LINGUISTIC LAPSES

WITH ESPECIAL REFERENCE TO THE PERCEPTION OF LINGUISTIC SOUNDS

BY

FREDERIC LYMAN WELLS, PH.D.

ARCHIVES OF
PHILOSOPHY, PSYCHOLOGY AND SCIENTIFIC METHODS

EDITED BY
J. MCKEEN CATTELL AND FREDERICK J. E. WOODBRIDGE

NO. 6. JUNE, 1906

COLUMBIA UNIVERSITY CONTRIBUTIONS TO PHILOSOPHY AND PSYCHOLOGY
VOL. XIV. NO. 3.

NEW YORK
THE SCIENCE PRESS

CONTENTS.

CHAPTER.		PAGE.
I.	PREFATORY	5
II.	LITERATURE	6
III.	METHOD	15
IV.	RESULTS	24
V.	THE CONSTANT ERROR	45
VI.	HISTORICAL	49
VII.	RELATIVE PERCEPTIBILITY	59
VIII.	PRACTISE	62
IX.	SENSATION HABITS	64
X.	INTRODUCTORY	73
XI.	THE PSYCHOPHYSICAL LINGUISTIC UNIT	74
XII.	CLASSIFICATION	78
XIII.	THE MOTOR LAPSE	81
XIV.	THE SENSORY LAPSE	96
XV.	THE EVIDENCES OF APHASIA. CONCLUSION	108
	SUMMARY	110

I.—Prefatory.

Investigations along the present lines have been too few and their results too meager to justify exclusive attention to any single aspect of the problem in the present series of experiments. Before a searching investigation of any single point may be undertaken, it is necessary that a more thorough understanding of the main facts of the entire field be at hand than is the case at present. The object of the present in-

s from
hus far
before
a reply
against
wholly
igation
experi-
ocaliza-
ogy, so
of this
as the
ntry, a
narrow
ny as-
ulness,

though it has been necessary to dismiss many others, themselves fit matter for a larger series of experiments than the present, with a page or a paragraph. The territory is new, and the principal landmarks must be established before thorough exploration can begin.

The writer's obligations are first of all to Professor Cattell, who suggested the general method, and was of continual subsequent help, and to Professors Thorndike and Woodworth, who were of essential assistance in the statistical portions. For their time and services as subjects, the writer is indebted to Dr. C. J. Bennet (I.), Mr. A. Lipsky (II.), Mr. G. Cutler Fracker (III.), Mr. F. G. Bruner (IV.), all at that time of the Department of Psychology at Columbia University, and especially to Dr. V. A. C. Henmon (V.), of Columbia University, and to Dr. Masatsugu Tsukahara (VI.), of Hiroshima. All save the last named speak English as the native language, and the last named is, beside his native language, thoroughly familiar with English, French and German. As subjects in the experiments on the visual

CORRIGENDA.

Page 1. C. J. Bennet *read* C. J. Bennett.

Page 41. Constant error for þ, s and h *read* þ, s, and h.

Page 54. Transpose ostfr. and oberd. tt, bp.

Page 58. *ὕδωρ read ὕδωρ.*

I.—Prefatory.

Investigations along the present lines have been too few and their results too meager to justify exclusive attention to any single aspect of the problem in the present series of experiments. Before a searching investigation of any single point may be undertaken, it is necessary that a more thorough understanding of the main facts of the entire field be at hand than is the case at present. The object of the present investigation, therefore, involves the study of linguistic elements from many points of view, for our knowledge of the whole field is thus far so limited that certain advances must be made along all lines before any one may be thoroughly explored. This fact must serve as a reply against any charge of inconsequentiality that may be brought against these experiments, which might under other circumstances be wholly justified. But so long as there exists not one scientific investigation touching other than remotely upon the bearings of the present experiments, so long as there is, indeed, outside the field of cerebral localization, hardly one definitely established fact of linguistic psychology, so long is it not justifiable to devote one's self to a single aspect of this problem, if indeed one is justified in naming such an aspect as the definite object of any investigation whatever. In such a country, a single investigator may not penetrate very far along a single narrow line without losing his bearings. It is for this reason that many aspects of the problem have been treated with perhaps equal fulness, though it has been necessary to dismiss many others, themselves fit matter for a larger series of experiments than the present, with a page or a paragraph. The territory is new, and the principal landmarks must be established before thorough exploration can begin.

The writer's obligations are first of all to Professor Cattell, who suggested the general method, and was of continual subsequent help, and to Professors Thorndike and Woodworth, who were of essential assistance in the statistical portions. For their time and services as subjects, the writer is indebted to Dr. C. J. Bennet (I.), Mr. A. Lipsky (II.), Mr. G. Cutler Fracker (III.), Mr. F. G. Bruner (IV.), all at that time of the Department of Psychology at Columbia University, and especially to Dr. V. A. C. Henmon (V.), of Columbia University, and to Dr. Masatsugu Tsukahara (VI.), of Hiroshima. All save the last named speak English as the native language, and the last named is, beside his native language, thoroughly familiar with English, French and German. As subjects in the experiments on the visual

lapse, thanks are also due to Miss Helen Kleinknecht and to Mr. Sven Froeberg, then also of the Department of Psychology.

The present study falls into two divisions: first, that especially devoted to the perception of linguistic sounds; and, second, that concerned with the general study of the linguistic lapse. Several studies are concerned in the literature of the first topic, but it is believed that they may be conveniently discussed under a separate heading before proceeding to independent treatment of the subject. On the general subject of lapses there exist three important studies to which such constant reference throughout the text is necessary that it has been judged wisest to discuss them only in this relation. The present study will therefore concern itself first with the more important of those investigations touching upon matters involved in the perception of linguistic sounds.

II.—Literature.

Previous investigation along the lines of the present experiments is somewhat limited, and the greater portion of it is open to such serious objections in method that it is difficult to attach any great significance to results thus obtained. In most cases, however, the work touches only indirectly upon the present subject.

The first investigation along these lines was the work of Wolf,[1] of Frankfurt, who in 1871 published the results of certain experiments conducted on pathological cases, in which the organ of hearing was affected to a varying degree. Wolf operated with significant words, generally polysyllables, upon subjects divided into five groups, according to the condition of their hearing apparatus. He was not a psychologist, and it is not inspiring to read of the earnestness with which he impressed upon his subjects the absolute necessity for a conscientious repetition of the sensation, no matter how far from a significant word it might be. It is unfortunate that this usage was followed here, for in other respects the investigation is carefully handled, and the results are tabulated with considerably more thoroughness than those of his successors in the field. But for the fatal defect of significant words the results would have some value, though, being on pathological subjects, a direct qualitative comparison with those of normal subjects would hardly be possible.

Observations were made for consonants in initial, medial and final positions; for vowels the amount of error was too small to give results. The subject was close to the operator, and all test-words were repeated as often as was desired. Qualitatively the results have little signifi-

[1] Wolf, Sprache u. Ohr., Braunschweig, 1871.

cance, and in fact only a quantitative statement of them is given, *i.e.*, the percentage of cases in which a given sound was falsely interpreted. The error ratios do not depart materially from the results of certain of the writer's experiments with nonsense syllables; for the best subjects the absolute amount of error is rather less than for those of the writer, on account of the favorable position of the subject, the unlimited repetition of the test-word, and the test-word's significant content.

A more significant investigation was reported by this writer two years subsequently.[1] While for the majority of the tests there seems still to be too much reliance on the significant word, there is some noteworthy matter on the acoustic penetration of the individual sounds, which seems the most reliable work on the subject to which the writer has had access. The method of experimenting is as good as is available, but data from a greater number of subjects would be necessary for the acceptation of the results as universally reliable. It is regrettable that a larger number of consonants was not tested.

The experiments were made in the open, 'Zu Nachmittagszeit bei windstillem Wetter in einer kleinen Allee,' the investigator always acting as operator, and care being taken that not only was the stimulus perceived, but that it was distinguished. The difficulty of the variable intensity of the stimulus was met, perhaps as satisfactorily as might be, by enunciating each sound as loudly as possible. It was found, then, that the greatest distance at which a given sound might be both heard and distinguished was as follows:

A 360; O 350; EI, AI, 340; E 330; I 300; EU 290; AU 285; U 280; S (C) H 200; S 175; CH (ich) 130; CH (Buch), R, 90; F, V, 67; K, G, T, D, 63; P, B, 18; H 12 Schritten. (56 Schritten=140 ft.)

As the sounds were in all cases pronounced at their greatest possible intensity, the distinction of voiced and voiceless of course disappears. The presentation of the results lacks a variability index, neither does it appear that more than one subject was used, though this is perhaps not so essential here, since the relative values should hardly be significantly altered. The same order appears to hold for large enclosed spaces. An empty space is more favorable to the perception of single sounds than a full space on account of its greater resonance; but this same factor is disadvantageous in dealing with sound-complexes, the resonance of the preceding disturbing the perception of the succeeding elements.

Especially do the vowels act unfavorably on the consonants. The larger the hall, and the emptier, the slower should be the enunciation, emphasis being laid on the consonants rather than the vowels.

To demonstrate that the difference between voiced and voiceless

1 Wolf, Neue Untersuchungen über Hörprüfung u. Hörstörungen, Arch. f. Augen-u. Ohrenheilk., 1873, III. (2), 35.

sounds is not only one of laryngeal action or inaction, Rousselot[1] measured the comparative acoustic penetration of sounds voiced and unvoiced in normal speech, subtracting the laryngeal action by whispering. Data regarding the conditions of these experiments are almost entirely lacking, and, as usual, measures of variability are absent. The figures are as follows:

Distance at which sounds were heard in a whisper inaudible above 8 meters.		Distance at which sounds were heard in a tone of voice not clear above 9.6 m.	
i	8 meters	aeiou	9
k	7.2	ptk	8
g	7	b	7.5
j	6.6	sf	7
pb	6.1	dmn	6
u	6	jg	5.7
t	5.6	z	5.5
d	5.5	vuö	5
f	4.9		
v	4.7		
e	3		
mnlr	2		

While it cannot be denied that these results demonstrated the now generally accepted fact that the oral articulation is less intense in the voiced than in the voiceless sounds, some reservation must be placed upon their acceptance as reliable measures of acoustic penetration. The figures, it will be observed, do not correspond well with the results of Wolf, nor with those of Müller and Pilzecker, to be cited below. More extended and accurate researches might serve to establish a more constant ratio of acoustic penetration than the investigations quoted, but its lack of absolute value would render it hardly profitable to attempt them from this point of view. Indirectly, however, it might possess considerable significance. If the relative acoustic penetration of an individual's phonology were known accurately for a large number of subjects, it should be possible to determine how much of a significant word was heard at a given distance, and how much was supplied. Then according to the manner in which words or sentences were interpreted it should be possible to determine approximately what phonetic elements were necessary or unnecessary for apperception. Though more laborious, it would probably be a much more reliable method for investigating the apperception of the spoken sentence than any yet devised.

1 Rousselot, Les Modifications Phonétiques du langage, 1891, p. 38.

In 1888 a few experiments were made by Sara E. Wiltse at the instance of G. Stanley Hall, on Sound-blindness, so termed, apparently, with a view to devising some simple hearing test for use in the public schools.[1] The first tests were made upon 259 pupils of the Boston Latin School with polysyllabic English words, apparently no significance being attached to whether the individual was familiar with the word or not. Some standard of pronunciation-intensity was apparently used, but exactly what is not clear. No system of phonetic transcription appears to have been agreed upon. Words were repeated successively as often as desired. No attention seems to have been paid to varying distances of the subject from the operator. Under these circumstances, which include almost every condition that ought not to be permitted in such an investigation, it is not surprising that the results given show nothing of significance, and apparently seemed to the investigator hardly worth systematizing.

In a second experiment, monosyllabic words were used as stimuli. The hearing of each subject was tested with a tuning-fork, two cases of deafness being found in the eighty-four subjects tested, which group consisted of those who had confused vowel sounds in the previous test. Save that the subjects were at approximately equal distance from the operator, the same elementary precautions are lacking here as previously, destroying whatever significance the results quoted might otherwise have. Five hundred and thirty grammar school pupils between the ages of eight and fourteen were next tested with the same monosyllables, and by the same general method. The results of this experiment are analyzed and presented more completely than those of the previous experiments, but the most elementary groupings of the sources of error are neglected, there being actually no distinction drawn between errors causing the return of nonsense syllables and those causing the return of words.

In view of these facts, the acoustic penetration of the various linguistic sounds being so ill established, and, perhaps, establishable, one can hardly expect to find much in the nature of correlation between this acoustic penetration and a relative psychological impressiveness, provided such a thing can be shown to exist. Müller and Pilzecker have assumed that this impressiveness should be correlated with the degree of memorability of the sound, and quote at some length results along these lines obtained during the research, 'Experimentelle Beiträge zur Lehre vom Gedächtniss.'[2] The form of the test was memory for nonsense syllables. The twelve subjects were classified as *Starkauditif* and *Schwachauditif,* which terms appear self-explanatory. First was considered the memorability of the sound with regard to its

1 Wiltse, Am. J. Psych., 1888, I., p. 702.

2 Zt. f. Psychol. u. physiol. d. Sinn., 1901, Ergänzungsband, I., p. 247.

position in the nonsense syllable, which consisted always of a vowel between two consonants. In comparing the memorability of sounds in certain positions it is necessary to consider only those cases in which a part of the syllable was correctly recalled. This treatment of the data gave the following results:

Subj.	In. Cons.	Fin. Cons.	Diff.
Starkauditifen			
A	95	71	24
B	55	62	—7
C	29	36	—7
D	83	64	19
E	69	68	1
F	42	35	7
G	29	45	—16
H	94	100	—6
Schwachauditifen			
I	38	37	1
J	20	19	1
K	43	22	21
L	22	29	—7
A[1]	27	33	—6
G	92	90	2

While these results have been interpreted to signify a greater memorability of the initial over the final consonant, this seems hardly justified by the figures brought forward. Of the 8 *Starkauditifen* 4 show negative results, and of the 6 *Schwachauditifen* 2, in all, 6 out of 14. Observe, also, that the performance of those giving negative differences is rather more even than that of those giving positive differences. Out of the 8 who give positive differences, these are in 4 cases too small for significance, and in 3 so large as to give the whole a distinct bimodal distribution. Absolutely, five of the six negative differences correspond very closely, and all are sufficiently great to be significant. On the whole, therefore, if a conclusion had to be reached from these results, the negative differences seem more trustworthy than the positive ones, but it is hardly possible to regard the material here presented as conclusive on either side.

The character of the sounds in the partially remembered syllables was next taken into consideration. The results here seem of a more reliable character than those above, and in many cases a reasonable interpretation can be placed upon the good or ill persistence of a sound. The data of the *Starkauditifen* are more significant for pres-

[1] A and G were considered in certain series as *Schwachauditif.*

ent purposes. They do not correlate well with those of the *Schwachauditifen* save in certain cases, as the persistence of SCH in both groups, where apparently the visual imagery was in each case predominant. The number of cases in which for the *Starkauditifen* a given vowel persisted in the fragment of a test-word is as follows:

EU	Ö	I	EI	Ä	Ü	AU	O	AA	E	A	U
121	100	75	70	69	69	65	65	64	55	46	38

The lack of correlation with the results of the *Schwachauditifen* is more marked here than in the case of the consonants, and many facts in the table are difficult to explain, *e.g.*, the wide variation in the memorability of the digraphs which ought theoretically all to have been at or near the top of the list. It seems regrettable that the individual judgments, or some statements of variability, were not included, for this might have thrown light on these divergences, as well as enhanced the significance of the results.

The order of memorability for the final consonants (no arrangement of initials appeared practicable under the conditions of the experiment) was as follows:

SCH	P	Z	M	T	F	CH	N	L	R	K	S
56	52	51	49	47	43	42	40	38	37	35	25

The results form a very respectable continuum, with probable errors at least sufficient to destroy the significance of the smaller differences. They do not correlate at all with those of acoustic penetration as determined by Rousselot and Wolf, nor with any possible system of phonetic classification, and hardly with any experimental determination of the relative distinguishability of sounds as given in the writer's or other experiments. And it is not probable that a larger number of observations would remove these discrepancies, for there is reason to believe that acoustic penetration varies with the individual too greatly for the determination of any standard, and as regards the phonetic classification the obvious discrepancies are already so great as to be hardly redeemable by increasing the number of cases. Correlation with the relative distinguishability of sounds might be brought closer than at present. Especially in this connection is it unfortunate that the individual records were not given. Further determinations along these lines are highly desirable, though the visual imagery must always be a very disturbing factor.

Bagley approached the problem of acoustic impressiveness from a different viewpoint. In the study of 'The Apperception of the Spoken Sentence,'[1] he states the problem somewhat as follows:

[1] Am. J. Psych., 1900, XII., p. 80.

'Have the various consonants or classes of consonants varying degrees of significance for perception? Are there among the auditory symbol elements certain elements which are determining, and others which are indifferent . . .? The question now arises, apart from an associative supplementing (due to context, etc.), Are there other objective or physiological factors which give the various elements a varying degree of significance? Are certain consonants for any reason more fundamental than other consonants?'

The stimuli employed were phonograph records of slightly mutilated words and sentences, the subject recording the stimulus as heard from the phonograph. This method has two important disadvantages. First, with such speech-recording apparatus as can be bought in the open market even at the present day,[1] reproduction is from twenty to one hundred times less distinct than normal speech. By this is meant that from twenty to one hundred times as many auditory errors are made with it as with normal speech. With some sounds, particularly the explosives, the difference in distinctness is so great as to be almost unmeasurable. Then, too, the sounds are not recorded with accuracy, but certain perversions in the curve can be demonstrated to occur. Moreover, there are physiological difficulties in the way of enunciating a satisfactorily mutilated sound-complex.

It must be apparent to anyone familiar with the most elementary facts of phonetics that such omissions necessarily work changes in the glides, etc., of the sounds adjacent so as to produce a result considerably different from the mere subtraction of a single sound from the complex. It is physiologically impossible to eliminate such an element without working far-reaching changes in the phonetic values of the other components of the word. In the absence of other objections, these facts would militate considerably against the acceptance of the results, which were in brief as shown in the subjoined table:

[1] 1905.

Elision	Total Judgments	Right	Wrong	
p	47	20	27	
t	43	22	21	
k	40	14	26	
b	28	9	19	
d	44	25	19	
g	26	12	14	
	228	102	126	
				44.7% right.
f	23	9	14	
th	27	11	16	
ch	29	13	16	
v	38	18	20	
j	43	25	18	
	160	76	84	
				47.5% right.
s	36	20	16	
sh	42	21	21	
z	16	3	13	
zh	18	11	7	
	112	55	57	
				49.1% right.
m	43	17	26	
n	32	23	9	
ng	9	2	7	
	84	42	42	
				50% right.
w	10	7	3	
r	36	28	8	
l	42	28	14	
	88	63	25	
				71.6% right.

That is, out of the 47 stimuli where p was elided, the elision was supplied correctly in 20 cases and in 27 cases not, etc. These results could not be accorded significance if they came from a single subject, and the

inevitable lack of a variability index impairs the results for a plurality of subjects. Moreover, it may be questioned, taking the limited number of observations into account, whether the differences in the percentages of right judgments are in themselves sufficiently great to warrant the drawing of any inferences from them. The difference in the last group is certainly significant, but it may be doubted whether this significance has any psychological character. It has been noted in the writer's experiments with nonsense-words that w and English r show a considerable tendency to go unheard, and it may be that we supply them more readily in mutilated sentences because we are more used to not hearing them anyway. Moreover, there will, in these nonsense-words, be frequently a consonant supplied which does not belong there; under certain physiological conditions, indeed, consonantal enthesis is almost a constant error. The only consonants which the writer has observed to share in this process are l and English r. If now we show a marked tendency to supply l and r where they do not belong, how much more shall we tend to supply them where they do belong? These considerations should account fully, on purely physiological grounds, for the correct perception of the l and r elisions, without the necessity of assuming a greater or less degree of 'psychic fundamentality.'

There follows in support of these results the statement that in both the phylogenesis and ontogenesis of language the mutes (explosives) are the first consonants to appear. It is difficult to see how the first of these statements has any foundation in philological fact, Whitney to the contrary notwithstanding; as to the second, the nasals are physiologically simpler than the explosives, requiring no closure of the nasal passage, and appear about contemporaneously with them. 'These results,' continues this investigator, 'may now be compared with the substitutions which the various observers made when the words were misinterpreted. These substitutions may be considered, in the main, those which followed the line of least resistance, *i.e.*, required the least energy for their production. The data of this determination are mostly (!) such words as were not filled out by the observer into 'meaningful,' but into nonsense symbol-complexes.'

Total number of substitutions 221

p	3	f	1	s	6	m	2	w	63
t	26	th	5	sh	4	n	2	r	26
k	8	ch	2	z	1	ng	8	l	21
b	6	v	7	zh	0			y	15
d	11	j	3						
g	1								
Total	55		18		11		12		125
	9.1		3.6		2.7		4		31.2

average for each sound of the group.

	No. Rep.	No. Subst.	Av. Ea.
Elements	22	221	10
Compounds	14	21	1.5

But it does not seem justifiable to term nonsense-words the examples of this process cited. All but two are to the writer distinctly 'meaningful,' *i.e.*, the associo-suggestive process would operate distinctly in their favor to the exclusion of many other possible substitutions. However, the results quoted do not show much correlation with those previously cited, save in the considerable preponderance of the so-called semivowels. This is, however, again explicable on the purely physiological grounds referred to above, and is hardly connected with any psychological processes.

It does not seem then that any overwhelming significance can be attached to the data hitherto summarized. There is certainly no evidence of correlation between what Scripture terms acoustic penetration, and what has here been called, for want of a better term, acoustic impressiveness, *i.e.*, between physical and psychical phonetic values. No one denies that such correlation exists, but a reliable investigation of the question involves many as yet unsolved problems.

III.—Method.

It is a matter of the most elementary experience that locutions are frequently modified in their transmission from cortex to cortex, and that this modification may work a change in the form only, which is naturally rare, or in signification only, which is extremely rare, or in both form and signification, which probably covers at least 99 per cent. of the cases observed. The change in form is here directly and almost wholly dependent upon the change in signification. Within certain limits, we hear actually what we expect to hear, and in all cases is the

locution profoundly modified by expectation—using this term in its widest sense. Instances are so frequent as to be difficult to recall. In a laboratory exercise a student was once asked if he were sketching the lumbar section of the cord, and replied affirmatively. Upon inspection the section proved to be cervical, and the student, of whose ability to distinguish there could be no question, explained that he had heard *lumbar* as *longer*. This cervical section showed greater structural detail than the other sections at hand, and did, therefore, take longer to draw. Such instances could of course be multiplied indefinitely. Very frequent are those cases in which a familiar but imperfectly understood word fuses with an unfamiliar word of somewhat similar sound. By such process is derived the information that ammonia is the food of the gods; that a certain portion of the alimentary canal is known as the Areopagus; and that the cerebral hemispheres are connected by the Pons Asinorum.

The associo-suggestive process is not always so easy to trace, but it must be assumed that an analogous one exists in every error. It is impossible to isolate this element entirely, but when it is removed as far as possible from the conditions of the experiment, it is found that under ordinary linguistic conditions faulty perception almost never occurs. In general, it is safe to say that under ordinary linguistic conditions no purely sensational error of perception can be shown to exist, and that all errors that are found are complicated to a greater or less extent with processes of association and suggestion.

It goes without saying, however, that this fact by no means excludes the physical element in determining, both quantitatively and qualitatively, what errors shall take place. Under proper conditions, those sounds will still be most frequently confused with one another whose physical likeness is greatest, and the varying degrees of confusion will still constitute a measure of the relative similarity of any series of linguistic sounds. For obviously association and suggestion will lead to the most ready confusion of those sounds already sensationally nearest to one another, although this sensational difference may be so great as to render purely sensational confusion next to impossible. It is essential in experiment, however, that this associo-suggestive process should be as constant as possible, and that it favor no one substitution more than another save on purely physical grounds.

We are adding a factor which tends to diminish perceptional differences; we must see to it that this factor is constant in order that the resulting diminution may be constant. In the examples previously cited this is obviously not the case. Consider the instance in which *lumbar* was heard as *longer, i.e., ong* substituted for *umb*. We should here have no right to say that *mb* stood nearer to *ng* than, for example, to *nd*, because *lunder* or *londer* are nonsense, and a prime factor

here is that the hearer make sense and not nonsense out of what he hears. Granted that he makes an error, he must make one that will make sense, and this the substitution of *ng* alone suffices to do. The associo-suggestive process therefore acts unequally in favor of such a sound as *ng*, which precludes the drawing of any inferences as to the physical similarity of *ng* and *mb*. This is the fatal objection to the use of significant complexes in experiments of this nature. Obvious as this objection may seem, it has been overlooked by more than one investigator along lines related to the present subject, the value of whose results is therefore considerably impaired, if not destroyed.

To determine satisfactorily the mutual relationships of a series of linguistic sounds, it is necessary that the associo-suggestive factor be present, but it is equally necessary that it be constant, *i.e.*, that the extent and direction of its operation be governed by pure chance over as great a number of cases as practicable. This cannot be secured by the use of significant stimuli. Nonsense syllables are therefore the only key to the situation. In employing these, the associo-suggestive factor is present, and it may in individual cases act more in one direction than another, but this variability is, if the series be properly constructed, the result of pure chance, and is distributed accordingly. If the number of observations be sufficiently great, there is no good *a priori* reason for holding that the resultant modifications in auditory sensation do not furnish an accurate quantitative as well as qualitative index of the physiological similarity of the sounds confused.

As has been above indicated, the method employed in the construction of the series of stimuli is a matter of considerable importance. When, instead of employing a test-word consisting of a single consonant between two neutral vowels, which reduces the associo-suggestive factor to a minimum, we make a polysyllabic nonsense-word, we do two things: we first increase the associo-suggestive factor by increasing similarity to actual words, and we effect a greater dispersal of the attention than is the case with the first method. It is impossible here to attend wholly to a single intervocalic consonant, but attention must be directed to all the consonantal and vocalic elements of the test-word. Here, also, the memory factor begins to enter. There is reason to believe that these mnemonic factors will favor sounds in certain positions rather than others, say, at the beginning or end of a test-word, over and above those near the middle. It is therefore necessary that the individual sounds tested be equally distributed with reference to their position in the test-word.

For this same reason, the length of the test-words should be constant, *i.e.*, all should contain the same number of phonetic elements. After some experiment along these lines, it appeared that a trisyllabic test-word, containing three vowels and three consonants, always be-

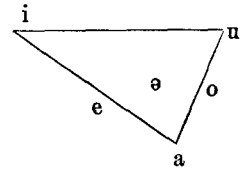
ginning with a consonant and ending with a vowel, was the most desirable form. Consonant combinations are of course to be avoided, unless a special study is being made of them, in which case they should be treated as single consonants. With these and other mechanical conditions to be satisfied, it is easily apparent that every series of stimuli must be artificially constructed. Words from foreign languages are worse than useless. They contain foreign phonetic elements, their sounds are not evenly distributed, they will contain consonant combinations, be almost inevitably of varying lengths, and contain other sounds than those under consideration. They are thus inefficient and wasteful in the extreme. In an artificial series there is, of course, none of this. The number of cases of each sound tested is predetermined, and arranged to correspond with the number of test-words in the series. It is desirable that after the above-mentioned conditions are satisfied, the arrangement of the series be governed by pure chance as much as possible. The consonantal skeleton of the series should be arranged first, beginning with the initial consonants, then the medials and finals. The vowels should then be filled in, care being taken that each vowel employed occurs the same number of times in each syllable. Under no circumstances should the series be written out word by word. It is perhaps unnecessary to add that every series should be of sufficient length to ensure its being thoroughly forgotten by the subject, in which case it may be repeated three and even four times with perfect safety. The exact length of the series must be governed mainly by the number of phonetic elements under consideration.

It is apparent that a single investigator must confine himself to a comparatively limited number of these elements, on account of the number of observations necessary to attain a conclusion regarding each. Those sounds only must be selected which occur in the native language of both operator and subject; the hearing of foreign sounds is matter for another consideration, which will be treated in its place. It is no doubt desirable, however, that such a group of sounds be selected for investigation as is to some extent common linguistic property, and that sounds which are the exclusive property of the language be left for another consideration. The main groups of explosives, spirants, liquids, and nasals are thus entitled to first consideration. Here the English language presents certain phonological individualities, particularly as regards the interdental spirants þ and ð, and the bilabial so-called semi-vowel w. These it seemed best to include as such an integral part of the phonology of the language. In short, determination was made upon the following groups of an infinity of possible consonantal and vocalic sounds:

Consonantal symbols have their normal English values, vocalic symbols their continental (German) values.

	Labial	Interdental	Dental	Guttural	Laryngeal
Explosives	pb		td	kg	
Spirants	wfv	þð			h
Liquids			lr		
Nasals	m		n		

The labials and labiodentals should be considered as a single group, for there is no auditory differentiation, in subjects whose native language is English, between one group and the other. It seemed best also to class w as a spirant, though it should not be confused with the regular bilabial voiced spirant b̥. The terminology of dental and guttural is inaccurate, the significant character of these sounds being due rather to the portion of the tongue than to the portion of the mouth-cavity involved, but has been retained as sanctioned by usage. No phonetic classification can be other than an approximation to conditions of very limited application, and there should be no invasion of the territory where the correlation between definiteness and accuracy becomes an inverse one. The symbols for the interdental spirants are to be interpreted in their Germanic values, and r is an approximation of the French type, but produced very near the boundary of the hard and soft palates. Neither the English spirantal nor the German uvular r's were tested.



In spite of all that has been urged against it, the writer still believes that the vowel triangle, especially as elaborated by Vietor, is the most practical system of vowel representation. The fuller forms would be out of place here; the simplest is that given above. This figure indicates tongue positions only. In i the tongue position is highest and front; in u, the same height but in the back of the mouth. Between the two is the Russian Ы vowel. E stands midway between i and a, the fundamental sound into which all other vowels resolve upon a sufficiently wide opening of the mouth and removal of all physiological obstructions. With o and u a rounded position of the lips is customary, but not necessary, it being quite possible to produce with a constant position of the lips sounds recognizable as any member of this series. A striking analogy holds between the vowel triangle and the so-called color curve. The vowels produced along the

sides of the triangle correspond to the saturated colors, and the i e ä a o ö u ü, etc., are but the nuclei about which we group certain habits of phonetic movement and sensation. Inside the triangle are the mixed vowels, the phonetic browns, just as i might be the yellow, and u the blue. The 'obscure' or 'dark' schwa ə is the gray of vowels, the sum of all the positions of the 'saturated' sounds, and the form of their last historical appearance before lapsing into silence.

In making a comparison of the reactions of an individual to various classes of stimuli, it is of the first importance that these stimuli be constant. It would not be practicable to obtain a statement of the sensational differences between saturated rĕd and orange if different reds and oranges were employed in each exposure. In psychological experiments it is usually possible as well as necessary to have the compared stimuli stand in constant relation to one another. In the present problem, however, this constancy is not attainable. The number of linguistic sounds possible to produce is infinite. We only distinguish for convenience certain groups of variations about a common center, just as there may be 200 recognizable color-differences in the spectrum, but only six or seven are commonly taken into account. Now, as the human linguistic apparatus does not function with mechanical precision, it is impossible to enunciate exactly the same sound twice save by pure chance. Then, too, a sound is more sensitive to external conditions than, say, a color; its quality is necessarily modified by the shape of the room, the relative position of subject and operator, etc., which tend to a still further variation in the physical stimulus. That this also varies with the individual enunciating it, needs not to be enlarged upon. It must be recognized, therefore, that in dealing with the perception of linguistic sounds we are not dealing with a constant stimulus (this in its strictest sense, indeed, we never have), but with one that is quite variable, more variable than is usual in psychological experiment. Stress is laid upon this difficulty, not because it is in any sense to be considered fatal, but because its presence must be held to account for a considerable measure of such lack of correspondence, and extension of the small end of the error-distributions which the results may fairly be expected to show.

Mechanical devices for the reproduction of language might indeed be expected to give a more constant stimulus than would be the case with the human voice, and there are indications that such is the fact; the reasons why such apparatus is unavailable for present purposes are, save in so far as they have been already touched upon, matter for consideration elsewhere. Moreover, since much of the significance of such work is attached to its bearings on the history of language, it is even more desirable that the actual conditions of variations be simulated, rather than that recourse be had to artificialities.

It is needless to emphasize the necessity for an accurate system of phonetic transcription on the part of the subject, and this is a matter which gives much trouble in the earlier stages of an investigation. The consonantal values are constant, and will give little difficulty, but historical change has wrought such havoc with the older system of English vowel representation that it is quite useless for such purposes as the present. Under the circumstances it seems desirable that the subject should be acquainted with the method of interpretation, and should be instructed to employ his symbols accordingly.

Every vowel sound heard may then be expressed in terms of that given symbol, to which, in the subject's opinion, it stands nearest. On occasions when another symbol must be employed by the subject he can devise one for himself, and acquaint the operator with its significance at the close of the series. No greater accuracy is practicable than can be attained by this method. It is the writer's opinion that much useless refinement has of late crept into our methods of the analysis of linguistic sounds, which is altogether the most unfortunate result of the just and necessary introduction of the experimental method into the study of phonetics. It should be remembered that microscopic precision by no means implies accuracy. Our means of perceiving linguistic sounds are, as the writer hopes to show, far from accurate. There is no inconsiderable experimental reason to believe that our methods for graphically recording and reproducing linguistic sounds are not only still more inaccurate, but that they in many cases give a constant and definite perversion of the sound they are entrusted to record. Is it not then very unjust to insist on a representation so refined that no instrument can record, far less reproduce it, and which is for the most part purely a matter of individual sensitiveness, suggestibility and conscientiousness? To what sound of a certain group of sounds is a certain sound of the group physiologically nearest? This is the sole question with which it is at present attempted to deal, and this is precisely the question which is answered by such a representation as that above advocated. This does away with much labor in calculating results, and in this problem above all others is the simplest method the most accurate.

Mention has been previously made of the variability of the stimulus caused by differing resonance conditions beyond those imposed by the operator. The changes which may take place within the operator are probably of greater significance. These may be classed as physical and psychical according to their causation. Physical changes in the stimulus are due to widely differentiated functionings of the speech apparatus and the psychical to the central processes of the phonetic lapse. The coarser physical modifications which the sounds of language may undergo in enunciation are, with their causes, fairly well

recognized. There is a general tendency in normal speech to the spiration of explosives; it may indeed be said that in the speech of many persons, voiced explosives are properly non-existent, all being spirated. The voiceless explosives are not so subject to this process, which may, as Wundt holds, be the product of a high utterance speed, but is here much more probably due to decreased utterance energy and attention. Under these conditions, intervocalic voiceless explosives are normally voiced. Slowly enunciated voiced explosives are always, however, unvoiced. Physiologically, g exhibits the least resistance to this process, and d the most. Conversely, k is the most tenacious of its voiceless character, and t the least. The mouth passage may also be incompletely closed during the enunciation of nasals. It is not probable, however, that, with proper precautions, these errors modify the results to any considerable degree. The English language recognizes the existence of no bilabial or guttural voiced spirant, but English-speaking persons constantly interpret the guttural voiced spirant as g, so that this error is compensating. The bilabial spirant ie interpreted as v, and coincident B-v is to be accepted as frequently due to this cause. The interdental spirant ð is rarely substituted for D. The voicing process of the voiceless explosives is practically negligible, neither do any tendencies to spiration appear in the results.

An internal error, that is, an error arising directly from the operator, far more subtle and difficult to deal with, is that of the phonetic lapse. This generally takes the form of a substitution, *i.e.*, the enunciation of a (usually) phonetically allied sound in place of the proper one, but metatheses and assimilations also occur. If the operator becomes conscious of his error, he notes it, and interprets his results accordingly, but there is no reason to believe that this will always be the case. Were such errors to pass unnoticed, they might well lead to serious perversion of the results. In fact the sole safeguard against the error of the lapse, and the most effective one against all forms of the internal error, is that of its coincidence. In all tests of this nature the internal error is so common as to render a plurality of subjects an absolute necessity. Caution should be exercised in counting coincident errors, based upon the frequency of this particular error when there is no coincidence. Abnormal errors, where the degree of coincidence is high, might properly be disregarded, or accorded separate treatment. In the following case, Raigeki, raigeti-rageti-raigeti-raideti-raigeki, there is a coincident K-t among four subjects, the fifth of whom is, however, correct. Under such circumstances it would be absolutely impossible to decide on the proper treatment of this error without a previous knowledge of the non-coincident interchangeability of t and k. The internal error, if one exists, is obviously a substantial lapse. The auditory error K-t, is, outside of this case,

practically non-existent. Neither is the error T-k exactly a common one, but k is far more frequently auditorily substituted for T than any other sound. From one's knowledge of the frequency of these lapses it seems therefore more just, in this instance, to consider the four coincidences as the correct interpretations of an enunciatory lapse, and the single divergence as an error, T-k. Fortunately such cases as these are rare. Thus there would be little room for doubt regarding the following completely coincident metathesis:

Nomaku monaku monaku monaku monaku monaku.

Despite the frequent auditory interchangeability of m and n the coincidence can hardly be explained otherwise than by an internal metathetic lapse between m and n. This particular lapse was found to be not infrequent in the experiments performed.

Physiological internal errors are more difficult to correct in this way, for the error of the phonetic lapse is a matter of relatively pure chance, while the physiological errors may sometimes be confused with the true auditory ones. Each doubtful case must be judged for itself alone.

The remaining details of the experiment were of the simplest character. The tests were made in a room 31′ 8″ by 31′ 1″ by 14′ 10″, the subjects, two at a time in number, being seated facing the operator at a distance of 8.5 feet. A series containing 96 trisyllables, presenting each consonant 6, and each vowel 19 times (20-A's) in each position respectively, constructed as above outlined, was enunciated in a tone best to be described as approximating that used in repeating an unfamiliar proper name. No accent qualities were emphasized, nor did they appear to influence the results, but a slight expiratory and chromatic stress occurred on the second syllable. The rate was adjusted to the slower subject's rapidity of recording, a series generally occupying from twelve to fifteen minutes. With two exceptions, only one series per day was given, and there was no regularity of interval in the series. If, for any reason, a subject was unable to give complete record of the trisyllable, its space was left blank, and the test-word repeated at the end of the series. The number of series constructed being less than the number of series-records for each subject, three series were repeated to each, but this had no apparent influence on the results. Seventy-two series in all were taken, twelve from each of six subjects, giving in all 1,296 interpretations of each consonant and 4,104 of each vowel, the total number of interpretations being thus 216 interpretations of each consonant and approximately 684 of each vowel for each subject.

IV.—Results.

From the qualitative standpoint, the reliability of the results depends not so much upon the number of cases as upon the number of errors; the more errors a subject makes, the more reliable, qualitatively, are his results. Artificial means of increasing the number of errors are unavailable, on account of the constant errors which they introduce. With the practise effect, this fact forms a limitation of the reliability of the method. The largest number of errors made by one subject was 1,041, the smallest 579, a variation of about 2:1 in six observed cases. At the distances employed no correlation could be traced between number of errors and hearing acuity, as there is none between number of errors and acoustic penetration of the stimulus, as determined by other investigators. The following is an absolute record of the errors of each individual subject:

Subject I.

	P	T	K	B	D	G	F	þ	H	W	V	Ð	L	R	M	N	T
p		2	6	1					10		2						21
t	1								1								2
k	9			2		2		1	4								18
b	4				1	9			2	9	7		4	4	1		41
d				4		3			1	2	1	3	2			2	18
g			1	5						1	4			3			14
f	2							3	1		3						9
þ			1				12										13
h	5		5	1		2			11	1		1					15
w	1								1	1	10	1	12	4	4		33
v	2			6	1	5			5	14		2	5	3		3	46
ð				1	1	1					12		1			1	17
l					5	1				1	1	7		2	4	10	31
r					1				1	8		1	6	1		2	19
m				1		1			2	2			2			12	20
n						2			1				4		35		42
T	24	2	13	21	9	26	12	4	29	38	40	15	36	16	44	30	359

SUBJECT II.

	P	T	K	B	D	G	F	þ	H	W	V	Đ	L	R	M	N	T
p	2		5	3					11					1			20
t	1		1					2				1					5
k	10		1						4								14
b					1	10				7	7		3	2	1		31
d				7		2		1	3		1	11	1	1		1	28
g	3		1	5	4				1			2		1		1	18
f	1							3	1		2						7
þ							2										2
h	4		1	1					7	2		2		2		1	13
w				15	1	4			1	1	33	2	7	4	2		69
v	1			6	1	1			1	8	2	3	4	3	1		29
ð	1			1	5						7		1	1			16
l				1	1	2		1	2	6	1	4	1	2	5	6	31
r				1	2	1				3			6	1		1	14
m				1	1	2			1	6	1		1	1		13	27
n				1	1	2			1	1		2	8		30		46
T	21	0	8	42	17	24	2	7	26	33	52	27	31	18	39	23	370

SUBJECT III.

	P	T	K	B	D	G	F	þ	H	W	V	Đ	L	R	M	N	T
p	1	1	17	5		2	1		22				1	2			51
t			4		1				1			1	2				9
k	10	1				4		1	9								25
b	3				2	11			5	26	18		5	2		1	73
d		1		4		3						8	2	3		2	23
g	1			3	2	1		1	4	3					3		17
f	1			1	1			2	2	1	1			1			10
þ		4	1				8		5								18
h	1		3	1		1			3	3			1	1			11
w				1					4	1	4		4	1	2		16
v	2			22	3	9	4		12	41		12	4	15	4		128
ð	1			1	4	2			2	1	9		3	3		1	27
l	1			1	4	1			2	2		6		2	3	5	27
r					2	3	1			21	1	2	16		1		47
m	1			1		5			4	20		1	5	2		21	60
n	2			1					4	1		1	3		30		42
T	23	7	25	41	19	41	14	4	76	119	33	31	46	32	43	30	584

SUBJECT IV.

	P	T	K	B	D	G	F	þ	H	W	V	Đ	L	R	M	N	T
p	5	1	20	5		1			9		2	1					39
t	3		6			1		1	1		1	1					14
k	16	2	1			1			8		2						29
b	2	1		1	7	14			2	14	26	6	5	2			79
d		1		9		7	1		1	2	5	33	13	5	2	2	81
g	2		4	13	8	1			3	6	8	4	1	5	3	1	58
f	2			1				13		1	2						19
þ	1	4					4		1								10
h	20	1	8	5	1	10	1		6	18	8	5	8	4	4	2	95
w			1	2		1	1		5	1	11		1	4	2		28
v				7		1	1		1	8		3		1			22
ð				1							6		1				8
l				1	3	5			2	6	1	14		5	1	2	40
r				3	3	6				21	8	4	6	1	2		53
m	1			1		3			4	6			6		1	14	35
n			1		1	5			3	1	3	2	16		51	1	83
T	47	10	40	48	23	55	8	14	40	83	83	73	57	26	65	21	693

SUBJECT V.

	P	T	K	B	D	G	F	þ	H	W	V	Đ	L	R	M	N	T
p	1		12	3	1	2			12		4		2	3		1	40
t	1		2														3
k	8	1	1			6		1	4		2						22
b	7				11	30			1	13	24	2		2	1		91
d		1		3	1	2						8	4		1	1	20
g			1	6	5	1			3	3	5	3	2	2	1		31
f	2		2				1	7			3						14
þ			1				1										2
h	14		4		1	2			17	3	3	2	4	3		2	38
w			1	1		3				4	9	1	4	9	3	1	32
v			1	3	1	8			2	14		7	6	2	2	1	47
ð		1			1						4						6
l	1			3	4	1				5	2	4		5	1	2	28
r					3	4			2	15	4	2	16		2		48
m						1			2	4	1	1	2		1	14	25
n					2	1				1			6	1	19	1	30
T	33	3	24	19	29	60	1	8	26	58	61	30	46	27	30	22	477

SUBJECT VI.

	P	T	K	B	D	G	F	þ	H	W	V	Đ	L	R	M	N	T
p			4	3		1	2		4		1						15
t	1		1	1	1		1	2	1			1					9
k	41	7	1	3		9			14	3	5	1		1			84
b	13		1	2	2	24			16	29		6	7	7			105
d		2		4		7			2		4	27	3		1		50
g	2			6	2				2	7	6					2	27
f	5		1	1				1	16	2	2	1					29
þ							(3)										(3)
h	15		5				6		4	6	3		1	1			37
w	1					1			1	13	8		6			1	18
v	2			6							1						8
ð																	
l													1				1
r			1	14	58	32			21	39	25	32		1	4	4	230
m	2			5		2			5	15	2		4			19	54
n				2		1			6	2	3	2	6	1	36		59
T	82	9	13	45	63	77	9	3	88	103	59	70	27	10	41	26	725

SUBJECT I.

	A	E	I	O	U	T
a		41		16	3	60
e			45	3	1	49
i		15			3	18
o	2				27	29
u	3	2	20	11		36
T	5	58	65	30	34	192

SUBJECT II.

	A	E	I	O	U	T
a		41		8	1	50
e	2		33			35
i	2	32			16	50
o	6	3			13	22
u			17	20		37
T	10	76	50	28	30	194

SUBJECT III.

	A	E	I	O	U	T
a		100	6	14		120
e	20		69	1	2	92
i	6	105			7	118
o	10	4	1		19	34
u	5	4	37	48		94
T	41	213	113	63	28	458

SUBJECT IV.

	A	E	I	O	U	T
a		64	2	35	3	104
e	7		47	6	5	65
i	3	117		8	19	147
o	16	10	2		43	71
u		7	29	18		54
T	26	198	80	67	70	441

SUBJECT V.

	A	E	I	O	U	T
a		17	1	9	3	30
e	5		7	8	2	22
i	3	21		5	35	64
o	13	9			15	37
u		2	25	20		47
T	21	49	33	42	55	200

SUBJECT VI.

	A	E	I	O	U	T
a		14		7		21
e	6		56	5	8	75
i		13			16	29
o	19	17	3		51	90
u	1	4	21	11		37
T	26	48	80	23	75	252

The capital letters in horizontal column indicate the objective stimulus, the small letters in vertical column the sound erroneously substituted, the numbers indicate the frequency of the hearing of the sound represented by the small letter opposite for the sound represented by the capital letter above. This arrangement gives at once the character and frequency of error with each sound, and the character and frequency of erroneous substitution of each sound. Thus Subject I. heard an objective P once as t, 9 times as k, 4 times as b, twice as f, etc., in all 24 errors on P. On the other hand, a subjective p was erroneously substituted twice for T, 6 times for K, once for B, etc., there being in all 21 erroneous substitutions of p. And so on through the six tables.[1]

It would be fallacious to make a direct qualitative comparison of the results of the six subjects, as they vary over a range of about 2.1, which would create false divergences and agreements. The reduction of the results to a common denominator is effected in Table II., in which a different arrangement is adopted for convenience in checking agreements and divergences.

1 Figures standing under and opposite the same letter indicate the number of times the sound represented by the letter was unperceived.

Subject ...	I.	II.	III.	IV.	V.	VI.
P						
x		8.7	4.0	9.6	2.9	
t	4.2	4.3		5.8	2.9	1.2
k	37.4	43.4	40.0	30.7	23.5	50.0
b	16.6		12.0	3.8	20.6	15.7
d						
g		13.0	4.0	3.8		2.4
f	8.3	4.3	4.0	3.8	5.9	6.1
þ				1.9		
h	20.8	17.4	4.0	38.4	41.2	18.1
w	4.2					1.2
v	8.3	4.3	8.0			2.4
ð		4.3	4.0			
l			4.0		2.9	
r						
m			4.0	1.9		2.4
n			8.0			
y			4.0			
%E	11.1	10.6	11.6	24.7	15.7	38.0
T						
p	100.0		14.3	10.0		
x						
k			14.3	20.0	33.3	78.4
b				10.0		
d			14.3	10.0	33.3	22.4
g						
f						
þ			57.2	40.0		
h				10.0		
w						
v						
ð					33.3	
l						
r						
m						
n						
%E	0.9	0.0	3.2	4.6	1.4	4.2

K

p	46.1	55.5	68.0	48.8	48.0	28.6
t		11.1	16.0	14.6	8.0	7.1
x		11.1		2.4	4.0	7.1
b						7.1
d						
g	7.7	11.1		9.8	4.0	
f					8.0	7.1
þ	7.7		4.0		4.0	
h	38.4	11.1	12.0	19.5	16.0	35.7
w				2.4	4.0	
v					4.0	
ð						
l						
r						7.1
m						
n				2.4		
%E	6.0	4.2	11.6	19.0	11.6	6.5

B

p	4.8	7.1	12.0	10.2	15.8	6.4
t						2.1
k	9.5					6.4
x				2.4		4.3
d	19.0	16.7	9.6	18.4	15.8	8.5
g	23.8	11.9	7.2	26.5	31.6	12.8
f			2.4	2.0		2.1
þ						
h	4.8	2.4	2.4	10.2		
w		35.7	2.4	4.1	5.3	
v	28.6	14.3	52.8	14.3	15.8	12.8
ð	4.8	2.4	2.4	2.0		
l		2.4	2.4	2.0	15.8	
r		2.4		6.1		29.8
m	4.8	2.4	2.4	2.0		10.7
n		2.4	2.4			4.3
%E	9.7	19.4	19.0	22.7	8.8	21.7

D

p					3.3	
t			5.3			1.4
k						
b	11.1	5.9	10.6	30.7	36.6	2.7
x					3.3	
g		23.5	10.6	34.7	16.6	2.7
f			5.3			
þ						
h				4.3	3.3	
w		5.9				
v	11.1	5.9	15.9		3.3	
ð	11.1	29.4	21.2		3.3	
l	55.5	5.9	21.2	13.0	13.3	
r	11.1	11.8	10.6	13.0	10.0	79.5
m		5.9				
n		5.9		4.3	6.7	
j						9.6
z						4.1
%E	4.2	7.9	8.8	10.7	13.8	33.8

G

p			4.8	1.8	2.2	1.6
t				1.8		
k	7.7		9.5	1.7	9.7	10.9
b	34.7	41.6	26.2	24.9	48.3	29.0
d	11.5	8.3	7.1	12.4	2.2	8.5
x			2.4	1.8	1.6	
f						
þ						
h	7.7		2.3	17.8	2.2	
w		16.6		1.8	4.8	1.6
v	19.2	4.2	21.4	1.8	12.9	
ð	3.8		4.7			
l	3.8	8.3	2.4	8.9	1.6	
r		4.2	7.1	10.7	6.4	38.7
m	3.8	8.3	11.9	5.3	1.6	2.4
n	7.7	8.3		8.9	1.6	1.6
j					1.6	
y						3.6
z						2.4
%E	12.0	11.1	19.4	25.9	21.7	37.8

F						
p			7.1			16.7
t						8.3
k						
b						
d				12.5		
g						
x					50.0	
þ	100.0	100.0	56.8	50.0	50.0	
h				12.5		50.0
w						
v			28.4	12.5		
ð				12.5		
l						
r			7.1			
m						
n						
s						25.0
%E	5.6	0.9	6.5	3.7	0.9	5.6

þ						
p						
t		18.2		4.0		50.0
k	10.0		25.0		12.5	
b						
d		9.1				
g			25.0			
f	30.0	27.3	50.0	52.0	87.5	25.0
x						
h						
w						
v						
ð						
l		9.1				
r						
m						
n						
s	60.0	36.4		12.0		
z				24.0		
sh				8.0		
þ						25.0
%E	4.6	5.9	1.8	5.8	3.7	1.8

H

p	25.0	33.3	27.7	19.5	27.8	4.2
t	2.5		1.3	2.3		1.1
k	10.0	12.1	11.3	17.4	9.3	14.8
b	5.0		6.3	4.3	2.3	17.0
d	2.5	9.1		2.3		2.1
g		3.0	5.0	6.5	7.0	2.1
f	2.5	3.0	2.5			17.0
þ			6.3	2.3		
x	27.5	21.2	3.8	13.0	39.4	4.2
w	2.5	3.0	5.0	10.9		2.1
v	12.5	3.0	15.2	2.3	4.6	
ð			2.5			
l		6.1	2.5	4.3		
r	2.5				4.6	22.3
m	5.0	3.0	5.0	8.7	4.6	5.3
n	2.5	3.0	5.0	6.5		6.4
y						2.1
%E	18.5	15.3	36.6	21.3	19.9	43.5

W

p						
t						
k						2.5
b	23.0	20.6	21.6	16.0	20.9	24.6
d	5.1			2.3		
g	2.6		2.5	6.8	4.8	5.9
f			0.8	1.1		1.7
þ						
h	2.6	5.9	2.5	20.5	4.8	5.1
x	2.6	2.9	0.8	1.1	6.4	11.0
v	35.8	23.5	34.1	9.1	22.6	
ð			0.8			
l	2.6	17.6	1.7	6.8	8.1	
r	20.5	8.8	17.5	23.9	24.1	33.0
m	5.1	17.6	16.7	6.8	6.4	12.7
n		2.9	0.8	1.1	1.6	1.7
z				1.1		
y				2.3		1.7
%E	18.1	15.7	51.8	40.3	28.7	54.6

V						
p	5.0			2.4	6.5	1.1
t				1.2		
k				2.4	3.3	5.7
b	17.5	12.9	54.5	30.9	39.1	(59.3)
d	2.5			5.9		4.6
g	10.0	1.8		9.5	8.1	6.8
f	7.5	3.7	3.0	2.4	5.0	2.3
þ						
h				9.5	4.9	3.4
w	25.0	61.1	12.1	13.1	14.7	9.1
x		3.7				1.1
ð	30.0	12.9	27.3	7.1	6.5	
l	2.5	1.8		1.2	3.3	
r			3.0	9.5	6.5	28.5
m		1.8			1.2	2.3
n				3.6		3.4
z				1.2		9.1
j						1.1
v						21.7
%E	18.5	25.0	15.3	38.9	13.9	40.7

In VI.'s results the b errors are percentages of 216; elsewhere the figures given are considered as departures from a constant error, b.

Ð						
p				1.2		
t		3.6	3.1	1.2		1.4
k						1.4
b				7.1	6.7	8.4
d	17.6	39.3	25.0	39.3	26.6	37.8
g		7.1		4.8	10.0	
f						1.4
þ						
h	5.9	7.1		5.9	6.7	
w	5.9	7.1			3.3	
v	11.8	10.7	37.4	3.6	23.3	
x						
l	41.2	14.3	18.7	16.7	13.3	
r	5.9		6.2	4.8	6.7	44.8
m			3.1		3.3	
n		7.1	3.1	2.3		2.8
z	11.3	3.6	3.1	13.1		
y						1.4
%E	7.9	13.0	14.8	38.9	13.9	32.9

L						
p			2.2		4.3	
t			4.3			
k						
b	11.1	9.4	10.9	8.3		22.5
d	5.6	3.1	4.3	21.6	8.7	9.7
g				1.7	4.3	
f						
þ						
h			2.2	13.3	8.7	3.2
w	33.4	21.8	8.7	1.7	8.7	19.3
v	13.9	12.5	8.7		13.2	
ð	2.8	3.1	6.5	1.7		
x		3.1		5.0		
r	16.7	18.7	32.7	10.0	34.7	
m	5.6	3.1	10.9	10.0	4.3	12.9
n	11.1	25.0	6.5	26.6	13.0	19.3
z						6.4
y						3.2
%E	16.7	14.8	21.3	27.8	21.3	14.3

R						
p		5.1	6.2		11.1	
t						
k						8.3
b	23.5	10.5	6.2	7.4	7.4	58.3
d		5.1	9.3	18.5		
g	17.6	5.1		18.5	7.4	
f			3.1			
þ						
h		10.5	3.1	14.8	11.1	8.3
w	23.5	21.0	3.1	14.8	33.3	
v	17.6	15.4	46.8	3.7	7.4	
ð		5.1	9.4			
l	11.7	10.5	6.2	18.5	18.5	
x	5.9	5.1		3.7		8.3
m		5.3	6.2		3.7	
n						8.3
y						8.3
%E	7.9	8.8	14.8	12.5	12.5	5.6

M

p						
t						
k						
b	2.3	2.6			3.2	
d				3.0	3.2	2.4
g			7.0	4.5	3.2	
f						
þ						
h				6.0		
w	9.1	5.1	4.6	3.0	9.7	
v		2.6	9.3		6.4	
ð						
l	9.1	12.8	7.0	1.5	3.2	
r			2.3	3.0	6.4	9.7
x				1.5	3.2	
n	79.6	76.8	69.6	77.1	61.2	86.0
%E	20.4	18.1	19.9	30.6	14.3	19.0

N

p					4.3	
t						
k						
b			3.3			
d	6.7	4.3	6.7	9.1	4.3	
g		4.3		4.5		6.9
f						
þ						
h		4.3		9.1	8.7	
w					4.3	3.4
v	10.0				4.3	
ð	3.3		3.3			
l	33.3	26.0	16.7	9.1	8.7	
r	6.7	4.3				13.8
m	40.0	56.4	69.9	63.6	60.8	65.4
x				4.5	4.3	
s						3.4
z						3.4
y						3.4
%E	13.9	10.7	13.9	10.2	10.7	13.4

Subject....	I.	II.	III.	IV.	V.	VI.
A						
e		20.0	48.8	26.9	23.8	22.9
i		20.0	14.6	11.5	14.3	
o	40.0	60.0	24.4	61.4	61.9	72.6
u	60.0		12.2			3.8
%E	0.7	1.5	6.0	3.8	3.1	3.8
E						
a	70.5	54.1	46.9	32.3	34.7	29.1
i	25.1	42.2	49.2	59.1	42.8	27.0
o		4.0	1.8	5.1	4.1	8.3
u	3.4		1.8	3.5	18.4	35.4
%E	8.5	11.1	31.1	28.9	7.1	7.0
I						
a			5.4	2.5	3.0	
e	69.3	66.0	61.6	58.7	21.2	70.0
o			0.9	2.5		3.7
u	30.8	34.0	50.8	36.2	75.7	26.2
%E	9.5	7.3	16.5	11.7	4.8	11.7
O						
a	53.3	28.6	22.3	52.1	21.4	30.4
e	10.0		1.6	8.9	19.0	21.7
i				11.9	11.9	
u	36.6	71.4	48.8	26.8	47.6	47.7
%E	5.0	4.1	9.2	9.8	2.9	3.4
U						
a	8.8	3.3		4.3	5.5	
e	2.9		7.1	7.1	3.6	9.4
i	8.8	53.3	25.0	27.0	53.7	21.6
o	79.4	43.3	67.8	61.6	27.3	68.8
%E	5.0	4.4	4.1	10.2	8.3	10.8

The capital letter at the head of each section indicates the objective stimulus, and the small letter under it indicates errors in its substitution. The figures indicate what percentage of subject's total error consisted of erroneous substitution of the small letter opposite to which it stands. Figures opposite the symbol x placed in the column instead of the lower case correspondent of the objective stimulus indicate the percentage of non-perception. The figures entitled %E indicate the percentages of the total occurrences of the objective stimulus erroneously heard; they are given as a rough index of the reliability of each subject's results; obviously, the higher the %E, the more reliable the results.

There are various ways in which correspondences may be checked other than on a percentile basis; arrangement by relative position appears occasionally to give more satisfactory results. The nature of the problem precludes very close correspondence within the actual number of cases, and the limitations already indicated determine the number of cases possible to gather from a single subject. In many ways, therefore, relative position is quite as safe a guide as direct percentile comparison. The results with the individual sounds under investigation may now be taken up.

The three principal confusion-sounds with P are its voiced homorganic b, the guttural explosive k, and the laryngeal h. IV. and V. form a group apart from the other subjects in respect to a greater tendency to hear h for P than k. With V. this difference is particularly striking, h being nearly 100 per cent. more frequent than k. Such a divergent record indicates a special phonetic habit. IV. again shows such individuality in the small number of b-errors, this error standing next to k and h in other subjects. This fact, and lack of coincidence in the remaining b-errors seem to indicate that these are not for the most part the result of intervocalic voicing on the part of the enunciator. The unheard P's are absent in two subjects, and are practically all initials; there is, in fact, throughout a slight tendency for initial voiceless explosives to go unheard, just as final voiceless explosives are practically never heard. v is a very frequent error for B, and it is possible that certain of the v's in this table are confused with P through the medium of b. Such a phenomenon is noticeable in many of the tables, and might be termed a secondary, or indirect error. Spiration of P produces the bilabial voiceless spirant Φ which English-speaking hearers constantly record as f. The f-errors in the record might then be due to this cause.

But these errors do not show a high degree of coincidence, and as f is a sound almost never misheard, the degree of coincidence should be exceptionally high were the error one of enunciation. It is again more probable, then, that these errors are in the main auditory. His-

torically, the change p-f is the most common one which this sound undergoes in the idg. languages, forming a part of Grimm's Law in both permutations (though probably of different causation in each case), and also occurring in certain of the later Indo-Iranian dialects.

The sound T is sharply distinguished from the remaining voiceless explosives by its non-liability to error, it being among the three best heard sounds in the entire system. Its nearest neighbor is evidently again the guttural explosive, for the total per cent. of error in I. is too small for significance, and the non-coincident high percentage of þ-errors in the records of III. and IV. is apparently again the result of individuality in phonetic habit. Moreover, an accidental spiration of T by the enunciator would not result in þ, which is interdental, not alveolar, a spirated T standing much nearer to S, for which it is not heard. Although auditorily very stable, it may be noted that it and its voiced homorganic are the most unstable of the sounds involved in the second permutation of Grimm's Law, each undergoing change before either the labial or the guttural row. T is the most liable of the voiceless explosives to be voiced intervocalically, but the liability to error on this account does not seem to be materially greater than with P.

In K there is a strong reciprocal tendency to confusion with p, and an analogous similarity to h. The liability to confusion with h is, however, much less in all subjects save VI., where there is a considerable difference in the opposite direction. This phenomenon may with certainty be ascribed to phonetic habit, forming part of a series of important correlations to be considered subsequently. K is the least liable of the voiceless explosives to intervocalic voicing, and the errors K-g are fewer than the corresponding ones elsewhere, indicating a greater absence of this enunciatory error. The remaining errors are insignificant. K in the idg. languages probably undergoes no change save spiration that can be brought under linguistic law.

It is observable that in the voiceless explosives P, K and H are sharply distinguished from the dental T. Among the voiced explosives this differentiation is in a large measure lost. The voiced labial explosive is confused principally with v, g and d. Many of the v-errors are coincident, and as the bilabial spirant ƀ is interpreted as v by English-speaking subjects, it is possible that certain of these errors are due to faulty enunciation, though it is perhaps unnecessary to state that every voluntary precaution was taken to prevent such spiration. The relatively very great number of v's substituted by III. is the result of individual sensation habit. As between g and d, the guttural still retains greatest similarity to the labial, though in II. and III. the dental is slightly superior. The voiced sounds appear throughout more closely related to one another than the voiceless.

By their less energetic occlusion they are also more closely allied to their homorganic spirants, and this relationship is reflected in the auditory substitution of the spirants. We are confronted here also with the reverse of the tendency to intervocalic voicing in the appearance of p for B. This error is in the main probably as much the enunciator's as the subject's, and due to loss of vocalization consequent upon attempt at deliberate distinctness of utterance, as long-occluded voiced explosives necessarily become voiceless. This naturally in reverse order to that before noted, G losing its voice soonest and D retaining it longest. To this process are to be referred perhaps the majority of these errors.

In the idg. languages B exhibits some tendency to unvoicing, and of late years considerable tendency to spiration, but it is not probable that these are acoustic phenomena. There is a small, but fairly consistent, amount of confusion with the homorganic nasal, that has no parallel in idg. linguistic law, but is found in other languages, notably in certain of the North American groups. Confusions with n are probably secondary.

The results give the dental as also the best heard of the voiced explosives, but by a very small margin compared to that of T, it being hardly separated from B by the limits of the probable error. There is also confusion here with the labial rather than with the guttural, though both are well represented in the errors. There is again evident the evidence of phonetic habit in the enormous preponderance of r-errors in the record of Subject VI. With regard to this subject it should also be noted that the j- and z-errors probably represent ð, of which they are here the constant errors. There is, as one would expect, a considerable amount of this spiration, and relatively little unvoicing. There is less tendency to confusion with the nasal, which is probably due to the fact that the occlusion of the labial explosive is considerably longer than that of the dental, and the explosion not so clear-cut. The v-errors are probably of secondary origin, and the remainder fortuitous.

As has been observed, G stands closer to its voiceless homorganic than either B or D, and this relationship is well reflected in the tables. It stands farther from the dental than B, and closer to the labial than D. There is naturally considerably more unvoicing in the records. Note again the preponderance of the r-errors in Subject VI. It is improbable that the v-errors are wholly secondary in character, at least so far as B-v is concerned. The spirant ȝ, however, unrecognized in the English language, is interpreted variously as g and v, and certain of the v's may come through this medium, though enunciatory spiration of G is very unlikely under the conditions of the experiment. These v-errors play not the least simple part in the already observable tendency to auditory

confusion of the gutturals and labials, which plays a considerable part also in linguistic history, but has not yet been brought under accurate philological law. There is considerable nasalization, almost equally divided between m and n, for which there appears no satisfactory explanation. No symbol for the guttural nasal was provided in the experiments, nor was a single one recorded, but it is possible that many of the n-errors would find their place here. G approximates the phonetic least common multiple, *i.e.*, its errors cover a wide range, of the sounds studied, more closely than any other save H.

The voiceless spirants are by far the best perceived of linguistic sounds, being approached by the voiceless explosive T alone, but the attempt at a biological explanation of this fact, *i.e.*, the advantage of ability to distinguish the hiss of dangerous enemies, is probably to be ranked with the theory of O as the original sound of language, by lip-rounding suggested by the shape of the sun. The voiceless spirants appear also superior in acoustic impressiveness according to Müller and Pilzecker's tables, but these are here for the most part consonantal digraphs, where the visual factor may be to a large extent involved. The obvious tendency with F is to a confusion with its neighbor spirant þ. In the language of Subject VI., þ does not occur, and we find his misinterpretations divided between the labial explosive p, his constant error for þ, s and h. Why h should preponderate so remarkably is not clear, and probably due to some unrecognized peculiarities in the Japanese phonology. The changes from P to F in idg. philology are apparently made through the medium of a bilabial Φ, which is, however, very unstable, rapidly degenerating into the labiodental. Once at least the two are found side by side, as a bilabial Φ in ahd. from an urg. p, and a labiodental F from an idg. P-urg. Φ-F. Such a condition is of course most transitory. p is occasionally heard for F as a constant error among linguistic communities whose phonology does not contain the sound F, and there is considerable evidence that this constant error is not subject to the same rulings as those which govern the present auditory confusions. F and S are among the most stable sounds in the idg. languages.

þ shows a reciprocal tendency to confusion with f, and its errors are again almost wholly confined to the voiceless spirant group. In subject VI. a constant error s occurs, which appears to be the constant error for all languages except the Germanic not including this sound in their phonology. It will be observed that this subject once recorded þ correctly, almost at the beginning of the experiments. The amount of confusion with the dental explosives is not so great as that of the more typical spirantal error. Although auditorily nearly as good a sound as F, it cannot be regarded as a stable sound.

From the phonetic standpoint, H is physiologically a spirant,

being produced by the friction of the breath-stream against a small glottis, with the cords not sufficiently tense for vocalization. Auditorily, however, it seems fairer to regard it as an explosive, for it has been observed that sounds tend to be confused with others of similar expiratory character, and the bulk of the H-errors is obviously distributed among the explosives. As noted, it forms a third member of the P-K group, and stands nearer to the labial than to the guttural.[1] The small number of p-errors by VI. are doubtless connected with the fact that P is not an integral part of the Japanese phonology, occurring only in borrowed words, the large number of k-errors being thus partly of secondary origin. The preponderance of b-errors in this subject may also be associated with this cause. H tends to go unheard more frequently than other sounds, though there is no great coincidence in the non-perceptions. Spirantal confusion is slight, except in Subject VI., where there is a marked reciprocation with f, evidently associated with a sensation-habit foreign to the English-speaking subjects. The previously noted tendency to r-errors in this subject is also noticeable. Nasal errors are slight, but quite constant. It will be observed that there are none of the sounds investigated which have not been heard for H, and only one, ð, which has not been so heard by more than one subject.

In like manner, there is only one sound, þ, for which h was not at some time substituted. These facts stamp H at once as the least common multiple, the ə, as it were, of all consonants. It is held by Scripture,[2] that continued weakening of enunciation stress leaves H for the voiceless sounds, and a vowel for the voiced. The latter assertion is hardly so well grounded as the former, not being supported by examples, and being hardly applicable to the most important example of such a process, the vocalization of the idg. nasal sonants. There seems no good reason why H should not thus result from all sounds, whether voiced or voiceless, for it is frequently in the idg. family the offspring of earlier voiced sounds, as continued weakening would, if carried far enough, cause the voiced sounds to lose their voice. Paradoxical as it may seem, the instruments of Scripture have even indicated the existence of a voiced H.

W is the most frequently misheard of any sound in the series. Its errors also show a marked tendency to remain about its place of articulation, not found with other sounds, save to a certain extent with V. Outside of its immediate physiological neighbors, v and b, its only important confusions are with r and m. The r with which it is confused is probably the English r, and the often-observed tendency of

[1] The glottal stop is also generally interpreted as b.

[2] 'Elements of Experimental Phonetics,' 1902, p. 465.

children to confuse these sounds may be in part of an auditory nature. VI.'s r-errors represent r-errors plus l-errors, as r is VI.'s constant error for l. Although an integral part of the phonology of primitive idg., it has not proved a stable sound in the dialects, modern English being the only one that has preserved it.

V belongs in general to the same group as W, with which there is considerable reciprocation, notably in the case of Subject II., where individual phonetic habit appears to be involved. The results indicate b, however, as the most similar letter, with a certain amount of gutturalization and very little nasalization. In general, the voiced spirants appear more than any other group of sounds inclined to confusion with sounds of the same or closely allied place of articulation, though there is considerable confusion between v and ð. The record of Subject VI. is anomalous. The sound V does not occur in the Japanese language, but does occur in all the other three languages with which the subject has long been familiar. There is already to be noted, therefore, a disappearance of the constant error, 19 V's out of 216 being heard as v. Neither should V be a difficult sound for the Japanese to learn, its voiceless homorganic being already present, thus giving it a distinct advantage over þ, Ð and L, which are totally foreign. B is apparently the constant error, being heard in 128, or 59 per cent., of the cases. The ð-errors are of course represented by z, and there is again prominence of the r-substitutions. In the idg. languages V is a fairly stable sound, interchanging occasionally with B and sometimes with M.

The interdental voiced spirant is most frequently represented among the English-speaking subjects by d, and in the Japanese it is also the most frequent departure from the constant error, excepting, of course, the inevitable r. The remainder of the errors are practically divided between v and l, the large percentage of l's in I.'s record being again, apparently, the result of phonetic habit. A certain amount of substitution of VI.'s constant error, z, is to be found among the remaining subjects, but the percentages fall considerably below those of d, l and v. In the Germanic group linguistic law changes ð into d.

The liquid L has no particular affinity to any member of the consonant-group, the errors being nearly evenly distributed over b, d, w, r and n. There is also considerable disagreement among the subjects. IV. shows considerable individuality in the non-substitution of w and v (VI.'s substitutions of v are of course reflected in the large number of b's), and this subject also has a great predilection for the d-error, which may be compared with his confusion D-r. The results permit no certain arrangement in order of similarity within the group. VI.'s constant error for L is, as indicated, r. This is also the only sound

into which L shows other than sporadic tendency to change in the idg. languages.

The character of the R has already been indicated. It shows the same general tendencies as L, save that there is no confusion with the nasals, and slightly more with h. The preponderance of v-errors in III. is observable throughout, and can be ascribed to sensation habit. R is among the most stable sounds of the idg. languages, never undergoing an uncombinatory change, though peculiarly subject to the processes of metathesis.

The nasals are confused almost wholly with each other, none of the other errors being of significant quantity save N-l, which is again disproportionately great in I. The two sounds tend to interchange somewhat in the idg. languages, the balance being distinctly in favor of N, also the better heard sound. No important idg. linguistic law governs these sounds except as regards final M's in Germanic, and they are relatively very stable.

With the vowels it is more possible to arrive at certain *a priori* conclusions than is the case with the consonants. As regards relative similarities, given the physiological relationships of the vowel-triangle, it is obvious that A is most closely related to, and should be most frequently confused with, o and e, E with a and i, I with e and u, U with i and o, O with a and u. Moreover, those vowels should be best heard which stand at the extremities of the vowel-triangle, U, A and I, as being liable to modification in the fewest directions.

A is by far the best heard of the vowel sounds, and as should be expected is modified principally to o and e, rarely reaching the extremities i and u. It is probable that the reason for its lack of confusion is the ease with which it may be enunciated accurately, being much less liable to variation than the remainder, as practically the result of opening the mouth with the tongue at the normal *indifferenzlage*. O is physiologically nearer to a than e, and this similarity is well reflected in the tables. The percentile preponderance of u's in I.'s record is insignificant, as the total number of errors is only 5. In the idg. languages, A is not the stable sound indicated in these tables, being considerably more liable to modification than either I or U.

The position of E in the vowel-triangle is nearest to that of the neutral vowel, with which it is always closely associated; observe its employment to represent the neutral into which unaccented 'full' ('saturated') vowels degenerate from ahd. into mhd. Under these conditions it is natural that E is more than any other sound liable to confusion with its neighbors. The amount of confusion is altogether about equally divided between a and i, though o shares somewhat as being at the same anatomical level. Phonetic habit again seems re-

sponsible for such deviations as in a for subject I., and o for subject VI.

I is not so well heard a sound as its physiology would lead one to expect. It is true that the sound represented by the English digraph ee in sheer is not a very high front I, thus approximating rather closer to E than the I of most other idg. languages, and this I is the highest and furthest front that an English-speaking person would be likely to maintain in practise. There is almost no confusion except with e and u. Historically, it is the most stable vowel sound of the idg. languages.

The records of O and U follow out in the main the principles evident in the tables already discussed. There is confusion almost exclusively with the neighboring sounds. In the idg. languages the two are not very stable, O less than U, and tending to frequent interchange. U unaccented changes sporadically to i in certain of the Germanic dialects, as in the suffix ung-ing, and in the North Germanic dialects U and O interchange almost indiscriminately.

V.—The Constant Error.

When there is heard by an individual a sound foreign to his native phonology, this sound is not interpreted correctly, but constantly as a certain sound that does form a part of the native phonology. Thus arise many of the peculiarities popularly known as 'accent.' The Frenchman and Russian persistently pronounce English þ and Ð as s and z, and this not because of any physiological inability to enunciate the interdentals, but because they actually hear them as s and z, and are, naively, unable to distinguish the two sounds, though they occur side by side in the same word. Much stress must be laid on this point, for the failure of students to grasp sounds of foreign languages is frequently believed by teachers to be due to enunciatory causes, whereas the pupil may actually fail to perceive them properly. It is obvious that these facts are also of much significance to foreign transcribers of unwritten languages, and militate much against the value of records not taken by persons trained to guard against such errors. Imagining English to be thus investigated by a Japanese, an untrained observer would report that the words think and sink, collar and corral, were identical. Since certain American phonologies have been more carefully studied, it has been possible to observe the constant errors occurring in the earlier transcriptions of proper names from these languages. Thus the tl frequently occurring finally and elsewhere in Mexican proper nouns is actually not a compound sound, but an explosive situated as regards both lingual and palatal place of articula-

tion between t and k. This sound, (L), is interpreted by the English as kl, by the Spaniards as tl, though the former spelling for political reasons eventually displaced the latter. It is next to impossible to distinguish kl, tl, gl, dl, in normal speech, (note that t and d in these combinations are not the same as intervocalic t, d), and this is occasionally reflected in historical change, notably in Class. Lat. tl, dl—Vulg. Lat. kl, gl, as vetulum-veclu radula-ragla, etc.[1] In view of these facts, it seems possible that the case reported by Josselyn,[2] who failed to distinguish in his enunciation of Klu (sic) Klux Klan a tl from a kl is due to an error of perception on Josselyn's part rather than to faulty enunciation by the subject. Some of Scripture's comment on the constant error does not appear well taken.[3]

The statement that the perception of a speech sound depends upon the ability to produce it is not deeply grounded in logic, and has the not very probable corollary that the child does not actually learn language by imitation, and that the ancient Persian investigations of linguistic origins were really founded upon sound theory. The production of a speech sound may rather depend upon the ability to perceive it. Simple constant errors with which all are familiar are Þ-s, Ð-z, in French, Russian and Japanese, L-r in Japanese, R-l in Chinese, and V-b in Japanese. As noted, a constant error F-p is reported by various investigators of uncivilized languages.

Further observations could of course increase this list indefinitely. Boas[4] observes that a Tlingit alternated between the L above described and y in attempting the English L. The German uvular R appeared as r, w and g. In Danish texts the L voiced in Eskimo appears regularly as gdl.

There appears also to exist a compound constant error. This the writer has had the opportunity to observe only in Japanese. If in the stimulus a certain sound occurs in phonetic surroundings in which it never occurs in the language of the subject, although the sound itself may occur there, the sound is not heard correctly, but its correspondent occurring in this combination is substituted for it.

Thus the Japanese phonology does not contain the combinations Tu and Ði (zi), these being replaced by tsu and ji. There is, therefore, a constant interpretation of tu as tsu, and Ði (zi), as ji. S appears as sh before i. A constant error may therefore affect a sound indiscriminately, or only in a certain phonetic surrounding.

The constant error has certain properties which differentiate it

1 As also in Primitive Italic; Osk. puklo, Skt. putra. Lat. saeculum (common nominal suffix tlo), Gr. ἄντλος. The fact that this change does not occur till very late in the combination stl, favors its auditory origin. Observe also jeder-jeglich.

2 Scripture, Op. cit., p. 120.

3 Ibid, p. 118.

4 American Anthropologist, 1889, p. 53.

from the ordinary variable misperception, and indicate it to be of a not wholly physiological character. It will be noted that in no case save Japanese V-b does the sound substituted by the constant error coincide with that error regularly determined by auditory similarity. In the case of Ð, for example, the constant error of VI. is z, which all the other subjects substitute with no great regularity, yet when VI. departs from his constant error he does so in the direction of d, the most frequent error of the other subjects, and also toward the individually favored r. More striking still is the case of L, where r, the constant error, is not especially favored by other subjects, but where VI., when he does depart from his constant error, keeps in fairly close agreement with the other subjects. With the sound V, there is some tendency to emancipation from the constant error, and as this coincides with the most frequent error of the other subjects, correspondences are well maintained throughout. In þ, the constant error is s, not f, the sound shown to be most closely allied. The total number of deviations from the objective is here too small for any further deductions. In general it may be said that while the constant error is not necessarily the same as the most favored variable error, the departures from it are along the same lines as those of the variable errors. A subject making a constant error or a sound departs from that error less frequently than does a subject making only variable errors from the correct interpretation. In the table of Percentile Distribution of Errors (p. 81), it will be seen that the total error on those sounds subject to VI.'s constant errors is subject to less variable error on the part of VI. than any other subject. In Ð alone does this rule find exceptions.

It may be remarked that the constant error is such only so long as the subject is quite naive. Persons with some training in this direction, as foreign teachers of their native languages to English-speaking students, are not nearly so subject to these errors, though the tendency may be far from obliterated. After the experiments were concluded, it was an easy matter to teach VI. to distinguish with facility the sounds previously confused, once his attention was called to the matter. He was also able to enunciate them so that they could be distinguished. Considerable difficulty was experienced with L only.

It is thus clear that the properties of the constant error are very anomalous, not admitting of easy explanation. Certainly they bear no direct relation to the phenomena of the variable error. It seems impossible, therefore, to regard them as wholly, or even principally, of peripheral determination, since the confusions do not appear to be based upon facts of physiological similarity. If þ, which we know to stand auditorily nearer to f than to s, is confused as a constant error with s rather than with f, by a subject whose native phonology

includes both f and s, there seems no escape from the conclusion that some central process is directly involved. But as regards the nature of this process almost nothing save pure speculation is possible. That a child inherits any linguistic tendencies is improbable both from philological and biological viewpoints. But it is possible that there exists in the growth of the child a formative period when any sound of language may be analyzed out with comparative facility, though it is difficult to say, from present determinations, whether the ontogenetic relationships of the child phonology are enunciatory or auditory in character. After this period sounds may be added auditorily only with extreme difficulty, or not at all, though if the elements are analyzed out for the subject he may synthesize them without much difficulty. But this fails to explain the peculiar difference in the substitutions of the constant error from those of the variable error. It does not seem at present possible to find any adequate explanation of this phenomenon. It seems also that the phenomena of the compound constant error must for the present be merely accepted as facts, unless explicable by sensation habits to be discussed below.[1]

Although it is not possible at present to establish a connection between these processes and those of certain linguistic changes, the similarity of the phenomena, and the absence of adequate explanation on other grounds, are worthy of notice. Prominent among them is the idg. labialized guttural development to be touched upon subsequently, and that peculiar development of guttural consonants before certain frontal vowels, observable in Sanskrit and in many modern idg. dialects, as well as the change differentiating the centum-shatam groups. It is very well for the grammarian to talk of palatalization in these cases, but to those seeking to explain these phenomena the word is very specious. It is difficult to conceive of any physiological enunciatory process which could change a voiceless guttural explosive into an affricate composed of a voiceless dental explosive and a voiceless cacuminal spirant, as in Skt., It., Eng., or finally into the voiceless spirants sh and s, via the t-affricate stage. The phenomena bear no relation to any theoretically possible phonetic change. As conditioned by certain phonetic surroundings, their closest analogy is to the compound constant auditory errors, as Tu-tsu, Ði (zi)-ji, above noted. It is true that it is impossible to show how the conditions of such constant error could occur, in the absence of any knowledge concerning the nature of such conditions; but the analogy cannot be overlooked as furnishing a very possible explanation among a host of improbable ones.

1 Cf. also pp. 51 ff.

VI.—Historical.

We have now to consider more fully the exact relations which the results bear to phenomena of linguistic history. It will obviously be impossible to give even the most cursory view of the whole field, but certain considerably worked over portions of the idg., with especial reference to Germanic, may well be undertaken. First is it necessary to eliminate certain of the detail of the tables, and to express the results in their more general relations. This is attempted in the table subjoined. It has probably become obvious that there is some tendency in error to preserve the character (explosive, spirantal, etc.,) of a sound at the expense of the place of articulation. The extent of this phenomenon is shown in the table. As labialism are classed erroneous substitutions of p, b, w, v, f, m, as dentalism, those of t, d, þ, ð, l, n, as gutturalism, k, g, laryngealism, h, while r, though possibly to be considered as a dental, seems best classed by itself. Thus, according to the table, 36 per cent. of I.'s errors with P substituted another labial, 4 per cent. a dental, 37 per cent. a guttural, and 21 per cent. a laryngeal.

Subject ...	I.	II.	III.	IV.	V.	VI.
P						
Lab.	36	9	28	10	26	28
Dent.	4	9	20	8	6	1
Gut.	37	56	44	35	24	52
Lar.	21	18	4	38	41	18
T						
Lab.	100		14	20		
Dent.			72	50	66	22
Gut.			14	20	33	78
Lar.				10		
K						
Lab.	46	55	68	57	64	42
Dent.	7	11	20	17	12	7
Gut.	7	11		10	4	
Lar.	38	11	12	19	16	36
B						
Lab.	38	59	73	25	36	32
Dent.	24	22	17	22	31	15
Gut.	32	12	7	27	32	19
Lar.	5	2	3	10		
r		3		6		30

D						
Lab.	22	22	31	30	43	3
Dent.	67	40	47	18	24	15
Gut.		24	11	34	17	3
Lar.		12		5	3	
r	11		11	13	10	79
G						
Lab.	58	71	65	34	71	35
Dent.	27	25	14	23	6	17
Gut.	8		10	2	10	11
Lar.	7		2	18	2	
r		4	7	11	6	38
F						
Lab.			36	12		17
Dent.	100	100	57	75	50	33
Gut.						
Lar.				13		50
r			7			
p						
Lab.	30	27	50		13	25
Dent.	60	73		48		75
Gut.	10		50	52	87	
Lar.						
r						
H						
Lab.	50	45	66	46	39	45
Dent.	8	18	15	14		10
Gut.	10	15	17	24	16	17
r	3				5	22
W						
Lab.	64	61	73	33	50	39
Dent.	8	20	2	14	10	2
Gut.	3	6	3	7	5	8
Lar.	3		2	21	5	5
r	20	9	17	24	24	33
V						
Lab.	55	78	70	48	67	35
Dent.	35	15	27	19	10	19
Gut.	10	2		12	11	11
Lar.				10	5	3
r			3	10	7	29

Đ						
Lab.	17	18	41	12	36	10
Dent.	59	65	52	72	40	44
Gut.		7		5	10	1
Lar.	6	7		6	7	
r	6		6	5	7	45
L						
Lab.	63	47	41	20	30	55
Dent.	19	31	22	50	20	40
Gut.				2	4	
Lar.			2	13	9	3
r	17	19	33	10	35	
R						
Lab.	64	57	72	26	61	72
Dent.	12	22	26	37	19	17
Gut.	18	5		19	7	8
r		10	3	15	11	8
M						
Lab.	11	10	14	3	19	
Dent.	89	90	77	82	68	89
Gut.			7	5	3	
Lar.				6		
r			2	3	6	10
N						
Lab.	50	57	73	64	73	69
Dent.	43	30	27	18	13	10
Gut.		4		5	9	7
Lar.		4		9		
r	7	4				14

A careful examination of these tables cannot fail to disclose a deep-seated tendency manifest in all sounds save the voiced spirants to change the articulation place rather than the articulation method. So universal does this appear in the tables, and so strongly has it characterized the writer's previous experiments, that it may be put forward as the ground-principle of auditory substitution; the articulation place is changed—the articulation method is preserved. It is possible to go even further than this, and to lay it down as a general proposition that the causes of all linguistic changes involving place of articulation must lie either in the neural mechanism or else be wholly sensory in character. Motor changes in place of articulation involve different series of muscles and consequently different inner-

vations; no t could physiologically change into a k, because different neural processes are required for each series of movements. Any phonetic change that involves the innervation of a different set of muscles involves a different discharge path of the nervous impulse, and thus all motor changes of this character must have their origin in the nervous system. The impulse that was intended to innervate one set of muscles would have to become switched off to innervate another, and this constantly. This is not necessary for such changes as f-v, g-k, or t-θ, etc., for the process is here wholly one of defective coordination, or the nervous impulse may be of varying intensity, but the same paths are always traversed. But if the articulation place is changed, involving different sets of muscles, a neural change is the only motor possibility. It is not, and perhaps cannot be, shown that such variations occur, or how and why they should occur. While the writer would not, therefore, exclude such possibilities altogether from causal efficiency in phonetic change, it seems justifiable to disregard them wherever the simple and inevitable error of sense perception affords an adequate explanation of changed articulation place.

There are in Grimm's Law at least four such phenomena, almost invariably lightly glossed over by the historical phonetician on account of the unsatisfactory physiological explanation for them. These are the changes p-ϕ-f, t-θ-þ, t-s, and k-χ-h. Now the labiodental f has not the same place of articulation as the bilabials p and ϕ, nor are either þ or s homorganics of t, þ being enunciated before, and s behind it. Coupled with the changes in articulation method, we have changes in articulation place, and p-ϕ-f shows that the change in articulation method was previous to that in articulation place. Widely differing innervations are required for f from those for ϕ and for þ and s as opposed to θ, a spirant t. Such changes cannot be regarded as other than neuromotor or sensory, and it is best to consider them sensory. Let it be remembered that we are dealing not with the change of explosive to spirant, but with the change in the articulation place of the spirant, *i.e.*, the changes ϕ-f, θ-þ, θ-s, χ-h. The most natural process of such changes in language is simply this. The rising generations imitate the sounds which they hear by the trial and error method, which results in their acquiring the easiest motor speech habit which at the same time brings satisfaction. Let us first take the ease factor. The movements f, þ and s are far more easy and natural to the normal vocal apparatus than ϕ or θ, as is shown by the very few languages that prefer these latter sounds over the former. In its endeavors to imitate the sounds ϕ or θ the child would be much more likely to stumble on f, þ or s earlier and with greater frequency than upon ϕ or θ. The movement of blowing, which approximates the ϕ most closely, is, to be sure, more natural than f, but it has the disadvantage

of being almost inaudible, so that it would never bring satisfaction. To produce a bilabial ϕ and a labiodental f of equal distinctness requires far greater energy for the former, and as the two are almost indistinguishable, either would bring the same satisfaction. The f would therefore survive, though its similarity to the blowing out movement causes the ϕ to persist longer than the θ, which has no such analogous advantage. As their practical indistinguishability causes them to bring equal satisfaction, þ supplants θ because it is the easier and more natural sound for the child to make. But subsequently in the history of the German dialects urg. t ex idg. d is spirated, and this time s is preferred to þ by the group that undergoes the change. This fact demands explanation, and the explanation is by no means an easy one. At the time when this change took place þ had disappeared from the language, but it is not certain that it existed in urg. prior to the first permutation. There is the simple fact that under identical circumstances, so far as we can trace, the primitive Germans found it more natural to substitute þ for θ and their descendants s for θ, an occurrence not in the least remarkable in the view of such observations as those brought forward in the section on sensation habit. The above is offered as a simple explanation of a neglected chapter in Grimm's Law. The principle should, however, have general application, and may be repeated as follows: Changes due to physiological conditions of utterance speed, energy, etc., cannot effect a deflection of the innervation path, which deflection is alone capable of bringing about motor changes in place of articulation; but where this change of articulation place is present, it is generally best explained on a sensory basis as the substitution of a more natural movement which is similar enough to the original to bring the desired satisfaction. *Any sound of language will inevitably gravitate toward that sound easiest to produce, and at the same time sufficiently similar to it to bring satisfaction.*

Since the establishment of the *Junggrammatiker—in petto*—as the supreme arbiters of the destinies of philological if not linguistic science, it has been customary to class the phonetic changes of language into two groups according as their frequency permits the formulation of definite conditions governing them, or this is for any reason found to be impossible. There seems to be every justification for this ruling, for one finds, statistically, a group of changes operating under definite conditions throughout the language, and, on the other hand, a large group of changes of such limited application as to receive the term sporadic; generally ascribed to the chance workings of analogy, whether or not the medium of its operation can be certainly traced. The first group includes such changes as the laws of Grimm and Verner, to a certain extent Grassman's Law, and in fact

all those changes known to idg. philology under the name of laws. As the philologist will be familiar with these processes, it is unnecessary to describe them here; but from the psychologist's viewpoint it may be well to briefly summarize Grimm's Law, which will serve, so far as present purposes are concerned, as typical of the idg. sound laws. It is divided into two permutations, the first affecting the entire Germanic group with reference to the idg. family, the second ensuing upon the first, and affecting the German proper dialects of the West Germanic division. Of the first permutation no intermediate stages are preserved, and we know only the first and last conditions, which are in brief as follows:

idg.	p	t	k	bh	dh	gh	b	d	g
urg.	f	þ	h	b	ð	ȝ	p	t	k

Of the second permutation, whose theoretical outcome is ultimately the same as that of the first, probably every stage is dialectically preserved, even to the present day.

The process may be thus summarized:[1]

urg.	p		t		k		b		ð		ȝ
mfr.	p	ff	z	zz(t)	k	hh	b	v,f	d		g
rhnfr.	p (pf)	ff	z	zz	k	hh	b		d(t)		g
ostfr.	pf	ff	z	zz	k	hh	t		b		g
oberd.	pf	ff	z	zz	ch	hh	t		p		k

It is evident that, whatever may be the conditions operative here, they are in direct opposition to the observed tendencies of auditory change in all details save two, the change of the bilabial explosive to the labiodental spirant and the articulation place modification involved in the t-z change. The bilabial spirantal stage of the voiceless was very transitory, and the conditions governing the entire change to labiodental are far from clear. They may certainly have been auditory, and possibly phonetic, but this is a matter of small detail, compared with the obvious principle pervading the whole change, the exact opposite of that found in the auditory changes. As to the actual process that brought about the larger changes of Grimm's Law, one must borrow criticism of previous explanations from the realm of the cerebral localization controversies: 'Roh war operirt, roh beobachtet, roh geschlossen.' One thing, however, is certain; the change emanates from the speaker and not from the hearer. There is no larger process in Grimm's Law not to be brought about by some alteration of speed, intensity, etc., of utterance; the difficulty is that the necessary con-

1 Braune, Ahd. Grammatik, Sections 80 ff.

ditions seem to contradict one another. And Grimm's Law is to be taken only as a type; the changes that can be grouped together under linguistic law are rather those of method of articulation than those of place of articulation. To this rule there is an important exception in the development of the entire idg. labialized guttural row, to be summarized as follows:[1]

Idg.	Gk.	Lat.	Osk.-U	Ir.	Brit.	Germ.
q^u	$\pi\tau\varkappa$	qu,c	p,c	c	h	χu,χ,f
g^u	$\beta\delta\gamma$	gu,v,g	b	b	b	k^u,k,þ
g^uh	$\phi\theta\chi$	f,gv,v,g	f	g	g	3^u,3,þ

The conditions in Greek are as follows: The guttural occurs before and after u; under other circumstances the labial occurs before a and o and all liquids and nasals, the dental before e and i. Although the number of forms involved is necessarily small, there can be no question that the changes are not sporadic, and that the vocalic surroundings are the determining factor.

It seems impossible, however, to attribute such a change to purely phonetic causes. Such a change would controvert every phonetic principle, for there is no physiological way in which a guttural could thus interchange with a labial or a dental. Nor do these facts correspond very closely to the results of the writer's experiments, for there was no observed influence of vocalic surroundings on the error, and, in any case, the number of substitutions is quite out of proportion.

It is quite possible that we are dealing here with some sort of auditory constant error, and could any cause for the existence of such an error be found, it would be a most probable explanation. It is certain, from the data of the experiments, that one kind of constant error may occur with one vocalic surrounding, and another with another. But this is the result of sensation habit, which cannot be shown to exist in the Greek case. No other explanation seems possible, however, than along these lines.

In the Osko-Umbrian division of the Italic dialects, there is labialization throughout except before u, where the guttural is retained. It has been sought to explain this and other substitutions of the labial as the outgrowth of the labial *Nachschlag*. But this view is untenable from every standpoint of physiological phonetics. As in Greek the process is hardly explicable save on the basis of auditory constant error, the application of which were here much simpler.

In Celtic the condition is probably similar. Primitive Celtic k^u appears in Gaelic, Erse, Manx, as c (k), but in Welsh, Breton, Cornish

[1] Cf. Brugmann, Kurze Vergl. Grammatik, p. 168.

as p. Gu also appears as b initially, and medially after nasals. In certain initial combinations the guttural remains.

The conditions of the labialization in Germanic are not clear, but appear to be associated with a u in either the preceding or the following syllable; as u is a labialized vowel, Brugmann's classification of the process as dissimilatory is open to objection. It appears to have been a very early process, occurring probably before the change of Grimm's Law proper had begun, and perhaps even before Germanic was wholly separated from the other dialects. So far as explanations are concerned, it falls into line with the analogous processes in the other dialects. Note, however, that in Greek and Italic the guttural is preserved before a u, while the reverse condition obtains in Germanic.

An example of the opposite process, *i.e.*, the change of a labial to a guttural, is found in the borrowings of Vulgar Latin from Low German. The Low German w appears in Vulgar Latin initially as g (gu); *e.g.*, nfr. waron, afrz. garer, but medially no guttural appears, and the representation varies according to phonetic surrounding. The Greek voiceless spirants are represented by p, t, k, but it is probable that this change is chirographic only, as the literary language gives evidence of a recognition of the spirantal character, and it is at least certain that the interdental spirants existed in Old French, and probably also in its immediate ancestor. In support of this latter contention, note that Germanic þ appears as t, and not s, as it almost certainly would have been written had the interdental spirant been foreign to the language.

So much for linguistic law. It tends along the line of articulation method, rather than that of articulation place, and is thus, save in the exceptions discussed, hardly amenable to explanation through auditory constant error. There remains that considerable body of isolated phenomena known as sporadic changes, for which the influence of analogy is a much overworked *deus ex machina.* It may be possible through the medium of auditory error to relieve the god of some of this labor. It will be well first to tabulate those errors which may be considered of sufficient frequency to be reflected in the phenomena of sporadic change, provided they can be shown to be in part due to this cause. Such errors are as follows:

P, k,h,b. T, k. K, p,h. B, d,g,v. D, b,g,l. G, b,d. F, þ. Þ, f. H, p,k. V, b,w,ð. W, b,v,r,m. Ð, d,l,v. L, b,n,r. R, b,w,v,l. M, n. N, m,l.

To make any pretence of covering the field would be far beyond present purposes or possibilities. Through two of the most accessible departments it will be endeavored to indicate the general directions of sporadic change.

Thus in Indo-Iranian, the labial explosive k tends to remain, and changes sporadically generally to b, v and m. The change to k is very rare, and that to h is non-existent. Neither b nor bh change their place of articulation in any sporadic change.

The Indo-Iranian dentals cannot be closely compared to the English, the cerebrals being behind and the dentals in front of them. The cerebral t is known to change into p, but this alone among a host of other phenomena bears the slightest resemblance to observed auditory errors. The dental d changes frequently into l, Skt. kadamba, Pkt. kalamba; dh changes rarely to both bh and l.

The regular developments of k are k and χ, intervocalic voicing to g also being found. K interchanges very rarely with t, and still more rarely with p, the changes having apparently a dissimilatory factor in each case. K-h, however, is relatively common, Skt. nikasa, Pkt. nihasa, Skt. akasa, Simh. ahasa. There are a very few instances of k-s, sh, and k-z, zh. By far the most frequent sporadic change of kh is to h, Skt. sakhi, Pkt. sahi. The only sporadic changes of g are to zh and h; gh occasionally becomes h.

The change of V to b is extremely common in both Indian and Iranian dialects, and before u a regular change into g occurs in two dialects. There is a certain amount of change to the nasal, m being a more frequent resultant than n.

R and L interchange very frequently, but this alone of their sporadic changes presents analogy to auditory error.

N occasionally becomes m in Iranian, but this is not nearly so common as N-l, which in one dialect is regular. The change M-n is very rare even compared to other sporadic changes of M, as M-v.[1]

The application of the auditory error to sporadic change in Indo-Iranian is thus seen to be very limited. In general, the few analogies to auditory error noted are outweighed both quantitatively and qualitatively by foreign changes, and may therefore be the result of change or a third factor. It is manifestly unjust to select certain changes as due to auditory error which cannot otherwise be shown to form a species apart from other sporadic changes. Sporadic change in Indo-Iranian appears to tend to preserve the place of articulation rather than to change it, acting thus more in accordance with the principles of phonetic change.

Among those sporadic changes within the Germanic family presenting analogies to the phenomena of the auditory error may be enumerated the following:

1 Gray, Indo-Iranian Phonology, pp. 50-125.

Lit. svaigti, aisl. sykua, ags. swapan, ahd. sweifan.
Ahd. hriohhan, as. hriupan, ags. creopan.
Lat. sugera, ags. sucan, supan, aisl. supa, ahd. sufan.
Lat. niger, ags. nipan.

Got. skaman, ahd. scaman, got. scanda, ahd. scanta.
Gr. ἄμαθος, aisl. sandr, nhd. dial. sampt.

Aind. yuvan, lat. iuvenis, as. juguð, ags. ȝeoȝuð, ahd. jugund.
Gr. μυῖα, as. muggia, nhd. mücke.
Aisl. litell, got. leitils, aschwed. litin.

Gr. ἀ̓στραλός, eng. starling, lat. sturnus, ags. stearn.
Ahd. wadal, Woden, aisl. Oðenn.
Gr. ὁ̓μαλός, got. samana.
Gr. ὕδωρ, aind udras,[1] aisl. otr, got. wato (watins), aisl. vatn.

Gr. πῦρ, aisl. furr, got. fon (funins), ahd. funko.
As. finistar, ahd. finstar, idg. temsros, lit. tamsus, as. thimm, ahd. diustar.

Ahd. fihala, ags. feol, aschwed. fael, aisl. þel, ἄπαξ λεγόμενον for fel.
Ags. fenȝel; þenȝel, aisl. þengel.
Gr. πέλανος, aisl. fiol, aisl. þilia, ags. þel, but observe lat. tellus, aind. talam.[2]

A field which proves abundant in instances of the auditory error is that of borrowings, especially among languages one or both of which are practically unwritten. Such a condition obtains in the many borrowings from Latin into the Germanic dialects. Among the apparent errors in perception presenting analogies to the above auditory errors are the following:

asinus, got. asilus	coriandrum, ahd. chullintar
catinus, ae. cytel	locusta, ae. lopust
caccabus, ahd. kahhala	Mediolanum, ags. maegelan
catapulta, m,e. bolt	papaver, ae. papaeg
papyrum, ne. taper	pyxis, ne. box
pitupia, henn. zipf	scirpus, ahd. sciluf
(ne. tip by metathesis?)	tenda, ags. teld[3]
	cal (i) dumen, nhd. kaldaunen

1 The Greek stem ὑγρ is very possibly a variant of this, as Dr is often interpreted as g, cf. drink as gink in the language of some children.

2 For this and analogous material, Noreen, Urg. Lautlehre, pp. 142 ff., 197 ff., also Grimm, Deutsches Wörterbuch, V., 5.

3 Kluge in Pauls Grundriss, pp. 333 ff.

VII.—Relative Perceptibility.

On the basis of the figures given, it seems that the relative audibility of the various sounds is to be best expressed by the percentile average of the errors made in perceiving them. The subjoined table gives the per cent. of error of each sound for each subject; the actual number of errors expressed in percentile relation to the total number of observations. The averages of these percentages are taken as a measure of the relative audibility of the sounds. The principal source of unreliability in this measure is the fact that any single subject having a tendency to make considerably more errors would tend to inject errors due to individual phonetic habit into the result to a greater extent than a subject making in all a smaller number of errors. Then, too, a subject making a large number of errors may seem to depart considerably from the average of one with a small number, though proportionately their results might agree, and false agreements might also thus be created. These figures should be taken in connection with those of a table to be given subsequently, in which the percentile share of the errors on each sound in the sum total is given. This method is also influenced by phonetic habits, and does not greatly alter the relative positions of the first table.

PER CENT. OF ERRORS.

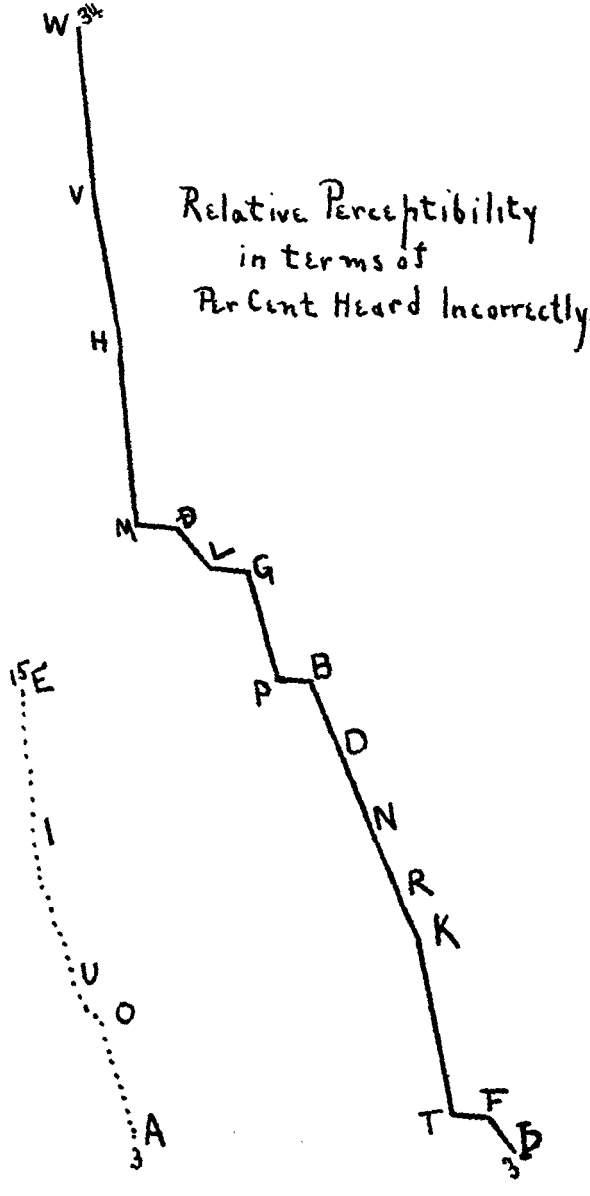
Subject ...	I.	II.	III.	IV.	V.	VI.
P	11.1	10.6	11.6	24.7	15.7	38.0
T	0.9	0.0	3.2	4.6	1.4	4.2
K	6.0	4.2	11.6	19.0	11.6	6.5
B	9.7	19.4	19.0	22.7	8.8	21.7
D	4.2	7.9	8.8	10.7	13.8	33.8
G	12.0	11.1	19.4	25.9	21.7	37.8
F	5.6	0.9	6.5	3.7	0.9	5.6
þ	4.6	5.9	1.8	5.8	3.7	1.8
H	18.5	15.3	36.6	21.3	19.9	43.5
W	18.1	15.7	51.8	40.3	28.7	54.6
V	18.5	25.0	15.3	38.9	28.2	52.8
Đ	7.9	13.0	14.8	38.9	13.9	32.9
L	16.7	14.8	21.3	27.8	21.3	14.3
R	7.9	8.8	14.8	12.5	12.5	5.6
M	20.4	18.1	19.9	30.6	14.3	19.0
N	13.9	10.7	13.9	10.2	10.7	13.4
A	0.7	1.4	6.0	3.8	3.1	3.8
E	8.5	11.1	31.1	28.9	7.1	7.0
I	9.5	7.3	16.5	11.7	4.8	11.7
O	5.0	4.1	9.2	9.8	2.9	3.4
U	5.0	4.4	4.1	10.2	8.3	10.8

It must be noted that two factors enter into the constitution of these positions; the absolute audibility, or acoustic impressiveness of the sound, and its relative liability to confusion with other sounds. The absolute audibility is possibly indicated by a comparison of those cases in which the sound went unheard. These affect the results considerably with H and W, otherwise the worst sounds on the list, but would not materially alter relative positions. Under the conditions of the experiment omissions should probably be given the same statistical rank as errors of substitution, and this is done in the table here given, though it is of course impossible in the percentile distribution table, where it is desired to effect a comparison between the number of errors made on a sound and the number of its erroneous substitutions. As the errors consist almost wholly of substitution, however, relative similarity, or liability to confusion with other sounds, is practically the sole factor in determining the position. And yet even here one must discriminate. A low place in the curve may be due either to a sound being somewhat like a larger number, or very like a small number of sounds. The former is the case with H, which spreads its errors with some show of a continuum over the whole phonetic field, the latter is the case with V, whose errors are confined almost exclusively to four letters, or with the nasals.

A statement of relative audibility based on these figures can have, therefore, only the most general significance. In general, the voiced sounds are poorer than the voiceless, this being correlated with their less energetic enunciation; the voiced spirants are the poorest of the group. The voiceless spirants are the best; the explosives being better than the spirants in the first case, and worse in the second. The great difference between two such closely allied sounds as the nasals is worth noting, and will be discussed subsequently in another relation. L and R are not closely related sounds here, the French R being employed.

The relations of the vowels have been discussed to some extent elsewhere. Except for the two extremes of the curve, A and E, the order is hardly what one would expect. The good showing of O is surprising, as also is I's poor one. The variation in audibility is very great for both classes of sounds, but especially so in the consonants, ranging from $\frac{0}{\infty}$ (in the case of S, not tested in these particular experiments, but with which the writer has never obtained an error) to nearly 35 per cent.

Save as regards giving a high place to the vowels, the curve shows no correspondence with the results of Rousselot. Save for the position here given to L, there is some show of correspondence to the figures of Wolf, and perhaps even more to those of Müller and Pilzecker, always bearing in mind that the results in their table are to be interpreted


Relative Perceptibility
in terms of
Per Cent Heard Incorrectly.
W 3½
V
H
M
L
G
P
B
D
N
R
K
T
F
3
E 15
I
U
O
A 3

in their German values. With these latter two sets of results, there may be a real tendency to correlation.

VIII.—Practise.

A well-defined practise effect is to be noted in all the cases observed, and the curve is plotted for every subject save V., who had acted as subject in previous analogous experiments. Certain changes in the conditions of the experiment also rendered it necessary to exclude the last three series of IV. The practise statistics are evolved by the following formula:[1]

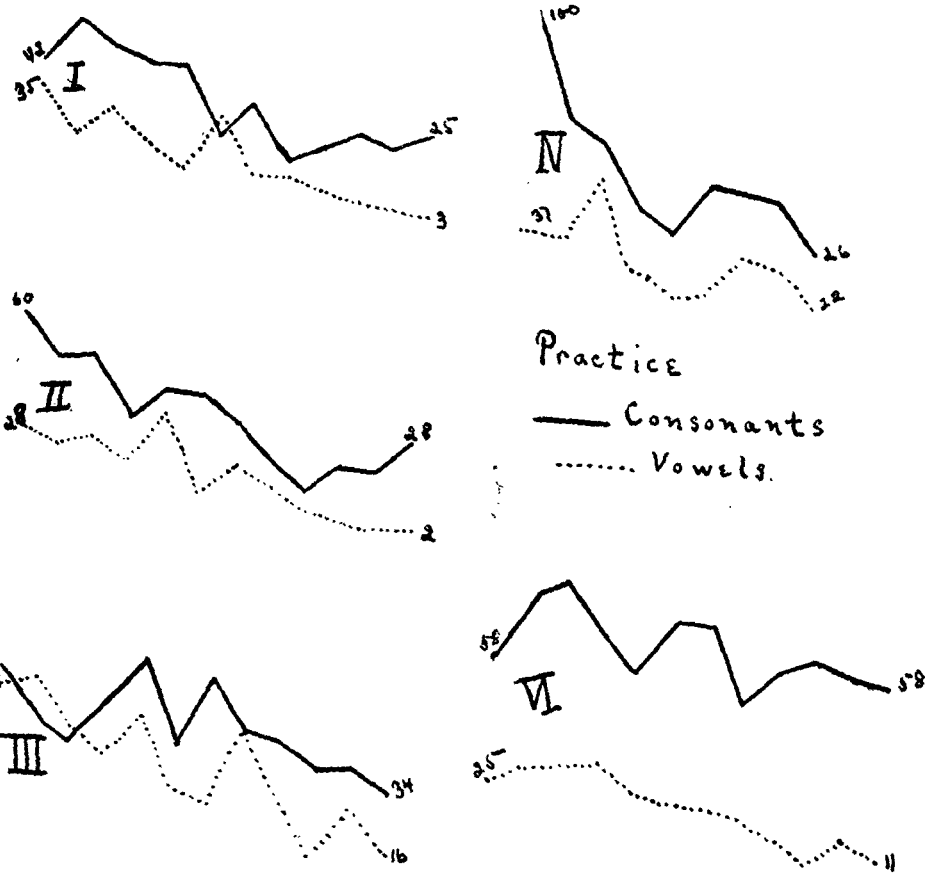
$$P=\frac{((n-1)\,e1-e2\ldots\ldots-e_n)+((n-2)e_2-e_3\ldots e_n)+\ldots\ldots e_n-1-e_n}{2}$$

where n signifies the total number of series and e the number of errors in each series. Thus from every e is subtracted algebraically every following e, and half the sum of the remainders is taken as the total practise. It is generally best to keep the positive and negative remainders separate; the average of these two taken without regard to sign then represents a neutral point at which positive and negative practise would be equal, and the difference between this average and the sum of the positive remainders indicates the actual practise. This method is adopted in the statistical statement, the average being represented by $\frac{T}{2}$.

Subject....	I.		II.		III.		IV.		VI.	
	$\frac{T}{2}$	P	$\frac{T}{2}$	P	$\frac{T}{2}$	P	$\frac{T}{2}$	P	$\frac{T}{2}$	P
Consonants.	476	401	577	546	407	249	396	343	368	159
Vowels.....	422	386	419	361	593	431	201	112	296	265

It will be noted that VI., while making more errors than any other subject, has also less practise effect. This is perhaps in part due to a considerable amount of practise attained by this subject in acquiring the mastery of several foreign languages. In this subject, as well as in II., III., and IV., there is a positive correlation between the number of errors made on vowels and consonants in each series, but in I. there is a most marked negative correlation. This seems best explained by peculiar conditions of attention. Only three times, twice in I., once in III., does the number of vowel errors rise above the number of consonantal errors; once again in III. it is equal. Toward the end of IV.'s curve there is to be noted an unexplained rise affect-

[1] For which the writer is indebted to Professor R. S. Woodworth.


I
42
35
25
3
II
60
28
28
2
III
61
34
16
IV
100
37
26
22
V
58
25
11
Practice
Consonants
Vowels.

ing both vowels and consonants, but the former one day previous to the latter, the former for three series, and the latter for but two. Chance appears the only explanation for this phenomenon.

IX.—Sensation Habits.

The previous experiments have been based on the *a priori* assumption that the amount of confusion is in itself a measure of differences in sensation, sounds much confused being very similar, and *vice versa*. The relative similarity of two constants must always be the same; it is a logical impossibility that one sound should be more like the other than the other is like the one. If, then, it is a correct hypothesis that the amount of confusion is a measure of sensational difference, it is obvious that the degree of confusion for each sound must be equal, or within the limits of chance variation. If, or where, this is not the case, there is indicated the presence of a third factor dependent neither upon pure chance, nor yet upon objective differences in the stimulus. The results must now be examined for the presence of such a factor. Theoretically, reciprocation should be perfect, *i.e.*, P should be heard as k as often and no oftener than K is heard as p, or the percentage of k-errors with P should equal the percentage of p-errors with K. Neither of these possibilities is a fact. Absolutely, P is heard as k nearly 33 per cent oftener than K is heard as p, but, on the other hand, a larger percentage of the K-errors are p's than of the P-errors are k's. And again, V is heard as b for the great majority of its errors, but there is no predominance of B-v.

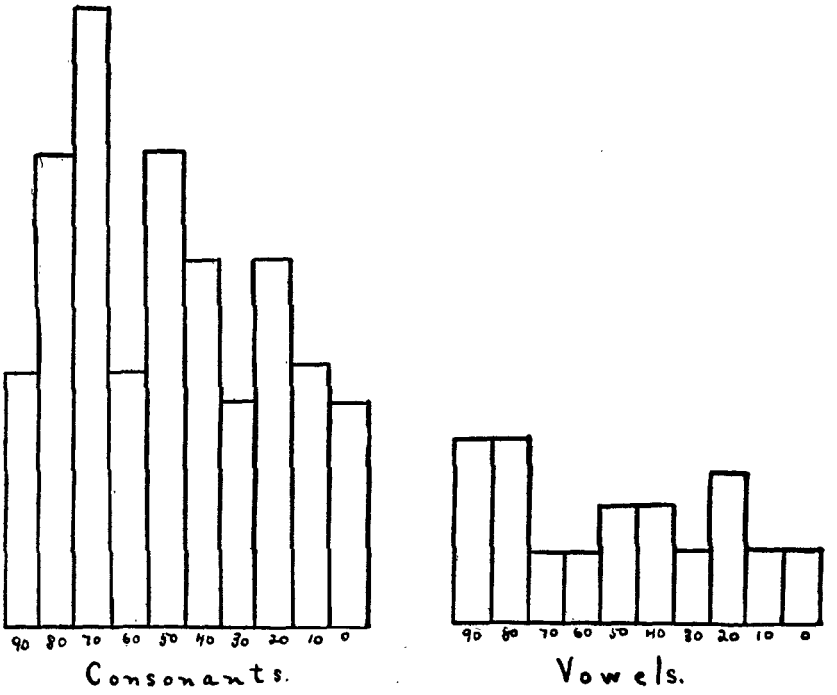
Most striking is the case of the nasals, where M is invariably heard as n oftener than N is as m by all subjects. Obviously if relative objective similarity were the predominant factor in such results as these, P would have to be more like K than K was like P, V would have to stand closer to B than B to V, the similarity between M and N would have to be closer than that between N and M, which are absurdities. Obviously there are certain sounds having a tendency to be heard rather than other sounds.

According to the theory that mutual similarities are equal, which they must be, objectively, there should be an equal tendency to hear a sound incorrectly and to substitute it erroneously for other sounds. Going beyond the similarity of two single sounds, any sound must be as much like the rest of the system as the rest of the system is like it, and tend to be confused accordingly. To what extent this occurs may be shown by a table giving in parallel column the total error made by any subject on a sound, and the per cent. of total error consisting of erroneous substitutions of that sound. This is simply

the vertical and horizontal columns of the tables first given reduced to a percentage basis.

Relative mishearing and erroneous substitution being equal, the percentage figures in the parallel columns should approximate one another; but an examination of the table reveals in many cases a tendency rather in the opposite direction; if the error on a sound is small, the amount of its erroneous substitution is large, and *vice versa,* exactly the reverse of what would seem to be demanded. Thus in the case of VI., but 1.8 per cent. of his errors are made on K, but 11.5 per cent. are made up of erroneous substitutions of k. Or, as a tendency in the opposite direction, 10.6 per cent. of VI.'s errors are made on G, but only 3.6 per cent. result from erroneous substitution of g. Striking cases of this sort occur with II. in W and III. in V, by which subjects these two sounds are heard unusually well, and frequently erroneously substituted. H is poorly heard and infrequently substituted by all subjects save IV., with whom a reverse condition obtains.

While the table is thus replete with examples of the tendency, it is a matter of some difficulty to obtain a satisfactory statistical statement of it. Following is a table of the percentage relation to each other of the per cent. of error and the per cent. of erroneous substitutions. If the making of a large amount of error on a sound were perfectly positively correlated with a large amount of erroneous substitution, the frequency surface of these percentile ratios should theoretically follow the form of 1-2 the probability integral; 1-2, since no account is taken of the direction of the relations, with the high end of the curve toward the high figure of the percentage relationships. The actual form of the surface is as follows:



Distribution of Percentile Relationships of Mishearings and Erroneous Substitutions.

PERCENTILE RELATION OF X ERRORS AND Y ERRORS.

Subject	I.	II.	III.	IV.	V.	VI.
P	88	95	44	82	82	2
T	100	∞	80	90	100	100
K	72	59	100	72	91	15
B	51	74	56	60	20	43
D	50	60	82	28	96	79
G	54	75	41	95	51	34
F	75	36	70	48	85	30
þ	30	36	22	70	25	25
H	51	60	14	42	69	42
W	86	42	13	33	56	17
V	86	57	25	26	76	11
Đ	89	60	86	10	19	25
L	89	100	58	70	60	29
R	84	79	68	40	56	8
M	45	77	70	50	82	75
N	72	50	70	25	72	44
A	8	19	34	25	63	80
E	84	46	4	32	44	54
I	27	100	95	61	54	19
O	90	78	53	94	88	28
U	94	83	29	77	85	49

Bimodal distributions are in each case distinct. There appear to be certain cases in which a positive correlation does obtain, and to the probable error of these figures is due the rise at the high ends of the curves. But after a sudden fall there is again a pronounced rise nearer the low end of the surface, less marked in the vowels than in the consonants. Here there are evident indications of the existence, in individual cases, of a negative correlation.

PERCENTILE DISTRIBUTION OF X ERRORS AND Y ERRORS.

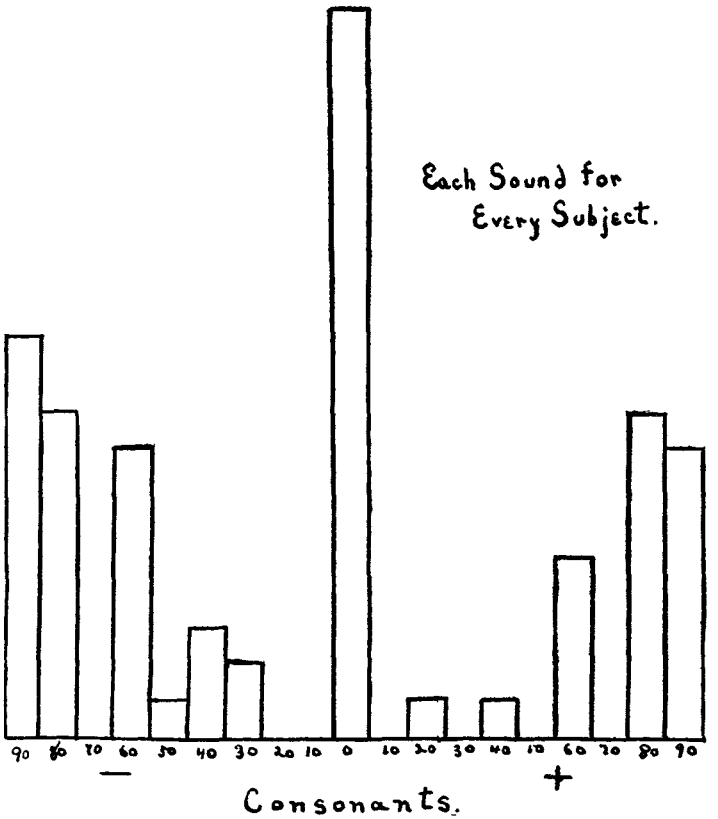
The figures in heavy faced type are the Pearson coefficients of the columns opposite which they stand.

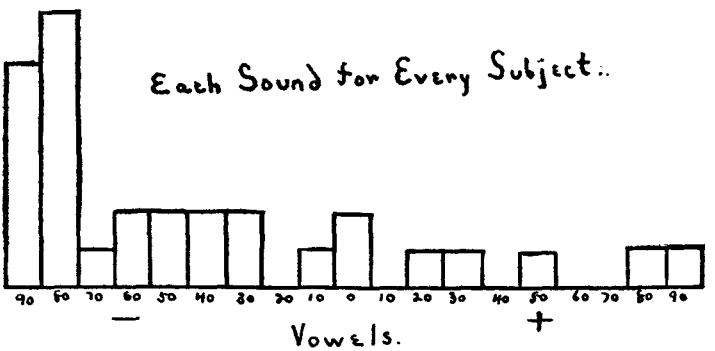
Subj.	I.		II.		III.		IV.		V.		VI.		
	x	y	x	y	x	y	x	y	x	y	x	y	
	66		**61**		**−4**		**−19**		**23**		**−40**		
P	6.7	5.9	6.0	5.7	3.9	8.7	6.8	5.6	6.8	8.2	11.2	2.0	—**.93**
T	0.6	0.6	0.0	1.3	1.2	1.5	1.4	2.0	0.6	0.6	1.2	1.2	—**.0**
K	3.6	5.0	2.3	3.9	4.3	4.3	5.8	4.2	4.9	4.5	1.8	11.0	—**.50**
B	5.9	11.4	10.9	8.1	7.0	12.5	6.9	11.4	3.9	18.7	6.2	13.6	—**.84**
D	2.5	5.0	4.4	7.3	3.2	3.9	3.3	11.7	5.9	6.1	8.6	6.5	—**.11**
G	7.2	3.9	6.2	4.7	7.0	2.9	7.9	8.3	12.3	6.3	10.6	3.5	—**.06**
F	3.3	2.5	0.5	1.8	2.4	1.7	1.1	2.7	0.2	2.9	1.2	3.8	—**.38**
p	1.1	3.6	1.8	0.5	0.7	3.1	2.0	1.4	1.6	0.4	0.4	1.6	—**.57**
H	8.1	4.2	8.6	5.2	13.0	1.9	5.8	13.7	5.3	7.8	12.1	4.8	—**.72**
W	10.6	9.2	8.8	18.2	20.3	2.7	12.0	4.0	11.9	6.7	14.1	2.4	—**.69**
V	11.2	12.9	14.0	8.1	5.6	21.9	12.0	3.2	12.5	9.6	8.1	3.7	—**.42**
Đ	4.2	4.8	7.0	4.2	5.3	4.6	10.5	1.1	6.2	1.2	9.6	3.8	—**.46**
L	10.0	8.7	8.3	8.3	7.9	4.6	8.2	5.8	9.4	5.7	3.7	15.6	—**.76**
R	4.5	5.3	4.9	3.9	5.5	8.0	3.7	7.6	5.5	9.8	1.4	15.6	—**.49**
M	12.3	5.6	10.1	7.8	7.3	10.3	9.4	5.0	6.2	5.1	5.6	7.1	—**.13**
N	8.4	11.7	6.0	12.0	5.1	7.5	3.0	12.0	4.5	6.2	3.6	7.2	+**.44**
	−60		**−11**		**−8**		**−25**		**−13**		**−41**		
A	2.6	31.3	5.1	25.8	8.9	26.0	5.9	23.5	10.5	16.5	10.3	8.3	—**.94**
E	30.2	25.6	39.1	18.0	46.2	20.0	44.7	14.7	25.0	11.0	19.1	34.8	—**.49**
I	33.9	9.3	25.8	25.8	24.5	25.6	20.3	33.0	16.5	30.5	31.7	6.3	—**.88**
O	15.7	15.0	14.4	11.3	13.7	7.3	15.1	16.0	21.0	18.5	9.1	35.7	—**.57**
U	17.7	18.8	15.4	19.1	6.1	20.4	15.8	12.2	27.5	23.5	29.7	14.7	**.0**

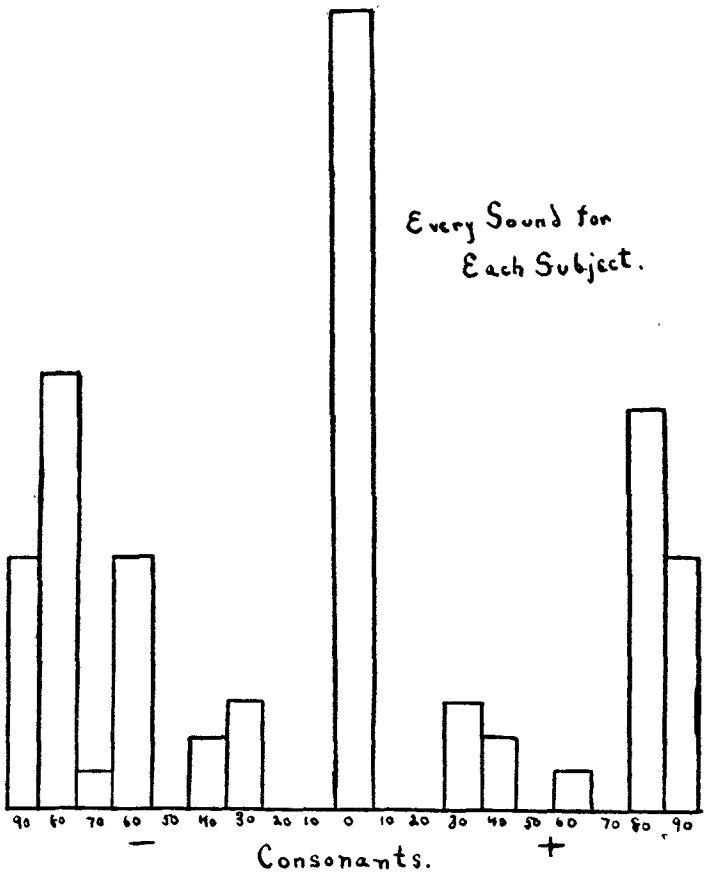
Another indication of the character of the relationship between mishearing (x) and erroneous substitution (y) is afforded through the medium of the Pearson coefficient. In this regard there are involved, besides the individual relationships, the liability of an individual subject to positive or negative correlation between the x and y of his own phonetic system and, on the other hand, the liability of an individual sound to positive or negative correlation of its x and y among the various subjects. The writer does not claim that the figures here presented are other than approximate expressions of the actual relationships; any attempt at greater precision were futile on account of the inevitable unreliability of x and y themselves.

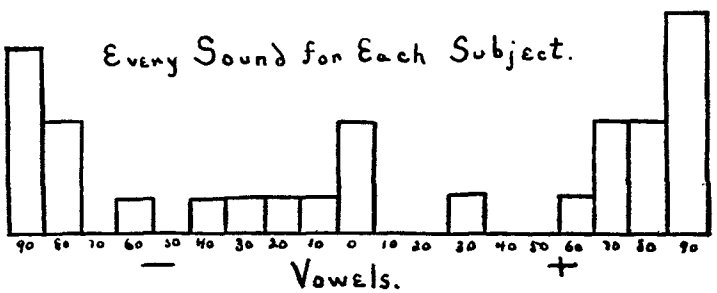
As will be seen by the table, such correlation as there is tends slightly in a positive direction for the records of individual subjects for every sound, but is strongly negative in tendency with the relations of each sound for all subjects. And yet these negative relationships are easily seen to be in so large a degree due to individual relationships that they cannot be held to represent a general tendency, for they merely represent the central tendency of very wide variations. Recourse must again be had, therefore, to a statement of the individual relationships, these being arrived at according to the formula $\frac{2xy}{x^2+y^2}$. From these computations the very unreliable sounds T, F and p have been excluded. The individual relationships are calculated in both ways as above, those of every sound for each subject, and each sound for every subject.

In the distributions there is brought out beyond a possibility of dispute the bimodality seen in the distribution by percentile relationships, and strongly indicated by the results in the general correlations. The number of zero cases is due to the fact that the relationships were calculated from integers only, this tending to obliterate small plus or minus correlations. There is nowhere a sufficient number of these cases to affect the bimodality of the distribution, though a more precise consideration of these cases themselves might form a trimodal distribution, a certain number of cases in which there was no correlation, possibly a mixture of the two extremes.


Each Sound for
Every Subject.
90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90
—
+
Consonants.


Each Sound for Every Subject.
90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90
—
+
Vowels.


Every Sound for
Each Subject.
90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90
—
+
Consonants.


Every Sound for Each Subject.
90 80 70 60 50 40 30 20 10 0 10 20 30 40 50 60 70 80 90
—
+
Vowels.

There is, however, an apparent tendency for certain sounds to be erroneously heard for other sounds, these naturally constituting, in the main, the group of well-heard sounds, as over against the group of badly heard ones.

Such a tendency is of course totally at variance with the hypothesis that amount of confusion measures objective differences in the stimulus, however accurately it may do so for individual sensations. The objective relations of stimuli are not their subjective relations, but each is modified by idiosyncrasy to subjective relationship with others. Thus, certain sounds appear to play a considerably greater part than others in the mental life of an individual, and these tend therefore to be themselves accurately perceived, and to be perceived for other sounds. There is a great sensitivity to this sound, and to all its qualities in other sounds; in a word, we have here the strongest possible evidence of sensation habit.

Motor habit is generally conceived of as due to the clearing out by repeated discharges of paths along the motor fibers down which any later impulse tends to discharge with greater ease and frequency. If, then, discharges along the efferent system may thus clear out paths for later motor discharges, what good reason is there why a path that has been traversed by a sensory impression should not be easier for the same impression to traverse than formerly, or than for a new impression to traverse a new path?

The growth of the apperceptive faculty is powerful confirmatory evidence from a purely psychological viewpoint, and everything that has been said on the physiological basis of motor habit applies with equal force on the sensory side of the reflex arc. Sensory highways may be beaten out by frequent travel as well as motor ones. There remains, however, the important distinction that no matter how well beaten out a sensory path may be, an absolutely new sensation having nothing in common with the one to which there is habituation could hardly discharge over the beaten track because it would not be taken up by that portion of the end-organ (in the ear, perhaps the basilar membrane), and a different set of fibers would inevitably initiate the sensation. In certain cases, it might then be necessary to push back the physiological basis of sensation habit into the highest central system. But in the case of linguistic sounds, this is not at all necessary. There are inevitably certain tone qualities common to any group of sounds, for no sound can be said to be the absolute opposite of another. Those qualities which an unaccustomed sensation has in common with an accustomed one will, travelling over beaten paths, be perceived much more forcibly, perhaps even temporally sooner, than the unaccustomed qualities, whose path will be obstructed. Then the qualities lacking to the habitual stimulus or sensation will be supplied to

the accustomed qualities by association, and the accustomed sound is heard instead of the unaccustomed one. And such a process explains equally why such accustomed sounds tend to be heard correctly. This is as near as the writer cares to approach the peripheral conduction theory, to be discussed below.

The auditory errors that have been under consideration are, ultimately, to be taken as substitutional lapses; they are in the last essentials due to inattention to partial similarity to known linguistic complexes, or perhaps to physiological defect in the transmission of the stimulus. Occasionally the errors tend to follow certain other forms well known in motor linguistics, as the metathesis, assimilation or substitution, and also presenting some analogies to recorded misreadings. To clear up this portion of the subject, it is necessary to trace out how far the analogies between linguistic sensation and movement are tenable, and in the present state of the subject this requires a somewhat full analysis of the processes of the lapse to which practically the remainder of the present paper is devoted.

X.—INTRODUCTORY.

There are four normal linguistic processes, two sensory, the visual and the auditory, and two motor, the phonetic and the graphic. The auditory and phonetic processes are analyzed empirically into elements whose composition constitutes words, and this analysis is carried over into the visual and graphic processes, save where there is ideographic writing. It is well to note how in some languages the grapho-visual system is dependent on the auditory-phonetic system, there being apparent independence in other languages. The ideographic system would naturally arise in those cases in which its users wrote before they spoke, the phonographic system when they spoke before they wrote. Linguistic origins are too far removed for even the purest conjecture on the historical bearings of this point. Ideographic systems do, however, degenerate into phonographic ones, and a certain amount of ideography is usually present in phonographic tongues, as our own numerals, &, +, —, etc. The present discussion of the lapse is purely from the standpoint of such phonographic language. It is possible that very different phenomena might obtain in ideographic languages, though the underlying principle were in each case the same.

Each of the above linguistic processes is subject to its own peculiar lapse. Lapses of the phonetic type have been voluminously collected by Meringer and Mayer,[1] and later by Bawden,[2] who also added some

1 Versprechen u. Verlesen, Stuttgart, 1895. To this work Bawden makes no reference.

2 Psych. Rev. Mon. Supp., Vol. III. (1900), No. 4.

material on the graphic lapse. It is believed that the present paper contains the first extended observations on the auditory lapse; indeed it is difficult to see how this lapse could well be studied save in the course of such experiments as those above described.

A lapse is the involuntary modification of any linguistic sensation or movement to another linguistic sensation or movement. The process itself is always central, no matter what its source of excitation. Theoretically such modifications might take an infinity of forms, but in practise nearly all may be referred to the types of assimilation, dissimilation, omission, substitution and metathesis, the second named being practically confined to the sensory processes.

Lapses are not only involuntary, they are for the most part also unconscious, *i.e.*, there is no awareness of them until their primary memory has been lost. For this reason the subjective content of the mutilated complex does not differ, in motor lapses, from the content of the unmutilated one, for the simple reason that the higher centers are not aware of the mutilation, and thus the lack of lapse appreciation, of which the adorers of the fetish that no unit can be smaller than the word have made so much, is hardly of essential significance. For the same reason introspective data are eminently subject to the psychologist's fallacy. Inattention is the first requisite of the lapse, and inattention precludes accurate introspection. Only when the product of a trained introspectionist are they admissible, and then only in partial explanation of anomalous phenomena.

It must be remembered that the mere fact that a linguistic lapse is unconscious, *i.e.*, not felt to be perceived incorrectly, hardly implies what Bawden assumes it to imply, that it is felt to be perceived correctly. It has yet to be demonstrated that, so far as the higher mental processes are concerned, the lapse is anything other than a product of inattention which permits the disturbing element to enter consciousness, and the law of suggestion, which permits it, when there, to express itself in a corresponding perception or movement. In motor lapses it might be said that the higher mental processes give the image or impulse merely; if it becomes confused or mutilated on its path to expression it is no affair of theirs, and they are not aware of it until it returns to them through the medium of sensation.

XI.—The Psychophysical Linguistic Unit.

So long as a machine runs perfectly, we might watch it indefinitely without gaining any idea of the function of its various parts, but if one of these parts be removed or altered, we may judge of the function of this part by the behavior of the machine under the new conditions.

A machine is in the highest sense a coordinated whole; a unit in itself; it really has no parts, for the function of not one can be altered without altering the other individual portions of the whole machine; the whole is more than the sum of its parts. The relation of its parts is analogous to that in a chemical compound, as FeS. It is impossible to remove the iron from this compound without changing materially the properties of the sulphur, and *vice versa.* But in a mixture of Fe and S, either may be removed without changing the properties of the other. FeS is therefore to be considered as a unit in itself, Fe+S as two units. That is a mechanical mixture upon any component of which any operation may be performed without affecting the properties of the remaining components. That is a chemical compound with which this is not possible. The portions of a mechanical mixture are to be regarded as units in themselves.

The question now confronts us, is language, from the viewpoint of physiological psychology, and tested by these criteria, a mechanical mixture, or a chemical compound? In either case, what are the elements? Is it, or is it not, possible to affect any elements or number of elements in a linguistic complex without affecting the physiological character of the remaining elements? Such a portion of a linguistic complex with which this is possible must be regarded as having a central and physiological individuality with reference to the remaining members of the sound-complex.

The term 'unit,' as employed in the present paper, must always be interpreted with a physiological bearing; the data are considered partly from the point of view of localization. The hypothesis of individual localization for individual sounds is one that is eminently suited for many phenomena of the lapse, and these phenomena will be considered with especial reference to their relation to this hypothesis. The term 'psychological unit' as applied to the word in language is, euphemistically speaking, vague. It is impossible to demonstrate any particular psychology behind a particular linguistic structure, therefore the definition of the word itself is of great difficulty. It is the old myth of the earth supported on an elephant and the elephant supported on a turtle.

It may be doubted whether in the whole course of empirical psychology there has ever been occasion to deal with a hypothesis so widely and unquestioningly accepted, and so little grounded upon actual fact. When the speech curve of an individual is observed on a phonographic record, it is indeed seen as a continuum, with few well-defined demarcations at any point in its course. But it is forgotten that this curve is representative of purely physical, not mental, facts, and that it is quite as unreasonable to argue that a single impulse would be the ground of such a curve as to make the same postulate for complete tetanus in the

frog-muscle. And yet this sort of *reductio ad absurdum* is exactly what has been applied. "In the flow of speech it is just as arbitrary a matter to consider certain portions to be separate sounds as it is to mark off by a line where a hill begins and a plain ends." Unfortunately for the simile, there is a large class of persons who gain a comfortable livelihood from the performance of just such tasks, but aside from this, language is, psychologically speaking, the product of certain very definite and separate nervous impulses. It might with equal justice be argued that walking does not consist of separate steps because the motion is continuous. The continuity is of a wholly non-nervous character, and arises simply from the necessity of shifting the organs of articulation through various positions from one place to another. Thus no one enunciates pumpkin (not punkin) without the p between the m and the k, but there is no separate innervation for this p, nor is it a psychological event, but merely an anatomically necessary transition stage in the movement from the position required for the m innervation to that required by the k innervation. Articulate speech consists of a very small number of these innervations, the glides between which, giving the appearance of continuity to spoken language, are of a purely physical character, with no neural or psychological significance whatever. The word Boston consists of the five innervational coordinations B o s t o n and the complex glides and *Übergangslaute* that inevitably occur in juxtaposing them have no mental basis. As a physical event speech may indeed be continuous, but as a neuro-psychical event it is highly discontinuous, easily breaking up into the elements that the phenomena of lapses indicate.

Perhaps the most conclusive experimental demonstration that motor speech cannot be regarded as a psychologically continuous whole, but that the processes must be due to rapidly successive innervational processes along highly specialized nerve tracts, is given in the following facts: The fastest successive movements that can be performed through discharges over the same innervation path vary with the individual from 8 to 14 per second. Even the high frequency electric current will not cross a synapse more than 19 times per second. The writer has records of 400 successive linguistic movements made by many subjects in 14 seconds and less, or at least 28.6 per second. Such a speed would be physiologically unattainable if there were not special tracts in the nervous system for each of these innervations. It is thus clear that we cannot regard the linguistic process as a neurologically continuous event, but as split up into the movements of the various separate innervations. A 'word' is a purely arbitrary division and may contain any number of ideas according to the philologically accepted language structure.

The inarticulate cry of an infant may be intended as an expression

of a more complicated idea than is expressible by any word of language, in the common acceptation of the term. In many unwritten languages it is almost impossible to obtain from the native an analysis into the easily analyzable grammatic elements. And the recurrence of elements shows that these analyses must have historical existence. The purely psychological unit is thus largely a matter of individual difference. The *reductio ad absurdum* also has its application here. If there is no distinction between a word and a sentence, a sentence and a paragraph, a paragraph and a volume, clearly the Encyclopedia Brittanica is a linguistic unit. The determination of the psychological unit as correlated with the span of attention indicated in the range of the lapse, is hardly justifiable, for one can never be certain, save within very narrow limits, of just whence the disturbing element enters consciousness, and whether all spatially or temporally intermediate elements are included in the transition to it. The smallest true lapse may through the processes of association and suggestion be the germ of a far-reaching change in the perception or movement which is not one of faulty sensation or movement, but the product of a desire for a congruous perception or movement with that of the true lapse which preceded it. To say that the linguistic unit must be greater than a sound or letter because words, word-parts or phrases may be involved in it, is to say that a wall is not composed of individual bricks, because when it tumbles over, certain of the bricks are still mutually adherent. There is thus no objection to considering the word in some cases as a psychological unit, if it is borne in mind that somewhere in the nervous system it is analyzed into smaller elements; but the writer envies no one the task of demonstrating in terms of language any relation between psychological content and phonetic extensity.

The determinations of Cattell that a word could be recognized and named in a shorter time than a letter do not bear upon the psychological unit; they are measurements of controlled association time, and never pretended to be otherwise. Association time, when so closely controlled as in this instance, only one association being possible, is a process somewhat subject to the effects of practise. In adult life we are more accustomed to associate the name of a word with its graphic image because we read words oftener than we do single letters, and are therefore able to perform this task somewhat more easily and rapidly. The fallacy of the 'new method of teaching reading' mentioned by Bawden is that this process is supposed to be carried over to children, where it fails to hold, for the reason that children have not the enormous practise effect with words over that with letters. The writer has not had many opportunities to test this 'new method' empirically, but the few observations made show about the sort of condition one would expect. The child tends to associate the word-image with an

indefinite image of the thing denoted, with no reference to the sound of the word. The result of this is the substitution of synonyms or species associations for the actual word. One individual upon whom opportunity for accurate observations was afforded would persistently make such errors as reading corn wheat, locomotive engine, dog cat, etc. After a year's infinitesimal progress he was taught to read at home by the phonetic method.

With equal practise effects it were rationally impossible for words to be read more rapidly than letters, because all psychological distinction would cease to exist. No definition could be imposed upon a word which single letters would not satisfy. P is a word; it means the bilabial voiceless explosive. Will it be asserted that the reaction times to A would follow a bimodal distribution according to its interpretation as a low mid-vowel or as the indefinite article?

XII.—Classification.

To a correct conception of the nature of the lapse a first essential is that a distinction be drawn between those lapses referable to association and suggestion, and those with which this is not possible, but which seem to be grounded in physiological processes. Bawden does not treat the physiological bases of the lapse in any detailed manner, and on these points his work is open to some criticism. In classifying the material attention is paid rather to the character of the lapse itself, whether phonetic or graphic, etc., and the manner of inducing it, whether central or peripheral, but there appears no real difference in the character of the lapse according to the manner of its induction or production, save in so far as the latter is motor or sensory. Substitutions, assimilations and metatheses necessarily totally different in causation are tabulated together because of some similarity on the above inessential grounds. Toward the end of the work a clearer conception of the significance of these varieties is indicated.

There are also evident in this work certain misconceptions of the limitations of linguistic science; thus on pp. 32-33 is expressed the hope that philological study will throw more light on the embryological and phylogenetic growth of language than in view of the results, both potential and actual, of linguistic investigation, appears possible.

Whitney long ago affirmed—one of his *obiter dicta* that has indeed stood the test of time—that language structure could in no case be taken as a criterion of social progress. Indeed, the old distinctions of agglutination, inflection, incorporation, etc., are every day losing force in all but the most conservative strongholds, it being quite impossible to demonstrate that any essential difference exists in the psychological

attitude behind them. The structural difference of French and Chinook is largely typographical. Still less is it possible to trace any phylogenesis in phonetics. Many languages spoken by the most barbarous have enormous phonological wealth, and others of the same status exhibit comparative poverty. But no sounds can be regarded as more primitive than others. It seems probable that language existed at least four thousand years before the date of the earliest extant material of significant extent. What phonetic and structural modifications have taken place since then—what might have occurred before then? Any phylogenetic correlations with the phenomena of lapses are unthinkable, save as the result of pure chance. The embryological development of language has not yet been thoroughly studied by a trained linguist, and all results on the phonology are subject to the not exactly negligible error to which the previous portion of this paper is devoted. It is probable that Bawden's statement, 'Certainly it is significant that it is the consonantal digraphs which the child learns last, that are the most often involved in the phenomena of lapses,' besides being indefinite, is open to doubt on both points. Bawden gives no figures on this point from his own material, but in the phonetic lapses of Meringer and Mayer, as well as in the writer's graphic material, either a letter or sound, or a whole word, is far more frequently involved than a word part. Most unhappy is the interpretation, on p. 33, of such lapses as *servival, ergent,* and *resceptacle* as a reversion to the 'orthographic instincts of childhood.' There are many factors, nearer than a reversion, that could cause such changes, principally through auditory analogy to other word of like sound, as serve, in the case of *servival.* Moreover, it can hardly be said that *serv* approximates phonetic spelling more closely than *surv,* or *erg* than *urg.*

On p. 46 reference is made to this profound statement: 'There are traces in language that indicate the sentence to have been historically prior to the word.' It is not probable that Bosanquet possessed a scientific grammar dealing with a period earlier than the latter half of linguistic history. Moreover, as has been indicated, the rational distinction between the sentence and the word or even the definition of either in terms of language is one of the most difficult problems of linguistic psychology, on which every additional speculation seems further to remove the solution. It is undesirable to give countenance to a statement of this sort, when there is so little knowledge of what either is, or whether the two are not identical. If the logician would leave linguistics alone as severely as the linguist sometimes does his logic, neither science (nor art?) would be the sufferer.

Subjoined, is a classification, with instances of the principal varieties of the lapse. It is probable that the psychological process is

similar for each variety, whether visual or auditory, and phonetic or graphic. The examples are then intended to serve as illustration merely, with no present discussion of the psychological details involved.

	Auditory	Visual	Phonetic	Graphic
Progressive	K hopopu	P rgjgd	T quike	K cow-cilling
Assimilation Regressive	P hokoku	K wnqsqz	R blass plate	G Endadin
Progressive	D ledibu	NBKSBL nbksl	T Tacius[1]	N sudden dawing[2]
Dissimilation Regressive	D lebidu	L Hemholtz	D Freue des Coitus[1]	
Metathesis	G B hobugu	A U Hutsase	We took off our hands and shook hats with them	SE aries
Omission	K þousho	S stet [1]	S outet	S acribed
Substitution	(passim)	Z lhxwcs	MAUSE.. Mäusefalle	T absolude

The only difference in the superficial character of the motor and sensory lapses is that the latter usually have a much greater extensity. In the case of visual substitution there is little limit to the perversions that may be due to suggestion. Under proper conditions of the 'fringe' the writer has read *Baseball* as *Kuroki, General Furnishings* as *General Fukushima,* and *New Commissioners Created* as *New Commissures Closed.* In each case the imagery of the illusion was perfectly distinct. It is impossible in such cases to analyze out the suggestive factor from the physiological one.

Upon this basis may be elaborated the already indicated classification of lapses into two species, the primarily psychological and the primarily physiological; the automatic, and those dependent on association and suggestion. Any amount of influence from both or

1 MM. (Meringer and Mayer.) 2 B. (Bawden).

either of the sources may be present in the causation of lapses. The higher type tends to include assimilations, substitutions and metatheses; the lower, dissimilations, omissions and probably also certain metatheses. The lower limit of extent in both types appears of a physiological character, but of the higher type there is practically no upper limit save that of suggestibility, of which, indeed, it possibly forms a rough test. On the basis of the premise, that the linguistic unit is that portion of the complex which is affectable without disturbing the relations of the remainder, the small limit of the ranges of the two varieties of lapse is a vital factor, and it is unfortunate that the answers to so few problems in psychology are less equivocal than this one.

XIII.—The Motor Lapse.

Before passing to a special treatment of each type of lapse, the general characteristics of both types may be considered with special reference to this question of the unit. While such processes may take place between words, as Meringer and Mayer's *viel zu* for *zu viel,* the greater number of examples are cases in which a single sound or letter is affected. There is no scarcity of material on the phonetic side, but its difficulty of accurate recording makes it more desirable to cite instances here from the graphic lapse, which records itself. In motor lapses this disturbance of the single sound or letter need not in any way affect the physiological or psychological subjective content of the remainder. The accompanying reproductions of an accurate copy of the original chirography illustrate this point with the greatest clearness.

PLATE I.

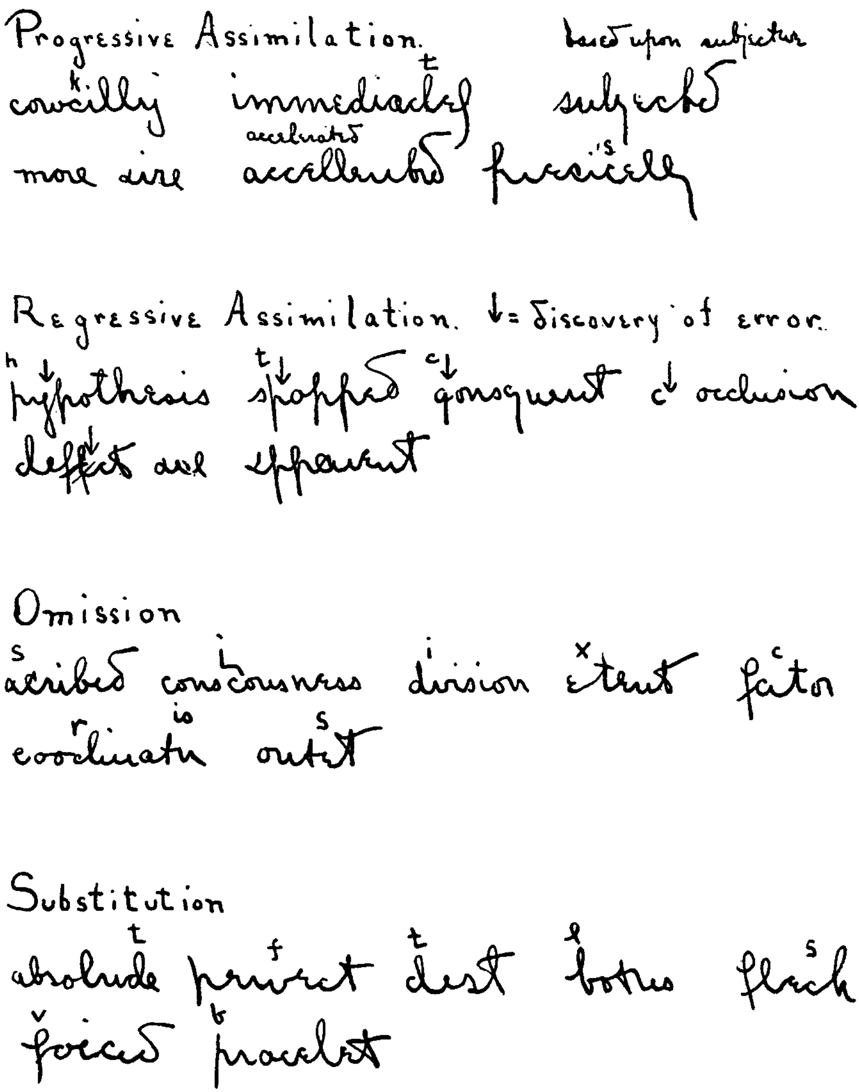
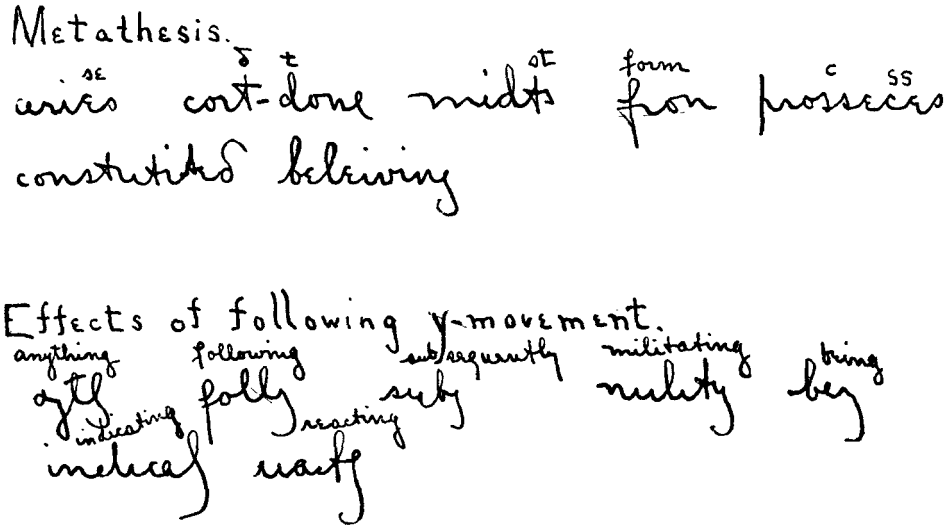

Progressive Assimilation.
Regressive Assimilation. ↓= Discovery of error.
Omission
Substitution

PLATE II.



These data, and all others on the motor lapse from the writer's observation, are non-experimental, produced under normal conditions. It seems supererogatory to introduce experimental conditions into the study of the motor lapse, since there is such a plethora of material at hand from other sources. It is probable that no exclusively psychological process is involved in any of the above cases. There is simply persistence, anticipation, transposition or substitution of certain portions of the linguistic complex, and this with no reference whatever to the remainder of the complex. Such a condition indicates physiological individuality for members of a complex able to act independently of other members of a complex, for these elements are not necessarily analyzed out by the higher mental faculties. How would it be possible, if the linguistic unit consisted of necessarily more than one letter or sound, for a single letter or sound to be subjected to processes such as those of metathesis, omission and substitution? The matter reduces itself almost to one of the simplest logic. And the same is true of auditory and visual lapses. The sensory, where there is no element of suggestion to increase the range, are rare save under experimental conditions, but are confined even more exclusively than the motor type to single sounds and letters, these being affected independently of the remaining sounds or letters in the group.

The lapses not referable to the higher mental processes almost never get beyond the limit of the single sound or letter. It is possible that in these cases in which this limit appears to be passed, an untraced associo-suggestive factor exists. There may now be considered a type of those cases in which a certain associo-suggestive factor can be traced. It has been shown that there is almost no limit to the amount of perversion which may be thus effected. Whole words are occasionally assimilated or substituted as wholes, and this perhaps gave original impetus to the word-unit theory. Unfortunately, the portion of the complex analyzed out by the lapse is in most cases far smaller than this, quite as small as, or even smaller than, in the quasi-physiological lapse.

By innumerable instances is it demonstrated that a single sound or letter is capable of associo-suggestive assimilation, substitution or omission, when this partakes of the character of negative substitution. Inasmuch as all are approximations to a form present in consciousness, they might in a sense be termed assimilations. From the writer's own experience is the following instance of omission as negative substitution: *Grated that.* The *at* of the *that* insinuated itself into the *granted,* but only just long enough to exclude the *n,* when the *ed* was written normally. There was no consciousness of the error until the entire phrase had been written, though the focus of consciousness had probably changed at least once, or there would have resulted *Grated thant,*

or possibly *Grat thanted.* The following are illustrations of normal associo-suggestive assimilation:

PROGRESSIVE ASSIMILATIONS.

PHONETIC.	GRAPHIC.
B.	B.
tidal wive	of men of (are)
blowing bib	one of my one (own)
indesdribable	make the assertion that self-assertion (realization)
Herbertian	how much dusting you much have done (must)
optic tup	paradax
MM.	beef steaf
Bild von sich Bild (gibt)	the leader blind and led by the land (h)
wünscht zu wünschen (wissen)	
gesehen wie sie gegehen wird (Aus-)	
einfacher ist die Eindrucksweise	
Konkret und Kontrakt (Abst-)	See also Plate I.
Enttäuschungen entlebt (er-)	
Stoss eines Erdbobens	
Sozialistische Zekten	
Kumulirung von Stupendien	
Worüber rauchzten sie (j-)	

REGRESSIVE ASSIMILATIONS.

PHONETIC.	GRAPHIC.
B.	B.
Jael took her into her apartments (him)	bug ..... (begun on)
extornal ..... (organization)	host ..... (historical)
collooding ..... (on the loop)	rad ..... (rapidly)
spice ..... (and time)	Branch ... (branch quite black)
ice-borgs ..... (are formed)	
MM.	See also Plate I.
Christ und Christentum (Kreuz)	
Mulkkuh	
Gerüchseindrücke	
Geschiehene Eheleute	
Lokuskapital (t)	

It is well noted by Bawden that any portion of a linguistic complex may 'persist' in consciousness beyond its proper time, and may thus express itself in a connotated movement. Persistence is here, however, a loose term, since it is often rather a recrudescence than a persistence. Persistence proper occurs only when the element affected is immediately repeated. This repetition usually occurs only once in normal persons, but may occur indefinitely in aphasia. More frequently, however, the element affected rises again into consciousness only after many linguistic movements have intervened. The movement is then made, displacing a linguistic complex of the same extent as itself, a letter if a letter, a word if a word, etc., after which the succeeding movements are taken up normally. This error may never enter consciousness. Here again is emphasized the strong sense of the number of units in a complex, and if any further confirmation is needed of the claim that the word is not *the* linguistic unit it is found here. It is also apparent that such localization as may be justified by the lower type of lapses in the enunciatory center is justified by these lapses in the psychomotor centre.

Related to the progressive assimilation are the phenomena of the regressive assimilation, classed by Meringer and Mayer and by Bawden as anticipation. In these, a linguistic complex, almost invariably a letter, displaces another of equal extent before its proper place instead of after. There are certain phenomena in this lapse of the greatest significance to the localization hypothesis, furnishing powerful psychological evidence in its favor.

It will be noted that very generally in the regressive lapses of Meringer and Mayer, and almost invariably in both the phonetic and graphic material of Bawden, the error is discovered, or, at least, so indicated, before the proper place of the erroneously made movement is reached. This is also universally the case with the writer's graphic material; the error is discovered before the proper place of the assimilated letter is reached by the pen. This fact opens to serious question the nature of the regressive assimilation. To cite an actual case, suppose the subject is to write *Engadin.* He writes *End;* now if he were to go on normally, and write *Endadin,* there might exist a true regressive assimilation. But of this there are almost no instances. In practically all cases in which the error is not discovered before the proper place of the assimilated movement is reached the word appears as *Endagin,* a metathesis. It is probable therefore that most if not all regressive assimilations are really abortive metatheses, in which the error was discovered or the primary memory of it lost before the arrival of the second member. Something of the sort is indicated in those lapses quoted by Meringer and Mayer in which the speaker's introspection gives evidence that the apparent regressive assimilation

would have been a metathesis if the error had not entered consciousness. Thus, "*'Ich werde auf das Ei . . . auf das Kreuz vereidigt.'* (p. 35.) Unkorrigiert hätte der Fehler so ausfallen können; *'Ich werde auf das Eiz verkreudigt.'*" And again, "*'Griebes . . . Liebesgram'* (p. 37); Ich glaube, ich wollte sagen *'Griebeslam.'*" This is one of the very rare instances in which the affected portions are not of the same extensity.

The second member should therefore be considered as having, as such, no part or lot in the lapse. It will be noted that in most instances of the graphic metathesis, the affected elements are closer together than in the regressive assimilations, the relative separation of the movements in the latter being probably related to the greater time given for discovery of the error and change in the focus of consciousness. It will be noted that this latter condition is all that is needed to abort the metathesis, and that this may take place without consciousness of the error. The corollary of the non-existence of the regressive assimilation, save superficially, would seem to be obvious. If a certain movement is erroneously anticipated, that movement is not made again so long as the primary memory of it persists; a fresh start must be had, so to speak, the focus of consciousness must change, before the movement may be again attended to. The theories enunciated by Stricker and Paul appear thus to receive important psychological confirmation.

There is, in fact, no case of motor metathesis which is not, in this sense, a progressive dissimilation, the second member being erroneously placed because of a consciousness of the individual movement-complexes, their number and identity, stronger than the consciousness of their order. When having made a linguistic movement prematurely, we arrive at that space in consciousness which it should naturally fill, there is involuntarily substituted the movement that it displaced. The writer is introspectively certain that this process underlies many of his own metathetic lapses, but surely no more so than was Aristotle that the seat of intelligence was in the heart.

If in the tables of 'Anticipatory Transposition' (B., pp. 100, 101), the end of the locution as printed indicates the point at which the error entered consciousness, or at least that it did not enter consciousness before that time, there is again emphasized the close connection between the regressive assimilation and the metathesis. The elements affected here are x and zero instead of x and y. It seems that if there is no change in the focus of consciousness between the actual position of the erroneously anticipated movement and its proper position, the movement will not appear in its proper position. Such a condition is illustrated in the following from the writer's observation, *Mollis, Ell, and Krafft-Ebing* (*Moll, Ellis, . . .*), or *brings inward* (*bring in-*

wards, B.,), which may be termed the complete lapse. The alternative condition, or incomplete lapse, is seen in *maglignant.* (B.)

While there may not have been consciousness of the error there was change in the focus of consciousness during the *li,* or the final result would have been *maglinant.* Such a view can no more be proved right than it can be proved wrong, but the balance of probability is thus in its favor: If the error enters consciousness the focus of consciousness has changed. In the phonetic lapses, where the process runs off quickest, and is therefore the most reliable, the chances are two to one that if there is no discovery of the error the lapse will be complete. But the chances are, from B., eleven to one that the error will enter consciousness before the articulation arrives at the proper position of the transposed sound. Consciousness of the error demands change in the focus of consciousness, but change in the focus of consciousness demands in no way consciousness of the error. The chances should be at least even that the focus of consciousness may change without causing consciousness of the error; and this chance fully serves to wipe out those cases in which there is an incomplete lapse without discovery of the error. Owing to the slowness of graphic movement and the time thus afforded for change in the focus of consciousness and discovery of the error, the complete lapse hardly occurs in the graphic variety. The nearest approach to it is in those cases in which the error enters consciousness at the moment at which the lapse should be completed, as *nod e* (B.), for *no education.* The complete lapse were *nod eucation;* the slowness of the graphic movement enabled the writer to correct himself. The nonsense quality does not, however, seem to be a very potent factor, for if, as in the graphic metathesis, a displaced letter is ready to step into the place of the absent one, the error is more likely to go unnoticed, giving the complete graphic metathesis.

It is worthy of note that an omission seems as subject to all the processes of the lapse as are the positive elements. Thus too *ull for utterance* (B.) as a regressive assimilation. We are not informed on the essential point of the vocalic character of the *ull;* but it appears merely an assimilation to the vocalic initial character of the *utterance.* Also, *mile distants* (B.), as metathesis.

One of the varieties of metathesis is doubtless to be explained as a regressive assimilation effecting a progressive dissimilation in which the second member is determined as the one previously displaced. In the absence of Meringer and Mayer's Law this process would sufficiently explain all cases of metathesis.[1] Very differently accented vowels and consonants, even juxtaposed vowels and consonants, are, however, subject to metatheses, as in *is equal Frank to it, dise, sdie*

[1] MM., p. 25. Lapses involving a plurality of elements tend to take place between elements of equal value for consciousness.

(*Side*) (B.), or the writer's *midts, aries.* If due to association and suggestion, such lapses are a direct contravention of Meringer and Mayer's Law, which has the support of too many theoretical considerations and empirical observations to be discountenanced by the meager data thus to be arrayed against it.

It is possible that there exists a wholly physiological variety of metatheses, independent of all conscious processes. The neurology of such a process would be idle to discuss in the present state of the whole matter. It is true, however, that this quasi-physiological lapse is rarely found outside the graphic variety, where Meringer and Mayer's Law hardly extends, save in extreme audiles. The whole matter of the exclusively physiological metatheses must at present be left an open question.

A third variety of metatheses, occurring only between juxtaposed letters, exclusively confined to the graphic variety, appears to be conditioned by the greater ease of the incorrect movement. Such lapses may firmly establish themselves in the chirography, as anaylsis or tounge in that of the writer. Where a number of figures must be rapidly noted, as in reading the chronoscope, the writer has found it especially frequent. On account of predilection for a certain type of movement, this may be anticipated, thus bringing these instances into line with the first group; but it is by no means clear that this is the process involved.

The most probable explanation lies in the physiological mechanism of coordination. The easier movement is anticipated simply because it travels over the synapses faster. The 'Peripheral Conduction Theory,' to be subsequently discussed, would be much more tenable if it would state itself in terms of synapses.

The processes involved in the omission are far from clear. The generalization of Bawden of these errors, as due, where no immediate cause can be traced, to the sense of having written the omission, may be passed over, for, besides being safely indefinite, if introspection is ever obviously worse than useless it is so here. In his whole table there are also only two non-experimental errors. Most of the omissions given in the other tables are not omissions proper, but motor dissimilations.

The phonetic lapse is again of less importance than the graphic, on account of the recording difficulties; and recourse is again best had to the graphic lapse for a study of the phenomena where the explanations of dissimilation, negative metathesis or assimilation do not appear to apply.

There are recorded all stages of the graphic eliminatory process, of which the omission is the culmination; the degrees of dwarfing and deformation of various letters form a continuum only gradually merg-

ing into the complete omission. To such cases as these the 'sense of having written' (whatever this may be) has no application whatever.

The gradual dwarfing and final omission of a letter may well be here considered as an innervational process; transient changes of nutrition in the centers would induce such phenomena, where they are not due to inhibition, acting from other causes. On this point pathological evidence speaks with no uncertain voice, particularly as regards phonetic conditions, loss, or difficulty in the formation of single sounds, being a far from rare occurrence.

The substitution is a product of the same general processes as the assimilation. There is, in fact, ultimately no difference between them, the distinction being merely that in the assimilation the effectively associated element is taken from an immediate body of linguistic elements, and is so taken, principally, if not often solely, on account of its spatial or temporal contiguity with the assimilated element or complex. In substitution the lapse is less directly dependent upon physical conditions, and more upon the higher principles of association, as similarity, contrast, etc. Thus *paradax* (B.), is an assimilation due to a contiguous frequency of the movement *a*, but the substitution of *a* in *real* (*Reeling off*) is due to no such cause, but to extraneous association with a similar sounding word through the influence of the auditory imagery. The motor imagery is perhaps predominant in such errors as *descriping* (as if by analogy to *script*), etc.

Certain associo-suggestive substitutions may occur very frequently in anyone's MS., as d-t in that of the writer, here probably through influence of auditory imagery. If this is sufficiently frequent, a new motor habit may be formed, causing d to be substituted for t quite automatically, with no reference to association. A striking instance of the degeneration of associo-suggestive to automatic lapses is seen in the part played in the writer's MS. by the final y movements. There is great partiality to the final downstroke; in any word in which it occurs the later movements will be mercilessly sloughed away in order to get to it as quickly as possible, as in the instances reproduced. Very frequently this final y movement appears automatically where it does not belong; so great a partiality to this at first voluntary movement has arisen that any number of paths automatically discharge into it. Thus, in many cases no clear demarcation of the varieties exists.

The processes of the lapse, especially those of assimilation and substitution, are not necessarily confined to actual linguistic movement, but some of the higher ideas, as those of doubling, capitalization and others, are also subject to them.[1] As an example of the lat-

[1] For a treatment of non-linguistic lapses: Jastrow, 'Lapses in Consciousness,' Pop. Sci. Mo., October, 1905.

ter, *Dhe.* (*The distribution.*) In this lapse the *d* was anticipated from the second word; but the capital quality of the *T* persisted, causing the *d* itself to be capitalized. A most instructive instance is a regressive negative metathesis of doubling very frequent in the MS. of the writer—*voicelles.* Here there is an instance of the 'complete lapse' of p. 88 affecting not a movement, but the abstract idea of doubling; it is as though only one letter might be doubled during a single focus of consciousness. The opposite form of this process is seen in Bawden's *inatt* (*innate*).

It is apparent that among the substitutional lapses are to be classed probably all the phenomena of analogical change in language. The spread of the weak perfects, and the vocalic levelling of the strong ones in Germanic, with numberless other far-reaching processes in all languages, are to be thus explained. In such instances as the assimilation of the old French nominative singular masculine of the third personal pronoun to *elli,* analogy to a hypothetical interrogative *qui* is to be accepted as the correct explanation. Such processes are paralleled in the sporadic lapse by the following: 'Es ist von einer Familie Namens Worms die Rede. Gleich darauf sagte ich,' *'Du Wormsl,'* statt *'Du Ernstl'* (MM) or, after speaking of Yonkers, the lapse *'Brunkers and Queens'* (*Brooklyn and Queens*) from the writer's observation, remaining uncorrected by the speaker. These changes are perhaps to be classed as assimilations rather than substitutions, since the disturbing element is here so near the surface. The various principles of association are exemplified in analogical change, thus gravis-grevis by analogy to levis illustrates the contrast analogy. Other examples of this nature occur in closely associated numerals, as dialectic ὀπτώ for ὀκτώ by analogy to a persistent ἑπτά, paralleled in the Germanic language by the well-known *ölf, zwölf* for *elf, zwölf,* a regressive assimilation, and sporadic labial umlaut.

The entire body of analogical change belongs here, no matter what the character of the associative process. The vast majority of assimilations and substitutions are recorded as lapses merely because of the transitory character of their exciting cause; when this is constantly present not only in the individual but in the entire linguistic community, its frequent occurrence gives the laws of imitation full play, the more so as it is probably an economizing process, tending to the elimination of inessential differences. The lapse then establishes itself in language or disappears according to the frequency of its occurrence and economic value; in a word, its naturalness.

The assimilations furnish certain indications that the motor psychophysical unit may be even smaller than the letter. Certain it is that lapses occur involving only special parts of those coor-

dinated movements ordinarily summed up under the name of letter or sound. As Meringer and Mayer point out, the cooperation of many muscles is necessary to produce linguistic movement, and for every single sound many different cerebral centers must be brought into activity. If other confirmation were wanting, the study of lapses would perfectly establish this theory, only the corollary is not, as Meringer and Mayer hold, that the linguistic unit is necessarily greater than the letter or sound, but rather that it may be smaller.

Every linguistic sound may be analyzed into three factors, the breath stream, determining stress accent qualities, the cord action, determining voicing or unvoicing, and giving characteristic pitch, and the various complicated oral movements, giving qualitative modification to the produced tone. Further analysis is theoretically, but not practically, possible for present purposes. Each one of these three factors, breath, vocal and oral movements, is subject to all the above forms of lapses independently of the other factors of the same linguistic sound. It is interesting to note that the lapse is here almost always associo-suggestive in character, the process assimilating certain qualities of the sound affected to another sound present in consciousness, but leaving the remaining qualities unchanged. These extremely analytic lapses probably underlie certain of the most far-reaching phenomena in the history of the idg. languages, but are not common in such present normal speech as the writer has had the opportunity to observe. The changes are so slight that probably the vast majority of those actually occurring are unperceived. Several instances were collected, it is just to say, from a different viewpoint, by Bawden, certain of which are subjoined.

This table must be interpreted broadly, on account of the deficiencies in phonetic representation and analysis.

ERROR.	CORRECT FORM.	REMARKS.
our corkey	our turkey was cooking	o of corkey as in cork
The Wêst	The East Indies or West	e of West as in fête
extêrior tintacles	exterior tentacles	e as in ten. (B.) It probably approximates more closely a in Mary? (W.)

The following are from Meringer and Mayer:

Diese Muse ist in Pier getauft.
Die drī. Die dritte acies.
Die Hunds grō. Die Hundsgrotte von Neapel.
O wie stiel ist hier zu fühlen. O wie still.

The following is one of the most striking of those that have come under the writer's observation. An individual was singing in company with others the song, "Im schwarzen Walfisch zu Ascalon." The fifth stanza opens with the words,

'Im schwarzen Walfisch zu Ascalon
Da schlug die Uhr halb vier.'

On arriving at the *Uhr* there was anticipation of the vowel of *vier* with the result of *Ühr, i.e.,* the lip, breath, and cord action of *u,* but the tongue position of *i.* There was consciousness of the error before arriving at *vier.* In the light of these instances it is apparent that whatever individuality may be assumed for those coordinations which we know as single linguistic sounds must also be assumed for the elementary processes constituting them, which are not empirically analyzed save by the phonetician.

There are no instances in Meringer and Mayer of a similar process in the graphic lapse, for their work is confined to the phonetic variety. It has come within the writer's experience but rarely. Its most common form is the shortening of one of the letters rising above the line, as b, l, t, h, to the height of the shorter consonants and the vowels; l is the letter most frequently affected by this process, on account of its similarity to the graphic e.

Very rarely a letter is raised above its proper place in the line, as in the y of the lapse *precicely* on Plate I. In the present MS. p was written without the final stroke. The potentiality of such lapses is, therefore, evidently present. The following table is selected from Bawden. It loses some significance from failure to reproduce the graphic form, but is the most important collection of these errors extant. It is to be noted that experimental conditions were operative in producing nearly half of them.

ERROR.	CORRECT FORM.	REMARKS.
and god	and got	Crossed the d.
chiel	child	The l was modified into e. (See above.) (W.)
loke	love and hate	
say	saw	The w had a descending loop added to it.

It would be impossible to leave this phase of the subject without some consideration of the possible analogy between its processes and those of the important phenomena of vowel harmony in the history of

language. These processes are in the nature of assimilations, and therefore of course wholly associo-suggestive in character. The lapse is manifested in a tendency to modify a vowel or vowels of the same 'word' to agree with a certain vowel in respect to certain factors of articulation. Such consonantal harmonies as those occurring in Sanskrit are too hemmed in by artificialities to be suited to the present discussion. The process may be either progressive or regressive, and varies in extent according to the language in which it occurs. In those languages in which it is most fully developed, as in Finnish, it may extend through an enormous number of syllables, or it may be confined only to the preceding, as in the Germanic umlaut, or to the succeeding, as in certain American languages.

The physiological explanation of this phenomenon put forward by Sweet is wholly untenable. This writer holds that it is merely the result of laziness—a much overworked term; that when the tongue was once put into the back or front position it was easier to keep it there as far as possible through the rest of the word. But it must be remembered that intervening consonants draw the tongue away from this position, necessitating its return for every vowel enunciated. And to apply this explanation to the regressive harmonies is to assert that laziness gets out of bed in the wee sma' hours to avoid the discomfort of doing so later. In regard to the causation of this phenomenon the writer prefers to agree with Oertel, whose treatment of this whole matter is eminently sound, attributing it to psychological anticipation; but this holds strictly for the regressive processes only, psychological transference being a more general, and perhaps more desirable, term. The transferred sound quality is persistent or anticipated in consciousness, the law of suggestion causing it to appear at other than its proper place. The fact that vowel always assimilates vowel, and consonant consonant, is in accord with Meringer and Mayer's Law. Vowel does immediately influence consonant, and consonant vowel, but these changes, in so far as they are motor, are easily physiological in character.

In our present linguistic situation, so far removed from any of the processes of harmony as other than an abnormal factor in the language, it is apparent that there are possible only certain generalizations regarding its psychological basis.

It is, as has been indicated, first and last a process of assimilation. When this is progressive, the phenomenon is comparatively simple, a sort of phonetic intoxication, causing the same factor to persist indefinitely. There is observed this definite fact: if it fails for any reason to operate in a single syllable it ceases there, and never reappears in a subsequent vowel. But this leaves the main question still

unanswered. Are the affected vowels changed as a whole, as must be the case if the word is conceived of as a whole, or is it more reasonable to assume successive steps in the progress? This point is more satisfactorily studied through an examination in connection with the regressive harmonies. Consider the hypothetical aggregation of syllables patakabokatapa, in which bo is the stem syllable assimilating to its labialized character the unlabialized vowels. Assume, also, the existence of a law changing all a's immediately following t's to e, which is unaffected by o. This must be understood as a mere simplification of actual linguistic phenomena. Then only those vowels will be labialized lying between the e and the inducing o. But in the absence of this limiting e, the harmonic process might extend much further. Clearly, then, the affected vowels are not assimilated as a whole, else all the affectable vowels in the word would be affected, the others being passed over, but only the individual vowels are affected within certain physiological limits.

And yet many individual vowels may be thus affected. It is absurd to suppose that two or more vowels according to the extent of this physiological limit might be affected as a psychological group. The standard vowel, therefore, affects only one vowel directly, and that one the nearest to it, for if this is not affected no other is. Then, by the law of assimilation that governs the language, the modified vowel affects its neighbor, and so on until the limit is reached, analogously to the falling of dominoes set up in a row. The actual working of this process is most clearly seen in the double umlaut of ahd., in which the final i of a trisyllable assimilates the vowel of the second, unaccented syllable, to itself, and if the vowel of the propenultimate syllable is a, this is umlauted by the induced i of the penultima to e. Propenultimate a never occurs as e unless the penultima is i, but penultimate a is historically umlauted to e, in later writers to i, before the final change of propenultimate a to e. All stages of the process are thus preserved, and the chronology is demonstrated.[1]

By analogous process occurs the assimilation of urg. e to i by an i or u in the following syllable, the u in this case contributing to the e its tongue-position in the horizontal, but not in the vertical plane. The opposite of this process is seen in modern English *syrup*, pronounced *serrup* by many worthy persons. Here it is the back quality of the u which alone is operative. But it may be asked what has become of the high quality, for the result should theoretically be somewhere between i and u, and on the same level of height. The answer probably lies in the fact that the unaccented u of syrup is far from a pure u, being drawn downwards in approximation of the schwa ə.

1 Braune, Ahd. Grammatik, Section 27, Anm. 4.

It is probable also that y has not in normal speech the same high front position as i on account of its relatively frequent unaccented utterance. In this position it is drawn downward and backward to approximate the schwa ə, and its frequent unaccented is analogized into its infrequent accented pronunciation, giving a result already about as far back as the e, and only slightly higher up.

Primitive Germanic o and other vowels of analogous position assimilate i to e (*nizdos-nest), imparting to it the height but not the back or labial quality. The labial umlauts of North Germanic are other examples of the same process.

XIV.—The Sensory Lapse.

The sensory lapse presents superficially almost the same characteristics as the motor lapse, in omission, metathesis, assimilation and substitution. It is very difficult, almost impossible, to study these save experimentally. As has been indicated, one cannot altogether approve of the experimental method in studying the motor lapse, since it is quite possible to obtain enough material for purposes of study from ordinary conversation or manuscript. Moreover, there is a permanent record of the graphic lapse, but the data of the sensory lapse are altogether subjective in character, liable to error of memory, or to other causes of inaccuracy of recording. Where non-experimental instances of the sensory lapse can be found, they are valuable, but so few in number that they may hardly be used save as a check upon experimental data.

The data of the auditory lapse here discussed are collected from the writer's previously given experiments. Classified instances are subjoined:

ASSIMILATION.

Progressive.		Regressive.	
Lukepi	lukeki	Kabagu	kagagu
Nabama	nabana	Limuda	mimuda
Pohuku	pohuhu	Diþonu	ðiþonu
Hobugu	hobubu	Kuvumo	kimumu
Napeko	napepo	Latadu	tatadu

DISSIMILATION.

Progressive.		Regressive.	
Wawapu	wavapu	Gagime	ragime
Reraði	revaði	Heteho	beteho
Lagelo	lagedo	Butoti	bukoti
Wofuwu	wofuru	Dodite	bodite
Haþeði	haþedi	Fifebe	difeba

METATHESIS.

Viþoda	ðifoda	Famenu	fanami
Kateno	katone	Witopu	wutopi
Hobugu	hogubi	Pidaha	hidapa
Tovida	tavodi	Nifuwo	nifovu

In the visual lapse the problem is complicated by the possibilities of simultaneous and successive presentation, but the results obtained by simultaneous exposure do not differ in any essential from those made with auditory stimuli, nor from those records obtained with successive visual stimuli in any experiments with which the writer is acquainted. So far as the writer's experiments in this field are concerned, they constitute practically a repetition, with slight variations in method, of the experiments described in the admirable study by Ranschburg,[1] though it should be stated that access was not had to Ranschburg's work until the experiments were practically completed, so that the results, though corresponding, are independent. The apparatus employed by the present writer was a type of simple mnemometer, consisting of a 100 cm. kymograph drum actuated by an electric current. Before this kymograph, and tangent to it, was placed a perpendicular brass screen with an aperture 8 mm. by 40 mm., the kymograph being caused to revolve at such a speed as to give an exposure of one second. Upon the rough side of the ordinary glazed paper were typewritten the test-complexes in vertical column, ample time for recording intervening between their exposure with the kymograph revolving continuously, though in practise it was generally stopped between exposures. To form the test-complexes there were used the twenty lower case consonants of our alphabet, each occurring equally in each position, the arrangement being otherwise governed by pure chance, save that a letter was not allowed to appear twice in the same complex save in one series, it being desired to avoid the dissimilation as already sufficiently established by Ranschburg's work, and by non-experimental observation.

It is desirable not to use vowels on account of the word similarity thus obtained (this is of course unavoidable in the auditory lapse), and also because the complex is then so much better perceived that it must be longer than certain physiological limits make desirable. The subject was allowed to choose his own distance from the screen, and after each exposure wrote down the complex as retained upon a blank provided for the purpose. This method is more subject to mnemonic error than oral repetition, but here is introduced the operator's error of recording unless the subject speak into a phonograph, which is over-refining matters. The series were 5, 6 and 7 letters respectively in length. Subjects found little difficulty with 5, 6 gave the best results, while there was considerable mnemonic breakdown with 7, and almost total with 8. Classified illustrations of the results are subjoined.

---

1 Über Hemmung gleichzeitiger Reizwirkungen, Zt. f. Psych. u. Phys. d. Sinnesorgane, 1902, 30, pp. 39-86.

ASSIMILATION.

Progressive.		Regressive.	
Rgjpd	rgjgd	Wnksqz	wnqsqz
Rbtpgj	rbttgj	Pgbjrlc	pjbjrlc
Gdsqmn	gdsqmm	Frgxwjr	xrgxwjr
Pgbrlc	pgbrbc	Rjlmgdf	rdlmjdf
Pcwbnq	pcwpnq	Zvchlx	xvchlx

METATHESIS.

Qfzndp	qfzdnp
Cxbhlv	cxblvh
Qptfgwh	qptfwhg
Cqmfk	cmqfk
Jwdbrc	jwbdrc

PROGRESSIVE DISSIMILATION.

Dfjxfnl dfnjxl
Rndwdz rndws
Flkskbr flksbr
} See also p. 107

OMISSIONS NOT RECOGNIZED.

Bxfcwl	bfxcl
Cxbhlw	czbhlw
Srxgbzq	srxgbz

OMISSIONS WRONGLY PLACED.

Bwvcknz	bwvkn-z
Dlhkpmn	dhkpm-n
Vncstxp	szn-txp
Frmgtb	frmg-t
Mzkhxbw	mzhb-wm

SUBSTITUTIONS.

Grqtb	grptb
Htwlcvs	htwlczs
Xpjfmk	xpgfmx
Pgbjrlc	pghjrlc
Hqgvst	hqzvst

Some attempt has recently been made to explain certain forms of the sensory lapse, notably the metathesis, not only upon a physiological, but even upon a peripheral, basis. Practically the entire body of experiment along these lines is on the visual lapse. The explanation is, briefly, that certain stimuli have a tendency to travel along the peripheral nerve more rapidly than others, and thus are apperceived first by the centers. If, now, this difference in conduction speed between two juxtaposed letters is so great in favor of the following that it reaches the brain before its slower neighbor, it would be apperceived as chronologically preceding, although objectively following. Thus if the figure 1 were conducted along the periphery very much faster than 2, 21 might be read as 12, since this was the actual succession of the arrival of the stimuli in the cerebrum. Frequently a single letter of the complex presented will not appear in consciousness, *although its gap is felt,* and suddenly without warning it rises above the threshold. This is attributed to a retardation in the conduction of the stimulus along the periphery, the letter not being forgotten and then remembered, but actually appearing for the first time in consciousness.

Upon close consideration this position seems hardly tenable. While undoubtedly marking a distinct advance over the word-unit theory, it still retains many grave defects. Firstly, it is not shown how, or why, a certain stimulus should be conducted along the periphery in a shorter or longer time than another. *That* such a thing happened it would be

forever impossible to show, since the first process we can measure is recognition. But to assume that the peripheral is alone sufficient to determine subjectively the chronological order of perception necessitates that conduction time be closely, if not exactly, correlated to recognition time. The only thing which, at least in the case of visual stimuli, can possibly be conceived of as tending to decrease conduction time for one stimulus rather than another is sensation habit; a certain sensation by frequent perception smoothing out its own pathway along the periphery to be travelled more easily by it. But unlike the situation with sounds, which are analyzed in the end-organ, the physiological area on the retina on which all stimuli must fall is limited, and as there is hardly an individual fixation for each letter, the area is necessarily covered indiscriminately with images of all letters; some assisting each other's pathways, others obstructing them, but anatomical selection would be impossible. All the letters of the alphabet placed one over the other would form a meaningless black; and this must be the outline of the conduction paths in the retina and optic nerve.

If the theory of variable conduction speed is to hold, clearly a most potent factor in the rapidity of conduction should be the frequency of perception. But if this frequency of perception be compared with the time of recognition of the various letters as determined by Cattell, it will be at once seen from the character of the results that there is no correlation between frequency and speed of perception. Speed of perception depends upon ease of form analysis, a wholly central process. Neither is there any good correlation between frequency and speed of reproduction, though, as is not altogether remarkable, it is somewhat closer than in the first case. But it is very evident that the speed of conduction in the periphery is not influenced to any significant extent by frequency of perception, and also, as the relative positions show inconsiderable individual variation, it is not likely that other than objective factors determined the errors with the visual stimuli.

But granted, for the sake of argument, that the data of Cattell do not represent central differentiation times, but rather speeds of conduction along the periphery. It is then possible to controvert the theory not by reasoning and deduction, but by empirical fact. If according to these data w is much faster conducted along the periphery than e, w enters consciousness before an immediately preceding e.

Every letter occupying a higher position in this order should tend to precede in visual metatheses those having a lower, and the greater the difference in speed of perception the greater the probability of metathesis. Such, however, is not the case. Letters do not tend to be transposed in the order in which they should by this token enter consciousness any oftener than the laws of chance determine. Lastly,

there is not so great a difference in the recognition time of the various letters as this hypothesis would demand. Senso-mnemonic metatheses are frequent between events so widely separated as to preclude any difference between the subjective chronology and the objective one. This argument is of particular force in the auditory metatheses.

So much for the peripheral conduction theory as an explanation of metathesis. As regards the omission, the case against it is even simpler. When the subject strives to fill a gap in the mind, and the filling comes by the sudden surging of the correct letter over the threshold, the very presence of the gap is evidence of the previous perception of its contents. The gap may be perceived without the ability to fill it, which differs from the former process only in that the letter has lapsed from memory permanently instead of temporarily. In these omissions the gap is almost always felt if present objectively. Under the conditions of experiment, subjective chronology, as determined by the order of the arrival of the stimuli in the brain, is the sole criterion of objective chronology.

Now if a gap indicated that a letter was late in arriving in the brain, clearly such a gap could be placed only as subjectively of later occurrence than objectively, which holds for only about half the cases, the remainder being divided between those rightly placed, and those in which the subjective omission precedes the objective position of the omitted letter. For omissions not recognized, rare in sensory, though relatively common in motor lapses, the peripheral conduction theory has no place whatever. However retarded the impulse or stimulus may be, once it is started in the periphery it must get there just the same.

Assimilation is an associo-suggestive process, and thus wholly central in character; other considerations render it preferable to discuss the dissimilation subsequently.

These considerations appear fatal to the peripheral conduction theory; they seem to establish that any explanation of the sensory lapses is to be sought centrally. However, in establishing that subjective and objective chronology are identical, there follows another vastly important point that takes at least two types of lapse altogether out of the domain of the purely sensory. Clearly, there can be no regressive processes in purely sensory lapses. In the visual experiments the writer employed simultaneous presentation, which, it is true, gives no absolutely definite chronology, but the unpublished research of Miss Kleinknecht, who upholds the peripheral conduction theory, gave similar results as regards metatheses, and both regressive assimilation and dissimilation occur in the auditory lapse, where the objective chronology is fixed. But clearly, a subject could not assimilate or dissimilate an earlier sound to a later one until he had perceived the later, nor could he in metathesis transpose two elements until he had perceived them

both. The process is therefore not sensory but mnemonic, and an explanation of all regressive characters in the sensory lapse must be sought along these lines.

The question now arises whether the remaining forms of lapses, the progressive assimilation and dissimilation, the omission and substitution, are to be regarded as primarily sensory or mnemonic. Such processes may of course always be wholly mnemonic, but in certain cases it is difficult to determine whether or not a sensory factor is present. When an omission is wrongly placed, as in Bwvcknz, bwvkn-x there is probably involved a form of metathesis analogous to Bawden's 'Transpositions' in the motor lapse, and as such, a mnemonic process. Omissions rightly placed it is unsafe to regard as lapses in the present sense of the term, but they are probably rather mnemonic than sensory, while omissions not recognized must always be of doubtful nature. The substitution is probably sensory and associo-suggestive in the auditory lapses, and mnemonic and associo-suggestive in the visual.

The experiments thus become from some points of view experiments in memory rather than in the linguistic lapse as such. The mnemonic metathesis yields certain interesting data regarding the nature of time-memory. The memory of the chronological order of events is much weaker than that of the events themselves. It is the logical connection between them that enables us to hold them in chronological order. When the logical connection is much weakened, as in the above experiments, the memory of the order of the stimuli breaks down, though that of the occurrence of them remains perfect.

From their unpronounceability the associative connection of the visual stimuli is much weaker than that of the auditory stimuli, hence the metathesis is as common with the former as all the other forms put together, while it is perhaps the least frequent of the auditory errors. The briefest period of inattention in reading is sufficient to effect one of these metatheses. The writer once received a letter apparently opening with the words, 'In the last conservation I had with you.' There had probably been complete perception of the word, but the merest instant of inattention to its content had caused two of its elements to change places. Conservation being itself a word, the pseudo-hallucination was puzzled over for at least three seconds. This particular lapse and its converse are frequent under various conditions. The tendency of witnesses to make in good faith the sequence of events more logical or more dramatic[1] instances again the strong consciousness of events coupled with the weak consciousness of their order. This is beyond all doubt the best explanation of mnemonic metathesis, whether linguistic or otherwise in character.

1 Marie Borst, 'La Fidélité du Témoignage,' Archives de Psychologie, 1903, pp. 234-314.

There is an extreme tendency of omissions to be wrongly placed, and naturally so, for obviously, when the event itself has lapsed, how much more must the time of its occurrence have lapsed? The instances of omissions not recognized are rare, as the series were of constant length, and may in some cases be due, not to independent effacement from memory, but to a dissimilatory process with adjacent similar letters.

The most difficult and uncertain problems in the field of sensory lapses are those of assimilation and dissimilation. With regard to the assimilation, it is indeed possible to ascribe it to the persistence in memory of a previously perceived stimulus, displacing a dimly perceived one, but this is rather describing the process. The regressive assimilation is in like manner only the backward operation of a later perceived stimulus upon an earlier dimly perceived one. And yet there are other conditions at work here, as may be seen from an examination of the accompanying tables of auditory lapses. The progressive assimilation tends rather to affect poorly heard sounds in assimilating them to good ones, as witness the large number of assimilations of P, H, W, V, L, and the relatively few progressive assimilations of F, þ, N, K, T. To some extent the sounds are assimilated to similars; indeed, the table might well pass for the record of consonantal errors on a single series. But the regressive table shows rather the inverse of this condition. F, þ, N, T, are here well represented; note especially the condition in the nasals, where the correlation is almost exactly inverse to that in the previous column. The behavior of the nasals may often be taken as an index of conditions elsewhere, as they occupy positions near the ends of the audibility curve, and are almost exclusively erroneously substituted for each other. What deep-seated conditions lead M to be progressively assimilated to n, and N to be regressively assimilated to m? As they are so obviously related, both progressive and regressive processes are probably mnemonic, and the answer to this question is quite essential to the understanding of the nature of the auditory assimilation. For the present it must be left unanswered.

QUALITATIVE TABLE OF AUDITORY LAPSES.

An Objective	Is progressively assimilated to	Is regressively assimilated to	Is progressively dissimilated to	Is regressively dissimilated to	Metathesis
P	3k,2b,f,t	f		3h,v	h
T	p	d,2þ		k	
K	3p,h	h			p
B	2d,w,v	2v,g	d,g	r,v	3g,r
D		g,ð	2r,h,ð	b	
G	4b,k,d,m	l	2b,r	r,ð	2b
F		s,h	þ	b,x,s,d	
þ		v	sh		
H	2f,v,r,b,z,k	2p,f	l	b,m	þ
W	4h,3b,2r,v	m	2b,l,v,h,m,r,ð	v,l	
V	m,w,g,ð	r,w,h,b	g	w	2b,ð
Ð	d,l	d	3r,3d,n	3l	t
L	3r,2w,p,t,b,d	2d,b,n,m,v	2d,2v,2r,n,b,h	n,h,d	
R	2v	2l,b	l,h,d,v	n,w,x,ð	ð
M	4n,l	n	5n	4n	4n
N	m	4m	m,g,r	3m,d	
A					e
E					a
I					6e,u
O					e
U					3o

Metathesis between sounds represented by capital and small letters, the capital being objectively preceding.

There exists more light upon the subject of the dissimilation, perhaps because its conditions are more subject to experimental control. The term must be employed for two processes ultimately probably identical, though differing in manifestation. One of the dissimilated elements is either lost, or another element is erroneously substituted for it. The former condition tends to obtain in the visual, the latter in the auditory lapse. While it is difficult to arrive at a satisfactory explanation of this fact, the ultimate cause is perhaps to be sought along the following lines. In reading the apperceptive process is more rapid than in hearing, the physiological limit being lower. As in the graphic metatheses so in the sensory lapses, the insertion of the second element, even though erroneous, is in the nature of a correction, a gap being felt which must be filled; but in the visual process this insertion does not occur because the process is so rapid that all is past before there is the slightest possibility of a reaction to this gap, even if its presence enters consciousness. In one case the gap is present, felt, and filled; in the other case it is not filled, and but vaguely, if at all, felt.

Another reason why the gap tends to go unperceived in the visual lapse is perhaps to be found in the lesser rhythm sensitivity of the visual process as compared with the auditory. Though the sound may not be apperceived, it is perceived as noise; it represents some linguistic sound, and that sound must be filled in to preserve the rhythm. This is perhaps also in line with the fact that auditory dissimilatory substitutions tend toward a closer approximation of chance distribution than is the case with the assimilations. The rhythm sense of the trisyllable was the only thing which placed them there at all. Thus also Ranschburg found that if five place figures were occasionally exposed together with the usual sixes, a gap caused by a visual dissimilation in the sixes was liable not to be perceived, the subject thinking merely that a five place figure had been exposed. The writer's experiments with letters were not so successful in this regard.

Ranschburg appears to have been led to the study of the visual dissimilation through his general mnemometric researches on the normal and the insane. He operated with zero and the nine digits, using one-third second exposure, all exposures, except as previously specified, consisting of six figures. His main results are as follows: The assimilations, substitutions and metatheses are noted, but are few in comparison with those errors seeming to be induced by the presence of a figure identical or similar to that erroneously perceived. Assimilation may be only to a figure similar to that of the assimilator, but is generally to identity with it. Ninety per cent. of the simple errors are confined to the fourth and fifth numbers, the fifth being the most frequent of erroneous perception. If there is close spatial contiguity,

assimilation may occur between totally dissimilar figures, and assimilation is very frequently associated with metathesis. If in the four right hand numbers, especially the third to fifth, there occur two similar or identical elements, the chances of error are increased over 700 per cent. with the identicals, and 300 per cent. with the similars. This is an increase much greater than that attained in the writer's experiments. The numerical high extreme of the error-distributions with the dissimilar stimuli coincides approximately with the low extreme of the distribution of errors with identicals; the errors with similars fall between them. The numerical ratio of the three kinds of errors is as 59:24:8. His general conclusion, which may be cited as the dissimilatory principle, is as follows: 'Die Aufmerksamkeit vermag innerhalb einer bestimmten minimalen Zeitdauer durch heterogene Reize erzeugte Empfindungen (resp. Vorstellungen) in grösserer Anzahl als durch homogene Reize verursachte in ihrem Blickpunkt zu fassen.'

With these results the writer's experiments are in qualitative agreement. Indeed, it may be said that save for the observations on the omission they contain no results not to be found in greater detail in the earlier research. There seems to be some justification, however, for disagreement on certain grounds of interpretation. Here Ranschburg confines himself to the dissimilation, not discussing the causation of the other types. The distinction between progressive and regressive appears unfortunately disregarded.

The question of whether the dissimilation is to be regarded as a process of coalescence (Verschmelzung), or as one of interference (Hemmung), is decided in favor of the latter. The point giving the *coup de grace* to the coalescence theory seems very well taken. "Es wäre schwer verständlich," he writes, "wieso dasjenige, was physiologisch einmal verschmolzen ist, psychisch wieder trennbar ist. Die Erscheinung der Unsicherheit der Auffassung, sowie besonders des successiven verspäteten Auftretens der fehlenden Empfindung, die selbst bei den richtig angegebenen homogenen Reihen fast constant war, die Verdrängung einer verhanden, aber unklaren Empfindung durch eine illusionäre, und die hernach dennoch auftretende, manchmal richtig erkannte, manchmal als Illusion beurteilte richtige Empfindung, sind nur aus dem retardenten Einfluss einer Hemmung, nicht aus der Verschmelzung zweier physiologischer Erregungen verständlich."

While the fact that features of similarity not recognized by the naive subject can be shown to enter into the dissimilation argues strongly for its grounding on a physiological basis, yet the employment of the word 'retardenten' seems to indicate a desire to put the matter on a peripheral basis, against which view probably sufficient argu-

ments have elsewhere been cited. The process must have a physiological basis, but it must also be central, and involving centers lower than the apperceptive ones. It seems to the writer that the process is better to be described as one of 'Verdrängung,' a term elsewhere employed in this connection also by Ranschburg. As it appears that only one of a certain type of movements may be made during a single focus of consciousness, so only one of a certain class of sensations may be perceived during a single focus of consciousness, and when a second similar sensation attempts its way into the perceptive centers, it is met with the announcement 'Besetzt!' The subject is thus temporarily 'sound-blind' or 'letter-blind' to that second stimulus. If the memory of the sensation of this stimulus persists until the focus of consciousness on the first stimulus is past, then it may appear in consciousness; if it has persisted well, it will appear correctly; if badly, something only more or less similar in outline will be substituted; if not at all, it will not appear, or the substitution will be governed by pure chance.

As has been indicated, it is very evident that it is always the first sensation which is perceived, and the second similar or identical sensation which is temporarily kept *ante portas*. But this could apparently produce only progressive dissimilation, while, as has been observed, the regressive process has quite as good a justification of its existence. But a regressive dissimilation, occurring with objectively successive stimuli, cannot be explained otherwise than by some central bouleversement of the actual chronological order. The whole problem of the regressive dissimilation and the entire regressive process thus becomes a most perplexing one. The assimilation is known to be very frequently associated with metathesis, and with the dissimilation this may possibly be more frequent even up to 50 per cent. of the cases. Then, again, it may not. And there is one important fact that militates against the hypothesis that the regressive is the progressive plus metathesis. As the previous table shows, all assimilations tend to occur when a generally well-heard sound is followed by a badly heard one, the well-heard one progressively assimilating the bad one, and regressively, *vice versa*. In the dissimilations there is tendency for the progressive variety to occur between two badly heard sounds, and the regressives rather between well-heard sounds. There appears a tendency to metathesis, about 2:1, when a badly heard sound is followed by a relatively good one. The conditions favorable to assimilation are therefore unfavorable to metathesis. The product of the progressive dissimilation is also unfavorable to metathesis. These facts militate against the involvement of the metathesis in the regressive process, but it can hardly be effected in any other manner.

In the experience of the writer, there has been noted, non-experimentally, a peculiar dissimilatory tendency under normal reading con-

ditions. The dissimilation appears to be invariably regressive, and always characterized by the complete loss of the dissimilated letter. In the instances quoted below, the illusion persisted in memory sometimes for years. It was only by the merest accident that the proper spelling of *Helmholtz* was discovered, and only by etymologizing that the errors *encylikal* and *encylical* were corrected. The two instances of the assimilation are also regressive, and visual.

DISSIMILATIONS.

podromic	dimissory	encylical	encylikal	Hemholtz
bailisk	incapatiate	imperturable	Zweikausflexion	Rebuhn
pedrix	expolatory			

ASSIMILATIONS.

Phasiphae fêtre champêtre

METATHESES.

			ST	V S
soltafara	Ysdragill	peredast	Utsane	Conservation

Metatheses observed in the speech of children learning to read (of constant recurrence):

Hutsase Misaka aosis

The last-cited instance of the dissimilations is somewhat complex. The word itself is *exploratory*; the first r being lost, the memory image gave exploatory, which was at once metathesised into the more 'meaningful' complex expolatory. The context did not correct the error, which had reference only to this particular 'exploratory,' and it was not discovered until some months subsequently.

Certain lapses in the tables of both Meringer and Mayer, and Bawden, indicate the existence of a motor dissimilation. They are not wholly satisfactory instances, many being open to another interpretation. And it must be remembered that phonetic lapses of this sort are subject to the recorder's auditory lapse, not taken into account. Thus one of these lapses quoted by Meringer and Mayer was heard by only one of two hearers present. On the other hand, a distinct subjective inability to enunciate the second n is recorded by the author of *tende. tendenziös* (MM). An explanation may be sought in a lapse of the motor imagery of the word (the *Stilles Versprechen* of Meringer and Mayer), which reproduces itself in the movement. The writer is compelled to regard the historical dissimilations as of doubtful character, except perhaps in the instance of Grassman's Law, where, in spite of the universality of its operation, the irregularity in the position of the lost aspiration argues rather for a voluntary and motor character.

XV.—The Evidences of Aphasia. Conclusion.

A few words may be said regarding the analogies possible between the phenomena of the lapse and those of aphasia. It does not seem, on the surface, that any great similarity exists between the two. If we examine the four, or at most five, types into which the motor lapse may be classified, we shall find little that is closely paralleled in the phenomena of aphasia. Aphasia knows little of such processes as dissimilation and metathesis, and nothing of assimilation in its usual form in the lapse. This includes all the phenomena of the lapse which are of necessity other than physiological in causation. The omission has probably always a physiological basis, and constant substitutions must be conceived of in the same way, but constant substitution is not found in the lapse. It is precisely this class of matter, omissions and substitutions, that constitute practically the entire body of aphasic phenomena. Here then, if anywhere, are to be sought analogies between the phenomena of aphasia and the lapse; and, as was the case with the latter, the essential question is the smallest collocation of linguistic sensation or movement analyzed out by the processes of aphasia.

The lapse occasionally involves whole words; aphasia almost always does so, but it is not this limit that concerns us here, but the limit of what portion of a word, if any, may be involved. It has been shown that among the phenomena of the lapse there is practically no empirically analyzable linguistic element not subject to the processes of the lapse. To what extent may this be said of the processes of aphasia?

If the elements of a compound not analyzed by any psychological process of which we are cognizant are shown to be analyzed by the objective record given in their motor expression, these elements must be analyzed out by the consciousness of the lower centers, which hypothesis it is best to disregard, or through some purely physiological individuality in the structure of the nervous system. It may be considered well established that the formation of spoken language involves the activity of a higher and lower enunciatory center, the higher, psychomotor, or propositionizing center, and the lower, or enunciatory center proper. In affections of the first center there is difficulty in associating the idea with its word, but the phonology as such is not impaired; in affections of the second, linguistic imagery is perfect, but the phonology is affected. Empirically, it is of course impossible to analyze out what is psychomotor and what is enunciatory in grave lesions where both centers are involved, but it is frequently that one center is affected alone. The entire enunciatory center may be so completely involved as to destroy all power of articulation, though the associative processes are unimpaired, but it may again be only partially

affected, giving rise to an articulation usually marked by extreme thickness of utterance (dysarthria[1]); or the affection may be only local in character.

The effect of a very localized lesion would, if there were no functional localization within the area, be the same as that of a less severe generalized lesion, *i.e.*, only a lower degree of dysarthria; if, on the contrary, there be localization within the speech area, the loss of certain members of the phonology would be affected by such a lesion, provided their centers lay in the affected area. Individual sounds of language are lost, independently of other sounds; so much is absolutely certain. Now, if the loss of individual sounds is not due to an affection of the individual centers but to one of the entire motor tract, clearly those individual sounds should stand in a certain historical relation to one another; they should form, embryologically or phylogenetically, a group apart from those which remain, just as concrete and abstract substantives form two such groups; the former being lost much more readily than the latter. If there is no cerebral individuality for the individual sounds of language, those sounds should, according to the genetic principle, be the earliest lost which are least firmly grounded in the individual consciousness. What the exact criterion of this grounding might be, it is better not to determine in advance, but rather to examine the data with a view to arriving at such groups empirically. On the other hand, if there were physiological individuality for the individual members of a phonology, the loss of certain of its members would be subject to no such grouping, but would merely indicate that the localizations of these sounds stood in such anatomical relation to one another that they were likely to be involved together in any mechanical disorganization of their particular locality. If the enunciatory center functions as a whole, the losses must follow some application of the genetic principle; the absence of this condition argues against its functioning as a whole.

The material that bears on this question is very scanty and also very uncertain, being in no case with which the writer is familiar gathered by an observer of special linguistic training. Many of the most vital questions that suggest themselves in every case must therefore remain unanswered. But such material as that cited by Wernicke, Kussmaul, Elder, Bastian and Onuf is not inaccessible, and is hardly necessary to summarize at this point. There is not evident in any case, motor or sensory, a grouping according to any traceable application of the genetic principle; indeed a more hopeless phonological confusion than that represented in the retentions and losses of Elder's Case XIII. could scarcely be constructed. Still, it must be remem-

1 The writer employs throughout the terminology of Elder.

bered that the phylogeny of phonetics is inestablishable, and the ontogeny very ill established; so that there can hardly be all the desirable certainty on this point. From the biological standpoint, it is probable that the ontogenetic relations only are significant, so that further light on this subject may be hoped for. In the present state of our knowledge, however, such facts as these are hardly explicable otherwise than by a physiological affection of central areas concerned in the production and coordination of definite linguistic movements.

No one feels more keenly than the writer the unsettled state of almost every phase of the problem with which it has been attempted to grapple, and in many cases all that may be hoped to have been accomplished is a clearer statement, perhaps, of difficulties remaining to be explained. It is not desirable at present to set up in terms of neurones an anatomical scheme of the finer linguistic analyses; hypothetical histology has done more harm than good to most psychological theories that have concerned themselves with it. But leaving the anatomical question aside, every fact bearing upon this point under the writer's observation is more convincing than the last of the impregnability of the position taken by Hermann Paul, on theoretical grounds, more than twenty years ago: 'Das Bewegungsgefühl bildet sich nicht für jedes einzelne Wort besonders, sondern überall, wo in der Rede die gleichen Elemente wiederkehren, wird ihre Erzeugung auch durch das gleiche Bewegungsgefühl geregelt.'

Summary.

Errors made in the perception of linguistic sounds are made in the place rather than in the method of articulation. Within this general principle, the principles governing the perception of foreign sounds are of an entirely different character from those governing the perception of familiar sounds. Errors in perception are much more frequently the cause of sporadic than of regular historical change. The correlation between the number of misperceptions and erroneous substitutions of a linguistic sound is likely to be strongly positive or strongly negative; where the latter a habit of sensation is indicated. If every constituent of linguistic sensation or movement analyzed out by the processes of the lapse has an individuality in the nervous mechanism, then this individuality extends to the limits of empirical linguistic analysis. Pathological evidence corroborates this last datum so far as the individual alphabetic sounds.