MEDIATED GENERALIZATION AND THE INTERPRETATION OF VERBAL BEHAVIOR

IV. EXPERIMENTAL STUDY OF THE DEVELOPMENT OF INTER-LINGUISTIC SYNONYM GRADIENTS ¹

BY JOHN P. FOLEY, JR., AND MARY A. MATHEWS

The George Washington University

INTRODUCTION

In the initial paper of the present series (1), a theoretical account of the conditioned response phenomenon of mediated generalization was presented and it was suggested that various aspects of verbal behavior might be understood in terms of mediated as well as non-mediated generalization. Subsequent papers reported evidence of generalization (*a*) along more than one homophone gradient from a given stimulus word (3), (*b*) along a synonym gradient from the stimulus word (3), (*c*) along a synonym gradient two degrees of transformation removed from the original stimulus word (3), and (*d*) along an antonym gradient from the stimulus word (2). The positive results indicating generalization along all of these dimensions may be interpreted as, to this extent, confirming the previous theoretical analysis (1).

If we accept the fact of mediated generalization along, let us say, synonym gradients, the question may next be raised as to the *origin* of such synonym gradients. More specifically, can we control the experimental stimulus-response conditions in such a way that synonym generalization will or will not take place? And in what manner would such mechanisms operate in the common verbal behavior of every-day life? It is with these questions that the present study is concerned.

In other words, the present study represents an attempt to investigate experimentally the *origin* and *development* of synonym generalization under normal every-day stimulatory conditions, such as are afforded by classwork in a foreign language. The experimental design thus required two groups, originally matched with respect to the recall of a list of English words presented immediately after

¹ The present paper represents part of a research project being conducted by Dr. C. N. Cofer and the senior author under a grant-in-aid from the American Association for the Advancement of Science. The writers are indebted to Dr. Cofer for a critical reading of a preliminary copy of the manuscript.

several reinforcements with lists of their Spanish equivalents. One (Experimental) group then received several weeks of the usual instruction in Spanish; the other (Control) group did not. Then both groups were again given reinforcements with the same Spanish lists, after which the same list of English equivalents was presented and its recall tested.

METHOD

1. *Materials.*—Spanish words were selected for use in the present study because of the possibility of getting Spanish words, included in the vocabularies of the beginning lessons, which did not bear a resemblance to English words or to words in other languages with which a subject might be familiar.² The 10 words selected were taken from the vocabularies presented in the first 10 lessons of the textbook³ used in the elementary Spanish classes. These words are presented in Table I, as is the Test List of 10 English words, each being the prescribed equivalent of one of the Spanish words. In each case, care was taken to select short Spanish words which least resembled, homographically or semantically, any English word, and every effort was made to minimize other complicating semantic relationships.⁴

In addition to the above two lists, two other 'buffer' or practice lists were utilized, to be used at the beginning of the initial and final testing, respectively. As indicated in Table I, Buffer

TABLE I
LISTS OF WORDS USED IN THE EXPERIMENT

Buffer List A	Buffer List B	Spanish Reinforcement List			
		First Presentation	Second Presentation	Thrd Presentation	English Test List
eleven	edith	(3) hijo	(2) cosa	(4) ciudad	(1) street
six	bernard	(4) ciudad	(7) pared	(9) reloj	(2) thing
forty	louise	(7) pared	(8) zapato	(5) cuaderno	(3) son
three	vivian	(2) cosa	(1) calle	(10) tiza	(4) city
sixteen	joseph	(8) zapato	(3) hijo	(7) pared	(5) notebook
nine	dorothy	(9) reloj	(10) tiza	(6) cena	(6) supper
twelve	henry	(10) tiza	(9) reloj	(3) hijo	(7) wall
five	calvin	(6) cena	(5) cuaderno	(1) calle	(8) shoe
		(5) cuaderno	(4) ciudad	(8) zapato	(9) watch
		(1) calle	(6) cena	(2) cosa	(10) chalk

List A consisted of eight numbers (spelled out) and Buffer List B was composed of eight Christian names. These lists were similar to those employed in previous studies of this series (2, 3), the selection of numbers and names being dictated by the desire to minimize the possibility of generalization effects from these sources.

2. *Procedure.*—The Buffer Lists, the three presentations of the Spanish Reinforcement List, and the English Test List were the same for all 80 Ss. The same intra-serial order (that of Table I) was used for every S in the case of all lists. Retention was measured by the method of retained members for the Buffer and English Test Lists, the Ss being told that they would not be asked to

² German words, for example, were excluded because of their frequent resemblance to Yiddish words.

³ Turk, L. H. *Introduction to Spanish*. Boston: Heath, 1942. Pp. 331.

⁴ The writers recognize the possible existence of generalization gradients arising from the instructions as well as the possible existence of intra-serial 'circular' gradients, such as *city-wall*, *city-street*, *chalk-notebook*. Since the materials and methodology were identical for the experimental and control groups, however, such factors would not operate differentially in the case of the two groups.

remember the Spanish Reinforcement Lists. It will be noted that the three presentations of the Reinforcement List contain the same words but in a different order, the same intra-serial order and sequence of lists being followed for every S in both Experimental and Control groups. Thus the positions throughout the reinforcement presentations of all Spanish words having a semantic relationship to a given English word in the Test List were the same for all Ss. The serial orders of word presentation are shown in Table I, reading from top to bottom, and the relationships of semantic equivalence between Reinforcement and Test Lists are indicated by the numbers in parentheses.

The first testing was done between September 30 and October 22, 1942, before any of the Ss had had instruction in Spanish. Both Experimental and Control groups were run simultaneously. Classes had been in session for only a short time, and none of the Ss at that time knew the meaning of any of the Spanish words; in fact most of the Ss did not know that they were Spanish words. The second testing was carried out between November 16 and December 16, 1942, both groups again being run simultaneously, so that the amount of time since initial testing was the same for both groups. By the second testing, the Experimental group had completed the first 10 Spanish lessons (*cf.* Materials), so that they had presumably formed many or all of the Spanish-English associations employed in the present experiment. The Control group had not been instructed in Spanish during this period. According to the hypothesis previously advanced (1), the experimental repetition (reinforcement) of the Spanish words should increase the reaction potentials of their English equivalents to a greater extent in the Experimental (Spanish-instructed) than in the Control (non-Spanish-instructed) group; if this should occur, one should expect the English Test List to be better retained by the Experimental than by the Control group.

Each S was tested individually in an inside, windowless room, having a low noise level. The lists were typed on white paper and presented one word at a time by means of the Gerbrands memory drum (5, No. MI-4). By using a multiple-exposure shield, previously described (4), no change of paper was necessary for the exposure of the five lists. The drum was set at the one and one-half sec. exposure speed for the presentation of all words. Each experimental session required approximately 10 min. for each S.

The regular procedure was as follows. After the S had been comfortably seated at a table containing only the memory drum, the following specific *instructions* were given by E: "Watch this opening (indicating it) in which a series of words will be exposed one at a time. As each word is exposed, say it aloud and think of its meaning. When all the words have been exposed, you will be asked to put down on paper as many of the words in this series as you can remember. Are there any questions?" Buffer List A was then presented, after which S was given a slip of paper and a pencil with the instructions: "Now, put down as many words in this list as you can remember; their order is not important." The slip of paper containing the recalled words was taken up by E, who then gave the following instructions before presenting the Reinforcement Lists: "Now *this* time you will be given a list of words in a foreign language. As each word appears, say it aloud *as best you can* and try to think of its probable meaning. You will *not* be called upon to remember this list, although you should make an effort to think of the meaning of each word as you pronounce it aloud." No other comments were made during the presentation of the three Reinforcement Lists, other than to repeat the above instructions before each presentation. Before the presentation of the English Test List, E said: "Now *this* time you will be given a list of English words. As each word appears, say it aloud and think of its meaning. When all the words have been exposed, you will be asked to put down as many of the words in *this* list as you can remember." The procedure followed in the second testing was identical to that of the first testing except that Buffer List B replaced Buffer List A.

Following S's recall of the English Test List, he was asked the following questions in order: 1. "Do you have any comments?" 2. "Did you make use of any aids or other devices to help your recall? What devices?" 3. "Did you notice any relationship between words on any of the different lists? What relationships?" These questions were repeated at the conclusion of the second testing, after which a fourth question was asked: "Did you notice any specific relationship between any of the foreign words and any of the English words? What relationship?"

3. *Scoring.*—In the case of the Buffer Lists and the English Test List, the score was computed in terms of number of words correctly recalled, as in the method of retained members. The order in which the words were recalled was not considered. All legible words were scored, and slight mistakes in spelling did not count as errors so long as it was clearly evident that the correct word and not some other word (especially the homophone) was intended.

4. *Subjects*.—Eighty Ss were used in the experiment, 17 male and 63 female. They were obtained from Spanish and Psychology classes and were entirely naïve with respect to the purpose of the experiment. As previously described, the Ss were divided into Experimental and Control groups of 40 Ss each, equated on the basis of scores on the first administration of the English Test

TABLE II
ANALYSIS OF PERFORMANCE OF EXPERIMENTAL AND CONTROL GROUPS ON
BUFFER LISTS A AND B

Measures	Buffer List A		Buffer List B	
	Experimental Group	Control Group	Experimental Group	Control Group
N	40	40	40	40
Total Correct	221	225	235	235
Total Incorrect	22	22	1	4
Range Correct	3-8	4-7	4-7	3-8
Mean Correct	5.53	5.63	5.88	5.88
S.D. Correct	1.10	.94	.84	1.00
Median Correct	5.57	5.74	5.91	5.88
Q Correct	.74	.71	.64	.67

List. Thus from the data presented in Table III it will be noted that the two groups make mean scores of 6.25 and 6.38, respectively, whereas the respective median values are 6.56 and 6.37. The reliability of these differences will be discussed in the following section. Although no attempt was specifically made to match the two groups for Buffer List score, inspection of Table II will reveal that the groups are well equated in mean and median scores on both Buffer List A and Buffer List B; these data lend additional confirmation to the statement that the two groups were well equated in 'learning ability.' The groups were also approximately equated as to age, sex ratio, and number of years in college.

RESULTS

The major results of the experiment, in terms of the number of words on the English Test List correctly and incorrectly recalled by both groups on the initial and final testing, are presented in Table III. The reliabilities of the differences between Experimental and Control groups on the first and second testings are reported in Table IV.⁵ It will be noted that computations of central tendency, variability, and reliability are reported in terms of both mean and median measures.

On the first testing, the differences between the Experimental and Control groups are small and statistically insignificant. Thus a

⁵ Since normality of distribution could not be assumed, σ_{Mdn} was computed throughout by the following formula: $\sigma_{Mdn} = \frac{i\sqrt{N}}{2F}$.

TABLE III

ANALYSIS OF PERFORMANCE OF EXPERIMENTAL AND CONTROL GROUPS ON FIRST AND SECOND TESTINGS WITH ENGLISH TEST LIST

Measures	First Testing			Second Testing		
	Experimental Group (E)	Control Group (C)	Difference (E)-(C)	Experimental Group (E)	Control Group (C)	Difference (E)-(C)
N	40	40		40	40	
Total Correct	250	255	- 5	308	273	35
Total Incorrect	17	14	3	3	14	- 11
Range Correct	4-8	3-9		5-10	5-10	
Mean Correct	6.25	6.38	-.13	7.70	6.83	.88
S.D. Correct	1.18	1.30		1.29	1.28	
Median Correct	6.56	6.37	.19	7.70	6.63	1.08
Q Correct	.82	.76		.97	1.01	

TABLE IV

RELIABILITY OF DIFFERENCES BETWEEN SCORES OF EXPERIMENTAL AND CONTROL GROUPS ON FIRST AND SECOND TESTINGS, RESPECTIVELY

Analysis in terms of Mean			Analysis in terms of Median		
Measures	First Testing	Second Testing	Measures	First Testing	Second Testing
σ_{ME}	.19	.21	σ_{MdnE}	.19	.32
σ_{MC}	.21	.21	σ_{MdnC}	.21	.40
σ_{ME-MC}	.28	.29	$\sigma_{MdnE-MdnC}$	.28	.51
M_E-M_C	-.13	.88	$M_{dnE}-M_{dnC}$	.19	1.08
Significance Ratio	-.45	3.01	Significance Ratio	.68	2.12
Probability Value	.6718	.9987	Probability Value	.7527	.9832

mean of 6.25 words was recalled by the Experimental group as compared with a mean of 6.38 words by the Control group. The reliability of this difference is indicated by a significance ratio of -0.45, with a probability of .6718 that such a difference would not have arisen as a sampling error from a true difference of zero. Similarly, the median value of 6.56 words recalled by the Experimental group is .19 words larger than that for the Control group; the sigma of the difference is .28, with a significance ratio of 0.68 and probability-

value of .7527. Thus, no significant differences exist with respect to the mean or median number of words recalled by the two groups on the first testing. The fact that the small differences are in opposite directions in the case of mean and median measures also indicates that the groups were well equated in performance on the initial testing.

On the second testing, however, prior to which the Experimental group had received class instruction in Spanish, the differences are large and statistically significant. The mean numbers of words recalled by the Experimental and Control groups are 7.70 and 6.83, respectively, the difference of .88 words yielding a critical ratio of 3.01 and probability-value of .9987. In terms of the median, the difference is also very striking, the significance ratio being 2.12 with a probability-value of .9832. The probability that such a difference might have arisen from chance factors is thus very small.

Since the differences between Experimental and Control groups were small and insignificant on the first testing, but large and significant on the second testing, and since Spanish instruction of the Experimental group was the only experimental variable, the results would seem to indicate the operation of generalization gradients established in the Experimental group during the Spanish instruction. It is interesting to note that the mean for the Experimental group on Buffer List B, following Spanish instruction, is identical with that of the Control group, and that their medians are also approximately the same (*cf.* Table II). It is thus apparent that the Spanish instruction did not generalize to the Christian names in Buffer List B, a result to be expected in terms of the theory of mediated generalization under consideration.

An additional check on the results is afforded by comparing the gross number of Ss in the Experimental and Control groups who showed an increase, no change, or a decrease in number of correct English words recalled from the first to the second testing. These data are reported in Table V. It will be noted that 80 percent of the

TABLE V

TOTAL FREQUENCY OF SUBJECTS IN EXPERIMENTAL AND CONTROL GROUPS SHOWING INCREASE, NO CHANGE, OR DECREASE IN NUMBER OF CORRECT WORDS RECALLED FROM FIRST TO SECOND TESTING

Nature of Change	Experimental Group		Control Group	
	Number of Subjects	Percentage of Subjects	Number of Subjects	Percentage of Subjects
Increase	32	80.0	17	42.5
No change	4	10.0	13	32.5
Decrease	4	10.0	10	25.0

Experimental group and only 42.5 percent of the Control group showed an increase in score on the second testing; 10 percent of the Experimental group showed no change in score, as compared with 32.5 percent of the Control group; and only 10 percent of the Experimental group showed a decrease in score, whereas 25 percent of the Control group showed a decrement. These results are corroborated by the range in magnitude of the change in score from first to second testing, the range being from 4 to -1 in the Experimental group, and from 3 to -2 in the Control group.

Perhaps the clearest indication of mediated generalization effects, however, is found in a direct statistical comparison of the changes from first to second testing in the case of the Experimental and Control groups. The measures of central tendency and variability of these changes ⁶ will be found in Table VI, and the reliability of inter-

TABLE VI

CENTRAL TENDENCY AND VARIABILITY OF INCREASES IN SCORE OF EXPERIMENTAL AND CONTROL GROUPS FROM FIRST TO SECOND TESTING

Measures	Experimental Group	Control Group
Mean Increase	1.53	.45
S.D. of Increases	1.38	1.45
Median Increase	1.50	.27
Q of Increases	.87	1.07

group differences in such changes is indicated by the data presented in Table VII. From these tables it is seen that the Experimental group showed a mean increase of 1.53 and median increase of 1.50

TABLE VII

RELIABILITIES OF THE DIFFERENCES BETWEEN EXPERIMENTAL AND CONTROL GROUPS IN MEAN AND MEDIAN INCREASES IN SCORE FROM FIRST TO SECOND TESTING

Analysis in Terms of Mean		Analysis in Terms of Median	
σ_{M_E}	.22	σ_{Mdn_E}	.28
σ_{M_C}	.23	σ_{Mdn_C}	.24
$\sigma_{M_E-M_C}$	.32	$\sigma_{Mdn_E-Mdn_C}$	.37
M_E-M_C	1.08	Mdn_E-Mdn_C	1.23
Significance Ratio	3.36	Significance Ratio	3.35
Probability Value	.9996	Probability Value	.9996

words correctly recalled from the first to the second testing. In marked contrast, the corresponding increases for the Control group were only 0.45 and 0.27 words. The increases in Control mean and

⁶ Since there were a few negative values, or decreases from the first to second testings, the mean, median, S.D. and Q were computed algebraically.

median may be attributed primarily to practice effects, and may thus serve as a base for evaluating the improvement displayed by the Experimental group. The difference of 1.08 between the Experimental and Control groups in mean change from first to second testing yields a significance ratio of 3.36 and probability-value of .9996. An equally reliable difference is obtained in the case of the median. The chances that such an inter-group difference could have arisen as a sampling error from a true difference of zero are thus extremely small, so that the operation of generalization gradients established during the Spanish instruction of the Experimental group is clearly indicated.

The number of *correct recalls* of each presentation word in Buffer Lists A and B as well as in the first and second testings with the English Test List have been tabulated. The relative frequency of recall of a given presentation word did not differ markedly from the Experimental to the Control group, and intra-serial primacy and recency effects were clearly apparent in the case of all lists. Differences in the preexperimental reaction potentials of all words, as well as differences in serial position, make further analysis of this matter unwarranted.

An analysis of the individual *incorrect recalls* in each of the two groups in most cases reveals generalization effects theoretically similar to those reported above as producing correct recalls. With one exception (*fix*, probably intended as *five* or *six*), all of the 44 incorrect recalls of Buffer List A in both groups (*cf.* Tables I and II) were incorrect numbers, the incorrectly recalled number often being a verbal compound of the correct presentation number, as in the case of the relationships *three—thirteen*, *five—fifteen*, *nine—nineteen*, *forty—forty-three*, *forty—forty-five*; a quantitative treatment of these and other semantic relationships is impossible owing to the nature of the stimulus words. The total of five incorrect recalls of Buffer List B were all Christian names: *George*, *Harry*, *Helen*, *Lillian*, *William*.

Of greater interest are the incorrect recalls of the English Test List, for here the operation of generalization gradients is strongly suggested. A complete discussion of the incorrect recalls made by both groups on the two testings combined would seem to be justified. The most common error was the incorrect recall of *walk*, which accounts for 25 of the total of 48 errors made by both groups on both testings. The related recall of *sidewalk* occurred two times in the combined tabulation of total errors. Both *walk* and *sidewalk* bear a quasi-synonym relationship to *street* in the Test List, and the single incorrect recall of *gutter* is in the same general category; *walk* also bears a quasi-homophonic relationship to the presentation word *chalk*. From the presentation words *notebook* and *chalk*, generaliza-

tion seems to have occurred to words in an 'educational category,' as evidenced by two incorrect recalls of *school*, of *study*, and of *pencil*, and a single incorrect recall of *pen* and of *paper*. The single incorrect recall of *pocketbook* is partially identical to the presentation word *notebook*. The single incorrect recall of *boy* and of *brother* would seem explicable in terms of their relationship to the presentation word *son*, whose homophone, *sun*, also occurred once as an incorrect recall. The two incorrect recalls of *dinner* bear a close semantic relationship to the presentation word *supper*, as does the single recall of *food*. The incorrect recall of *repair* may be attributed to its relationship to *shoe* in the Test List, as may the recall of *hose* by a single female S. There remain only three of the total of 48 incorrect recalls of the English Test List unaccounted for in the above discussion; in these cases (*one*, *thick*, *shells*) the relationship to a presentation word is either ambiguous or obscure.

Finally, let us consider the Ss' verbal reports. Reference to the Procedure will reveal that each S was asked three questions at the conclusion of the first testing and that the same three questions in addition to a fourth were asked at the end of the second testing. These questions were primarily directed towards discovering whether or not the S had perceived the semantic relationship between the Spanish Reinforcement Lists and the English Test List. None of the Control group reported the relationship on the first testing; on the second testing three Control Ss correctly reported a single instance of a Spanish word in the Reinforcement Lists meaning the same as an English word in the Test List. Of these three Ss, two were not very certain of the relationship in meaning, and the third reported having come across the relationship in reading in English literature. In addition to these three Ss, two other members of the Control group reported a general suspicion of such a relationship, although they were unable to cite one or more correct examples. In the Experimental group, four Ss reported a single case of such a relationship on the first testing; one of these Ss stated that his perception was based upon his knowledge of Latin; another reported that his example "may be a guess." From all indications, most of the Ss did not even identify the Reinforcement List as Spanish words at the time of the first testing. On the second testing, two Ss in the Experimental group failed completely to report the relationship, even after being asked all four questions; 11 Ss reported the relationship in a few of the words; and 27 reported the generalized relationship. Of this latter group, four specifically stated that they did not perceive the relationship at the time, *i.e.*, they were able to report it only after being questioned; on the other hand, three Ss reported a definite attempt to utilize the Spanish-English associations as an aid in recall.

Numerous other comments were made by the Ss of both groups in answering the questions. Many reported that Buffer List A contained only numbers, that Buffer List B contained only Christian names, that the three Spanish Reinforcement Lists contained the same words but in different orders, and that the lists employed on the two testings were the same except for the Buffer List. Various mnemonic devices were also reported, and there was frequent speculation concerning the nature of the experiment, as well as postulation of incorrect relationships. A detailed treatment of these comments would seem unwarranted.

THEORETICAL ANALYSIS

Let us now consider the theoretical analysis of the present experiment⁷ in terms of the concepts of classical conditioning and of mediated generalization. The theoretical mechanisms involved are diagrammatically presented in Fig. 1, to which reference should be made in connection with the discussion which follows. The procedure employed in the initial testing was the same for both Experimental and Control groups, and can be disregarded in the present theoretical analysis.⁸

Following the initial testing, the Experimental group received Spanish instruction, whereas the Control group did not. Theoretically, it is assumed that during this period of Spanish instruction, the Experimental group acquires the Spanish-English associations,⁹ so that the Spanish words come to serve as conditioned stimuli for their appropriate English equivalents. This is brought about through the visual and auditory presentation of the English word, e.g., *supper* (UCS), followed by the S's vocalization and/or subvocalization of the response word *supper*; when this occurs simultaneously with the visual and auditory presentation of the Spanish word *cena*, the latter becomes a conditioned stimulus (CS_x) for the vocal response *supper* (R)¹⁰ and its subvocalization or implicit, fractional

⁷ Although no theoretical analysis was reported in previous experimental papers of this series, the present analysis can be applied, with modifications, to the previously reported experimental demonstration of generalization along synonym (3) and antonym (2) gradients.

⁸ As previously indicated in the section on Procedure, the initial testing of both Experimental and Control groups was carried out (a) to determine the amount of recall of the English words on the part of both groups prior to Spanish instruction of the Experimental group, and (b) to insure that both groups were approximately equated in this respect.

⁹ The writers recognize that only certain of these associations were formed, although this fact does not alter the experimental design or present theoretical analysis.

¹⁰ This would be the simplest case. It is also conceivable that some other response, such as the implicit movement of the finger or arm or a movement of the stomach or other part of the digestive tract, might also occur in this situation and might become conditioned to both *cena* and *supper*. The rôle of such complicating factors has been advisedly omitted from the present discussion, although its inclusion would not essentially alter the nature of the theoretical analysis which follows.

I. DURING SPANISH INSTRUCTION:

(OMITTED FOR CONTROL GROUP)

II DURING FINAL PRESENTATION OF SPANISH REINFORCEMENT LISTS:

III DURING FINAL RECALL OF ENGLISH TEST LIST:

IN EXPERIMENTAL GROUP: STRENGTH OF CS_y $\rightarrow$ R SUPPER = $z + y' (fy + x \text{ OR } x')$ IN CONTROL GROUP: STRENGTH OF CS_y $\rightarrow$ R SUPPER = z

FIG. 1. Theoretical schema illustrating the rôle of mediated generalization in the development of inter-linguistic synonym gradients

kinesthetic responses with their attendant stimulus function (r_s). In Fig. 1, the strength of the conditioned vocalized R to *cena* (CS_x) is denoted by x , and that of the attendant implicit, fractional kinesthetic responses is denoted by x' . These reaction potentials would not, of course, exist in the case of the Control group.

In the final test situation, the three presentations of the list of Spanish words constitute a conditioning situation in which the visual presentation of the word *cena* (or other Spanish word) is followed (through instructions) by the S 's vocalized response *cena*, the latter becoming conditioned, through direct reinforcement, to some unspecified 'recall stimulus' (CS_y), such as the memory drum, experimental room, or some other aspect of the complex stimulus situation. In Fig. 1, the strength of this reaction potential is denoted by y . Now, the vocalized response *cena* is attended by subvocal and implicit fractional kinesthetic responses with their resulting stimulus func-

tions (r_s), and as noted above, the latter have been previously conditioned to the response *supper*. Thus in the Experimental group, indirect or 'mediated' generalization will occur from the 'recall stimulus' (CS_v) to the response *supper*, the strength of which mediated association is denoted in Fig. 1 by y' . This indirect or mediated generalization from CS_v to the response *supper*, via *cena*, will thus strengthen the reaction potential of that response. No such mediation will exist in the case of the Control group.

Finally, in the single presentation of the English Test List, the visual presentation of the English word *supper* (UCS) is followed by vocalization (R) of that word (*cf.* Procedure), the vocalized response becoming conditioned (to a greater or lesser degree) to the simultaneously present 'recall' or 'memory drum situation' stimulus (CS_v), the strength of which association is denoted by z in Fig. 1. This latter reinforcement of the behavior segment $CS_v \rightarrow R$ *supper* is present in both the Experimental and Control groups, so that the magnitude of z may be assumed to be common and equal for both groups. In the case of the Experimental group, however, z will theoretically be incremented by y' (*cf.* above),¹¹ the latter being a function of y plus x or x' . Since y' is not present in the case of the Control group, this incrementation will occur only in the case of the Experimental (Spanish-instructed) group, so that the $CS_v \rightarrow R$ *supper* association will theoretically be stronger in the case of the latter group.¹² Hence a reliably greater number of the English words should be recalled by the Experimental group.¹³ The positive results of the present experiment thus conform to predictions made on the basis of the present theoretical analysis.¹⁴ These results are all the more significant when it is realized that many of the Ss in the Ex-

¹¹ It may be assumed that incrementation of z will occur by algebraic summation with y' (the magnitude of the reaction potential derived indirectly via *cena*).

¹² Stated in other words, the reaction potential of the response *supper* is derived in the Control group solely from the experimental presentation of that word, whereas in the case of the Experimental group there is the additional incrementation indirectly through *cena*. Since the Experimental and Control groups were initially equated with respect to the P-list of English words, and since the methodologically differentiating factor was the additional reinforcement derived indirectly through the Spanish instruction, any difference between the two groups in subsequent performance may be attributed to the influence of indirect or mediated generalization via the Spanish-English associations.

¹³ In the interests of simplification, the present theoretical analysis has omitted consideration of intra-serial associations resulting from the conditioning of a given verbal response to the vocalization or sub-vocalization of its predecessor. In so far as the presentations of the test list were the same for Experimental and Control groups, this factor can be disregarded in the present analysis.

¹⁴ It is possible, of course, that part of the improvement shown by the Experimental group resulted from the direct reinforcement of the English words themselves in the Spanish classroom. The fact that the words in the English Test List were so well known, however, would seem to discount the importance of such a factor, as would some of the evidence contained in the verbal reports of certain Ss.

perimental group did not know the meaning of all the Spanish words, as indicated by their own verbal reports.¹⁵

SUMMARY

This experiment was designed to study the origin and development of mediated generalization under normal every-day stimulatory conditions, such as are afforded by classwork in a foreign language. Two groups of 40 Ss each were originally equated with respect to the recall of a list of English words presented immediately after three reinforcements with lists of their Spanish equivalents. One (Experimental) group then received several weeks of the usual instruction in Spanish; the other (Control) group did not. Both groups were then retested, being given reinforcements with the same Spanish lists after which the same list of English equivalents was presented and its recall tested. A significant difference was now found between the two groups, the higher recall score of the Experimental group being interpreted in terms of the operation of mediated generalization gradients established in that group during the Spanish instruction. The theoretical analysis of mediated generalization previously presented (1) is extended and applied to the present experiment.

(Manuscript received July 8, 1943)

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¹⁵ Larger differences between the two groups could have doubtless been obtained if the Experimental group had been *experimentally* instructed with respect to the meaning of the specific Spanish words employed. The present experiment was concerned, however, with the formation of mediated generalization gradients in the usual, every-day-life situation.