanation would be to see if even more dissimilar test stimuli would yield decrements in response speeds on this trial. Alternatively, the test stimuli may have constituted such a small proportion of the entire stimulus complex conditioned to the criterion response that introduction of test stimuli produced changes whose detection would have required a much more reliable response measure.

Since a number of investigators (13,38,39,44,61) had obtained flat gradients on the first test trial, this result was not entirely unexpected. And, in fact, the explanation in terms of incidental stimuli summarized above was first proposed by Hull (42) a number of years ago to account for this phenomenon. At present, unfortunately, no criteria exist for ascertaining the proportions of stimulus compounds to be attributed to training stimuli and to incidental stimuli during acquisition and to test stimuli and incidental stimuli on the first test trial. Therefore, whether or not flat or falling gradients will be obtained on the first test trial can neither be predicted nor even accounted for except by conjecture after they have been obtained. The situation is further confused by the results of a recent well designed study (32) in which a falling gradient was obtained on only the first trial. How this falling gradient and the flat gradient on the present and other studies are to be reconciled can only await further procedural refinements and experimental findings.

Response speeds to test stimuli on the second trial were below those for any of the other test trials as well as below comparable points for the four trial averages. Not only were the steepest gradients for both levels of association strength obtained on this trial, but also the gradient for high association strength was most strikingly above that for low association strength. The second problem, therefore, is to account for these differences between the results for the second trial and those for all four test trials as well as for the other trials individually.

The second trial gradients may have been due to direct effects of dissimilarity between training and test stimuli and levels of association strength. The explanation which seems most consistent with the findings for the other three trials, however, is that stimulus dissimilarity and association strength determined the second trial gradients only indirectly through changes in the similarity of the incidental rather than the test stimuli. As suggested above, changes in postural, receptor orienting, and self-instructing responses may have occurred following presentation of dissimilar test stimuli on the first test trial. The extent of such shifts and, therefore, of dissimilarity between the incidental stimuli of training and test trials might well have increased with decreasing similarity of training and test stimuli and for diminishing association strength. Such changes would account for the appearance of downward gradients on the second test trial which varied with level of association strength. In fact, since the test stimuli were the same through all four test trials any account of the differences among gradients for the same association strength for those trials must appeal to changes in some other events. The suddenness of the shift argues against any changes in the strength of associations which are viewed as cumulative. Furthermore, the general pattern of the shift was consistent with what would have been expected for changes in the similarity of stimuli. It seems reasonable, therefore, to identify those "other events" as the incidental stimulus components of the stimulus complex.

The assumption that new incidental stimuli were present on the second trial provides a seemingly adequate solution to the third problem, that of accounting for the increases in response strength from the second to the fourth test trials. Since the instructions to _S_s to respond as rapidly as possible had not changed these increases merely represented the strengthening of associations between the new incidental stimuli of those trials and the _jex_ response.

Implications for the Rorschach.--Regardless of the nature of the changes underlying the generalization gradients obtained over all four test trials or on each of the four test trials individually, the findings of the present study are pertinent to theory and research concerning determinants of responses to Rorschach stimuli. First, the results of the preliminary scaling suggest that a solid-figure simplification of Card V can be placed along continua of similarity to more familiar forms such as silhouettes of "bird" and "bat." It would be desirable to confirm this finding with the actual Card V and with other Rorschach "wholes" and "details"; but there is no reason to believe that those stimuli could not also be scaled for similarity to properly selected familiar forms.

More important, interpretation of the present results required no classes of antecedent events other than stimulus similarity, number of trials, and response-produced stimuli, and no principles beyond those of stimulus generalization and of a direct relationship between trials and response speeds. That the observed gradients may have resulted from changes in incidental stimuli, and that level of association strength may have also acted through changes in incidental stimuli, does not alter this conclusion. It may be conjectured that inter-individual and, though rarely reported, intra-individual differences in responses to particular formal details of Rorschach stimuli may also be attributed in part to changes in incidental or accompanying stimuli.

In order to appreciate more fully this simplification in the number of concepts and principles necessary to provide at least an approximate explanation of the occurrence of many responses to Rorschach stimuli it is profitable to examine the interpretation of the results of a recent study which, because the independent variable consisted of an alteration of a Rorschach form, bears some resemblance to the present investigation.

The hypothesis which Kraus (49) set out to investigate was that if unstructured inkblots arouse anxiety, then greater unstructuredness should arouse more anxiety which in turn would activate "deeper unconscious processes." His stimuli were presented tachistoscopically, either in-focus ("clear") or out-of-focus ("blurred"); by definition, the latter was a condition of increased unstructuredness. Out-of-focus presentation resulted in fewer responses, more vista responses, and relatively more CF than FC responses. These three findings were interpreted as due to increased "blocking," greater anxiety, and diminished emotional control, respectively. In addition, though no figures were given, Kraus reported that Ss gave "house" or similar architectural responses to the "blurred" stimuli, while animal responses were more frequent under the "clear" condition. To explain this result he proposed that the relative increase of "house" or similar responses was a manifestation of anxiety which was so great that Ss were symbolically retreating to the warmth and shelter of their homes.

The reduction in the number of responses, as Kraus hypothesized, might have been due to increased anxiety-motivated blocking. A simpler, tentative explanation would be that blurring the stimuli made them even less similar to familiar objects, and because of decreased generalization of responses from familiar objects to the blurred stimuli, the number of responses to the blurred stimuli was reduced. Among the specific responses which he mentioned was "blur of light." It seems probable that with out-of-focus presentation the stimulus presented to Ss was highly similar to a "blur of light." Stimulus generalization would then account for this response.

If different areas of blots are differentially bright, as would be expected with a blurred presentation, some colors will appear "farther back" (83) than others and thus, more vista responses should occur on the basis of this change. This is a simple psychophysical phenomenon which seems entirely explicable in terms of changes in the stimulus. When forms or outlines have been deliberately made indistinct, CF responses should predominate over FC since the resemblance of the figures to forms has been decreased. Finally, though data are needed, it seems at least equally probable that blurring the figures made them more similar to houses and buildings seen under certain conditions, such as fog, than to animals. If so, stimulus generalization would explain the house and other architectural responses.

Unnecessary though some of the concepts and principles which Kraus used may be, his interpretation was probably more dependent on changes in stimulus factors than the accounts of response occurrences offered by most Rorschach theorists. Illustrative of this disregard for stimulus factors is the view expressed in a recent authoritative contribution to Rorschach testing (48). In essence it was argued that instead of investigating the stimulus determinants of responses to the Rorschach, the occurrence of such responses should be accepted and used as a starting point for testing the validity of the "interpretive hypotheses." Such hypotheses would take concrete form as "Do responses in which Form (F) plays a greater determinant role than Color (C) indicate controlled emotional expression?" and "Do animal movement (FM) responses reveal (among other things) the presence of less mature fantasy than human movement (M) responses?"

With respect to the Rorschach in particular, and presumably for projective tests in general, the implication to be drawn from the results of the present study is simple. It is, explanations of the occurrences of responses in terms of similarity, number of trials, and response-produced stimuli and of principles of stimulus generalization and the relationship between trials and response strength should be proposed before introducing less well, if at all, defined concepts and principles for which the supporting data are inadequate.

Summary

The present study had two objectives: (a) to demonstrate stimulus generalization from complex, familiar forms, and (b) to determine the feasibility of interpreting the occurrence of responses to stimuli of projective tests in general, and, in particular, of responses to the Rorschach stimuli in terms of the concepts and principles of general stimulus-response theory. Specifically, stimulus generalization to Rorschach-like inkblot stimuli was investigated as a function of type of training stimulus and strength of association between training stimuli and the criterion response.

The Ss were 192 undergraduates, primarily from introductory psychology courses at the University of Massachusetts. The training stimuli were silhouettes of a "bat" or a "bird," both of which were on previously established continua of similarity to three increasingly dissimilar test stimuli; the second of the test stimuli was a uniformly black version of Rorschach Card V. The training and test stimuli were presented tachistoscopically and Ss' speeds in saying "jex" were recorded.

A white dot on a black ground was the stimulus used to bring associations between incidental stimuli and the jex response to asymptotic levels before Ss learned to respond to the training stimuli. Half of the Ss trained with each stimulus were carried to a high or asymptotic level of association strength and half were trained to a low level. Immediately after training, and

with no further instructions, each of the four combinations of type-of-stimulus and strength-of-response was divided into three subgroups to each of which one of the dissimilar test stimuli were presented on four successive trials.

When averages of response speeds for all four test trials were considered, response strength decreased with decreasing similarity between test and training stimuli and the gradient for the high association strength groups was above, but parallel to, that for the low association strength groups. Type of training stimulus had no effect on learning or on generalization. When gradients for the four test trials were considered separately, however, they differed from the gradients for all four trials and from each of the other trials. On the first test trial, response speeds were the same for all test stimuli and there was no difference between association strength groups. Generalization and the greater speeds of the high association groups were most marked on the second test trial. On trials three and four the generalization pattern of reduced response strength to increasingly dissimilar stimuli was maintained. The progressive increase in response speeds to the more dissimilar stimuli from the low values on trial two, however, indicated that relearning was taking place.

Though trial to trial gradients might have reflected the direct influence of similarity between the training and test stimuli and of association strength, the preferred explanation postulated changes in the similarity of incidental stimuli. Presumably Ss reacted to the first test trial with changes in postural, receptor-orienting, and self-instructing responses which, it was hypothesized, were greater for decreasing similarity between training and test stimuli and for the low association strength groups. These changes would thus have increased the dissimilarity of the response-produced incidental stimuli of the training and first test trials and those stimuli for the last three test trials to produce the gradients observed on the second test trial. The gradual relearning of trials three and four would reflect strengthening of the *jex* response to the altered stimulus complex.

Since stimulus response concepts and principles seemed adequate to explain these results it was suggested that when responses to Rorschach stimuli in test situations are to be explained, these concepts and principles should be employed first. Only when they prove inadequate should additional, less general, and less well understood concepts and principles be postulated.

References

1. Abt, L.E., & Bellak, L. Projective psychology. New York: A.A. Knopf, 1950.

2. Andreas, B.G. Empirical gradients of generalization in a perceptual-motor task. J. exp. Psychol., 1954, 48, 119-122.

3. Anrep, G.V. The irradiation of conditioned reflexes. Proc. roy. Soc., 1925, B 94, 404-425.

4. Attneave, F. Dimensions of similarity. Am. J. Psychol., 1950, 13, 516-556.

5. Auld, F. Jr. Contributions of behavior theory to projective testing. J. proj. Tech., 1954, 18, 421-426.

6. Bass, M.J., & Hull, C.L. The irradiation of a tactile conditioned reflex in man. J. comp. Psychol., 1954, 17, 47-65.

7. Baughman, E.E. Rorschach forms with altered stimulus characteristics. J. proj. Tech., 1954, 18, 151-164.

8. Beck, S.J. Rorschach's test. Vol. I. New York: Grune & Stratton, 1944.

9. Beck, S.J. The Rorschach test; a multi-dimensional test of personality. In Anderson, H.H., & Anderson, G.L. (Eds.) An introduction to projective techniques. New York: Prentice-Hall Inc., 1951.

10. Beritoff, I.S. On the fundamental nervous processes in the cortex of the cerebral hemispheres. Brain, 1924, 47, 109-148.

11. Blackwell, H.R., & Schlosberg, H. Octave generalization, pitch discrimination, and loudness thresholds in the white rat. J. exp. Psychol., 1943, 33, 407-419.

12. Britt, S.H. Tonal sensitivity in the white rat. J. comp. Psychol., 1935, 19, 243-264.

13. Brown, J.S. The generalization of approach responses as a function of stimulus intensity and strength of motivation. J. comp. Psychol., 1942, 33, 209-226.

14. Brown, J.S., Bilodeau, E.A., & Baron, M.R. Bidirectional gradients in the strength of a generalized voluntary response to stimuli on a visual-spatial dimension. J. exp. Psychol., 1951, 41, 52-61.

15. Brush, F.R., Bush, R.R., Jenkins, W.O., John, W.F., & Whiting, J.W.M. Stimulus generalization after extinction and punishment: an experimental study of displacement. J. abn. soc. Psychol., 1952, 47, 633-640.

16. Buss, A.H. A study of concept formation as a function of reinforcement and stimulus generalization. J. exp. Psychol., 1950, 40, 494-503.

17. Buss, A.H., Weiner, M., & Buss, E. Stimulus generalization as a function of verbal reinforcement combinations. J. exp. Psychol., 1954, 48, 433-436.

18. Buss, A.H. Stimulus generalization as a function of clinical anxiety and direction of generalization. J. abn. soc. Psychol., 1955, 50, 271-273.

19. Cofer, C.N., & Foley, J.P. Mediated generalization and the interpretation of verbal behavior: I. Prolegomena. Psychol. Rev., 1942, 49, 513-540.

20. Duncan, C.R. Stimulus generalization and spread of effect. Am. J. Psychol., 1951, 64, 585-590.

21. Eisen, N.H. The influence of set on semantic generalization. J. abn. soc. Psychol., 1954, 49, 491-496.

22. Ellis, A. A critique of systematic theoretical foundation in clinical psychology. J. Clin. Psychol., 1952, 8, 11-15.

23. Epstein, S., & Smith, R. Thematic apperception as a measure of the hunger drive. J. proj. Tech., 1956, 20, 372-384.

24. Eriksen, C.W. Some personality correlates of stimulus generalization under stress. J. abn. soc. Psychol., 1954, 49, 551-565.

25. Eriksen, C.W., & Hake, H.W. Multidimensional stimulus differences and accuracy of discrimination. J. exp. Psychol., 1955, 50, 153-167.

26. Gibson, E.J. Sensory generalization with voluntary reactions. J. exp. Psychol., 1939, 24, 237-253.

27. Gibson, E.J. Retroactive inhibition as a function of degree of generalization between tasks. J. exp. Psychol., 1941, 28, 93-115.

28. Gilmore, R.W. Primary stimulus generalization to a complex vocal stimulus. Ph.D. Thesis, Unpublished, University of Pittsburgh, 1951.

29. Goss, A.E., & Brownell, M. An application of stimulus-response concepts and principles to projective test behavior. _J_. _Person_., in press.

30. Grandine, L., & Harlow, H.F. Generalization of the characteristics of a single learned stimulus by monkeys. _J_. _comp_. _physiol_. _Psychol_., 1948, 41, 327-338.

31. Grant, D.A., & Dittmer, D.G. An experimental investigation of Pavlov's cortical irradiation hypothesis. _J_. _exp_. _Psychol_., 1940, 26, 299-310.

32. Grant, D.A., & Schiller, J.J. Generalization of the conditioned galvanic skin response to visual stimuli. _J_. _exp_. _Psychol_., 1953, 46, 309-313.

33. Grice, G.R. The acquisition of a visual discrimination habit following response to a single stimulus. _J_. _exp_. _Psychol_., 1948, 38, 633-642.

34. Grice, G.R., & Saltz, E. The generalization of an instrumental response to stimuli varying in the size dimension. _J_. _exp_. _Psychol_., 1950, 40, 702-708.

35. Hake, H.W., Grant, D.A., & Hornseth, J.P. Generalization and discrimination in the conditioned eyelid response to sound stimuli. _Amer_. _Psychologist_, 1948, 3, 361.

36. Harlow, H.F., & Poch, S. Discrimination generalization by macaque monkeys to unidimensional and multidimensional stimuli. _J_. _comp_. _Psychol_., 1945, 38, 353-365.

37. Hilgard, E.R., & Marquis, D.G. _Conditioning and learning_. New York: Appleton-Century-Crofts, 1940.

38. Hilgard, E.R. Methods and procedures in the study of learning. In Stevens, S.S. Ed. _Handbook of experimental psychology_. New York: Wiley, 1951.

39. Hovland, C.I. The generalization of conditioned responses: I. The sensory generalization of conditioned responses with varying frequencies of tone. _J_. _gen_. _Psychol_., 1937, 17, 125-148.

40. Hovland, C.I. The generalization of conditioned responses: II. The sensory generalization of conditioned responses with varying intensities of tone. _J_. _genet_. _Psychol_., 1937, 51, 279-291.

41. Hull, C.L. The problem of stimulus equivalence in behavior theory. _Psychol_. _Rev_., 1939, 46, 9-30.

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

43. Hull, C.L. The problem of primary stimulus generalization. Psychol. Rev., 1947, 54, 120-134.

44. Hull, C.L. Simple qualitative discrimination learning. Psychol. Rev., 1950, 57, 303-313.

45. Hull, C.L. A primary social science law. Scient. Mon., 1950, 71, 221-228.

46. Humphreys, L.G. Generalization as a function of method of reinforcement. J. exp. Psychol., 1939, 25, 361-372.

47. Ivanshina, E.A. An investigation of static irradiation of the excitatory and inhibitory processes in the auditory analyzer of children. Abstract in Psychol. Abst., 1934, 8, 72.

48. Klopfer, B., Ainsworth, J.D., Klopfer, W.G., & Holt, R.R. Rorschach technique. New York: World Book Co., 1954.

49. Kraus, A.R. Shifts in the levels of operating defenses induced by blurring of ink blot slides. J. clin. Psychol., 1956, 12, 337-341.

50. Lashley, K.S., & Wade, M. The Pavlovian theory of generalization. Psychol. Rev., 1946, 53, 72-87.

51. Lawrence, D.H., & Coles, G.R. Accuracy of recognition with alternatives before and after the stimulus. J. exp. Psychol., 1954, 47, 208-214.

52. Lawrence, D.H. The applicability of generalization gradients to the transfer of discrimination. J. gen. Psychol., 1955, 52, 37-48.

53. Lindquist, E.F. Design and analysis of experiments in psychology and education. Boston: Houghton Mifflin, 1953.

54. Littman, R.A. Conditioned generalization of the galvanic skin reaction to tones. J. exp. Psychol., 1949, 39, 868-882.

55. MacCaslin, E.F., Wodinsky, J., & Bitterman, M.E. Stimulus generalization as a function of prior training. Am. J. Psychol., 1952, 65, 1-15.

56. Macfarlane, J.W., & Tuddenham, R.D. Problems in the validation of projective techniques. In Anderson, H.H., & Anderson, G.L. (Eds.) An introduction to projective techniques. New York: Prentice-Hall Inc., 1951.

57. McClelland, B., Atkinson, J., Clark, R., & Lowell, E. *The achievement motive*. New York: Appleton-Century-Crofts, 1953.

58. McGeoch, J.A., & Irion, A.L. *The psychology of human learning*. (2nd Ed.) New York: Longmans, Green, 1952.

59. Margolius, G. Stimulus generalization of an instrumental response as a function of the number of reinforced trials. *J. exp. Psychol.*, 1955, 49, 105-111.

60. Miller, N.E. Theory and experiment relating psychoanalytic displacement to stimulus-response generalization. *J. abn. soc. Psychol.*, 1948, 43, 155-178.

61. Miller, N.E., & Dollard, J. *Social learning and imitation*. New Haven: Yale Univ. Press, 1941.

62. Miller, W.C., & Greene, J.E. Generalization of an avoidance response to varying intensities of sound. *J. comp. physiol. Psychol.*, 1954, 47, 136-139.

63. Osgood, O.E. *Method and theory in experimental psychology*. New York: Oxford Univ. Press, 1953.

64. Passey, G.E., & Herman, P.N. The shape of the discrimination gradient for two intracontinuum stimulus separations. *J. exp. Psychol.*, 1955, 49, 273-277.

65. Pavlov, I.P. *Conditioned reflexes*. London: Oxford Univ. Press, 1927.

66. Perkins, C.C., & Tilton, J.R. Changes in stimulus conditions as a determiner of "regression" in the rat. *J. comp. physiol. Psychol.*, 1954, 47, 341-343.

67. Phillipson, H. *The object relations technique*. Glencoe, Ill.: The Free Press, 1955.

68. Postman, L. The experimental analysis of motivational factors in perception. In *Nebraska symposium on motivation*. Lincoln: Univ. Nebraska Press, 1953.

69. Rapaport, D. Projective techniques and the theory of thinking. *J. proj. Tech.*, 1952, 16, 269-275.

70. Razran, G.H.S. Stimulus generalization of conditioned responses. *Psychol. Bull.*, 1949, 46, 337-365.

71. Razran, G.H.S. This reference covers a series of studies done by Razran from 1938 through 1949. For specific titles see Razran (70) and *Psychol. Rev.*, 1938, 45, 532-538; *Psychol. Rev.*, 1938, 2, 370-376; *J. gen. Psychol.*, 1939, 21, 307-330; *J. exp. Psychol.*, 1939, 24, 95-105; *J. exp. Psychol.*, 1939, 24, 202-210; *J. Psychol.*, 1939, 7, 3-16; *J. exp. Psychol.*, 1939, 24, 432-438; *Psychol. Bull.*, 1939, 36, 578; *J. genet. Psychol.*, 1940, 56, 3-11; *Science*, 1949, 109, 447-448; *J. exp. Psychol.*, 1949, 39, 642-652; *Amer. J. Psychol.*, 1949, 62, 247-256; *J. exp. Psychol.*, 1949, 39, 820-829.

72. Reinhold, D.B., & Perkins, G.C. Jr. Stimulus generalization following different methods of training. *J. exp. Psychol.*, 1955, 49, 423-427.

73. Rosenbaum, G. Stimulus generalization as a function of level of experimentally induced anxiety. *J. exp. Psychol.*, 1953, 45, 35-43.

74. Rubinstein, E.A. Personality integration and the perceptual process. *J. clin. Psychol.*, 1954, 10, 23-29.

75. Sears, R.R., Whiting, J.M.W., Nowlis, V., & Sears, P.S. Some child-rearing antecedents of aggression and dependency in young children. *Genet. Psychol. Monogr.*, 1953, 47, 135-234.

76. Schlosberg, H., & Solomon, R.L. Latency of response in a choice discrimination. *J. exp. Psychol.*, 1943, 33, 22-38.

77. Schroder, H.M., & Rotter, J.B. Generalization of expectancy changes as a function of the nature of reinforcement. *J. exp. Psychol.*, 1954, 48, 343-348.

78. Spiker, C.C. The effects of number of reinforcements on the strength of a generalized instrumental response. *Child Develop.*, 1956, 27, 37-44.

79. Tinbergen, N. *The study of instinct*. Oxford: The Clarendon Press, 1951.

80. Thompson, M. The generalization of inhibition to stimuli varying in the visual size dimension. *Amer. Psychologist*, 1950, 5, 253-254.

81. Wickens, D.D., Schroder, H.M., & Snide, J.D. Primary stimulus generalization of the GSR under two conditions. *J. exp. Psychol.*, 1954, 47, 52-56.

82. Wickens, D.D. Studies of response generalization in conditioning. I. Stimulus generalization during response generalization. _J_. _exp_. _Psychol_., 1943, 33, 221-227.

83. Woodworth, R.S., & Schlosberg, H. _Experimental_ _psychology_. (2nd Ed.) New York: Henry Holt and Co., 1954.

84. Yum, K.S. An experimental test of the law of association. _J_. _exp_. _Psychol_., 1931, 14, 68-82.

Appendix A

Abstracts of Experiments Relevant to Primary Stimulus Generalization Grouped According to Experimental Paradigm*

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
			Classical Short-Trace Conditioning			
Anrep (3) 1923	Human Adults	Physical (Spatial)	Distances apart on skin	Vibro-tactile	Magnitude of salivary CR	Falling positively accelerated gradient
Bass & Hull (6) 1934	Human Adults	Physical (Spatial)	Distances apart on skin	Vibro-tactile	Magnitude of GSR (Tarchinoff)	Falling positively accelerated gradient
Hovland (39) 1937	Human Adults	Psycho-physical	25 jnd's between stimuli	Freq. of pure tones	Magnitude of GSR (Tarch.)	Falling negatively accelerated gradient
Hovland (40) 1937	Human Adults	Psycho-physical	50 jnd's between stimuli	Intensity of pure tones	Magnitude of GSR (Tarch.)	Falling neg. accel. gradient
Humphreys (46) 1939	Human Adults	Psycho-physical	5 jnd's between stimuli	Freq. of pure tones	Magnitude of GSR (Tarch.)	Falling neg. accel. gradient
Littman (54) 1949	Human Adults	Psycho-physical	25 jnd's between stimuli	Freq. of pure tones	Magnitude of GSR (Tarch.)	Shallow falling gradient with possible zero slope
....						

*In each section all studies above the line (..........) have been taken from Gilmore (28).

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Wickens, et al (81) 1954	Human Adults	Psycho-physical	25 jnd's between stimuli	Freq. of pure tones	Magnitude of GSR	Falling pos. accel. gradient (bell-shape)
			Classical-Simultaneous Conditioning			
Beritoff (10) 1924	Dogs	Physical	Not scaled	Freq. of tones	Freq. of leg with-drawal	Generalization greater later in training. Gradient not tested.
Britt (12) 1935	Rats	Physical	Cycles per second	Freq. & intensity of tones	Freq. of respiratory CR.	Gradient not tested. Fewer R's to test stim. than to CS.
Grant & Dittmer (31) 1940	Human Adults	Physical (spatial)	Distance apart on skin	Vibro-tactile	Magnitude of GSR (Fere)	Falling neg. accel. grad.
Hake, et al (35) 1948	Human Adults			Freq. of tones	Magnitude of eyelid CR.	Greater response to similar stimuli than to CS.
Ivanshina (47) 1930	Children	Physical		Freq. of tones	Magnitude of food grasping CR	No gradient

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Pavlov (65) 1927	Dogs	Physical (spatial)	Distance on skin	Vibrotactile	Magnitude of salivary CR	Falling gradient
Pavlov's laboratory, 64 experiments reviewed by Razran (70) 1949	Dogs	Physical	Equal physical scale units apart	Freq. of metronomes, tactile, tone, light	Magnitude of salivary R as % of R to CS	Crude falling gradients
Razran (71) 1938-49	Human Adults	Physical & psychophysical	Equal scale units apart when possible	Spatial light patterns, colcr lt. patterns, musical intervals	Magnitude of salivary CR	Crude falling gradient
....						
Grant & Schiller (32) 1953	Human Adults	Physical	Area in inches	Rectangles of light	Mag. of GSR	Smooth falling gradients
Eisen (21) 1954	Human Adults	Logical	Not scaled	Written words	Mag. of GSR	No consistent gradients
			Instrumental Conditioning			
Brown (13) 1942	Rats	Physical	Illumination in apparent ft-candles	Light intensity	Reaction latency & strength of approach	Falling concave gradient

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Brown, et al (14) 1951	Human Adults	Physical	Distance in visual angle between lights	Spatial position of lights	Freq. of resp. to test stim.	Falling neg. accel. gradient
Gibson (26) 1939	Human Adults	Physical	Distances apart on skin	Vibrotactile	Freq. of verbal R	Falling neg. accel. gradient
Grice & Saltz (34) 1950	Rats	Physical	Area	White circles	Freq. of opening door	Falling gradient
Miller (60) 1948	Rats	Logical		Rat Doll Wall	Freq. of striking	Falling gradient
Wickens (82) 1943	Human Adults	Physical	Octave apart	Freq. of pure tones	Freq. of finger lifting	Very shallow, non-significant gradient
....						
Duncan (20) 1951	Human Adults	Logical	Not scaled	Adjectives of high and low similarity	Number of repeats, number of different R's	Rising and falling gradient similar to Thorndike's spread of effect
Buss (16) 1950	Human Adults	Physical-logical	Not scaled	Medium, tall & short blocks	Verbal label	Falling gradient

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Buss, et al (17) 1954	Human Adults	Physical	Not scaled	Wooden discs	Freq. of nonsense syllable R	Falling gradient
Buss (18) 1955	Human Adults	Physical	Height in inches	Wooden blocks	Freq. of nonsense syllable R	Falling gradient
Rosenbaum (73) 1953	Human Adults	Physical	Height in inches	Vertical rectangles	Simple motor	Falling neg. accel. gradient
Miller & Greene (62) 1954	Rats	Physical	Decibel readings	Buzzer intensity	Running response	Falling gradient from hi to lo; flat gradient from lo to hi
Andreas (2) 1954	Human Adults	Physical visual-spatial	Degree of arc separation	Spatial light pattern	Freq. of motor R	Rising and falling gradients around training stimulus
Eriksen (24) 1954	Human Adults	Physical	Area	Projected squares	Freq. of motor R	Falling neg. accel. gradient
Passey & Herman (64) 1955	Rats	Physical	Ft. candles	Light intensity	Running time	Falling pos. accel. gradient

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Brush, et al (15) 1952	Pigeon	Physical	Diameter in cms.	Spot of light	Pecking	Falling gradient to larger and smaller spots
		Simultaneous-Discrimination Conditioning				
Harlow & Poch (36) 1945	Monkeys	Physical		Objects varying in form, color, & size	Freq. of choice	Falling gradient
Miller & Dollard (61) 1941	Rats	Logical		White and black rats	Freq. of imitative following in maze	Falling gradient
Schlosberg & Solomon (76) 1943	Rats	Physical		Cards ranging from black to white	Mean-log of latency of jumping	Falling gradient non-sig. from straight line
....						
Perkins & Tilton (66) 1954	Rats	Physical & logical		Painted and unpainted goal boxes & T-maze stems	Freq. of choice	Falling gradient
Reinhold & Perkins (72) 1955	Rats	Physical & logical		Variations in runways	Running time	Response strength less to novel than training stimuli

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Schroder & Rotter (77) 1954	Rats	Physical		Black and white T-mazes	Freq. of correct turn	Animals receiving same reward in both mazes extinguished more rapidly
			Lashley and Wade Type Discrimination Conditioning			
Grandine & Harlow (30) 1948	Monkeys	Physical	Inches & candle power	Blocks of different heights & brightness	Freq. of choice of non-rewarded stimuli	Falling neg. accel. gradient
Grice (33) 1948	Rats	Physical	Area in inches	White circles of diff. sizes	Freq. of door opening	Falling gradient
Lashley & Wade (50) 1946	Rats	Physical & logical		Two cards with diff. symbols, brightness, size, form	Freq. of errors & no. of trials	Rising gradient
Spence* 1947	Rats	Physical		White or black alleys	Freq. of errors	Falling gradient
....						
Margolius (59) 1955	Rats	Physical	Square cms.	Circles	Reaction latency	Falling neg. accel. gradients

---

*This article is referred to by Hull (43), but evidentally it was never published.

Author	Subjects	Similarity Continuum	Scale Units	Stimuli	Response	Results
Thompson (80) 1950	Rats	Physical	Area in sq. cms.	White circles	Latency time to open door	Neg. growth function (extinction effects greater the more similar stim. was to extinguished stim.)
MacCaslin, et al (55) 1952	Rats	Physical & logical		Vertical and horiz. stripes of diff. thickness. Inverted and upright triangles	Freq. of correct choice	Neg. growth functions with diff's dependent upon difficulty of prior training
			<u>Successive-Discrimination Conditioning</u>			
Blackwell & Schlosberg (11) 1943	Rats	Physical	Cycles per second	Freq. of of tones	Freq. & latency of grid crossing	Falling gradient

Appendix B

The test stimuli used in this study were obtained by asking Ss equivalent to those used in the study to rank a series of six forms along a continuum of dissimilarity using either the silhouette of a "bat" or that of a "bird" as a standard. A simplified reproduction of Rorschach Card V was designated to serve as the midpoint in the continuum, hence, Ss were to place three forms between the standard and Card V, and three after Card V. Separate groups of 20 Ss each were used with both standard figures. The results of their rankings are shown in the table below and the figures are reproduced on the following page.

Figure Number	Standard	% of Ss Assigning Figure to Rank						
		1	2	3	4	5	6	7
I	Bat	36%	64%					
I	Bird	81%	19%					
II	Bat	64%	36%		Test Fig. A in study			
II	Bird	19%	54%	27%				
III	Bat			72%		19%	9%	
III	Bird		19%	36%		36%	9%	
IV	Bat				100%	Test Fig. V in study		
IV	Bird				100%			
V	Bat			27%		64%	9%	
V	Bird		9%	36%		46%	9%	
VI	Bat	Test Fig. C in study				19%	81%	
VI	Bird					19%	72%	9%
VII	Bat							100%
VII	Bird						9%	91%

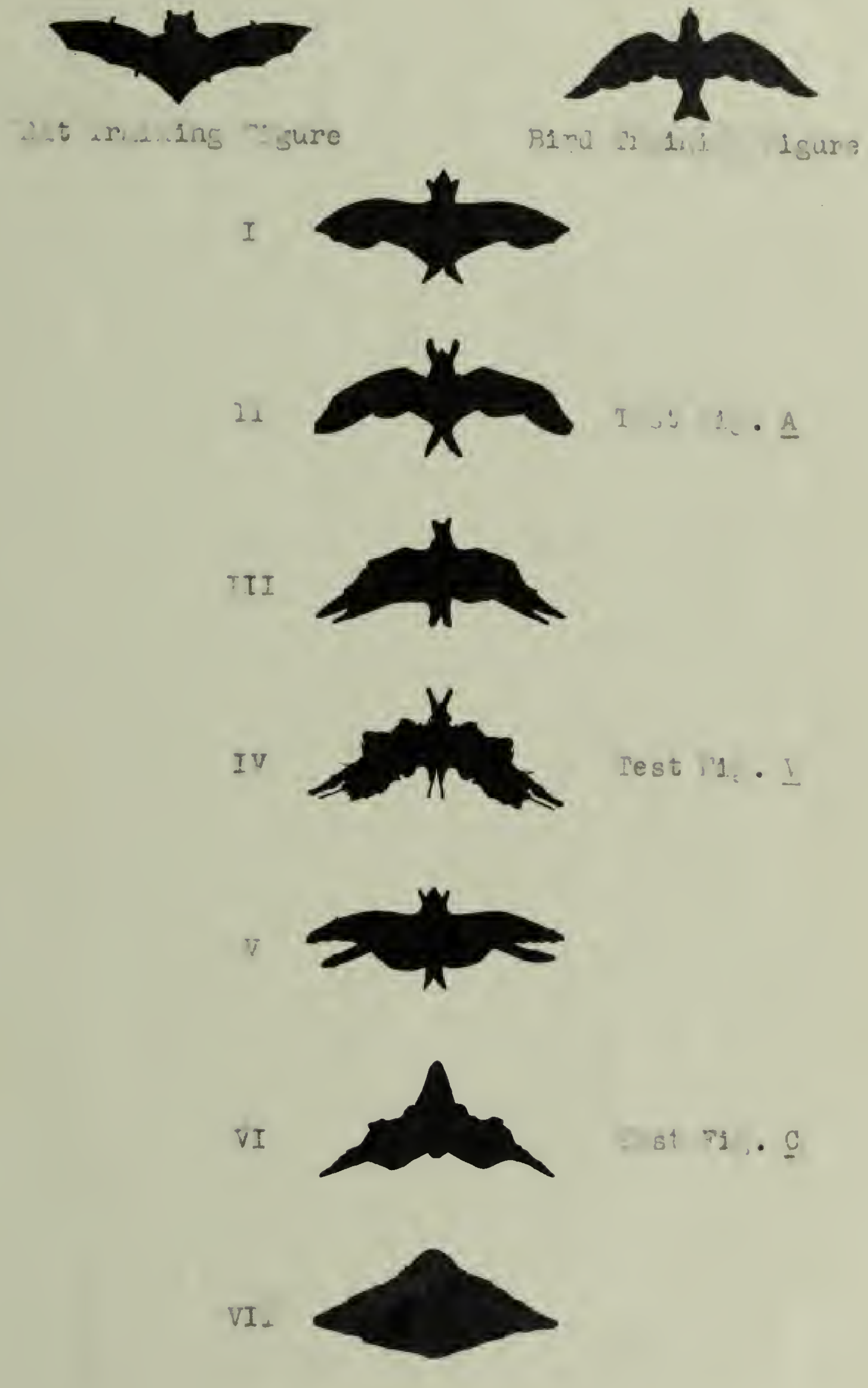

Fig. 4. Training stimuli for preliminary scalings (Roman numerals), and test stimuli.

Appendix C

Individual Response Speeds by Groups, to Test and Training Stimuli over the Four Test Trials

		Test Trials		
Ss No.	1	2	3	4
		Bat-High-Bat*		
	3.0	3.5	3.5	3.5
	2.9	3.3	3.1	3.0
	2.8	3.1	3.0	3.2
	2.9	2.7	3.0	3.3
	2.9	3.0	2.8	2.9
	2.8	3.2	2.7	2.7
	2.7	2.8	2.8	3.0
	3.0	2.4	2.7	3.0
	2.8	2.7	2.7	2.7
	2.5	2.6	2.3	2.8
	2.3	2.4	2.9	2.5
	2.5	2.5	2.4	2.4
	2.3	2.4	2.2	2.4
	2.3	2.1	2.6	2.2
	2.1	2.3	2.0	2.4
	1.8	1.5	2.1	1.7

*Asterisk indicates a synthetic group whose basis is explained in text.

Ss No.	Test Trials 1	2	3	4
		Bat-High-A		
194	2.3	2.8	3.0	2.6
192	2.1	2.7	3.0	2.5
179	2.5	2.1	2.7	2.7
166	1.7	0.9	2.0	2.1
146	2.2	2.1	2.1	2.1
126	1.6	2.6	2.1	2.1
115	2.7	2.5	2.5	2.2
103	2.5	3.0	2.6	2.8
94	2.9	3.3	2.0	2.6
76	2.8	2.3	1.6	2.1
69	2.5	2.3	2.4	2.3
51	2.7	2.9	2.9	2.5
48	2.9	2.8	2.7	2.9
31	2.5	2.6	3.1	3.5
19	3.1	3.2	3.3	3.3
8	2.3	2.3	2.8	2.5

Ss No.	Test Trials 1	2	3	4
		Bat-High-V		
196	2.7	3.3	2.7	2.7
184	2.1	2.0	2.0	1.6
180	1.9	2.5	2.5	2.5
158	2.1	1.1	2.5	2.2
147	2.7	2.7	2.7	2.8
133	3.1	2.0	2.5	2.5
122	2.8	1.9	2.2	2.8
110	2.5	2.0	2.2	3.5
102	3.4	3.4	2.7	3.0
91	2.2	3.0	2.9	2.5
79	1.3	1.6	2.7	2.1
65	3.2	2.3	3.3	3.1
52	1.3	1.2	0.8	0.8
45	2.9	3.0	3.7	3.4
27	1.6	1.8	2.1	2.2
23	3.1	2.8	3.3	2.6

Ss No.	Test Trials 1	2	3	4
		Bat-High-C		
195	2.5	2.2	2.7	2.7
170	2.9	0.5	2.4	2.2
162	2.1	1.5	1.9	2.2
153	3.0	1.9	2.1	1.8
135	2.5	1.6	2.0	1.9
131	2.9	1.2	2.3	1.7
114	2.4	2.0	2.1	2.3
99	2.6	1.8	2.3	3.0
90	2.7	2.9	2.4	1.9
81	2.8	2.7	2.9	2.7
68	2.8	0.2	0.7	2.3
54	2.8	2.8	2.6	1.9
38	2.5	2.0	2.5	1.8
25	1.9	2.4	2.2	2.4
15	0.5	1.2	1.1	0.7
12	2.2	1.7	1.8	2.1

Ss No.	Test Trials			
	1	2	3	4
		Bird-High-Bird*		
	4.3	3.9	4.1	4.0
	3.1	2.8	3.1	3.1
	3.1	2.9	2.8	3.0
	2.8	3.0	2.7	3.1
	2.8	2.9	2.9	2.9
	2.8	2.7	3.0	2.6
	2.9	2.7	2.7	2.8
	2.5	2.8	2.7	2.8
	2.9	2.5	2.8	2.4
	2.7	2.6	2.3	2.7
	2.4	2.8	2.4	2.3
	2.3	2.4	2.4	2.5
	2.3	2.7	2.4	2.1
	2.4	2.1	2.3	2.1
	2.1	2.2	2.1	2.1
	1.6	1.8	1.5	1.5

Ss No.	Test Trials 1	2	3	4
		Bird-High-A		
199	2.6	2.2	2.3	2.0
185	1.9	2.3	2.5	2.1
178	2.1	2.2	2.5	2.2
161	2.7	2.7	2.7	2.6
152	2.5	2.8	3.1	2.3
142	1.3	1.7	1.9	1.9
120	2.6	1.3	2.5	2.5
108	2.4	1.7	2.0	2.1
87	2.8	2.2	2.6	2.9
82	1.9	1.4	1.5	1.7
61	3.1	2.9	2.7	2.8
58	1.9	2.9	3.0	2.0
43	3.9	3.4	3.7	2.8
36	3.8	2.8	3.2	3.3
14	1.9	1.3	1.2	2.1
1	2.5	1.9	2.5	2.7

Ss No.	Test Trials 1	2	3	4
		Bird-High-V		
204	2.4	2.1	2.5	2.5
183	2.1	2.7	2.9	2.2
173	2.3	1.8	1.5	2.8
160	2.6	2.3	2.7	2.7
148	2.8	1.9	1.9	1.9
140	2.6	2.0	1.9	2.5
127	2.6	2.5	2.9	2.3
112	2.2	2.1	2.3	2.3
98	2.7	2.0	1.5	2.9
86	3.2	0.2	2.0	2.7
66	0.2	0.2	1.9	1.4
59	3.1	3.3	2.7	2.5
42	0.9	1.4	1.2	1.3
30	2.4	1.3	1.6	4.2
22	2.2	2.6	2.5	2.3
4	1.5	1.9	2.1	2.0

Ss No.	Test Trials 1	2	3	4
		Bird-High-C		
201	3.1	2.4	2.9	3.2
187	2.0	1.8	2.2	2.0
172	2.3	0.2	2.8	2.3
159	3.1	2.1	2.0	1.9
145	2.3	0.7	1.5	1.8
136	2.7	2.7	1.9	2.3
124	2.7	2.7	2.4	2.5
113	2.7	1.9	2.4	2.6
104	2.9	1.9	1.8	2.4
78	2.9	0.6	0.2	1.3
67	2.4	2.8	2.8	3.1
57	2.3	1.3	2.0	1.3
40	2.0	0.2	0.2	0.2
35	2.7	3.5	1.7	1.5
24	2.0	2.7	2.4	1.9
2	1.8	0.2	0.6	1.1

Ss No.	Test Trials			
	1	2	3	4
	Bat-Low-Bat*			
	3.5	3.5	3.5	3.5
	3.0	3.1	3.1	3.1
	2.9	2.9	3.1	3.1
	3.0	2.8	3.1	2.8
	2.6	3.1	2.9	3.1
	3.0	2.7	2.8	2.8
	2.7	2.8	2.9	2.9
	2.7	2.7	2.7	2.7
	2.8	2.6	2.6	2.6
	2.3	2.4	2.9	2.5
	2.5	2.5	2.5	2.5
	2.6	2.2	2.3	2.3
	2.2	2.3	2.5	2.3
	2.2	2.2	2.2	2.2
	1.7	1.6	2.5	2.7
	1.3	1.2	1.2	1.2

Ss No.	Test Trials 1	2	3	4
		Bat-Low-A		
151	2.9	3.2	2.8	2.8
197	2.5	2.5	2.5	2.7
182	2.9	3.3	3.2	3.4
175	2.0	2.0	2.5	2.2
157	1.8	1.7	2.3	2.6
134	2.6	1.6	3.0	2.7
129	2.6	2.3	2.2	3.3
116	2.2	1.5	2.3	1.7
105	3.5	3.1	3.5	2.8
85	1.5	1.7	1.8	1.6
84	1.9	1.2	1.6	2.3
64	2.3	2.3	2.4	2.2
49	2.2	2.3	2.0	2.6
41	1.9	1.4	2.5	2.1
21	2.1	2.5	2.1	2.4
5	2.0	1.8	1.9	2.6

Ss No.	Test Trials 1	2	3	4
		Bat-Low-V		
198	3.0	2.2	2.5	2.7
181	2.5	0.2	1.7	0.8
171	2.2	0.6	1.1	2.3
165	2.7	2.9	2.2	2.4
150	1.8	1.6	1.7	1.7
143	2.7	1.8	2.2	2.3
123	2.6	2.5	2.1	2.1
117	3.4	2.8	2.7	2.8
96	0.4	1.9	2.2	1.9
83	1.9	1.5	2.4	2.4
70	1.6	1.6	1.6	2.1
53	2.0	2.0	2.1	2.1
37	3.0	3.0	2.1	3.1
29	2.5	0.2	2.1	2.9
20	3.3	1.6	3.3	2.9
11	3.1	0.3	1.4	0.5

Ss No.	Test Trials 1	2	3	4
		Bat-Low-C		
202	0.2	0.4	0.5	0.8
190	2.2	0.3	0.3	1.2
174	2.5	1.7	2.0	2.3
163	1.5	1.5	1.6	1.3
149	1.5	1.8	2.0	2.1
138	2.4	3.0	2.4	2.2
121	2.9	1.7	1.6	2.5
111	1.9	1.9	1.9	2.0
107	1.8	1.3	1.4	1.5
93	2.7	1.4	2.1	2.6
73	2.8	2.0	2.0	2.1
63	2.8	2.2	2.6	2.5
39	3.0	1.9	1.7	2.6
32	1.0	2.7	2.4	2.3
17	2.1	0.2	1.0	2.5
9	2.4	2.3	2.3	2.7

Ss No.	Test Trials			
	1	2	3	4
	Bird-Low-Bird*			
	3.4	3.4	3.4	3.4
	3.0	3.0	3.0	3.0
	2.6	2.6	3.4	3.1
	2.9	2.9	2.9	2.9
	2.4	2.3	3.5	3.2
	2.2	2.9	3.2	2.9
	2.5	3.3	2.7	2.6
	2.7	2.8	2.7	2.7
	2.5	2.7	2.8	2.5
	2.6	2.3	2.7	2.5
	2.5	2.6	2.1	2.8
	2.2	2.6	2.4	2.4
	1.8	2.5	2.5	2.3
	2.2	2.2	2.2	2.2
	2.4	1.9	2.1	2.1
	1.6	1.6	1.6	1.6

Ss No.	Test Trials 1	2	3	4
		Bird-Low-A		
203	1.9	2.0	1.9	2.1
186	2.6	2.5	2.2	2.9
169	2.2	1.7	2.4	2.4
164	2.1	1.8	1.7	2.2
156	3.4	3.0	3.1	3.1
141	1.7	2.1	2.1	2.3
132	2.8	2.4	2.5	2.3
119	3.0	2.6	2.8	2.9
89	2.5	2.3	1.7	2.0
74	3.2	3.0	1.8	2.9
71	3.5	3.4	3.1	3.2
56	2.5	2.2	2.3	2.1
44	2.8	2.7	2.8	2.3
33	2.3	3.8	3.5	0.8
13	3.0	2.6	2.2	2.6
6	2.2	1.9	3.1	3.1

Ss No.	Test Trials			
	1	2	3	4
		Bird-Low-V		
193	1.7	1.1	1.4	1.4
191	1.9	1.9	2.2	1.9
176	2.0	1.4	1.2	1.1
168	2.8	2.6	2.3	2.8
155	2.4	2.9	2.6	1.8
139	1.5	1.1	0.9	1.2
128	3.0	2.0	2.1	2.7
109	3.0	0.2	1.3	1.9
101	2.4	2.3	2.3	2.2
92	3.0	0.6	2.7	2.7
72	1.6	0.2	1.3	2.4
50	2.7	1.1	2.0	1.6
47	3.5	3.1	3.0	3.1
28	2.8	2.4	2.9	2.7
18	2.7	2.5	2.4	2.2
10	3.7	1.7	1.9	0.4

Ss No.	Test Trials			
	1	2	3	4
		Bird-Low-C		
200	3.1	2.5	2.8	2.9
189	2.1	0.2	1.8	1.5
177	2.7	2.5	2.6	2.5
167	1.5	0.6	1.9	1.5
144	1.8	2.3	1.7	1.5
125	2.5	1.5	1.4	2.4
118	2.2	1.6	1.0	0.6
100	2.6	2.2	2.1	1.8
95	2.7	1.1	2.0	3.3
75	1.8	1.6	1.9	1.4
62	1.4	2.3	1.5	2.2
60	2.4	0.6	1.7	1.7
46	1.7	1.5	1.3	2.1
34	1.8	0.2	2.0	2.5
16	2.2	0.7	0.2	0.2
7	2.4	2.2	2.4	2.1

Acknowledgments

The writer wishes to express his appreciation to the members of his thesis committee, Drs. S. C. Goding, S. Salwak, A. W. Purvis, W. Field, C. C. Neet, and A. E. Goss, for their cooperation throughout the completion of this work.

Dr. Albert E. Goss, who served as thesis director and who originally suggested the study, deserves an especial note of thanks for his unfailing support, encouragement, and guidance.

Mr. Joseph Mach, laboratory technician, designed the tachistoscope used in the study and also assembled the complicated electrical system which resulted in a smoothly functioning, efficient apparatus. A sincere expression of gratitude is extended to him.

Finally, Mrs. E. Marie Clancey Moylan's sustained devotion to the many tiresome and detailed tasks of checking and rechecking her husband's work is at this time gratefully acknowledged.

APPROVED:

Albert W. Purvis

[illegible]

Albert E. Goss

Stanley J. Sarlwak

Stavell C Gordon

DATE: May 21, 1957