

THE PSYCHOLOGICAL REVIEW.

STUDIES ON THE TELEGRAPHIC LANGUAGE. THE ACQUISITION OF A HIERARCHY OF HABITS.

BY PROFESSOR WILLIAM LOWE BRYAN,
University of Indiana ;
AND SUPERINTENDENT NOBLE HARTER,
Warsaw, Indiana.

I.

THE PSYCHOLOGY OF AN OCCUPATION.

A field for research is offered in the psychology of occupations. The chief engagement of every one is the acquisition or exercise of one or another association of habits, such as constitutes skill in a game, trade, profession, language, science or the like. With a little license one may call all of these occupations. In mastering an occupation, doubtless the whole man is involved, body and mind, sensation and movement, thought, interest, imagination, will,—innumerable known and unknown aspects of our psycho-physical life.

It might be argued that such an affair is too complex for scientific treatment until we have done with more elementary things, the fusion of ideas, the psycho-physic law, the chemistry of the cell, or whatever may be still more elementary. In reply, it may be said that the history of science justifies the study of concrete facts, however simple or complex, whether or not the results can at once be correlated with other facts and theories. One studies microscopically, another macroscopically. One studies the chemistry of the cell, another tone sensations,

another comparative religion. A fact fixed at any point stands in its own right, throws light at once upon the less and upon the more complicated aspects of reality, and so does its share toward a future correlation of the sciences into science. The fashion of a time may run now to narrower, now to broader studies; but time justifies all work which meets its test, verifiability *ad libitum*.

Most psychological studies, doubtless with good reason, have dealt with abstractions. This is obviously true of the studies, earlier and later, on will, association, attention, etc.; for these 'faculties' are plainly not concrete phenomena of conscious life, but artificially isolated aspects of conscious life. It is no less true that in the later laboratory studies on the fatigue of a muscle, the reaction time in a silence cabinet, or the like, we are dealing with abstractions. The reacting man, muscle, or ganglion is, indeed, concrete; but when a given process in one of these is studied experimentally, the first and hardest task is just the isolation of that process from 'disturbing conditions'—that is, from the complex stream of life in which alone it normally occurs.

The best of these analytic studies, earlier and later, are invaluable to science and, in due course, to the conduct of affairs. Invaluable, but still far from sufficient, by themselves, either for science or for practical guidance. The scholar singles out of the complex processes before him, some general aspect (law) or some group of facts. He exploits one or the other precisely and systematically. Excellent! But too often the price of this precision and system is an absorption which makes him blinder than his neighbors to facts or laws that are in the processes concerned, but outside the range of his methods, and to the actual course of events in which all the facts and laws known and unknown are interfused.

This blindness to things before his nose, but out of the focus of his attention, is the disease-of-the-scholar. He assumes that the particular principle or fact which he has defined substantially determines the whole stream of life in which it belongs. He writes an essay on will, or studies the latent period of an excised muscle, and thereupon issues commands to the

public schools. Science is his debtor if he has developed any truth. Science has time to wait for the rest. But if he tries to put his learning to work, the realities which he has ignored will have their revenge.

However, it is easier to see the need of trustworthy concrete psychology than to supply the need. The actual concrete processes of life are, indeed, all about and within us, but in a bewildering tangle. Out of this tangle we are all forced to get some 'knowledge of human nature' so that we may live together. To our own insights in this direction we may add those of others, those of artists and other sagacious men, those sanctioned by the folk. In this way we build up a concrete psychology, each for himself, and by this we guide ourselves in dealing with one another. It is the dream of the scholar to supplant this lore of the folk by an array of knowledge equally concrete and practical, but immeasurably wider, more accurate, more systematic, and freer from personal bias. The dream is long in fulfilling. There are quick ways, but they lead to pseudo-science. Witness phrenology, physiognomy, graphology and the more precocious chapters in criminology. Such outcomes warn us that there is no profit in fleeing from studies which pay for their precision by being abstract, to studies which pay for their concreteness by being untrustworthy. Better any fragment of cerebral physiology which is true, though by itself unable to tell any one what to do, than a Science of Human Character which tells every one what to do, but is not true. It must be recognized that macroscopic studies are subject to the same tests as the microscopic. The essential test in both cases is verifiability *ad libitum*.

The best examples of psychological studies at once concrete and reliable are to be found in the literatures of comparative psychology, psychiatry, criminal and individual psychology. Here in the best cases we have pictures of the typical conduct of animals, children, melancholiacs, paranoiacs et cetera, which instruct us better than unscientific popular psychology can, what to expect and what to do in dealing with individuals of these sorts. To this group of studies the psychology of an occupation would belong.

It would be well worth while if we could discern in any one man the chief subjective effects of mastering an occupation. Learning the business has been his chief concern, his most thoroughly evolutionizing experience. It has been an affair not of weeks or months of forced laboratory practice, but of years, wherein the natural interests of life have constantly driven him toward levels of skill only to be reached under such stimulation. In the measure that he has mastered the occupation, it has mastered him. Body and soul, from head to foot, he has—or one may say he *is*—the array of habits which constitutes proficiency in that sort.

Can such a case be studied with profit to science? The probability that it can be is increased by the fact that an occupation leads many men toward the acquisition of the same set of habits. These men are scattered all along the way from apprenticeship to mastery. Many of them begin and quit after touching lightly and being lightly touched by the business. These dabblers and failures are highly instructive objects of study. Many others press on into some usable degree of proficiency. These men are colleagues not in name only, but psychologically and physiologically. They have similar knacks, or similar traditions of the trade, or similar habitudes of some kind necessary in their business. They know, as well as they know anything about themselves, what the main habitudes developed by their occupation are; and if the psychologist can find his way to the right questions, they can give a valuable introspective account of those habitudes. It may be possible in the case of some occupations to supplement such testimony by objective experimental tests. A few in each occupation become experts, and of these an occasional one becomes able to do easily and quickly what his lesser colleagues can scarcely believe possible. Such cases are, of course, hardest to understand, and may escape all definition. But it would surely be worth while to begin the study of the genius by following him along that part of his path which he shared with many others. We might in this way, at least, find the point where he disappeared. That would be something.

In a word, society has already made for us in each occupa-

tion a vast experiment in the development of habits. If we can make use of some of these ready-made experiments, if we can delineate the path or paths by which one travels toward mastery of an occupation, if we can discover and describe the characteristic stages of the progress, if we can do these things so that every detail of our work can be objectively verified by any competent scientist, and so that the outcome will be accepted as true by those who have mastered the occupation, this should prove not unprofitable work. It should supplement what analytic psychology can do for pedagogy and psychiatry; for it would portray the actual typical procedures of men in learning or in failing to learn. And it should supplement what analytic psychology can do toward developing the science of mind; for it would exhibit not theoretical syntheses of alleged psychic elements, but the actual syntheses which the science of mind must accept and explain.

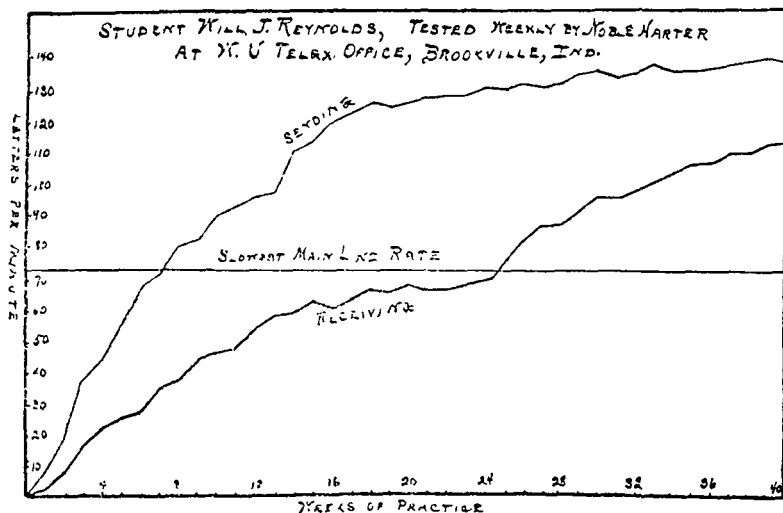
During the past five years the authors have made studies in the psychology of one occupation—telegraphy, utilizing throughout the work the experience of telegraphers as well as the methods of psychological research. The foregoing pages are not intended to overemphasize the importance of the results obtained, but to express a conviction which the study has developed, that in this direction lies a programme worthy the labor of many good men.

II.

DATA OLD AND NEW.

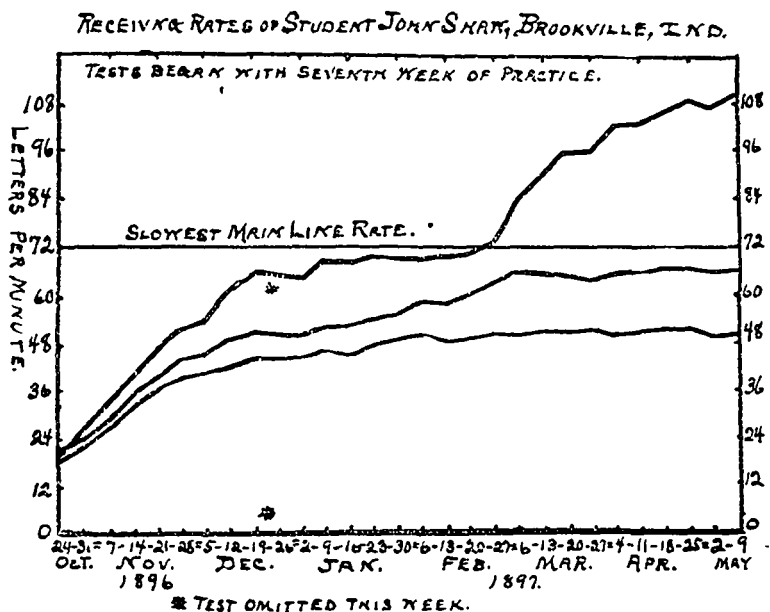
In a former series of studies on the physiology and psychology of the telegraphic language [PSYCH. REV., IV., p. 27] the authors gave the curves of improvement in sending and receiving. These curves were determined by the records of individuals tested each week, from the beginning of practice until fair proficiency was reached, and were confirmed by a consensus of opinion from about two hundred operators. As the conclusions of this paper are based in part upon those curves, one of the figures (X.) from the former paper is reproduced for convenience of reference.

Fig. X.



Reproduced from PSYCH. REV., IV., 44.

Fig. XI.



Connected discourse curve at the top; word curve in the middle; letter curve at the bottom.

The salient feature of the pictures shown in Figures II. to X., is the difference between the two curves. The sending curve has a form made familiar by many published practice curves. The receiving curve has for several months a similar form, but suddenly rises into what looks like a second practice curve. Moreover the history of expert telegraphers shows that after some years the receiving curve may ascend rapidly a third time.

Interest in the novel form of this curve deepens as evidence appears to show that it represents, in general, the course of improvement in various other acquisitions, *e. g.*, the learning of a foreign language, of chemistry, of English composition, etc. Interest is further challenged by the difficulty of explaining the form of the curve. In the former paper the authors proposed no explanation. None of our reviewers, nor of the psychologists with whom we have conversed, has given us a hint as to its meaning.

To investigate the problem further the following experiment was devised. A student should be tested each week on

- (a) rate of receiving letters not making words,
- (b) rate of receiving letters making words, the words not making sentences,
- (c) rate of receiving letters making words, the words making sentences.

These tests were made in the winter of 1896-1897. The subject was John Shaw, of Brookville, Indiana, who had begun the study of telegraphy about six weeks before the making of first test, Oct. 24, 1896. The method of making the test is described in *PSYCHOLOGICAL REVIEW*, IV., p. 48. The test was made each week until May 9. One test day, Dec. 26, was missed. The results are given in Figure XI.

Before discussing these results we subjoin evidence relating thereto derived from the introspections and observations of telegraphers. As hitherto noted (*loc. cit.*, p. 27), one of the authors (H.) was for years a telegrapher. To supplement his experience we have held long and satisfactory conversations with operators¹ of every grade up to the most expert men in the

¹ We cannot express too warmly our thanks to the members of the telegraphic profession for their cordial assistance without which the present study

country. We have asked telegraphers three principal questions :

A. To what is attention mainly directed at different stages of progress?

The answers agreed entirely, and were as follows: (*a*) At the outset one ‘hustles for the letters.’ (*b*) Later one is ‘after words.’ (*c*) The fair operator is not held so closely to words. He can take in several words at a mouthful, a phrase or even a short sentence. (*d*) The real expert has all the details of the language with such automatic perfection that he gives them practically no attention at all. He can give his attention freely to the sense of the message, or, if the message is sent accurately and distinctly, he can transcribe it upon the typewriter while his mind is running upon things wholly apart.

The feat of the expert receiver—for example of the receiver of press despatches—is more remarkable than is generally supposed. The receiver has two advantages over the sender. He can receive mentally far faster than any one can send; and with the typewriter he can transcribe much faster than any one can send. To bring the sender’s rate up to that of the receiver abbreviated codes have been prepared. The receiver must translate the code into English words, and transcribe these correctly capitalized and punctuated, upon the typewriter. He takes, in this way, eighty or eighty-five words a minute. If mistakes are made by the sender, the receiver is expected to correct them as they come, and send a clean copy to press. The work continues for hours without leisure for re-reading, the pages being taken away to press as fast as they are finished. Yet, even during the performance of this astonishing feat, the operator is able at will to think about the significance of the despatches or to think of anything else he chooses. An Associated Press man, who has worked for years in one of our large cities, said to us: “I am in danger of allowing errors

could not have been successfully carried on. Especial thanks are due to Messrs. H. E. Jones, Assoc. Press, Cincinnati; Lot Lee, Assoc. Press, Indianapolis; Supt. Miller, Western Union, Cincinnati; E. B. Cassel, Chief Despatcher, Monon R. R., Bloomington, Indiana; and J. E. Sullivan, Chief Despatcher, Wabash Railroad, Peru, Indiana.

made by the sender to get into my copy, if I let my mind wander; but the truth is that in the last weeks, while taking press, my mind has been most of the time at home with a sick child."

B. How far can one 'copy behind' in different stages of his progress?

It should be explained that receiving is practically always 'copying behind.' That is, one does not, or should not, anticipate from part of a group of clicks what the rest will be; for if one guesses wrong, confusion of mind and error are likely to follow. Beginners are prone to guess ahead, and must acquire the habit of not doing so. Experts learn to wait. One expert said, "It is more natural to read back." He was asked if 'reading back' was like counting the strokes of a clock just after it is done striking. He replied, 'precisely.'¹

The answers to the second question were also concurrent. (*a*) The beginner must take each letter as it comes, *i. e.*, he can copy behind one letter. (*b*) Later he can wait for words. (*c*) A fair operator can copy behind several words in connected discourse. (*d*) The expert prefers to keep six to ten or twelve words behind the instrument.

A count of the number of clicks (dots and dashes) in ten groups of ten words each, taken from a press despatch, gave the following result: 220, 275, 172, 214, 189, 267, 303, 260, 196, 281; average, 237.7. The achievement of the telegrapher in keeping correct hold of so long a series of sounds, and in doing this with a constantly changing series is, without doubt, one of the most remarkable feats of its kind. This is an example of a skill not to be reached by forced laboratory practice, but only by years of intense work.

C. What happens when you have to receive the disconnected words of a strange code or list of figures, such as bank clearings or the like?

The universal experience of operators upon this point was expressed by one expert thus: "When I get a word indicating

¹ If, however, the first words of a very familiar phrase occur, they may betray even the expert into anticipating the rest of the phrase. This fact is a significant illustration of the subjective solidarity of phrases. See below, p. 364.

that a list of figures is to follow, I sweat blood until I can catch up." He said he could wait for six figures if they were in groups of three separated by a comma, but if the figures were isolated, he would want to be not more than three or four behind. In a word, he could hold in mind forty to sixty or more of the elementary groups of the Morse code, if these 'made sense,' but only three or four, if wholly disconnected.

Note on the Reading of the Blind. To get cross light upon some of the foregoing points, information was sought concerning the reading of the blind, from Miss Nellie Love, an expert teacher in the Indiana Institute for the Blind at Indianapolis. She reports as follows:

"(1) Upon what is the attention of the pupil fixed as he reads?

Upon first reading a new selection:

(a) In a First Reader class of twelve every one kept his finger on the letters, spelling each word either out loud or to himself.

(b) In a Second Reader class of eighteen the attention of all but three was upon the words. These three read to see what the story was about.

(c) In the Fourth Reader class of seventeen the larger number gave attention to the words; the others to the thought.

(d) In the next grade, a class of about the same size, more regarded the thought, only three or four the words.

(e) In the highest grades the attention was upon the thought, except when the words were unfamiliar.

"(2) How far does the pupil read with his finger ahead of his voice?

(a) In First and Second Reader classes, not at all.

(b) In Third and Fourth Reader classes, most pupils keep finger and voice together. Two report the fingers one word ahead.

(c) In the highest reading classes the majority keep finger and voice together. Several read three or four words ahead. One pupil, a very bright boy, keeps a line ahead, eight or ten words. He reads the end of one line with the finger of his right hand and at the same time reads the beginning of the next line with his left hand.

(d) In the advanced classes, where reading is not a special subject, the best pupils keep finger and voice together. In each class that studies reading as one subject, pupils who study each day, read and study the lesson, and then are able to read smoothly, rapidly, and several words ahead of the voice."

In all grades, sentences are read faster than disconnected words, and disconnected words faster than disconnected letters. The rates are not reported. All these results are closely analogous to those found among the telegraphers. Of course there are no blind children who have attained a proficiency corresponding to that of the expert telegrapher.

III.

CONCLUSIONS.

The immediate conclusions from the foregoing data will be given first; later (under IV.), an interpretation and discussion of these conclusions in connection with related literature.

1. *A Hierarchy of Habits.*

One might perhaps suppose that receiving telegraphic messages is simply transliteration or, at most, transverbalization from the code into the mother tongue. The operators reject this view. The evidence before us proves that they are right in doing so. Neither the letter curve nor the word curve nor both together, account for the receiving curve¹ except for a short period (see Figure XI.). Most plainly, the letter and word curves fail to account for the receiving curve where it rises rapidly from the plateau, while they continue their slight ascent. From an early stage some curve or curves associated with the combination of words in connected discourse must coalesce with the letter and word curves to give as a resultant the receiving curve. At the period when the resultant curve is rising rapidly, while the letter and word curves are rising slowly, the higher constituent curve (or curves) must be rising rapidly.

What does this higher constituent curve represent in the

¹ The connected discourse curve in Figure XI. will be spoken of as the receiving curve; its constituent curves, as letter and word curves respectively.

learner? Certainly not merely nor mainly increased familiarity with the meaning, structure or logical connection of sentences in the mother tongue. When, for example, the learner has rapidly shot up from a rate of eighteen to a rate of twenty-five words per minute, no one can believe that he has made this gain because of a sudden and enormous gain in knowledge of the language he has used all his life. All the facts point to the conclusion that the telegrapher must acquire, besides letter, syllable, and word habits, an array of higher language habits, associated with the combination of words in connected discourse. Mastery of the telegraphic language involves mastery of the habits of all orders. In a word, *learning to receive the telegraphic language consists in acquiring a hierarchy of psycho-physical habits*. For a discussion of this conclusion in connection with related literature see below, under IV., p. 360.

2. *The Order of Learning the Habits of the Telegraphic Language.*

The synchronous curves of Table XI. and the experience of operators agree in showing that from an early period letter, word and higher habits make gains (a) *simultaneously*, but (b) *not equally*.

(a) The simultaneity in these gains is shown in Fig. XI. by the fact that from the point where the curves diverge, each continues to rise. This is perhaps to be explained by the fact that from an early stage the learner practises with sentences, taking them as slowly as necessary. In this way there is incidental practice of every language unit and of every language unit in its proper setting.

(b) The curves of Figure XI. show also, however, that for many months the chief gain is in the letter and word habits, that the rate of receiving sentences is, in this period, mainly determined by the rate of receiving letters and words, and that rapid gain in the higher language habits does not begin until letter and word habits are well fixed. This objective result is supported by the introspective evidence of operators. In the first days one is forced to attend to letters. In the first months one is forced to attend to words. If the learner es-

says a freedom for which he is unfit, suddenly a letter or word which is unfamiliar explodes in his ears and leaves him wrecked. He has no useful freedom for higher language units which he has not earned by making the lower ones automatic. The rank and file of operators are slaves to the machinery of the telegraphic language. They must copy close. They cannot attend much to the sense of the message as it comes, but must get its form, and re-read for the sense. Only when all the necessary habits, high and low, have become automatic, does one rise into the freedom and speed of the expert.

3. *The Plateaus.*

We are now prepared to offer an explanation for the salient peculiarity of the receiving curve,—its plateaus.

A plateau in the curve means that the lower-order habits are approaching their maximum development, but are not yet sufficiently automatic to leave the attention free to attack the higher-order habits. The length of the plateau is a measure of the difficulty of making the lower-order habits sufficiently automatic.

(a) *The first ascent.* No plateau appears between the learning of letters and of words, because very soon these are learned simultaneously. However, as the letters are few, one is each week able to give more complete attention to the mastery of syllables and words as wholes. This perhaps accounts, in part, for the rapid progress of the first weeks.

(b) *The first plateau.* For several months the learner is compelled to attend almost exclusively to words. The number of words which he has to learn in order to receive whatever messages come, is great. The average amount of practice which each word receives is therefore small, and the increase in the average rate of receiving correspondingly slow. This very slow increase of rate we have called a plateau. It continues until the learner has the necessary vocabulary so well learned that he can have his attention free for something else.

Another retarding influence during this period is doubtless the learner's slight hold upon the higher language habits. The importance of this retarding influence in comparison with that

of an imperfect vocabulary, can not be determined without additional investigation.

(c) *The second ascent* represents the acquisition of a new set of language habits. This is *a priori* probable from the consideration that in practice curves generally rapid progress appears when the developing function is in an early stage. We are not, however, left with a probability. While the receiving curve is rising rapidly the synchronous word and letter curves are continuing their ascent slowly. We, therefore, *know* that the learner is gaining speed by taking in some way increasing advantage of word combinations. Part of the reason why he improves so fast is, doubtless, that he has already been unconsciously habituated for certain phrases and forms of word combination in the period when he was attending mainly to words. *It may be that the rapid ascent of any practice curve represents mainly a quick realization of powers potentially present by reason of preceding gradual and unconscious habituation.* With the increased ability in taking sentences there comes, without doubt, increased ability to take isolated words and letters; *but, as one improves, the three curves diverge more and more. This means that skill depends more and more upon the acquisition of higher language habits.*

(d) Only the first few months of the period during which one is a practical operator, but not an expert, have been investigated experimentally. Our knowledge of this period rests mainly upon the testimony of operators. Men of this rank, of course, vary widely in skill and in rate of improvement. There is, however, one essential point in which operators who are not experts are more or less alike. They are all, in some degree, tied to the mechanism of the language. They cannot copy far behind. The mind must not wander far from the incoming stream of words, even to dwell upon the sense of the words. Few operators ever obtain complete freedom in the telegraphic language. These few must earn their freedom by many years of hard apprenticeship. Our evidence is that it requires ten years to make a thoroughly seasoned press despatcher.¹

¹ We have shown above that receiving is not translating either letter by letter or word by word into the mother tongue, but involves the use of a great

(c) *The final ascent.* The testimony of experts is that the ascent from drudgery into freedom is as sudden as was the ascent from the first plateau.

Note on the Sending Curve.

Why does the sending curve have no such succession of plateau and ascent as appears in the receiving curve?

There is no plateau in the sending curve in the earlier part of its course, because, as in the early part of the receiving curve, the various habits involved are acquired simultaneously (compare page 357), and there is no sharp ascent later, even when one becomes an expert, because such an ascent is mechanically impossible. At all stages one has in mind plenty of words ready to be sent as fast as the motor habits will permit. At first one is learning motor letter habits. Soon, however, also motor word habits. The sending curve rises accordingly in a fashion analogous to that of the receiving curve in its early stage. By and by, however, a mechanical limit is reached. Sending is, at the best, a slow business. A letter or digit requires from one to six strokes. Spaces of various length must be allowed for. One cannot utilize both hands and several fingers, as with a typewriter. So, at less than fifty words a minute, a maximum has been reached that cannot be surpassed.

4. *Effective Speed and Accuracy.*

(a) *Effective Speed.*

It has long been known that connected words can be read faster than disconnected, and letters combined in words faster than disconnected letters.¹ The facts upon this point, old and new, justify, we believe, the following conclusion: *Effective* array of higher language habits—that telegraphy is psychologically a distinct language, almost or quite as elaborate as the mother tongue. This view is supported by the fact that so long a time and such intense labor are required for the mastery of telegraphy—an amount of time and labor which would, without doubt, make the same men equally expert in any foreign language.

¹ We dissent, however, from the view that it is only or mainly the logical connection in sentences which accounts for the rapid rate in reading them. We believe (p. 366) that there are mechanical habits corresponding to often recurring peculiarities of sentences. This is shown by the fact that a series of words making no sense, if skillfully arranged in familiar sentence forms, can be read far faster than a series of words taken at random, and almost as fast as words making sense. Almost, but not quite. A consciousness of the sense appears to be still one factor in the affair.

speed depends, in a relatively small degree, upon the rate at which the processes dominant in consciousness occur; in a relatively great degree, upon how much is included in each of those processes. For further discussion see below, under IV., 4. p. 374.

(b) *Effective Speed and Accuracy.*

The gain in speed made possible by adding mastery of the higher language habits to mastery of the lower, does not lead to less, but to greater accuracy in detail. We have found invariably that many more mistakes are made in receiving disconnected letters than in receiving, at a much more rapid rate, letters that form words; and that, in turn, many more mistakes are made in receiving disconnected words than in receiving, at a still rapider rate, connected discourse. The practical experience of the telegraph companies proves the same. Although mastery of the higher order habits thus helps the receiver to accuracy in details, it cannot supply his ignorance of details. If a word not in his vocabulary comes as part of a dispatch, he is very likely to get it wrong. If he is often found making errors of this sort, it is proof that he needs a more extensive and accurate telegraphic vocabulary. Such a man is trying to receive faster than he can. He is trying to gain speed at the expense of accuracy. This is not *effective* speed, as his superiors will quickly let him discover. For further discussion see below, IV., 4. p. 374.

IV.

DISCUSSION.

In the foregoing, we have given little more than a bare statement of results. In the discussion of these results, we desire, first of all, to give the plain meaning of the facts known to us. We shall, however, use entire freedom in suggesting a wider circle of interpretations for which the evidence is not made out. We have, however, no interest in any theory suggested, except to see it tried by facts and assigned its proper measure of probability.

1. *A Hierarchy of Habits.*

A man is organized in spots—or rather in some spots far more than in others. This is true structurally and functionally.

It is strikingly true of the various sense organs and their functions. No less of the various parts of the central nervous system and their functions. A man has some habits which are sporadic and isolated, some which are bunched together in loose groups (such as the outlay of skills which make one a carpenter), and then, some habits which are knit together into a hierarchy.

A hierarchy of habits may be described in this way: (1) There are a certain number of habits which are elementary constituents of all the other habits within the hierarchy. (2) There are habits of a higher order which, embracing the lower as elements, are themselves in turn elements of higher habits, and so on. (3) A habit of any order, when thoroughly acquired, has physiological and, if conscious, psychological unity. The habits of lower order which are its elements tend to lose themselves in it, and it tends to lose itself in habits of higher order when it appears as an element therein.

There is reason to believe that proficiency in chess, geometry, chemistry and the like, involves in each case the mastery of habits which are associated in some such hierarchical fashion. Leaving these slightly investigated fields, however, we turn to that of language. The proposition that a language exists subjectively as a hierarchy of habits, is supported by a considerable amount of evidence scattered through recent psychological literature. This proposition is by no means identical with the obvious truth that a language is, objectively considered, a system composed of various units—letters, words, sentences, etc. The existence of the objective system is evident to all who know the language; the existence of a corresponding system of subjective habits demands proof. Is there, for example, a psycho-physically unitary habit corresponding to a familiar word, or does the recognition of a word involve the separate recognition of each letter? The latter view has been held. It requires convincing evidence from experimental psychology and psychiatry to prove that the recognition of a word is ‘eine gesonderte Funktion.’ In like manner it will require evidence not yet fully forthcoming, to show what higher language units and what characteristics of spoken and written language (*c. g.*, cadence, sentence-length, etc.) are represented subjectively by distinct habits.

(a) *Letters*.—A letter (printed or telegraphic) presents to sense a manifold. Recognition of the letter and recognition of its elements are distinct functions. One may recognize the dash and the dot of the telegraphic code after a little practice, and may *know* that J = — . — ., without being able to recognize that group of clicks when heard. To recognize the group as a whole with maximum rapidity requires weeks of practice. On the other hand, one may recognize a letter as a whole—for example, in Old English type—but be wholly unable to reproduce in memory the essential parts of which it is composed.¹

(b) *Syllables*.—Höpfner, in his study 'Ueber die geistige Ermüdung von Schulkindern,'² finding that word errors are more frequent than syllable errors, and that letter errors are more frequent than errors as to parts of letters, remarks: "Silben sind im Wort und Buchstabenteile im Buchstaben fester gefügt als Wörter im Satz und als Buchstaben im Wort. Wörter und Buchstaben sind also 'sebständigere' Elemente."

This observation is doubtless correct. Syllables are, however, sufficiently 'independent' to make it worth while for primary teachers to use the child's stock of known syllables in teaching new words. Mr. Harter is of the opinion that a learner of telegraphy pays little direct attention to the syllables as such, but is really helped in the hearing of new words by the presence of familiar syllables.

(c) *Words*.—A child or one suffering partial aphasia, may recognize the letters of a word, but not the word as a whole. See, for example, the case reported by R. Sommer,³ who concludes: "Die Verbindung von Lautreihen zu Wörter ist eine gesonderte Funktion. Ein 'Wort' ist schon deshalb nicht als 'Lautreihe' zu betrachten." On the other hand, children are frequently taught to recognize words as wholes before they know the letters of the alphabet. Decisive proof that the recognition of a word does not consist in the successive recognition of its letters, is afforded by Cattell's result⁴ that a familiar word can be re-

¹ See Goldscheider and Müller, *Zur Physiologie und Pathologie des Lesens. Zeitschrift f. klin. Med.*, Bd., XXIII., s. 131-167 (1893). Reviewed by Walschek in *Zeitschrift f. Phys. und Psych. d. Sinnesorgane*, VII., 228.

² *Zeitschrift f. P. und P. d. Sinnesorgane*, VI., 217.

³ *Zeitschrift f. P. und P. d. Sinnesorgane*, V., 318.

⁴ *Phil. Stud.*, II., 647; III., 470.

cognized in almost the same time that it takes to recognize one of its letters. This abundantly verified result one of the writers has found true of many children who are in their second school year.

Analogous facts appear on the motor side. One may be able to produce the separate sounds of a foreign language with considerable accuracy, as Karsten points out,¹ and still may not be able, without additional practice, to pronounce words. On the other hand, we pronounce the words of our own language with ease, but require special practice to produce the elementary sounds composing them. Karsten puts the matter thus :

(3) Nach dem oben gesagten wird man nicht einwenden wollen, dass, wer das bewegungsgefühl für das ganze hat, auch das für die einzelnen theile besitze und umgekehrt. Durch das erinnerungsbild ist eine bewegung von anfang bis ende abgegrenzt, dauer und art der mitwirkung aller in betracht kommenden organe fest bestimmt. Zwar können wir eine bewegung absichtlich an irgend einem puncte abbrechen, aber diese abgebrochene bewegung ist dann eben nicht mehr dieselbe, sondern eine andere, welche bei genügender wiederholung ihr eigenes erinnerungsbild entwickelt. Die bewegungen des arztes beim operieren, des malers, des musikers sind mechanisch und räumlich alle enthalten in den einem jeden von uns geläufigen bewegungen; doch gehört übung, das heisst ausbildung der bewegungsgefühle dazu, um gerade eine bestimmte bewegung genau auszuführen. Auch kann man eine bewegung, die man z. b. mit fünf fingern leicht macht, nicht sofort mit einem oder zwei fingern nachahmen; das wäre zwar ein theil der früheren, aber doch auch eine bewegung für sich, für die das bewegungsgefühl erst eigens entwickelt werden muss.—Kurz das bewegungsgefühl kann etwas einheitliches sein, auch wenn die wirkliche bewegung compliciert ist, und einheitliche bewegungsgefühle für grössere lautgruppen können in der seele sich bilden getrennt von denen für die einzelnen theile, aus welchen jene gruppen bestehen.

(d) *Word groups.* As certain letters often appearing in the same order give rise to a unitary word habit, so several words often appearing in the same order give rise to a phrase habit. Such word groups sometimes come to have a unity almost equal

¹Sprecheinheiten ü d. Rolle in Lautwandel ü Lautgesetz; *Proceedings Mod. Lang. Assoc.*, Vol. III., 1887, p. 3.

to that of single words. As a rule, doubtless, the fusion is not so close; that is, we pass more easily than in the case of words from the consciousness of the whole to the consciousness of the parts. Nevertheless, the tendency of the first part of a familiar phrase to suggest the rest,¹ and the fact that everyone has not only a characteristic vocabulary, but a characteristic outlay of word groups, show that phrases exist subjectively as unitary habits. Furthermore, it has been shown that one who reads a language with a certain skill is liable to make phrase errors as distinct from letter or word errors.²

Paul³ points out that we have many word groups (*e. g.*, *auf der Hand liegen*) in which a word has ceased to be associated with its ordinary meaning, in some cases (*e. g.*, *das Bad austragen*) so completely that it requires a knowledge of the history of language to explain the connection between the meaning of the phrase and that of the individual word. In such cases, the language unit dominant in consciousness is evidently the phrase and not the word.⁴

(*e*) *Habits Corresponding to Characteristics of Words, Phrases, etc.* The language habits so far noted are specific *i. e.*, in each case a specific stimulus (letters, syllable, word or group of words) leads to a specific reaction. It is, however, a fact of the highest importance that one's stock of specific habits contains the material for innumerable other specific habits (and also, some hold, for 'generic' or 'plastic' habits). When one has learned *bat*, *cat*, *many*, *model*, one has four specific habits; but one is within two steps (which may be taken in a breath or only after deliberate pains) of a new habit corresponding to *mat*. The first step is dissociation (in the manner described by Martineau and James⁵) of the *at* from the first two words, and of the *m* from the second two; the second step is the fusion of these dissociated habits, when they appear in the order *m-at*, into one new specific unitary habit correspond-

¹ See case mentioned above, p. 353.

² Cf. Berger: *Ueber den Einfluss der Uebung auf geistige Vorgänge*, *Phil. Stud.*, V., 175.

³ *Principien der Sprachgeschichte*, 2 Aufl., 83.

⁴ Cf. Cattell, *Mind*, XI., 64.

⁵ James, *Psychol.*, I., 484.

ing to *mat*. (There is something arbitrary in the designation of *two* steps in the making of a new habit out of old ones. To ordinary introspection the process seems to have many steps when it occurs slowly and painfully, and only one step when it occurs in a flash, as when we recognize and adopt in an instant a new slang word—mugwump, popocrat. The words dissociation and fusion only designate and emphasize two essential phases of the whole process which ends in a new habit.)

In like manner, one's acquisition of these four words is partial preparation for *met*, *bet*, *cad*, and also for *bonnet*, *calico*, and for every word containing any syllable or letter learned. Further, the trochaic rhythm of *many* and *model* may become dissociated from these words, and may reappear as an aid in learning other trochaic words.¹

In the same manner, any element or characteristic of a word group habit may become serviceable in the learning of new groups. Doubtless, the primary effect of using a given word group is to establish a quite specific habit. One can re-read a sentence more quickly than one can read a new sentence containing the same words in a different order. One can even re-read a sentence more quickly if one follows the rhythm first used. The dissociation of language elements from the specific wholes in which they have occurred, and their use in the construction or understanding of new sentences, are a task—perhaps the most remarkable task of which men are capable. The stupider or lazier one is, the less one has inclination or power for this task. But even the stupidest and laziest man meets, with some measure of success, the conversational emergencies that confront him. From his small language capital, there rise substantially the right nouns, verbs, phrases, but's, if's, not's, and even the right inflections to denote the attitude and temper of his mind; and these elements fall together with amazing swiftness into sentences never before used by him. One who has genius for expression differs from the dullard in having a larger language capital, greater facility in dissociating the elements and characteristics, and greater facility in making new combinations. Until we have had a great deal more research

¹ Müller und Schumann, *Zeitsch. f. Psych. u. Phys. d. Sinnesorgane*, VI., 280f.

in regard to the higher language habits, conclusions in respect to them must be proposed with reserve. At present the following points seem probable :

(a) It is well known that the average *length of sentence* is characteristic for a given author. In most cases, perhaps, the author is unconscious of his sentence-length habit.

(b) A *rhythm* often used probably becomes habitual, apart from any particular words, and is then an aid in reading and a factor in making new phrases, sentences, and paragraphs, having that rhythm.

(c) A certain *order* of the parts of speech (*e. g.*, 'he walked out of the way,' or 'out of the way walked he') often recurring becomes habitual, determines the making of new sentences, gives us a sense of ease in reading straightforward prose, and a sense of shock at sentences like Browning's 'Irks care the crop-full bird? Frets doubt the maw-crammed beast?'—even when, as in this case, the words are all familiar.

(d) A *grammatical construction* often used to express a certain feeling (of plurality, futurity, doubt or the like) comes to be automatically associated with that feeling, apart from any particular sentence, so that either instantly and effortlessly suggests the other, to serve as one of many elements in the reading or making of a new sentence.¹

In like manner we may suppose that every peculiarity of style up to the structure and tone of a volume, corresponds to a more or less perfectly fixed habit. An E. P. Roeish novel betrays in its author a habit on its way to becoming as specific as sneezing.

Note on the development of new habits out of old ones. The old theory that doing particular things gives 'general training' of body and mind is nowadays confronted with the view that there is no such thing as 'general training'. The two views are perhaps not so irreconcilable as they appear to be in current psychological and educational discussions. The chief subjective effect of an act is doubtless its tendency to establish the habit of repeating that act; and, conversely, the best way to

¹ For the discussion of the point whether grammatical habits are specific or plastic, see below.

acquire skill in a particular act is to practise that, and not something else. But every bodily or mental process involved in an act is practised, and through dissociation and reassociation may appear in innumerable other actions. In the case mentioned above (p. 364), the 'fringes' of emotion and intention when the four words were learned tend to [reappear upon repetition of these words ; but may also, because of their exercise then, come up to reinforce the set of mind in a subsequent attack upon the multiplication table or the woodpile. When a boy drives the last nail in a fence as carefully as the first he is not thereby made ready to build a house, nor to codify the law of the commonwealth, nor to do anything else in the world so well as to drive nails into that fence ; but his skill in nail driving will reappear when he undertakes carpentry ; and the set of mind with which he drove them will reappear when he is a lawyer. We may deny that Grant's study of algebra gave him a general training of the mind that prepared him for the Wilderness, or for anything else so well as for that algebra, and nevertheless see that the mood of his hours with the algebra came up in his 'We'll fight it out on this line if it takes all summer.'

Professor Royce suggests¹ that besides specific habits one acquires generic or plastic habits, which lead not to a specific reaction upon a specific stimulus, but to a certain sort of reaction upon a certain sort of stimulus. He mentions especially the habits corresponding to the rules of syntax as in this sense generic. This view is attractive, and may be true. It may be, however, that there is no such thing as a plastic or generic habit, except in the sense that a habit may enter as an element into many different processes. Whether or not there are generic habits involved in the origination of higher mental processes, we believe that all habits tend to become in the same sense specific.

2. *The Order of Acquiring Habits which Constitute a Hierarchy.*

Every one knows that, in general, habituation in certain actions leaves us free for others. This principle is, however empty and useless in a given field until we know what habits

¹ PSYCHOLOGICAL REVIEW, V., 118 ; *Educational Review*, VI., 212.

are to be learned there, and which of these must be learned first, which second, etc. It is highly probable that in geometry, chemistry or whist one must acquire a hierarchy of habits; that some of these habits should be learned before others; and that some of them may with advantage be acquired simultaneously. Perhaps the most expert men have already felt their way to the right methods; but psychology and pedagogy would be greatly enriched by explicit and verifiable knowledge upon these points. Such knowledge the general principle stated above is impotent to give. It can only tell the student to do first things first. To discover what things *are* first in any particular field requires painstaking investigation, or a consensus of the practical experiences and intuitions of those who work in that field, or both. Though no one can foresee the results of such investigations in any particular case, there will be idlers in the psychological market place, when the results appear, ready to say: "Nothing new. We have known all along that some things must be done before others."

In point of fact, teachers of reading are not agreed as to the best order of studying the various language units. The older custom was to learn first the letters, then many syllables, then many words, and then at last to read sentences. In details this method varied widely; but its essential principle was to master lower units first and use these in picking out the higher. The newer custom is based upon an opposite principle. In the 'word-method' the pupil is taught a word as a whole before he knows any letter. In the 'sentence-method' the pupil is confronted with a short sentence before he knows any word or letter. In the later methods the subsidiary language units are to be learned incidentally, while the main attention is given to the higher language units and to the sense.

It is proved possible to learn to read by the older or the newer methods, and, indeed, by any method which brings the pupil for a long enough time into contact with print. The mind will find a method of its own. We believe, however, (1) *that by no device is it possible to gain freedom in using the higher language units until the lower have been so mastered that the attention is not diverted by them; and* (2) *that it is, neverthe-*

less, wise at all stages to practise with the highest language units possible, and thus learn all the units in their proper setting.

The alphabet-spelling-book method makes sure of the first requirement, but is grossly wasteful of time in postponing reading exercises which involve simultaneous practice of all the language units in their proper setting, and which are constantly more profitable because more interesting. The new synthetic methods gain these advantages, but lose a more necessary one, unless the teacher realizes that the pupils must all the while be getting the alphabet and vocabulary and making them automatic. If this end can be achieved incidentally, well and good. If not, it must be achieved by periods of practice devoted thereto. In no case can making the language elements automatic be skipped.

Similar principles hold in arithmetic. It is a mistake to demand of children a thorough memorizing of the number series and of the fundamental tables before giving them any exercise with concrete numbers and problems. It is a greater mistake to spend the years when the plastic memory is at its best in number exercises which are interesting, but which leave the children with the alphabets of arithmetic imperfectly mastered. The high-school boy who must halt in his mathematical work to remember the multiplication table, is enjoying the fruits of a pseudo-freedom in the grades. *There is no freedom except through automatism.* It is possible to avoid both the extremes mentioned. The work should be filled with concrete interest in ways fully displayed in our modern elementary text-books on arithmetic. But at all times the teacher should see to it that there is thorough incidental practice of those number-relations which should become automatic, and at some times there should be direct hard work at memorizing those relations.

In addition to the evidence already presented in favor of the foregoing view, two general considerations are submitted.

(1) It is quite useless to raise the question whether or not children should acquire specific automatic habits. There is no escape from such habits except by death. The Indian does not escape. The wolf does not escape. Neither Shakespeare nor Caliban escape. There is no question of escaping automatic habits. The only real question is: Which ones shall we acquire?

The school and civilization answer: While it is possible, acquire those habits which are the alphabets of learning and of cultivated life. This is the first necessary step toward the freedom, adaptability, ingenuity, and efficiency which give superiority to man.

(2) A school method must be judged by the moods and tempers which it cultivates, not simply by what is learned, still less by the momentary interest it arouses. If one forces mastery of the multiplication table by methods which keep one-half the school cowed and the other half rebellious, one has obtained a useful result at disastrous cost. Better not know the multiplication table than be thus morally maimed.

If, on the other hand, one anxiously converts all school work into a round of entertainments, if one shields the pupils from having at any time a sense of resolute effort with hard tasks, if one keeps the pupils vibrating between excitement and ennui as at a circus or picnic, what of the moods and tempers thus cultivated? To what set of character do they lead? For what occupation do they prepare? Every one knows. These are the moods and tempers of the loafer, the tramp, the sport—the idlers, rich and poor, who afflict society with their inefficiency and their consequent misery.

There is happily no need to choose between the galleys and the circus as models for the school and home. There are many schools and homes where hard tasks are performed in a good temper; where thorough drill does not arrest, but prepares the way for higher development; where children begin to do what they must later do to succeed in any business—pass cheerfully from interest in desired ends to a resolute drudgery necessary for the attainment of those ends.

If this view of education is correct, the course of study has no more important function than to make clear the essential habits involved in the mastery of each school subject, and the order in which these are to be acquired; and the teacher has no more important duty than to arouse in children such an interest in some higher aspect of the subject, that they will willingly lend themselves to mastery of its details.

3. Plateaus.

Wide variation and sudden changes in rate of progress are not peculiar to the learning of telegraphy. In general, it is indeed *a priori* highly improbable that the rate of change in any process will be constant. For such constancy requires an extremely improbable constancy in the many factors which unite in determining the rate. As these factors increase in number and complexity, the less likely they are to effect a constant rate. Modern evolutionary science has emphasized the facts which indicate that changes in nature are regular and gradual. *Natura saltum non facit*. It is, however, now well-known that nature does make leaps. It may even be that saltatory change is the rule. The recapitulation theory invites us to picture the history of each individual as a series of steps corresponding to the stages in animal and racial evolution. No one has made out an accurate time table for all these steps (or even ascertained exactly what the steps are). But no one would claim that the rate of progress through them is uniform. The development of the body and the mind both show 'resting periods' alternating with periods of rapid change. We 'perch and fly.' We live for months or years upon a certain level of interests, efforts and achievements, and then suddenly undergo a more or less radical conversion. All things are become new. The old life sinks into the vast subsoil upon whose surface, for a season, bloom new forms of the life of attention.

The well-known examples of rapid change are, of course, not cited as specifically analogous to the plateaus and ascents of the telegraphic curve, but only to show that such alternations of camping out and moving ahead are not exceptional or abnormal. For specific analogies we must look to the history of analogous acquisitions. In this promising field for research nearly everything remains to be done. Preliminary inquiry has developed the following provisional results.

(a) *Languages*. As hitherto noted,¹ in learning to read (first year primary), and in learning a foreign language, one's progress is analogous to that of the student of telegraphy. In

¹ Loc. cit., 52.

the latter case, especially, there is the same rapid improvement at first, the same dispiriting level just below the ability to understand ordinary conversation, the same rapid ascent into usable knowledge of the language, and the same year long struggle, seldom completed, before one has freedom in the language.

(b) *English Composition*. In the Indiana University, we have each year several hundred students in conditioned English Composition. All entering students are tested as to their ability to write printable English. Those who cannot do so, are required to take the conditioned English until they can meet the test. A student may pass out of this work at any time. The heaviness of the work, the discredit of having to take it, and the special fee required, make the motives for getting through very strong. The instructors in this work tell us that the progress of most students is pictured in a general way by the receiving curve. A few students pass out of the work very soon. This generally indicates that they failed to do themselves justice in the first test. In most cases, there is rapid progress nearly up to the passing level, and then a long plateau above which the student seems incapable of rising. In some cases, where students were expected by the instructor to pass in a few weeks, they have kept drudging away for the rest of the year with slight improvement. Doubtless, in these cases, the interference of established language habits is an important factor in retarding progress.

(c) *Chemistry*. Several teachers of chemistry have reported that the progress of students during the first year's work in that subject is similar to that of the telegraphic student. There is the same period of rapid improvement in the first months, followed by a long period of slow progress. In the Indiana University chemical laboratory the latter period has long been recognized and named 'the period of depression.' At one time it was supposed by the instructors that this period of depression might be due to an inferiority in the latter part of the laboratory manual, but further experience has shown that this is not the case. An explanation of the chemist's plateau analogous to that given for the telegrapher's plateau would be: that on the plateau the learner is constantly hampered because

he cannot, on demand, remember any one of a large number of elementary facts which he has once learned; that the large number of elementary facts which he needs to know, makes his progress toward sufficient mastery of them very slow; that a rapid progress comes at last when he can turn his attention from mastering the elements to a freer use of these facts in attacking more complex chemical problems. The chemists whom we have consulted incline to regard this explanation as correct.

(*d*) *Miscellaneous.* A large number of individuals have reported analogous experiences in learning mathematics, music, whist, chess, checkers, et cetera. In all these fields we find one or more long discouraging levels, where practice seems to bring no improvement, ending, at last, in the case of those who persevere, in a sudden ascent. It is probable that in each case one must acquire habits of lower and higher order, and that the explanation for the telegraphic plateaus is the explanation for the plateaus in these fields. Of course, the curves in these widely differing fields must have different specific characters. Each must be investigated for itself. In a time when some fear a dearth of significant problems for psychological research the prospect of such a field is inspiring.

In general, we have here a point of view from which we may discern a difference between the master and the man of 'all-round' development, who is master of nothing. Both have, from the informal experiences of life, some knowledges and skills which fit them to undertake the mastery of a given field. Both have developed these potential instruments of mastery, have 'gone over' the principal items of knowledge and 'gone through' with the principal forms of skill required. The master has not stopped here. He has initiated himself body and soul in the elements, so that after a time such things are to him like letters and words to an educated man. They shoot together easily into new combinations. They are units of meditation, of invention. Meanwhile, to the man who has only 'a good general knowledge of the field,' the feats of the master are impossible and almost incredible. The master's units of thought are each to him a problem. He must give time and pains to each one separately. He cannot think with them. He

is necessarily a follower, or, if he essays the freedom without the power of the master, he is worse than a follower—a crank.

4. *Effective Speed and Accuracy.*

There is scarcely any difference between one man and another of greater practical importance than that of effective speed. In war, business, scientific work, manual labor and what not, we have at the one extreme the man who defeats all ordinary calculations by the vast quantity of work he gets done, and at the other extreme the man who no less defeats ordinary calculation by the little all his busyness achieves. The former is always arriving with an unexpected victory; the latter, with an unanswerable excuse for failure.

It has seemed to many psychologists strongly probable that the swift man should be distinguishable from the slow by reaction time tests. For (*a*), granting that the performances demanded in practical affairs are far more complicated than those required in the laboratory tests, it seems likely that one who is tuned for a rapid rate in the latter will be tuned for a rapid rate in the former, when he has mastered them. Moreover (*b*), a rapid rate in elementary processes is favorable to their fusion into higher unitary processes, each including several of the lower. Finally (*c*), a rapid rate in elementary processes is favorable to prompt voluntary combinations in presence of new emergencies.

In face of these *a priori* probabilities, eleven years' experience in this laboratory (the first three being spent mainly on reaction times) has brought the conviction that no reaction time test will surely show whether a given individual has or has not effective speed in his work. Very slow rates, especially in complicated reactions, are strongly indicative of a mind slow and ineffective at all things. But experience proves that rapid rates by no means show that the subject has effective speed in the ordinary, let alone extraordinary, tasks of life. How is this to be explained?

The following answer is proposed: The rate at which one makes practical headway depends partly upon the rate of the mental and nervous processes involved; but far more upon how

much is included in each process. If A, B and C add the same columns of figures, one using readily the method of the lightning adder, another the ordinary addition table, while the third makes each addition by counting on his fingers, the three are presently out of sight of one another, whatever the rates at which the processes involved are performed. The lightning adder may proceed more leisurely than either of the others. He steps a league while they are bustling over furlongs or inches.

Now, the ability to take league steps in receiving telegraphic messages, in reading, in addition, in mathematical reasoning and in many other fields, plainly depends upon the acquisition of league-stepping habits. No possible proficiency and rapidity in elementary processes will serve. The learner must come to do with one stroke of attention what now requires half a dozen, and presently, in one still more inclusive stroke, what now requires thirty-six. He must systematize the work to be done and must acquire a system of automatic habits corresponding to the system of tasks. When he has done this he is master of the situation in his field. He can, if he chooses, deal accurately with minute details. He can swiftly overlook great areas with an accurate sense of what the details involved amount to—indeed, with far greater justice to details than is possible for one who knows nothing else. Finally, his whole array of habits is swiftly obedient to serve in the solution of new problems. Automatism is not genius, but it is the hands and feet of genius.