THE
PSYCHOLOGICAL BULLETIN

THE ACQUISITION OF SKILL IN TYPE-WRITING;
A CONTRIBUTION TO THE PSYCHOL-
OGY OF LEARNING.

BY EDGAR JAMES SWIFT,

Washington University, St. Louis.

This investigation was undertaken in the hope of getting further information about some uncertain factors in the learning process.

Method and Conditions.—One hour each day was given to the test (and this testing constituted also the sole practice of the subject). The number of words written during the hour was recorded, and from these daily records the curve for this learning process was drawn. The subject kept track of his daily average, though in most instances the introspective notes were written before he was aware of the record that he had made for that day. The writing was from copy and the subject wrote as rapidly as possible, trying always to keep himself at the highest degree of effort. The hour for work was in the afternoon. In a few instances university duties made a change of time necessary, but such variation in the regular program was always recorded and its possible effect upon the curve was considered. The physical condition of the subject was also carefully noted each day. Unforeseen professional duties coming immediately after the first day's practice interrupted the work for the four following days, but during the remainder of the investigation there were only two interruptions in the continuity of the work, *i. e.*, on the sixteenth and thirty-first days. These two interruptions were caused by sickness. It will be seen

from this that while the investigation covered fifty days only forty-four entered into the curve.

The type-writer used was a Smith Premier No. 4. The subject (the writer) had never used any kind of a type-writer except to slowly finger out about a dozen short business letters two years before. It is doubtful if the number of words in all these letters exceeded five hundred.

Preliminary Statement.—The number of words written during the hour is shown on the vertical axis and the days are on the horizontal. The light line represents the daily record, while the heavy line is the smoothed¹ daily record.

On account of the variation in the length of words it seemed best to control this possible source of error by also recording the number and parts of lines written during the hour. This was begun on the twenty-third day and continued without interruption until the end of the investigation. The resulting curve differed so little, however, from the one given below that its reproduction here would be useless. The general course and form of the curve were unaltered.

At the close of each hour's test a record was made of any facts that had a bearing on the curve. Type-writing is particularly adapted to introspection as the subject is able to catch some of the fleeting processes that elude him when learning to write short-hand. These introspections were also carefully noted at the time.

Description of the Curve and Discussion of its Form.—

The initial rise, as before in learning short-hand,² was clearly due to the ease with which a few imperfect coördinations and associations are learned and to their effectiveness at this early stage. This rise is even more rapid in type-writing, because one learns to locate letters on the key-board more quickly than to associate new symbols with sounds.

The long drop on the fourteenth day was due, in large part

¹The method used in smoothing was to average the records for the first three days, then those for the second, third and fourth days, next those for the third, fourth and fifth days, etc., to the end. Naturally smoothed values could not be given for the first and last days. Consequently these days are not represented on the smooth curve.

²*Am. Jour. of Psychology*, XIV., 1903, p. 227.

at any rate, to harder 'copy.' Up to that time the subject had copied long personal letters, but on the fourteenth day he changed to lectures on the history of education. The average length of the words was much greater, and there were fewer of the short words frequent in letters and which the subject had come to write with considerable ease. As the curve for this period shows, seven days were required to excel the highest

record reached with personal letters. That the greater difficulty of 'copy' was the cause of the drop was evident not merely from the immeasurable 'feeling' of greater effort with lessened result but also from actual comparison of the two sorts of material. In one respect it is unfortunate that a change was made, since it breaks the continuity of the curve. But for the change the curve would probably have continued an upward

serrate course. From another point of view, however, it is fortunate, since this unevenness of assigned subject matter is just what often happens in the class-room.

The same irregularity from day to day that was observed in tossing balls and in the short-hand practice¹ was apparent here. Retardation alternates with progress. In many of the cases no reason could be found for the drop. The record for the ninth day illustrates this. The notes for that day say that 'the material was no harder than usual' and the subject was apparently in his usual state of health. Throughout the practice, on that day, he thought that he was doing at least as well as at any previous time. The only day when the low record could be accounted for by lowered physical vitality was the forty-eighth day.

From the twenty-second day the subject tried to observe the mental processes that accompanied the writing, and as these introspections were carefully written down at the close of the hour while everything was fresh in the memory, they form a kind of continuous history of the psychology of this learning process, so far as the subject could observe without interfering with the process itself, and in type-writing one may do this with little or no mental disturbance.

Introspective Notes with Discussion of Their Significance.—It has seemed best to give these notes quite fully, indicating the days on which they were taken.

22d Day.—The past week has been one of discouragement. The pleasure in the work that characterized the first ten or twelve days gave way to ennui.

It will be observed that the period of enjoyment of the work coincides with the first rapid rise. The work was new and progress continuous. The mental depression and the first drop in the curve begin at about the same time. In the experiments on ball-tossing,² and in learning short-hand writing,³ the same ennui was observed, and at that time it was thought to be an important factor in making plateaus. The same feeling during arrest of progress in type-writing sustains this view, though

¹ *Am. Jour. of Psychology*, XIV., 1903, p. 201.

² *Am. Jour. of Psychology*, XIV., 1903, p. 213.

³ *Ibid.*, p. 229.

here the greater difficulty of the material was an additional element in the retardation.

Uncertainty concerning the significance of periods of no progress was the immediate cause of this investigation. Bryan and Harter are of the opinion that '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,' and they add that 'the length of the plateau is a measure of the difficulty of making the lower-order habits sufficiently automatic.'¹ Previous investigation had led the writer to doubt whether there is any such separation of lower and higher-order habits, and notes bearing upon this were made from day to day.

23d Day.—Observation to-day left no doubt that after the first extended plateau the reaction on the keys is the same as it has been from the start, *i. e.*, writing by letter—only the associations are made more quickly. Up to the present time there is nothing that can properly be called a higher-order habit.

The several constituent factors that contribute to the acquisition of skill in type-writing are evidently operative together, though seemingly with varying degrees of prominence at different stages of the process. This will be seen from the introspective notes that follow.

24th Day.—Hands and fingers are clearly becoming more flexible and adept. The change now going on, aside from growing flexibility, is in learning to locate keys without waiting to see them. In other words, it is location by position. Observation, however, reveals the fact that association and location by sight are as yet far from perfect and are still in process of improvement. That is to say, both kinds of association are growing at the same time—that by sight improving and that by location (muscular, etc.) forming. The ennui so noticeable during the last ten days is disappearing. The feeling of pleasure which characterized the beginning of the work has returned.

The same difficulty in keeping up a maximum degree of effort to which the writer has called attention in an earlier paper² was observed in this investigation. Its effect upon the curve is undeniable, as will be seen from the note and score for the twenty-fifth day.

25th Day.—I wrote³ easily to-day—so easily indeed that I often found myself dropping into a state of relaxation, and great effort was continually

¹ PSYCHOLOGICAL REVIEW, VI., 1899, p. 357.

² *Am. Jour. of Psychology*, XIV., 1903, p. 213.

³ It has seemed best to give these introspective notes as they were originally written, retaining the first personal pronoun.

needed to approximate the maximum effort. It seems evident that the process of association and automatization is exceedingly complex. There is clearly no separation of periods in which lower- and higher-orders of habits are formed. Early in the practice certain very common and short words like 'the' and 'is' and 'an' seemed to lose their letters and the reaction to them became word-reaction. While this is clearly the case at the present time, still the general run of reactions is unquestionably of the letter type. Location (muscular, etc.), letter and word associations are now in process of automatization.

The variation, from day to day, in the learner's effective power is seen in the record for the twenty-sixth day. Frequently it is impossible to account for the difference.

26th Day.—The keys were not struck so readily to-day. Associations were slow, though my physical condition was apparently as good as usual. The feeling was very different from yesterday, when the associations were made so easily that at times it was impossible to avoid dropping into a state of ease which seriously interfered with the rapidity of the work. Though the score was kept up to-day it was done only with the greatest effort.

27th Day.—The work went easily to-day, but it was clearly letter-writing. Association by position is becoming more rapid, but sight is still an absolutely essential prerequisite to striking the right letter. The gain is evidently in increased rapidity of letter association. At times I found myself tending to drop into less intensive work, but this tendency was easily overcome. The feeling of yesterday was altogether absent. I felt that I could do it and that I was doing it successfully.

28th Day.—As one increases in skill dispersion of the attention becomes more marked. Growing automatization of associations and movements lessens the attention needed for each movement and so makes it possible to take in more of the situation. In this way one is able to look ahead somewhat, and this facilitates the reactions.

The notes for the twenty-ninth day are important in connection with the question of lower- and higher-order habits. A higher-order habit is evidently in the beginning of its formation, though the lower-order is still very imperfect, and in the acquisition of these higher-order habits the emotional state of the subject is seen to be a factor, as has been found to be the case in the formation of plateaus.

29th Day.—Reaction by the muscular sense is improving. Up to the present time the only words that can be said to be responded to as words, instead of as words composed of certain letters, are still 'the,' 'an,' 'of,' 'is' and a few other like common and short words. But even in these cases reaction is not infrequently response to the single letters composing the word. The question of maximum attention also is involved here. Only when I keep myself keyed up to the highest pitch of effort do I react to these words as words instead of to the letters composing them. It was impossible to-day to keep up the maximum effort, though associations seemed fairly correct and rapid.

32d Day.—The feeling that failure to maintain the maximum effort was the cause of the slight advance during the last few days led to the determination to resist every tendency to lag. To-day's improvement in the score is chiefly due, without doubt, to continual strain to keep up the maximum degree of effort. I doubt whether I wrote any faster, indeed I seemed to find the letters with a little more than the usual difficulty, but I 'pulled myself together' quicker after finishing a word. I kept nerved up to the work. The result was very exhausting and could not have been continued much longer than the hour. The writing to-day was clearly by letter.

33d Day.—It was very evident to-day that the writing was by letter and not by word. Even in the short, common words previously referred to, the letters constantly tended to obtrude themselves into consciousness when the least difficulty was experienced. The learning process is not, however, uniform from day to day. Certain elements in the process at times outstrips the others. In type-writing position-associations (localization by the muscular sense), sight-associations (letter associations) and the more complex word-writing, each have their turn in the foreground. We learn by sections. Energy is not equally distributed and when one element, as perfection of muscle movement or of some association, is having its turn the others must wait. But there is no proper time-separation into lower- and higher-order habits. Indeed it is not at all certain that the several component events in the process will always succeed one another in the same order in different individuals who are learning to do the same thing nor in the same individual in learning different acts.

34th Day.—I exerted myself to the utmost to-day to keep up a continuous maximum effort. Even with this continued strain I found myself at times dropping to a lower degree of efficiency. Severe effort to maintain a maximum degree of efficiency comes to be a continual recalling of oneself from a condition of sinking efficiency. With effort we put forth great energy, but it at once begins to droop and a new effort is needed to bring it up again to the point of greatest efficiency. It is probable that the variability of attention, which must be continually recalled to duty, is an important element in the variation of maximum effort. Later, of course, physiological fatigue enters, but hardly at the outset.

It is an interesting fact that on the thirty-fifth day, three days before the beginning of a new and almost continuous rise, the subject felt confident that he had practically reached his physiological limit. This is probably a phase of the emotional element culminating in the monotony that plays so large a part in the formation of 'plateaus.' Because of its significance the note is given below, just as it was written on that day.

35th Day.—It was clear to-day that I had practically reached my physiological limit for copying from fairly difficult matter, owing to the necessity of frequently referring to the manuscript. Any progress after this, I should say, would be exceedingly slow and the final limit cannot be much higher. It requires constant effort to bring the attention back so as to keep reasonably close to the maximum effort. There is a continual relaxation and the spurs must be applied instantly to keep up this speed.

The note for the thirty-sixth day shows the unreliability of one's feelings as a guide. At no time had the work gone so easily and the lessening of the maximum effort was not especially evident, and yet the drop was decided.

36th Day.—To-day I seemed to be writing more by words than at any previous time, though it was difficult to determine accurately as close observation disturbed the process and reduced it at once to what was clearly letter writing. In any case the associations came very easily.

Subsequent examination of the notes and their comparison with the curve shows that this period marks a turning point in the process. Everything seems to have been culminating at about this time. While the writing for the following day was by letter, that for the thirty-eighth day was unquestionably word writing. This strengthens the view of the writer noted on the thirty-sixth day, that at that time he was occasionally writing by word.

37th Day.—There was a noticeable difference between yesterday and to-day. While associations to-day were rapid they were undoubtedly letter associations, except, again, in the short and frequently recurring words. It would seem from to-day's introspection that muscle movements and letter associations have now reached a fair degree of efficiency, though the latter, at any rate, are as yet by no means instantaneous. Meanwhile mass associations (word associations) seem to be making more progress than formerly. The steps by which this was reached, if it turns out that they predominate during the succeeding stage of progress, were altogether subconscious. All factors of the perfected process have clearly been present almost from the start and the only justification for characterizing any particular stage by one element rather than the other is the prominence of the one or the other factor.

Word associations did predominate during the succeeding stage, as will be seen from the notes for the following days.

38th Day.—To-day I found myself not infrequently striking letters before I was conscious of seeing them. Until now it has not been possible to feel sure of this, except for some of the short, common words, but to-day word associations took a long jump forward. They seem to have been perfecting themselves just below the level of consciousness, since on previous days in one or two instances, there have been uncertain indications of their activity. Though clearly more frequent than before, they are still very rare and any little difficulty causes the learner to drop into letter-writing, even after he seems to have begun on the word as a whole. Position associations (muscle sense), also, is coming to the front. I found to-day that I was using them with much more accuracy than at any previous time. Indeed the whole process to-day seemed to show greatly increased power. Associations that in the past have given only the faintest suggestion of their activity—so faint that it was impossible to speak of them with assurance—clearly revealed themselves. It is evident that

the various associations are improving together, though certain ones are perfected earlier than others, *i. e.*, certain processes are well along while others are still in their beginning, at least so far as effective utilization of them is concerned. It has become more evident to-day that the several elements in the process reach a certain degree of efficiency below the level of consciousness. The learner suddenly finds a new factor to reckon with and this new element may not appear above the level of consciousness until it has attained some effective value.¹

39th Day.—The work did not go so easily to-day, though at the end the score was found to be the highest yet made. Constant effort was needed to keep reasonably near my maximum efficiency. All elements of the process, letter, word and position associations, were clearly at work but the letter associations predominated. At times, however, I found myself writing a word without being conscious of the letters, and position associations were clearly improving.

Irregularly alternating prominence of letter, word and position associations as shown during the days of this period is characteristic of a learning process.

41st Day.—The writing to-day was clearly by words. The number of words that are written at once without consciousness of the letters is increasing.

42d Day.—After one has reached a fair degree of efficiency the enthusiasm that increased his available maximum effort lessens and he drops to a lower level than he is really capable of at that time. At this time also one is apt to do better in the second half of the hour for the simple reason that he feels his tendency to relax and 'braces up.' Loss of enthusiasm was the only cause that could be found for to-day's drop. The feeling of monotony was marked.

43d Day.—All forms of association were noticeable to-day, but I was mentally fatigued.

44th Day.—It was quite evident to-day that all forms of association—letter, position, and word—were operative.

45th Day.—The active presence of all forms of association was clearer to-day than at any previous time. Moderately long or unusual words are still written wholly by letter, but the greater number and gradually increasing length of words whose letters do not come into consciousness in the writing is noticeable.

46th Day.—I made great effort to-day to raise the score but failed. The strain of attention was so great that, at the end, I was exhausted. All of the associations were at work and it was interesting to observe that they seemed to alternate with one another.

47th Day.—To-day everything went easily and again I pushed myself to the utmost to try to rise above the present level. Word- and position-associations were clearly in evidence along with those of letters.

The effect of fatigue on the learning process is shown in the notes for the forty-eighth day. The latest acquisitions—those that count most for growing skill—are for the time being lost.

¹ This same fact was observed in learning to keep two balls in the air with one hand. *Am. Jour. of Psychology*, XIV., 1903, p. 216.

48th Day.—I was mentally fatigued to-day and the work did not go well. Word associations were entirely in abeyance and those of position largely so. I worked very hard in order, if possible, to overcome the difficulty, but throughout the hour the writing was wholly by letter and even finding the letters was harder than usual.

49th Day.—All forms of association were evident, but the position associations were rather more conspicuous. It seems as though the different elements in the process were irregular in their activity. Even after they have all been observed for some time they vary on different days in their comparative prominence.

The unreliability of one's 'feeling' regarding his success on any particular day has already been noted (see the 39th day) but it was especially evident on the fiftieth day.

50th Day.—I seemed to write to-day with an ease not before experienced, and I had no doubt that I would greatly exceed my previous record. One thing was clear: not one form of association merely, but all, were improved and all were operative. The word association is probably, at least in its beginning, brought about by dispersion of the attention, as was shown by the fact that I not infrequently struck the key representing one or two letters ahead of the right one.

Summary of Results and General Inferences.

1. The learning process is irregular. Periods of advance alternate with those of retardation. The learner makes no progress for several days and then he leaps forward. His new position may be permanently held or he may fall back again; but if he does, it is only for a short time. Sometimes retardation or loss of power may be accounted for by physical condition or in some other way, but again no cause can be assigned for it.

2. As in ball-tossing and in short-hand writing, so here, maximum effort is a variable quantity, at times altogether beyond the learner's control.

3. The acquisition of skill in type-writing is an exceedingly complex process involving both mental and physical elements.

4. The elements involved in this process do not have separate periods for their beginning and development. Both simple and complex factors betray themselves to introspection early in the work, but they are present in different degrees of activity. This difference varies also from day to day, one being predominant one day and another the next. After the acquisition of a few imperfect coördinations and associations the

simple and complex processes intermingle with no distinct separation.

5. There are not one or two periods of delay in which lower-order habits are automatized and preparation made for a higher-order. The investigation in short-hand writing¹ left this question in some doubt, because of the difficulty of introspecting while writing, but this investigation has shown conclusively that in type-writing, at all events, such periods do not exist. Type-writing lends itself especially well to introspection and the subject was able on several days to detect all of the elements from simple letter associations to the complex word associations. Both of these were operative early in the work and, again, at the very last, letter associations were frequent.

6. The learner gradually passes from a period when lower-order habits predominate to a period of predominant higher-order habits. The latter, however, are a part of the process almost from the beginning. Automatization is going on all the time.

7. Plateaus have at least two causes. Considered from the point of view of automatization they are resting places. The learner has overshot his permanent power and must wait until the automatization is perfected. They are also due to a slump in enthusiasm. Monotony overcomes the learner. Further, these two causes react upon one another. After improvement in automatization the learner is able to do better and takes courage. Enthusiasm to advance, now that it is easier, overcomes the ennui.

8. Effort to spurt is helpful if not too severe, but overstrain exhausts the learner and hinders his progress by bringing into the focus of consciousness processes that serve him best when in the background.

9. Physical condition is always an important factor.

10. The process is subconscious. The learner suddenly finds himself doing something that he has not before been aware of. The new acquisition is well along, however, before it is discovered.

¹ *Am. Jour. of Psychology*, XIV., p. 727.