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STUDIES IN LINGUISTIC BEHAVIOR ORGANIZATION: I. CHARACTERISTICS OF UNSTABLE VERBAL REACTIONS*[1]

From the Psychological Laboratories of the University of Illinois

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INTRODUCTION

The general nature and the history of the experimental problems under investigation in these studies, as well as the technique devised for the purpose, have been described in a previous publication (2).

A striking feature of language is its compromise between stability and instability, and between specificity and generalization. Did not the stimulus-response relationships remain fairly stable and specific on the part of most members of a speech community during a given historical period, social interaction as we know it would be impossible. And yet the history of languages is a record of shiftings in stimulus-response relationships, and even within any given brief period it is obvious that the specificity is a relative matter; that we cannot analyze the environment into unit patterns and expect to find for each of these patterns a verbal response which is never elicited by other patterns. This means that there must be much variation of response even if the environment were to remain constant. And this variation of response seems to lead to a gradual assimilation of the categories of language to what might be called the 'objective categories' of the environment; that is, the overlap-

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[1]This experiment was carried out in the Psychological Laboratory of the University of Illinois during the academic year 1925-26.

Since the completion of the manuscript of this article, I have found in a volume edited by W. L. Valentine (7) an article by D. Wolfle (8), which is essentially a repetition of the experiments which I published in the monograph (2), with some additional features of method and interpretation whose resemblance to some of those of the present article may seem striking in the absence of any explanation by Mr. Wolfle. As a student in my laboratory, and in subsequent correspondence, Mr. Wolfle was made acquainted with much of the material here presented.

pings of patterns, the recurrences of common features of color, shape, sound, etc., come to be reflected in the interrelationships of the verbal units.

A serious fallacy which seems implicit in much pseudo-psychological theorizing in the field of linguistics consists in the assumption that linguistic material can be adequately studied without reference to the stimulus settings in which it occurs. This assumption proceeds from the notion of language as being the 'expression of ideas.' Actually, I do not see how we can escape the view that language, in its fundamental, living form, consists of a system of verbal responses to (chiefly external) stimulus patterns, closely interrelated with the patterns of manipulative behavior.[2] The fundamental unit to be investigated then is not a purely grammatical one, but a *stimulus-response unit.* It is not enough to say, e.g., that a certain word 'tends to influence the form' of another; this is a shorthand statement which conceals the real problem. Words and word-mixtures occur as responses to situations, and changes in the form or meaning of words are only one aspect of a changed relationship between certain patterns of stimulation and the response patterns of the individuals of a speech community. It is from a study of the conditions determining these changes in stimulus-response relationships that we may hope to arrive at the principles of linguistic change and of linguistic organization.

In the present experiment, the conditions provided were as follows: (*a*) verbal responses were attached to a number of stimulus-objects which resembled one another in shape or size, but which were so selected that there was a certain asymmetry in the objective classes to which they belonged; and (*b*) additional objects were subsequently introduced which systematically resembled the original objects but for which no specific names had been learned. In both cases the purpose was to provide conditions favoring varying degrees of instability in the stimulus-response relationships. Two main problems were under investigation: (*a*) what are the conditions determining relative stability and instability in verbal responses, and what characteristics differentiate stable from unstable stimulus-response units; and (*b*) in what manner and as a result of what changes

[2]This matter has been ably presented by Dr. Malinowski in his essay on "The Problem of Meaning in Primitive Languages," printed as a supplement to Ogden and Richards' *The meaning of meaning* (6).

does an unstable linguistic system tend toward an equilibrium among its component stimulus-response units.

METHOD

The general method consisted of (1) teaching the S's to respond to 'nonsense' figures with 'nonsense' names,[3] continuing the repetitions to the point of 'complete' learning; and (2) thereafter requiring the S's to continue to respond to the figures under various conditions.

At the beginning of the experiment the following instructions were read to each S:

> "I am going to teach you the names of a number of figures. As each figure appears, I shall pronounce its name. You will repeat the name after me, aloud. After each 4 repetitions of this procedure, I shall say 'call them out.' You will then attempt to call out the names of the figures as they appear, in a loud, distinct voice. If you are not sure of the names, guess. Be careful to pronounce the names exactly as I do. Do not be discouraged if you unable to learn them at once."

Before proceeding according to these instructions, E pronounced each of the names a number of times, permitting S to watch his lips, until S could repeat the names accurately (or as accurately as dialect differences permitted).

The apparatus used for presenting the figures is the 'bradyscope,' which has been described elsewhere (3). The figures were presented at the rate of 1 every 3 sec.; the change from one figure to the next occupied 1 sec. The bradyscope was placed at one end of a 10-x-7-ft. darkroom, the interior of which was painted a uniform flat gray. The apparatus was illuminated by a 100-watt 'daylight' lamp in a large reflector suspended above and behind the S's head. S sat at a distance of 1.5 m. from the apparatus. To his

[3]The word *nonsense* is used for want of a better. By a nonsense figure or object I mean one that has been artificially constructed in such a manner that it will have a minimum of resemblance to anything encountered in a subject's previous experience; by a nonsense word I mean a sound sequence which differs as much as possible from any word of actual language. Obviously, when subjects have been induced over a period of many months to attach certain names to certain figures, neither the names nor the figures can be said to be 'nonsense' in the sense that the term is used when we speak of Ebbinghaus' syllables. Consequently the criticisms which have been directed at the use of 'nonsense syllables' by various writers have no applicability to the materials used in these experiments.

right was E's table on which were the apparatus controls, screened from S by a hood. E sat at the end of this table, to S's right and rear.

As is shown in Figure 1, the S's were taught names for 12 figures, figures A1, B2, C3, and D4 being omitted during the first period of the experiment. I shall designate as a *series* the presentation of the 12 figures in random order, each figure occurring once in a series. I shall designate as an *L-series* (learning series) a series in which E calls out the names of the figures and S repeats them. I shall designate as an *R-series* (recognition series) a series in which S calls out the names without assistance from E.

Four series, representing four different haphazard orders of the figures, were in the bradyscope at each sitting. For each sitting four new haphazard orders were provided. On the first day, S was given Series 1, 2, 3, 4 as L-series; then Series 1 as an R-series; then Series 2, 3, 4, 1 as L-series; then Series 2 as an R-series. This procedure was repeated on succeeding days until he was able to name correctly six of the figures. Thereafter S was given alternately two L-series and one R-series until he could name eight of the figures. From this point he was given alternately one L- and one R-series until he could name all of the figures correctly in four successive R-series. To reach this point required for the various S's from four to ten sittings. The sittings occurred on five days of each week. Each sitting was terminated when a total of eight L-series had been given.

The *subsequent* history of the experiment is divided into two periods.

Period I. This was a period of about four months, from the first week of November to March 1. Up to January 20, the S's appeared on five days of the week; thereafter on three days each week. During this period the S's continued to name the 12 figures in four R-series at each sitting, being given no further L-series unless they made *uncorrected* errors. Slight indispositions of the various S's, vacation periods, etc., of course interfered with the routine of sittings; detailed information concerning the actual distribution of sittings in Period I for each S may be obtained from Figure 3.

Period II. This was a period of about three months, from March 8 to May 24, during which sittings occurred on three days of each week. No further L-series were given. During this period 16 figures were being presented, the 4 figures previously omitted having

been introduced. These 4 figures will hereafter be referred to as the *N-figures* (new figures), and the other 12 figures will be called the *O-figures* (old figures).

Period II is divided into two stages:

Period II-a. March 8 to April 14. The N-figures were introduced. Further, instead of the figures being presented in four series as previously, they were presented in one continuous series in which each of the figures (O and N) occurred four times in haphazard order. Thus the S's no longer had the assurance that when a given figure had once appeared in a given series it could not again occur in that series. The following instructions were read to S:

> "From now on the figures instead of being arranged in four separate series will be presented in one continuous series in which each kind of figure will occur a number of times. Be sure to name each and every figure promptly as soon as it appears, even though some of the figures may appear to be not quite the same as previously. Do not let a figure pass without naming it."

Period II-b. April 16 to May 24. A second variation of conditions was introduced. This consisted in presenting the figures in pairs, one on the left side of the bradyscope, the other on the right. The S's were required to name both figures, the one on the left first. Each figure was paired with each other figure, and each pair was presented with sometimes the one and sometimes the other figure in the left-hand position. In the paired series arranged in the bradyscope for each sitting each figure (O and N) occurred four times; the entire series was given twice, so that at each sitting the S's responded to each figure eight times (as compared with four times in the preceding periods). Since the speed of the bradyscope remained the same as before, the paired manner of presentation also had the effect of decreasing the time available for the response to each figure.

Throughout all periods of the experiment, E recorded all responses of the S's in phonetic symbols.

Measurements of Reaction-Time and Associations. On three occasions during Period I (Dec. 18, Jan. 21, March 3) and on three occasions during Period II (March 29, May 7 and 26), the reaction-times of the S's in responding to each of the figures were measured, two measurements being made for each figure on each oc-

casion. Thus for each S (with exceptions noted below) there were obtained six measurements for each figure in each of the two periods of the experiment. During Period II the reaction-time for the N-figures were also measured. In addition, on each occasion the reaction-times of verbal responses to 12 familar objects were measured, in order that these times might be compared with those for the experimentally learned responses. The following instructions were read to S:

> "I shall show you a series of figures. Some of these will be the ones whose names you have learned in this experiment; others will represent the following objects: table, house, pipe, duck, glove, hat, chair, shoe, umbrella, tree, bell, broom. As soon as you catch sight of each figure, call out its name as quickly as possible. I am going to measure the time it takes you to call out each name."

The nonsense figures and those representing the familiar objects (the latter cut from white Whatman paper and mounted on gray cards in the same manner as the nonsense figures) were then presented in haphazard order, each figure occurring twice.

Likewise on three occasions during Period I (Dec. 21, Jan. 22, March 5), and on three occasions during Period II (March 31, May 7 and 26), association measurements were made. The stimulus words were the names of the nonsense figures and in addition 12 English words (*father, brother, young, black, one, nine, this, he, eating, reading, now, seldom*). These were given in random orders, each word occurring twice at each sitting, so that six measurements were obtained for each word in each period. The inclusion of the English words was for the purpose of comparing the experimentally established associations with those obtaining in actual language. The following instructions were read to S:

> "Please keep your eyes closed throughout this experiment. I shall pronounce a series of words. Some of these will be ordinary English words; others will be the names of the figures which you have learned. As soon as you hear each word, call out as quickly as possible the first *other* word that pops into your head as a result of hearing the word that I pronounced. The first five words will be for practice."

The practice words *house, jumping, fast, red, who* were given, followed by the test series.

For the reaction and association time measurements, voice-keys

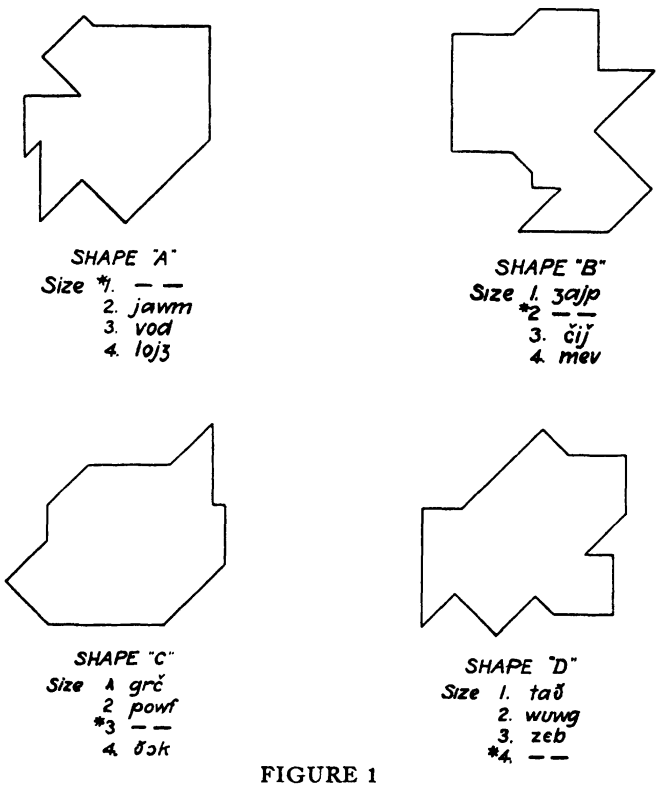


FIGURE 1

and a Dunlap chronoscope, the latter reading in 1/100-sec. units, were used. S and E sat in the darkroom; the chronoscope was located in another room, the readings being taken by an assistant. In the reaction-time measurements, the chronoscope was started by the falling of the bradyscope shutter; in the association measurements, by E pronouncing the stimulus word against the stimulus voice-key. In both cases, the chronoscope was stopped by S speaking his response against the reaction voice-key.[4]

The Nonsense Figures. The figures varied as to shape and size,

[4]A voice-key with the ordinary tripod base, standing on a table, is very likely to be tripped by floor vibrations. This difficulty was overcome by inverting the base, fitting the feet with levelling screws, and suspending the base from the ceiling of the outer room by piano wires which passed through the ceiling of the darkroom; the wires were provided with steel springs about 2 feet above the voice-key base.

there being four categories of each of these. The areas of the four sizes are geometrically related, as follows: size 1, 8 sq. cm.; size 2, 16 sq. cm.; size 3, 32 sq. cm.; size 4, 64 sq. cm. These sizes will be symbolized hereafter by the numbers indicated; the shapes will be symbolized by the capital letters *A, B, C, D.* Thus *C1* will refer to a figure of shape *C* and of area 8 sq. cm. (See Figure 1.) The designations of the N-figures will be starred, thus, **A1.*

The 4 shapes used in this experiment were selected from 80 shapes obtained from various combinations of the Chinese tangram figure. These 80 shapes were presented to 40 individuals who were instructed to record the objects of which each figure reminded them. In the case of each of the shapes selected, almost two-thirds of these individuals were unable to note any resemblance to an object; the responses of the others were highly individual and variable. These probably represent nearly the optimal conditions attainable with 'nonsense' figures.

The figures were cut from white Whatman paper, which has an excellent non-glossy surface, and were mounted on medium gray cardboard.

The Nonsense Names. The names assigned to the figures were selected from a list of all the possible monosyllabic combinations of the distinctive speech sounds of Middle-Western American English. From this list were chosen 200 syllables which had the least tendency to suggest actual words to myself and my assistant. These 200 syllables were then orally presented to 48 individuals with the request that they record any words of any language that the syllables suggested. On the basis of the results thus obtained, 12 syllables were chosen which (*a*) differed as much as possible in initial, medial, and final sounds from one another; and (*b*) had the least tendency to suggest actual words.

The names assigned to the different figures are indicated in Figure 1.[5] To avoid the necessity of printing phonetic symbols in the text of this article, the names will hereafter be referred to by giving, in single quotation marks, the shape-size designation of the figure to which the name was assigned *in the original learning,* as shown in Figure 1. Thus if we state that an S responded to C1 with 'C2,' this will mean that he called the shape-size combination *C1* by the name

[5]The values of the phonetic symbols are the same as those indicated in a table appended to my monograph (2).

originally learned for *C2*. This procedure is possible because in only a few isolated cases did the S's momentarily depart from the original phonetic forms of the words.

It will be seen in Figure I that the material selected provided no correlation between the phonetic forms of the names and the categories of shape and size in the figures. Every name is as different from all the others as to initial, medial, and final sounds as it was possible to make it. The words therefore constitute a *totally suppletive system.*

The Subjects. The 12 subjects were undergraduate students in the University of Illinois, of ages between 20 and 24 years. S's 1, 4, 7, and 9 are women. A larger number of S's were started in the experiment, but only 12 completed the various stages of the experiment, which extended over some 8 months.

Results in Period I

Table 1 summarizes the results in Period I for 8 of the 12 S's. The results for S's 5, 6, 10, and 11 are not included in this table because of the nature of their associative responses. The instructions for the association tests required the S's to respond with the *first other word* that occurred to them, and the 12 nonsense words were presented in a series in which 12 English stimulus words also occurred. The S's were therefore free, so far as the experimenter's instructions went, to respond to the nonsense words with English words or words of any other language, if these should be the first to "pop into their heads." The purpose was to test the functional facility of the artificial linguistic material; to determine to what extent these nonsense words would elicit 'spontaneous' functional associations conforming to their own categories, when presented without restrictive instructions and in temporal proximity to English stimulus words and responses. It was also thought desirable to determine to what extent the nonsense words might have become associatively linked through possible sound similarity or other factors with English or other words. Under these conditions, seven of the S's were found to respond to the nonsense words exclusively with other nonsense words of the system; S 3 did so with the exception of his responding to *mev* ('B4') with *zev,* the name of a racehorse with whose contemporary career this S had become financially involved. S's 5 and 10 responded exclusively with words other than those of the artificial system; S's 6 and 11 did so in 64 and 29%

TABLE 1

SUMMARY OF RESULTS FOR EIGHT SUBJECTS IN PERIOD I

The columns, numbered from left to right at the top, contain the following data: (1) the figure designations; (2) the average number of L-series required for the first correct naming of the figure; (3) the average reaction-time in naming the figure; (4) the total number of errors made by all S's; (5) total number of failures to respond; (6) the most frequently occurring error, and (7) its frequency; (8) the most frequent associative response to the *name* of the figure, (9) the number of occurrences, and (10) the average reaction-time of these associations; (11) the number of other associative responses, and (12) their average reaction-time; (13) the average reaction-time of *all* the associative responses to the various figure names; (14) the number of times that the name of the figure indicated in column 1 occurred as an associative response to all of the other figure names, and (15) the average reaction-times of such occurrences.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Fig.	L's	RT	Er.	F.	M. f. er.		M. f. assoc.			Others		All	As	Assoc.
						N		N	T	N	T		N	T
A2	26	111	32	6	'A3'	28	'A3'	42	118	6	127	119	26	118
A3	31	103	23	3	'A2'	16	'A2'	20	116	28	123	120	77	122
A4	17	87	3	1			'A3'	22	123	26	145	135	13	108
B1	19	99	12	2	'B3'	9	'B3'	35	93	13	120	100	20	124
B3	11	99	16	1	'B1'	13	'B4'	22	93	26	109	102	90	95
B4	18	85	4	0			'B3	16	121	26	135	130	41	103
C1	19	98	9	1	'C2'	7	'C2'	42	91	5	121	94	48	135
C2	21	96	13	1	'C1'	9	'C1'	18	111	29	127	121	90	103
C4	16	86	7	1	'D1'	6	'C2'	21	101	27	132	119	24	129
D1	37	92	12	1	'D2'	8	'D2'	41	90	7	143	98	27	133
D2	37	103	21	6	'D3'	10	'D1'	16	118	16	117	117	93	99
							'D3'	16	116					
D3	18	110	25	3	'D2'	18	'D2'	26	95	22	123	108	27	129

of the cases, respectively. Since the relation of the associative responses within the system is one of our primary interests, the results of the latter four S's have been omitted in the summary of Table 1.

The table reveals the following relationships:

1. *Relative Stability and Patterning of the Categories.* The data of columns 3 to 15 represent the S's performance during Period I; that is, *subsequent* to their having satisfied the criterion of four errorless R-series. It will be seen that the number of errors is extremely small, and that they are due primarily to the experimentally provided factors of instability in the system. Categories A and D show much more instability than do categories B and C. In comparison with the corresponding figures of categories B and C, figures A2, A3 and D2, D3 produce longer reaction-times and a larger number of errors and failures, the errors consisting chiefly in a confusion between A2, A3 and D2, D3. Figures A2, A3, and D2 also require a larger number of L-series than do any of the other figures. Figures A4 and D1, however, behave in a manner similar to that of the corresponding figures of the other categories, showing relative stability. These facts may be referred to the following conditions:

a. The relation of the figures to their backgrounds. The figures of size 4 occupied most of the exposure area, with a relatively narrow margin of gray cardboard around their edges; the other figures, in comparison, tended to be 'white figures in the center of a gray card.' In consequence, the responses to the figures of size 4 show marked differences from the responses to the other figures. They are learned more quickly; their reaction-time is distinctly shorter; they induce fewer errors and practically no failures to respond; there is no one most frequent error except in the case of C4, where, however, the number of occurrences is small and is due to the sound similarity between 'C4' and 'D1'; the associative responses to the names show considerable scatter and long reaction-times. Thus the responses to these figures show great stability and facility.

The figures of size 1 had, in comparison with the other sizes, somewhat the appearance of 'miniature' figures in the center of the gray cards. They were not thereby marked off from the other figures as distinctly as were the figures of size 4; they did not require fewer L-series than did sizes 2 and 3, nor were their reaction-times shorter. They did, however, induce a somewhat smaller number of errors than did sizes 2 and 3. The greater distinctness of the

size-4 figures is also shown by the fact that very few of the errors in response to the other sizes consisted in calling them by the size-4 name, whereas 'B1' and 'C1' were in a number of cases elicited by B3 and C2, respectively.

The four sizes in which the figures occurred were in geometrical progression (8, 16, 32, 64 sq. cm.). The differences in area were therefore such that no difficulties of discrimination would be expected. But in relation to the background cards of uniform dimensions, sizes 2 and 3 would be psychologically much more similar to one another than would any pair of which size 1 or size 4 is one member. This fact would account in some measure for the longer reaction-times and greater number of errors found for A2, A3 and D2, D3.

b. The behavior pattern induced by the system. The conditions discussed under (*a*) do not appear to explain all features of the instability in categories A and D. In category A, size 2 has the longest reaction-time, and is called by the name of A3 more often than A3 is called 'A2.' But in category D, the same relations hold, *mutatis mutandis,* for *D3* as compared with *D2.* Also, the associations 'A2'→'A3' and 'D3'→'D2' are much stronger than the reverse associations.

These and other facts seem to be explained by the general patterning of the system as revealed in the subjects' responses. According to this pattern, the system consists of four shapes each occurring in three sizes: small, medium, and large. Except for certain differences in the A and D categories, due to the special conditions there, the smallest figures of each shape category (A2, B1, C1, D1), the medium-sized figures (A3, B3, C2, D2), and the largest figures (A4, B4, C4, D3) in each case constitute a group whose members tend to behave similarly.

1) The similarities in the responses to the *large* figures have already been discussed. D3 conforms to this pattern in the relatively small number of L-series required, but the reaction-time and number of errors is considerably greater than for the size-4 figures. It is not unlikely that the analogy of the other shape categories has an effect here; 'D3' is the name of the largest D figure, but when D3 appears, it does not 'seem large enough' and there is a tendency therefore to call it 'D2.' In category A as well as in D, sizes 2 and 3 are both present, and the name of size 3 is chiefly associated with that of size 2, but in the case of 'D3' the association is

stronger and has a distinctly shorter reaction-time; this may be due to the frequent tendency to respond to D3 with 'D2'; there were 12 cases during Period I where the overt response to D3 was 'D2,' immediately corrected (overtly) to 'D3.' The *implicit* cases of this sort were probably quite numerous.

2) The behavior pattern with respect to the *small* figures is distinguished chiefly by the associative responses to their names. The most frequent response to 'A2,' 'B1,' 'C1,' 'D1' is in each case the name of the next larger figure of the same shape; the frequencies are very much larger and the scatter decidedly less than for the responses to the other names. The average associative reaction-times are the shortest that occur, except in the case of 'A2.'[6] The small figures are learned less quickly than are the large ones, but their difference in this respect as compared with the medium-sized figures depends upon the relative conditions of equilibrium in the various shape categories. The reaction-time in naming the small figures is about the same as that for naming the medium-sized figures, except in the case of A2. Again with the exception of A2, the number of errors tends to be less than for the medium figures, but greater than for the large figures. A2 therefore conforms to the behavior pattern of the small figures only in the high frequency of its name's most frequent associate. Here again, as in the case of D3, the general pattern of the system seems to have its effect; 'A2' is the name of the smallest A figure, but when A2 appears, it is likely to appear 'too large,' and tends to be called 'A3.' This error is, in fact, made more often than any other, and there are 23 cases in Period I where the S's first called the figure 'A3' and immediately corrected themselves; there were even cases where the response was, e.g., *jaw-vo-jawm*. This figure therefore has a tendency to release *both* responses, and the resulting interference would account for the long reaction-time in naming the figure and *perhaps also for the associative frequency*. I shall discuss the latter point in some detail in the final section of this paper.

3) The behavior pattern for the medium-sized figures is characterized by a somewhat greater tendency to errors, but chiefly by the fact that the names of these figures constitute by far the most

[6]The fact that the association 'A2'-'A3' has, in spite of its frequency, a long reaction-time is probably due to some difficulty in discriminating the word when it was quickly pronounced in the association tests; some S's occasionally understood it as *young*, a word which also occurred in these tests

frequent associative responses to the names of the other figures (see column 14 of Table 1), with (except for 'A3') the shortest average association times. This frequency comes about largely from the fact that in each shape category the names of both the small and the large figures are associated predominantly with the names of the medium-sized figures. It is to be noted, however, that the association *small→medium* is much stronger than the association *large→medium.* As for the associative responses to the names of the medium-sized figures themselves, we find 'A3' and 'C2' associated chiefly with the names of the small figures, 'B3' with that of the large figure, and 'D2' equally with those of the small and the large figures. We find also that 'A3' is associated 9 times with 'A4,' 'B3' 12 times with 'B1,' and 'C2' 9 times with 'C4.' Thus the situation presented by 'D2' is more or less general for the names of these medium-sized figures; they face both ways, tending to be associated with the names of both the small and the large figures.

2. *Conditions Determining the Associations.* We can now state the principles governing the establishment of the verbal associations as follows:

a. The greater the possibility of confusing an object a *with a specific other object,* b, *and the less the possibility of confusing it with any other specific object,* c, d, *etc., the firmer and more universal does the verbal association between the names of objects* a *and* b *become.*

The *small* figures are subject to confusion almost exclusively with the medium-sized figures. In accordance with this fact, the verbal associations small→medium come close to 100% occurrence.

The *medium* figures are subject to confusion with both the small and the large figures. In accordance with this fact, associations in both directions tend to be established, neither association being very strong. This comes out most clearly in the D category, where *D4 is lacking and D1, D2, D3 form a psychologically more similar series. D2 is overtly called 'D1' about as often as it is called 'D3,' and the associations 'D2'-'D1' and 'D2'-'D3' are of equal frequency and reaction-time. In the other categories, B3 is closer to B4 than to B1, and C2 is closer to C1 than to C4; the associations are in accordance with these relationships. The A-category might seem analogous to the D-category, but A4, due to its figure-ground individuality, has less tendency to enter into confusion with A3, and the latter's name is associated chiefly with 'A2.'

The *large* figures are subject to confusion almost exclusively with the medium figures, but their figure-ground individuality prevents this confusion from being of frequent occurrence. Consequently, while the most frequent associations are those with the names of the medium figures, the frequency is not large and the association times are long. The exception is D3, which, lacking the individuality of the size-4 figures, shows a stronger tendency to confusion with the medium figure and a consequently stronger association.

Thus the material clearly illustrates the operation of the two conditions stated in the principle. The names of the small figures elicit the firmest associations because these figures are capable of confusion with *one* other figure; the medium-figure names elicit weaker associations because these figures tend to be confused with *two* other figures; the large-figure names elicit weaker associations because these figures, though their only real possibility of confusion is with *one* other figure, yet possess such individuality that this confusion is of infrequent occurrence.

b. The weaker the tendency to confuse an object with any specific other object in its own immediate category, the greater is the tendency for its name associatively to elicit names from other categories.

The small-figure names are associated 27 times with the names of figures of other shape categories; the medium-figure names, 68 times; the large-figure names, 92 times. Of these occurrences, 33, 57, and 37%, respectively, are associations with the names of figures of other shape categories but of the corresponding size category. Thus associative interconnections with other categories are attributable chiefly to those stimulus-response units which are least definitely confused and associated with a specific member of their own category.

c. When a given stimulus-response unit has no strong tendency to be confused with any specific other unit of its own category, verbal associations on a purely phonetic basis may be established, regardless of the categories of the stimulus-objects themselves.

The stimulus word 'A4' elicits the association 'C1' four times for S 4 and twice for S 9; 'B3' elicits 'C1' three times for S 4, four times for S 9, once for S 12. All three of these S's had trouble with the voicing of fricatives, so that the final consonants of 'A4' and 'B3' were much nearer to that of 'C1' than for the other S's. The same explanation probably applies to the association 'B4'→'C2,'

which occurs twice for S 12 and exclusively for S 4. These occurrences indicate the importance of dialectal phonetic variations in furnishing foci from which levelling may spread.

d. When a given object is subject to confusion with a number of other objects, its name tends to become an alternative response to these other objects and an associative response to their names, and consequently to become the most frequently elicited name in the category.

To be noted is the peculiarly prominent position assumed by stimulus-response units having the relative positions of the medium figures and figure names of this material. For example, when either D1 or D3 appears, if any response mechanism other than, or in addition to, the one specific to the figure is activated, it is most likely to be the one corresponding to D2. Thus the 'D2' response tends to be activated not only by its own stimulus-object, but also by two others. The same is true, in varying degrees, for the response mechanisms corresponding to A3, B3, and C2. Moreover, the *names* of, e.g., D1 and D3, in consequence of the above relations, both tend associatively to activate the verbal mechanism 'D2.' The consequence is that the stimulus-response units corresponding to the medium-sized figures become, so to speak, the centers of gravity of their respective categories; they are the response mechanisms most frequently activated, and they are not only specific responses to a given object but alternative responses to the other objects of their category. The importance of this is understood when considered in connection with the finding in an earlier study (2) that names of the various objects of a category tend to become phonetically assimilated to the name of *one particular* object of that category. Of course, this tendency for a response to become an alternative response to other objects of the same category is at the same time an example of a 'generalizing' process.

However obvious these relations may seem, they are not so *a priori.* One might well have expected that the prominence of the *large* figures because of their figure-ground character, the readiness with which they were learned, and the short reaction-times required to name them, would have made them the foci of their categories. The principle which actually emerges, however, is that that response mechanism is most likely to become the center of a developing semantic-morphologic system which is most readily elicited as a 'confusion response' by the largest number of other stimulus-

objects. The special prominence of these response mechanisms is also seen in their tendency to be elicited associatively by the names of figures which do not belong to the same shape category, or in some cases even to the same size category. This is especially noticeable in the case of S 3, who gives the associative response 'B3' to the names of figures A3, A4, C2, C4, D2, D3, as well as to those of B1 and B4.

Results in Period II

In Table 2 are summarized the responses to the N-figures in the two stages of Period II, and in Table 3 are summarized, for comparison, the reaction-times and errors for the O-figures in *all* stages of the experiment.

In Period II are introduced the four N-figures. How will these be named? For *A1 and *D4 this can be predicted with considerable certainty; A2 and D3, respectively, alone stand adjacent to these figures in size. Moreover, the absence of the smallest figure in the A-category and of the largest in the D-category had had much greater effect on these categories in Period I than had the omission of *intermediate* figures in the B- and C-categories, so that already in Period I the name of A3 had shown a tendency to become attached to A2, and that of D2 to D3. And, in fact, Table 2 shows that 'A2' and 'D3' respectively were the almost invariable responses to *A1 and *D4, and that these responses had short reaction-times. These names thus underwent a semantic change, for which, however, the way had been prepared analogically in Period I by the presence of the size-1 and size-4 figures in the B- and C-categories. But as a result of this semantic change, a compensatory shift tends to occur; the tendency to call A2 and D3 by the names of A3 and D2, respectively, is greatly increased, so that by the end of the experiment this substitution is complete (invariable) for two of the S's (Nos. 4 and 7) for both figures; for S 2 it is complete for D3, and for S 11 it is complete for A2.

The responses to *B2 and *C3 could not be predicted with the same certainty. In the C-category, *C3 is intermediate in size between C2 and C4. However, C4 has the greater figure-ground individuality and the greater stability, as shown in Period I by the small number of errors and the short reaction-time. C2 is one of the more unstable medium-sized figures, with longer reaction-time and more errors. In accordance with these facts we find that *C3 is in about 90% of the presentations called 'C2.' However, it is also called

TABLE 2

RESPONSES TO THE N-FIGURES (ALL SUBJECTS)

In columns 2 and 3 are given the average reaction-times in naming the figures in Periods II-*a* and II-*b*. Under *responses*, the first number following each response designation indicates the frequency in Period II-*a*, the second number the frequency in II-*b*. *F* = failures to respond. Frequencies are in terms of number of occurrences per 1000 presentations.

Fig.	Reac.-time		Responses
	II-*a*	II-*b*	
*A1	90	81	'A2' (970,995); 'A3' (5,2); 'D1' (5,0); F (21,1).
*B2	110	90	'B3' (683,638); 'B1' (299,354); 'B4' (0,4); F (16,4).
*C3	106	90	'C2' (901,886); 'C4' (76,107); 'C1' (11,4); F (11,2).
*D4	103	82	'D3' (954,986); 'B4' (21,2); 'C4' (2,5); 'A4' (5,2); F (16,5).

'C4' on occasion, and S 10 gives it this name in 76% of the presentations and does so exclusively in the last 32 presentations.

In the B-category, *B2 is intermediate in size between B1 and B3. The latter is the more unstable, but B1 has not the same degree of individuality and stability as have the size-4 figures. Hence we are not surprised to find that while *B2 is called 'B3' in about 65% of the presentations, it is also called 'B1' in 30% of the presentations of II-*a* and in 35% of those of II-*b*. S's 3, 6, and 9 give *B2 the name B1 in about 90% of the presentations, S5 does so in 46%, while the others call it 'B3' in about 90%. In accordance with the situation thus outlined, we find that in II-*b* the average reaction-times for the responses to *B2 and *C3 are about 1/10 sec. longer than those for *A1 and *D4, and that, whereas the responses to *A1 and *D4 become more uniform in II-*b* as compared with II-*a*, the responses to *B2 and *C3 become more variable.

The effects on the O-figure responses of the introduction of the N-figures in II-*a*, and of the paired method of presentation in II-*b* may be seen in Table 3. The stimulus-response units whose stability is most affected by the introduction of the N-figures are indi-

TABLE 3

COMPARISONS OF THE RESPONSES TO THE O-FIGURES IN THE SUCCESSIVE STAGES OF THE EXPERIMENT (ALL SUBJECTS)

The frequencies of the errors for the three periods have been reduced to a common basis of *number per 1000 presentations.*

Fig.	Reaction-time			Errors and failures			Most frequent errors			
	I	II-*a*	II-*b*	I	II-*a*	II-*b*		I	II-*a*	II-*b*
A2	108	109	97	15	85	173	'A3'	11	83	166
A3	107	108	94	11	31	27	'A2'	5	18	11
							'A4'	2	6	9
A4	92	91	85	3	8	9	'A3'	1	6	5
B1	97	87	83	6	6	22	'B3'	4	4	13
B3	105	109	89	9	18	47	'B1'	2	4	12
							'B4'	4	10	31
B4	91	82	85	2	12	20	'B3'	1	8	13
C1	101	93	83	6	22	19	'C2'	6	20	12
C2	101	116	82	7	35	50	'C1'	5	32	45
							'C4'	1	0	1
C4	90	93	79	3	8	15	'C2'	1	2	9
D1	94	94	82	6	24	26	'D2'	3	24	20
D2	107	99	90	20	18	54	'D1'	6	12	30
							'D3'	6	4	11
D3	109	107	97	15	124	205	'D2'	7	120	194

cated in II-*a* not only by the increase in errors but also by the long reaction-times (figures A2, A3, B3, C2, D2, D3). The specific substitutions which chiefly tend to occur in the responses to these figures correspond to the points in each category-pattern occupied by the N-figures. A2 is intermediate between *A1 and A3; it must be called either 'A2' or 'A3,' since *A1 is regularly called 'A2.' The same is true, *mutatis mutandis,* for the responses to D3. Figure B3 is intermediate between *B2 and B4; i.e., between a figure called in most cases 'B3' and one called 'B4'; hence when it does not elicit 'B3,' it is more likely to elicit 'B4' than 'B1.' A similar explanation would apply to C2's almost exclusive confusion with C1, and to D2's preponderance of confusion with D1. It is only in the responses to A2 and D3 that a tendency to a complete semantic shift is evident. The other stimulus-response units mentioned above merely show an increased instability and variability. Thus the introduction of medium-sized N-figures tends to produce merely an extension of meaning of one of the names, while the introduction of the more distinctive size-1 or size-4 figures tend to produce a complete sematic change in one of the names and a compensatory extension of meaning of another.

The *associations* in Period II show little change as compared with Period I, and tables showing these responses have therefore been omitted. The chief change that occurs is a considerable shortening of the association times for all S's and an increasing tendency for the response 'D2' to be elicited by those names from other shape categories which have no strong associations within their own categories (i.e., the names of the medium and large figures). All S's showed a tendency in Period I to call D3 by the name of D2, and this tendency is greatly strengthened in Period II by the introduction of *D4. Thus 'D2' comes to be one of the most frequently elicited responses of the entire system, and apparently in consequence of this fact it is more likely than any other name to occur as an associative response to any name which has no strong association within its own category.

The results of Period II may be summarized as follows: given a series of objects of similar shape but of four different sizes, for any three of which names have been learned, the subsequent introduction of the previously absent size will have the following effects:

1. Size *1,* newly occurring, will elicit the name of *2,* and there will be an accompanying tendency, increasing with practice, for *2* to elicit the name of *3.*

2. Size *4*, newly occurring, will elicit the name of *3*, and *3* will increasingly tend to elicit the name of *2*.

3. Size *2*, newly occurring, will elicit from some individuals chiefly the name of *1* and from others chiefly that of *3*, but the latter tendency seems to be about twice as strong as the former.

4. Size *3*, newly occurring, will elicit chiefly the name of *2*, but from a few individuals chiefly that of *4*.

5. Thus where the newly introduced object is *intermediate* in size between two others, it elicits chiefly the name of that one of the two for which the responses previously were most *unstable*.

6. If we represent the names of the various sizes of any shape category by the letters *a, b, c*, then we may represent the equilibrium which such a system tends to approach by the pattern *abbc;* that is, if for four sizes only three names are available, such shifts occur as to give sizes 1 and 4 distinctive names, while sizes 2 and 3 elicit a common name. Further, responses *a* and *c* will have shorter reaction-times and be more stable then will the *b* responses. These relationships hold regardless of which of the four sizes was absent during the original learning of the names.

7. The name *b* is much more likely to occur as an associative response to names belonging to other categories than are the names *a* or *c*.

8. The above-mentioned tendencies are in general facilitated when (in Period II-*b*) the figures are presented in pairs, so that each figure appears many times alongside each of the others. The absolute values of the reaction-times are reduced, but the relationships between them remain the same. The variability in the responses to the intermediate figures increases markedly, while in the responses to the size-1 and size-4 figures it increases only slightly or even decreases, the latter being true for *A1 and *D4.

Individual Differences

The graphs of Figure 2 show the rate at which each S learned to name correctly the 12 O-figures. These graphs represent the learning up to the point where the S for the first time named all of the figures correctly in *one* R-series. The graphs of Figure 3 represent the further performance of each S during Period I; the last day of the graphs of Figure 2 is the first day of those in Figure 3. Figure 3 displays the degree of retention of the material over a period varying for the different S's between 122 and 135 days. The re-

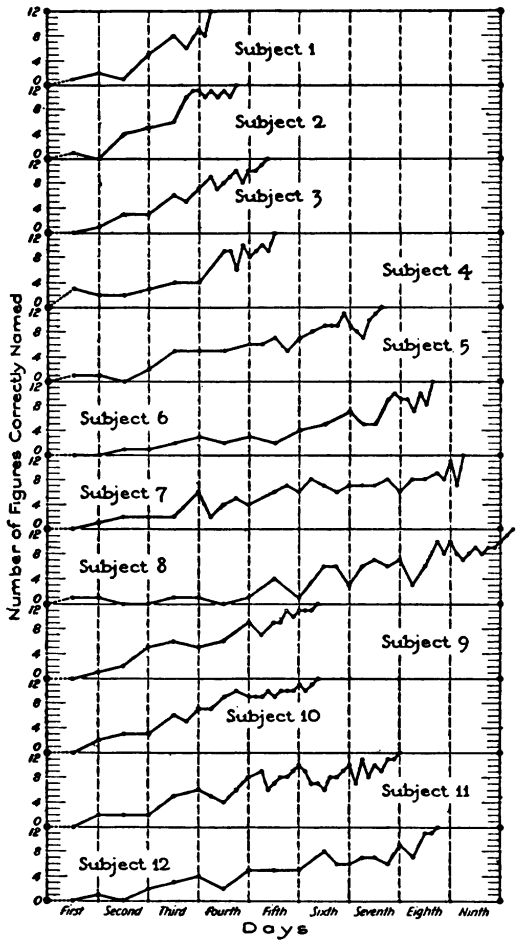
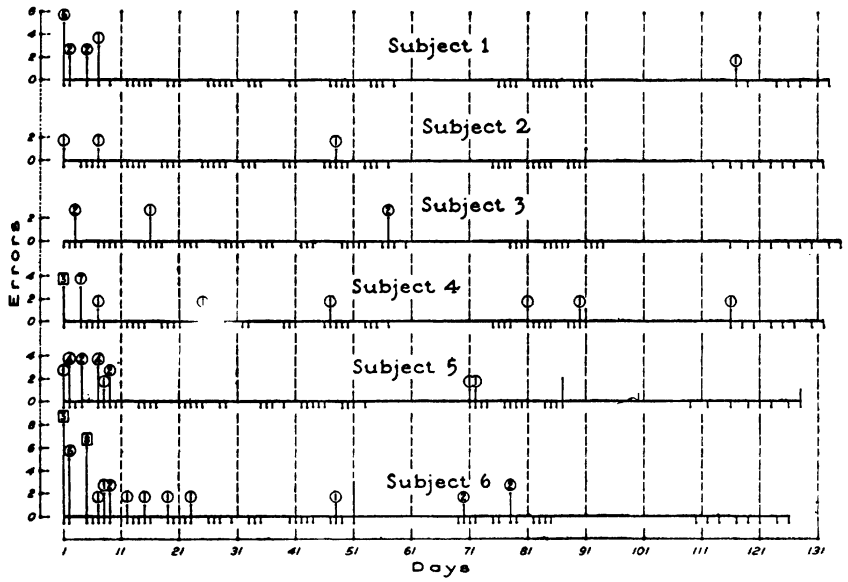


FIGURE 2

quirement during this period was that the S name all of the figures correctly in four successive R-series. The units of the horizontal axes represent days; each of the short vertical lines of uniform length *below* the horizontal axes indicates a sitting. The height of the vertical lines *above* the horizontal axes indicates the number of errors made (i.e., the number of *different* figures incorrectly named at a given sitting). The numbers placed in circles above these vertical lines indicate how many L-series were required before the S could on that day name all of the figures correctly in four successive R-



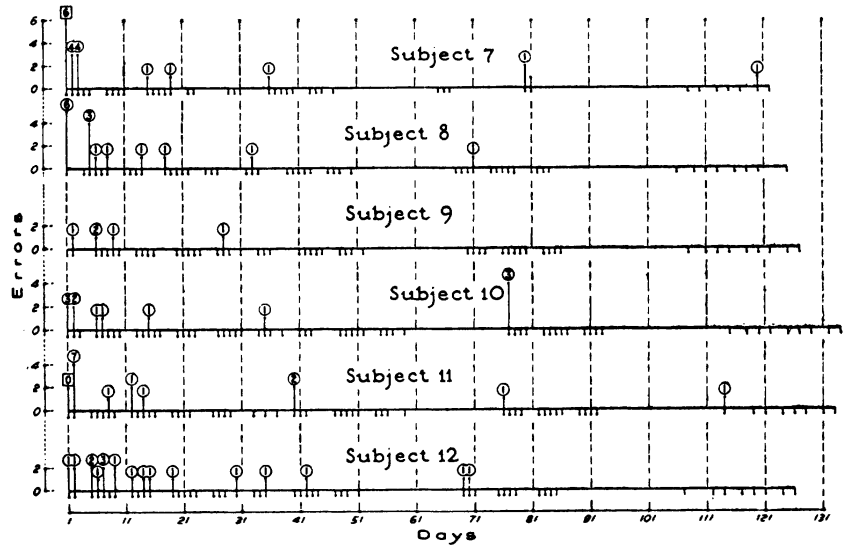


FIGURE 3

TABLE 4

SUMMARIES OF DATA FOR INDIVIDUAL SUBJECTS, PERIOD I

The vertical columns contain the following data: *S*: the number designation of each S; *L*: number of L-series required to attain 4 successive errorless R-series (all columns to the right of the *L*-column give measurements of performance *subsequent* to the attainment of this criterion); *Er*: total errors; *F*: failures to respond; *NRT*: average reaction-time in naming the nonsense figures; *NAT*: average association time in response to the figure names; *CNA*: total number of responses in the nonsense association tests which were common to at least 3 S's; *NAS*: nonsense association scatter (total number of *different* associative responses); *ERT*: average reaction-time in naming familiar objects in English; *EAT*: average association time for English words; *CEA*: number of English associations which corresponded to the most frequent responses of the group; *EAS*: English association scatter.

S	L	Er	F	NRT	NAT	CNA	NAS	ERT	EAT	CEA	EAS
1	32	20	7	93	109	66	19	68	90	68	14
2	31	12	0	109	102	63	21	68	90	53	16
3	35	16	1	88	97	56	24	60	71	68	13
4	46	10	2	103	122	69	22	84	94	71	13
5	54	23	6	92	—	0	—	70	124	47	22
6	70	30	9	92	323	21	49	54	168	35	23
7	76	45	2	80	93	69	20	66	71	71	13
8	99	13	4	118	129	66	28	79	93	57	18
9	43	34	0	87	122	54	34	86	113	64	16
10	46	12	3	98	—	0	—	77	202	24	46
11	63	16	2	114	176	22	56	91	180	32	35
12	63	28	10	100	131	35	48	88	125	55	21

TABLE 5

RESPONSES TO N-FIGURES, INDIVIDUAL SUBJECTS

In the vertical column on the left the S's are indicated by number. In the top horizontal row are indicated the N-figures (starred). Under *B2, e.g., Subject No. 1 has an average reaction-time in naming this figure of 1.26 sec.; in 8% of the presentations she calls it 'B1,' in 92% she calls it 'B3.'

	*A1		*B2			*C3			*D4	
S	RT	'A2'	RT	'B1'	'B3'	RT	'C2'	'C4'	RT	'D3'
1	117	100	126	8	92	90	100	0	122	100
2	88	99	89	5	93	111	99	0	75	99
3	77	99	91	88	11	68	100	0	81	99
4	77	99	94	9	91	82	100	0	80	100
5	70	99	83	46	54	82	88	12	87	97
6	85	99	94	87	11	87	97	3	87	99
7	70	100	75	15	85	72	95	4	80	100
8	103	99	116	6	93	122	95	3	106	97
9	77	100	105	93	7	82	99	1	82	94
10	73	99	95	6	93	101	23	76	86	99
11	102	98	108	3	96	115	99	0	109	95
12	84	96	95	3	92	105	92	2	106	99

TABLE 6

SUMMARIES OF DATA FOR INDIVIDUAL SUBJECTS, PERIOD II (O-FIGURES ONLY)

Under *RT* are given the average reaction-times of the various S's in naming the nonsense figures. Under *Errors* are indicated the total number of errors for all figures taken together, and the number of errors made in response to figures A2 and D3. All frequencies are in terms of number per 100 presentations. Under *Association* are given the number of associative responses common to at least 3 S's, and the average association times. No association measurements were made for S 7 in Period II.

S	RT	Errors			Association	
		Total	A2	D3	Com.	Time
1	88	46	12	21	60	100
2	90	74	13	40	60	75
3	86	37	3	5	44	76
4	89	139	54	74	65	98
5	79	82	10	32	0	—
6	84	36	2	3	15	288
7	76	198	71	63	—	—
8	108	41	4	7	57	95
9	78	30	2	4	46	96
10	89	24	3	2	4	215
11	117	96	47	14	23	128
12	88	31	8	2	21	105

series. Where the numbers are enclosed in squares, this means that the S, even after the indicated number of L-series, still could not give four correct R-series. The error lines without numbers represent errors made during reaction-time measurements. The two periods of about 20 days each in which no sittings are indicated were the Christmas and inter-semester vacations.

Table 4 summarizes the data for the individual S's in Period I. The error frequencies of Table 4 are based on an equal number of sittings (47) for all of the subjects. Tables 5 and 6 summarize the data for the individual S's in Period II. The relationships found in the data of Tables 4 to 6 are discussed under the following headings:

1. *Learning and Retention.* Both the graphs and the data of Table 4 show very considerable differences in rate of learning and in subsequent retention. There is some indication of a positive relation between learning and retention, although the experiment is not well designed for showing this relation, not only because of the (*necessarily*) small number of subjects but also because by the learning method used there was much overlearning of most of the material while the last one or two figures were being learned. Between

number of repetitions required for *one* correct R-series and number of errors and failures in the subsequent sittings of Period I, r=.54.[7]

2. *English and Nonsense Verbal Responses.* Between the reaction-times for English naming of familar objects and those for naming the nonsense figures, r=.52. Between the reaction-times for English associations and those for nonsense associations, r=.94. Between commonality of English associative responses and commonality of nonsense associative responses, r=.84 (i.e., those S's who gave the largest number of English associations which corresponded to the most frequent associations of the group did so also for the nonsense associations). Between English association scatter (number of different responses made to the same stimulus words on different occasions) and nonsense association scatter, r=.82. These results suggest that the same individuals who have developed the most specific and promptly released associations in ordinary language are also most likely to develop such associations in a new set of verbal material; those whose English associations are the most common associations of a group will also develop nonsense associations of this type. It should be noted that the most frequent English associations of this small group of S's were the same as those of a group of 100 subjects of an earlier study (1). The results also give us some confidence that, however artificial may be the linguistic situation provided by the experiment, the same processes of associative organization are at work here as in actual language.

3. *Association.* Between nonsense association time and nonsense association scatter, r=.85. Between time and commonality of associations, r=—.69. That is, the greater the variability in associative responses to the same words, and the fewer the responses which are most common in the group, the longer is the associative reaction-time. The correlations between *English* association time and *nonsense* scatter and commonality, and between *nonsense* association time and *English* scatter and commonality are almost identical with the above values. In the English associations, the r between time and scatter is .91; between time and commonality, —.81. These results are in

[7]All correlations are by the rank-difference method. While the reliability of any correlation based on 12 individuals is dubious, it will be seen in what follows that there are a number of relationships between various types of measurements made throughout the experiment which mutually confirm one another, and these consistencies may give some assurance that the relationships are not accidental. At any rate, important theoretical principles are suggested by the indicated relationships, and these principles will be tested in later numbers of these *Studies.*

agreement with the earlier study of the English associations of 100 subjects.

4. *Errors.* The errors made by the subjects in the course of this experiment are to be assigned a significance somewhat different from that assigned to errors in ordinary learning experiments. The errors here are variations of response which after the first weeks of learning are almost invariably of a systematic nature. The S tends to respond to a figure, not always with its own specific name, but sometimes with the name of the figure of the size larger or smaller, but of the same shape. This variation of response, this readiness to respond to an object not only with a uniform verbal response but sometimes also with the responses usually made to somewhat similar objects, undoubtedly is the behavior tendency which has been responsible for most linguistic (and logical) organization. Its end-products in language are semantic and phonetic word groups. 'Errors' of this type, particularly the semantic shifts which follow the introduction of the N-figures in Period II, represent a progressive change in behavior and *interconnection of response units* which are to be regarded as a very important form of human *learning.*

In Period I, those S's with the shortest reaction-times in naming the figures tended to make the largest number of errors (r=.74). Most of the responses counted as errors in Period I were 'multiple responses'; that is, the S on seeing a figure called out one name and immediately thereafter another, sometimes following this second name with a repetition of the first. Frequently the pronunciation of the first name was not completed before the S switched to the second. Either the first or the second response might be the previously learned name of the figure, though usually the second response was 'correct.' There was a strong tendency for certain of the figures to set off such multiple responses. These figures therefore tend to release two different responses, the one usually more readily or frequently than the other. But the recorded cases of such multiple responses were necessarily *overt* responses; nothing is more likely than that this simultaneous or successive activation of two response mechanisms occurred in the majority of the presentations of certain of the figures, at least for some of the subjects, but that they occurred *implicitly* preceding the overt and 'correct' response. The strong correlation between errors and reaction-time suggests that those S's whose overt responses were most prompt were most likely to give overt multiple or variable responses.

No significant relationship appears between the number of *overt*

errors made in Period I and the number made in Period II, nor between the total number of errors made in II and reaction-time. These facts reflect a much changed situation in Period II. The essential feature here is a difference in behavior of figures A2 and D3 as compared with the other figures. Certain S's, upon the introduction of the N-figures, not only give *A1 and *D4 the names previously learned for A2 and D3, but tend more and more frequently *to give A2 and D3 the names previously learned for A3 and D2.* By the last weeks of the experiment these S's invariably thus name A2 and D3, no longer as part of a multiple response, but as a prompt specific response to these figures. This renaming of A2 and D3 will hereafter be referred to as the *A2-D3 shift.* This shift, as we have seen, brings categories A and D into consistency with the other categories, so that the names of the four sizes of each category now conform to the pattern *abbc*. Other S's show this tendency to only a slight degree or not at all, making no more variable responses to A2 and D3 than to the other figures. Some S's who made very few overt errors in Period I show this tendency very strongly. Thus S 4, who made the smallest number of errors in Period I, was one of three S's making the largest number in II; but almost all of her errors in II consisted in the A2-D3 shift.

Since not all of the S's completed the association measurements of Period II, we can make comparisons only between the association measurements of I and the errors of I and II. We find between number of failures to respond in I and association time an r of .68. In so far as association time is a measure of associative organization, it therefore appears that those S's who most frequently are unable to make any verbal response whatever to an object show the least tendency toward such organization; those S's who show this tendency more strongly are more likely to respond with 'errors' than to make no response whatever. However, there appears no significant relation between *overt* errors in I and the association measures. Nor does such relationship appear in II, *except in the responses to A2 and D3.* Here those S's who show the strongest tendency toward the A2-D3 shift tend to have the shortest association times (r=.54), greatest commonality of associations (r=.75), and least associative scatter (r=.64). They also respond with the shortest reaction-times to the N-figures (r=.65) and they most consistently give these figures the names most frequently given them by the group as a whole (r=.51 in II-*a* and .83 in II-*b*). This last relationship is of especial interest. We have seen that the condition of maximum equilibrium

toward which each shape category tended after the introduction of the N-figures is that represented by the pattern *abbc*. To attain this equilibrium in categories A and D the A2-D3 shift was necessary; that is, a renaming of these two *old* figures. But in categories B and C this pattern was attained by an appropriate naming of the *new* figures, e.g., by giving *B2 the name 'B3' rather than the name 'B1.' It now appears that the S's who met the one condition tended also to be the ones who met the other, and also to be the individuals showing the greatest speed, specificity, and commonality in their associative responses *in the period preceding the introduction of the N-figures.* The differences between the individual S's in the tendency to the A2-D3 shift were much greater than in the commonality of their responses to the N-figures.

Further evidence of the differences among the individuals in their manner of adjustment to the new situation presented by the introduction of the N-figures is afforded by a comparison of their reaction-times in naming the O-figures in Periods I and II-*a*. The average reaction-times of some S's increased in II-*a*, those of others decreased. The following relationships appear: the smaller the percentage that an S's reaction-time in II-*a* was of that in I, the shorter was his average association time in I (r=.59), the greater the commonality of his nonsense associations (r=.75), the less his associative scatter (r=.67), the shorter his reaction-times for the N-figures (r=.62), and the greater his tendency to the A2-D3 shift (r=.62). And finally, we find that the shorter the reaction-time in naming the N-figures in II-*a*, the greater is the commonality of associations (r=.50) and the less the scatter (r=.51) in the period preceding the introduction of the N-figures.

The Relations between Instability and Association

We have seen that the most frequent type of 'error' in Period I was the 'multiple response'; the S begins with one response but 'corrects' himself, so that there is a pause between the two utterances, or at least a boundary produced by a strong stress on the corrected utterance. Either the first or the second utterance may actually conform to the conventional (originally taught) name for the figure. Such multiple responses can hardly be called contaminations, and yet the assumption seems justified that they are manifestations of the same underlying condition, viz., a state of balance between two reaction mechanisms. And, indeed, occasional examples of true contaminations occurred in responses to those figures which

tended most strongly to elicit multiple responses, e.g., figure B3. Had the verbal material been *dissyllabic,* and particularly if, instead of constituting a totally suppletive system, it had provided some initial sound similarities,[8] the multiple responses would probably more frequently have taken the form of contaminations.

Secondly, we have seen that the associations elicited by the nonsense names were in accordance with the multiple response tendencies, and that certain of these associations were as constant and speedy, at least for some subjects, as were the associations elicited by English words especially chosen as being among the most constant in the language. We must now consider the relationship between the multiple response tendencies and the associative tendencies.

It has been sufficiently demonstrated in earlier studies that in English, as well as in other languages, certain words will elicit the same associations on the part of from 60 to 90% of any sufficiently large group of individuals, with very short average reaction-times. It is also known that these words have been involved in considerable analogic change in the histories of the various languages. And thus, in conformity with the psychological doctrines current in 19th century linguistics, the analogical changes have been causally attributed to the associations. If a word *a* is strongly associated with a word *b* (so runs the explanation), then the *idea* of *a* not only tends to arouse the corresponding articulation but also the *idea* of *b*, the latter tending also to arouse a corresponding articulation. The result will frequently be an *Entgleisung,* a 'derailment,' the articulation of *b* beginning before that of *a* has been completed. Or, to put the matter in more modern physiological terms, if the sound and articulation of a word *a* have become conditioned stimuli tending strongly to elicit word *b*, then the beginning of the articulation of *a* may activate the *b* mechanism so strongly that an interference of responses results.

There are serious weaknesses in this explanation. Chief among these is the fact that though certain associations are found to be almost universal at the present time, and very constant and prompt in most individuals, they yet show very little tendency to produce mixtures of articulation. And, on the other hand, very many of the momentary *lapsus linguae* which have been reported by various writers[9] do not involve words between which strong or common associations can be demonstrated. Secondly, it is extremely doubt-

[8] As in Experiment I and II of my monograph (2).
[9] E.g., Meringer and Mayer (5).

ful whether, if a verbal mechanism *b* must first be aroused by another verbal mechanism *a,* it can be set in operation so quickly as to interfere with the articulation of *a.* And, finally, it seems highly unlikely that whenever a situation calls out, e.g., the verbal response *black,* this word should automatically drag forth the word *white,* regardless of the nature of the stimulating situation.

These deficiencies in the traditional explanation seem to me to proceed from an almost total neglect of the relationship of verbal responses to the stimulus situations which elicit them, and of the fundamental question of how the verbal associations themselves come to be established.

Why do certain words associatively elicit specific other words? The explanation offered by one of Thumb's critics was that the subjects *auf Schulbänken gesessen haben.* And, indeed, this would seem to indicate one type of situation in which verbal associations might well be established. For so far as our knowledge of the conditions of learning goes, if a sound-sequence or articulation *a* is to elicit an articulation *b,* then *a* and *b* must have occurred simultaneously or successively a certain number of times. Obviously, in the rote memorizing of grammatical paradigms, arithmetic tables, etc., such conditions are met, and this must account for much of the uniformity which we find in the associations of most individuals. But linguistic change did not begin with the foundation of schools, nor is it absent among unschooled populations today. And I have not found the associations of uneducated individuals or young children to differ much from those of the educated, *when the stimulus-words are chosen from the more universal and common stock of the language.*

The more general principle would be that the stimuli resulting from one verbal response become capable of eliciting a specific other verbal response whenever there is a frequent recurrence of environmental situations which tend to elicit both responses simultaneously or successively. An environmental situation might elicit such multiple responses either because it contains *both* of the objects *a* and *b,* each of which tends to elicit its own specific response, or because it contains an object *a* which tends to elicit not only its own specific response but also the response specific to another (absent) object *b.* This last type of situation is the type occurring in this experiment, and it must be a type very frequent under ordinary conditions. For the specificity of stimulus objects and of responses is a relative matter; every object in the world has some characteristics in common

with other objects, and may on occasion elicit the verbal responses which are relatively specific to these other objects. Experimenters who work with 'nonsense' material know how impossible it is to obtain any pattern, however fantastic, which does not set off some conventional verbalization. Thus when we say that a certain response is the specific response to an object, we are really stating a statistical probability; given numerous occurrences of this object, this response is the one which will occur most frequently.

The above formulation would mean a reversal of the traditional explanation; it is not the associations which cause the variations in response, but the tendency to variability is responsible for the associations. Thus both mixtures of articulation and verbal associations proceed from a common cause: the tendency of certain stimulus-objects to elicit multiple responses. It will be true, of course, that if we find a word *a* closely associated with a word *b* on the part of many individuals, this may serve as evidence that certain stimulus situations have had a strong tendency to elicit simultaneously or successively the two responses, and that under certain additional conditions this may result in mixtures of articulation. But, as has been pointed out above, mixtures of articulation may occur between words which are not at all strongly associated; a certain stimulus situation occurs which for the first time in the individual's history activates two particular verbal mechanisms simultaneously, and a 'contamination' may result in the absence of any demonstrable previous association. A verbal association therefore tells us at most what verbal mechanisms have tended to be simultaneously activated most frequently in the past. But it does not tell us under what conditions such simultaneous activation will take the form of contamination or analogic change.

Two further points are suggested by the data of this experiment. First, certain subjects may show extreme variability in their associative responses and yet make many variable responses to the figures. That is, a certain number of joint activations of two response mechanisms may in one individual result in a firm interconnection between them, and in another individual produce hardly any such interconnection. And yet in general the individuals who show the greatest tendency toward variation of response show also the firmest associations.

Secondly, let us consider, e.g., the responses to figures C1 and C2. The association 'C1'→'C2' is extremely constant, speedy, and common to all S's, whereas the reverse association is weak. Does this

mean that the stimulus-response unit C1→'C1' is more unstable than the unit C2→'C2'? The error records contradict this; the latter unit is much more unstable, particularly in Period II-*b*. In other words, if a verbal association *a→b* is very strong, and the reverse association is weak, *then it is not* a *but* b *which is unstable.* Given an object *B* whose name is *b,* the frequent occurrence of *b* as an associative response to other words indicates not *necessarily* an instability in the relation of these other words to their objects, but an instability of the stimulus-response mechanism *B→b*.

SUMMARY

The results of the present experiment suggest the following tentative principles:

1. Instability of verbal reactions results when stimulus-objects, because of common features, tend to activate not only the response most specific to them but also the responses relatively specific to other objects ('multiple responses').
2. This instability is revealed by frequent occurrences of the simultaneous or successive activation by one stimulus-object of two or more response mechanisms, and, where this tendency is strong, by lengthened reaction-time in the verbal response to the object.
3. This simultaneous activation of two or more response mechanisms may result in an interconnection between them, so that the sound or articulation corresponding to the one associatively elicits the other.
4. Verbal associations are possible *results* and indicators, not *causes*, of 'multiple response' tendencies such as are exemplified by contamination and analogic change.
5. A very strong verbal association *a→b,* when the reverse association *b→a* is weak, may indicate an instability of the response *b* in relation to its stimulus-object *B,* rather than an instability of *a* in relation to its stimulus-object *A*.
6. When a stimulus-object *B,* whose name is *b,* tends to be confused with *two* other objects *A* and *C* in about equal degree, the stimulus-response unit *B→b* may be very unstable, but the name *b* will elicit extremely variable associations, with long association times.
7. When to a group of named objects there is added a new, unnamed object resembling the others in such an attribute as shape, the new object elicits the name of that one of the original objects which most closely resembles it in other attributes (as of size);

or, if two of the original objects so resemble it equally, it elicits chiefly that verbal reaction which was previously most *unstable* and least *specific*. Such an introduction of a new object temporarily increases the instability of the entire system, but there is a tendency toward a new equilibrium, the pattern of which has been described in preceding pages.

8. Decided individual differences were found in the manner and degree of verbal organization. Those individuals whose reaction-times are shortest tend to make the most frequent *overt* multiple or variable responses in naming stimulus-objects, but long reaction-times may indicate frequent *implicit* responses of this type, which show their effect in the associative connections between the words. In general, those individuals whose verbal associations show the greatest commonality with those of the group, the greatest constancy, and shortest associative reaction-time show the most consistent and ready tendencies toward organization of the verbal material, especially when this organization involves shiftings and changes in a system of stimulus-response units to restore a disturbed equilibrium. These facts very definitely suggest that the various individuals of a speech community would participate in very different degrees in the initiation of semantic and analogic change.

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ÉTUDE DANS L'ORGANISATION DU COMPORTEMENT LINGUISTIQUE: I. LES CARACTÉRISTIQUES DES RÉACTIONS VERBALES INSTABLES

(Résumé)

Les conditions fournies dans cette expérience ont été les suivantes: (*a*) on a joint des réponses verbales (syllabes non-sens) à nombre d'objets stimuli (figures non-sens) se ressemblant en forme ou grandeur, mais choisis de sorte qu'il y a eu une certaine asymétrie dans les classes objectives auxquelles ils appartiennent: et (*b*) on a introduit après d'autres objets ressemblant systématiquement aux premiers objets mais pour lesquels aucuns noms spécifiques n'avaient été appris. Les résultats suggèrent les principes suivants: (1) L'instabilité des réactions verbales résulte quand les objets stimuli, à cause de traits communs, tendent à activer non seulement la réponse la plus spécifique à eux-mêmes mais aussi les réponses relativement spécifiques à d'autres objets ('réponses multiples'). (2) Cette instabilité est révélée par des occurrences fréquentes de l'activation simultanée ou successive par un objet-stimulus de deux ou plus mécanismes de réponse, et où cette tendance est forte; par un plus long temps de réaction de la réponse verbale à l'objet. (3) Cette activation simultanée de deux ou plus mécanismes de réponse peut résulter en un rapport réciproque entre eux, de sorte que le son ou articulation correspondant à l'un évoque l'autre. (4) Les associations verbales sont des *résultats* possibles et indicatrices, non pas des *causes,* des tendances de 'réponse multiple,' telles que montrent par exemple la contamination et le changement analogique. (5) Les personnes dont les associations verbales montrent la plus grande ressemblance à celles du groupe, la plus grande constance, et le plus court temps de réaction aux associations montrent les tendances les plus constantes à l'organisation du materiel verbal, surtout quand cette organisation comprend des déplacements et des changements dans un système d'unités de stimulus-réponse pour restaurer un équilibre dérangé.

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UNTERSUCHUNGEN AN DER ORGANISATION DER SPRACHTÄTIGKEIT: I. DIE BESCHAFFENHEIT LABILER SPRACHREAKTIONEN

(Referat)

Die in dieser Untersuchung verschafften Bedingungen waren wie folgt: (*a*) Sprachreaktionen (sinnlose Silben) wurden mit einer Anzahl von Reizgegenständen verbunden [attached] welche einander in Bezug auf Form oder Grösse ähnlich waren, welche aber so ausgelesen worden warden, dass in Bezug auf die objektiven Klassen, denen sie angehörten, eine gewisse Assymetrie bestand; und (*b*) es wurden später weitere Gegenstände eingeführt, die den ursprünglichen Gegenständen systematisch glichen, für die aber keine spezifische Namen gelernt worden waren. Die Befunde weisen auf folgende Grundsätze hin: (1) Es wird Unstetigkeit der Sprachreaktionen verursacht, wenn Reizgegestände, infolge gemeinsamer Eigenschaften, dazu neigen, nicht nur die ihnen spezifischste Reaktion, sondern auch die, für andere Gegenstände relativ spezifischen Reaktionen ('multiple Reaktionen')

in Gang zu setzen. (2) Diese Unstetigkeit offenbart sich im häufigen Vorkommen simultaner oder aufeinanderfolgender Aktivierung zweier oder mehrerer Reaktionsmechanism, und, wo diese Neigung eine starke ist, in einer Verlängerung der Reaktionszeit der Sprachreaktion auf den Gegenstand. (3) Diese simultane Aktivierung zweier oder mehrerer Reaktionsmechanismen kann eine gegenseitige Verbindung [interconnection] verursachen, so dass der dem einen Reaktionsmechanismus entsprechende Laut oder die entsprechende Ausprache [articulation] nun assoziativ den anderen Mechanismus hervorruft. (4) Sprachassoziationen sind mögliche *Resultate* und Andeutungen, nicht *Ursachen* der Neigung zu multiplen Reaktionen wie sie sich zum Beispiel in der 'Verunreinugung' (einer Assoziation durch eine andere) [contamination] und in analogischen Veränderungen [analogic change] erweist. (5) Jene Individuen, deren Assoziationen die grösste Gemeinschaft mit denen der Gruppe als Ganze, die grösste Beständigkeit, und die kürzeste assoziative Reaktionszeit erweisen, erweisen auch die beständigsten Neigungen zur Organisierung des Sprachstoffes, besonders wenn diese Organisierung Verschiebungen und Änderungen eines Systems der Reiz-reaktionseinheiten zur Wiederherstellung eines gestörten gleichgewichts in anspruch nimmt.

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