THE RELATION OF RHYTHM TO THE HAND- WRITING MOVEMENT

AN EXPERIMENTAL STUDY

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Much general interest has been attached in recent years to the problems relating to temporal controls of the handwriting movement. Chief among these problems are those having to do with rhythm. What is meant by the term "rhythmical writing?" Do better writers perform more rhythmically than poorer writers? What is the effect of imposed rhythm on performance? Is arm or finger movement better adapted to rhythmization? What are some of the most pertinent suggestions governing the use of and the emphasis on rhythm in penmanship instruction?

Psychological experiments in rhythm have not been without significance and value in their general bearing on these inquiries, but direct experimentation in the field of handwriting is essential to satisfactory solutions. The investigations of Freeman¹ and Nutt² are outstanding reports which have contributed substantially to a better knowledge of rhythmic movement in handwriting. In brief they show that temporal rhythm in writing increases with age of the writer and is assisted by increase of speed. They also note that it is not correlated with good form, in fact has a tendency to interfere with quality in certain cases, and that there is little distinction, if any, in finger and arm movement as to influence on rhythmization. These investigators have arbitrarily defined rhythmic movement as the tendency to give succeeding strokes the same time emphasis—in other words, rhythm is regarded as a simple uniformity in duration of strokes.

Two types of experiment here noted were undertaken with the desire primarily to gain more specific information regarding rhythmic movement as related to the penmanship of good and poor writers of both adult and child groups. The first of these was carried out by having the subject make to and fro movements, as in writing, with finger and arm movement, without and with imposed rhythm. By a system of electric contacts a kymographic record was made which

¹ Freeman, F. N.: The Handwriting Movement, *Educ. Mon.*, 1918, Vol. II, 2, 3.

² Nutt, H. W.: Rhythm in Handwriting, *El. Sc. Jour.*, Feb., 1917.

showed the relative amount of time spent on the stroke and the rest at the terminus of the stroke. The second experiment was effected by a photographic method by means of which the actual writing process was analyzed in terms of distance covered during each fiftieth of a second. This method proved very effective and accurate.

The first experiment did not provide means of studying actual writing movement as did the latter, but did reveal characteristic behavior of the respective sets of muscles used in handwriting. The criteria of rhythm here considered were (1) the approach to temporal uniformity of successive total strokes, from the beginning of each stroke to the beginning of its successor, and (2) equality of time spent on similar stroke elements (the period of movement or stroke proper, and the period of rest at the end of the movement) as well as their combination in the total stroke unit.

The results were analyzed so as to show the percentage of variation within these various units as summarized in Table I. The data of this table are presented graphically in Diagram I so as to make clear the effect of the imposed rhythm. The variation of the younger children is generally greater than that of any of the other groups.

TABLE 1.—AVERAGE PER CENT OF VARIABILITY FROM TEMPORAL UNIFORMITY

Group		Rest		Stroke		Total	
		Finger	Arm	Finger	Arm	Finger	Arm
Adult...	Good	13.7	18.2	10.5	8.7	6.8	6.4
	Poor	15.4	13.6	11.0	7.9	6.3	6.5
	Average	14.5	15.9	10.7	8.3	6.5	6.4
Adult...	Good	14.3	16.8	10.8	9.7	8.0	7.1
	Poor	16.1	17.3	13.0	11.0	8.4	7.8
	Average	15.2	17.0	11.9	10.3	8.2	7.4
Child...	Young	21.8	20.0	24.1	14.4	13.7	8.8
	Older	16.3	15.8	13.0	9.4	14.4	7.9
	Average	19.0	17.9	18.5	11.9	14.0	8.3
Child...	Young	18.6	22.9	20.5	17.2	11.8	12.3
	Older	15.8	21.7	15.5	14.9	8.8	9.7
	Average	17.2	22.3	18.0	16.0	10.3	11.0

Although there are many cases of overlapping the better adult writers maintain a slightly superior record of regularity. The rhythmic reaction to the total period as a unit is quite noticeable, for all groups here show less relative variation than in either the stroke or rest.

DIAGRAM I.—AVERAGE PER CENT OF VARIABILITY FROM TEMPORAL UNIFORMITY (Showing comparison of good and poor adult writers and younger and older children, under conditions of spontaneous and imposed rhythm, with the use of finger and arm movement.)

The finger and arm movements are doubtless distinctively significant for rhythmic behavior. The arm, because of its greater mass weight and consequent inertia, seems to be more easily adapted to natural rhythmic movement than the finger, especially in the case of children who have not yet gotten as ready control of the less gross finger mechanism. On the other hand, when the child attempts to follow a set rhythm, the inertia of the arm is manifest in the fact that the arm is less subject to rhythmitization than the fingers. Rhythmic habituation is apparently attained in arm movement, at least to marked extent, while the fingers, being unhabituated, yield more readily to the imposed beat.

This factor of habituation is marked also in comparison of the various groups as to the effect of an imposed rhythm on variation.

For adults, who have already acquired a comparatively high degree of rhythmic movement, probably as a more or less fixed norm of performance, the amount of variation is greater in both finger and arm movement when the rhythmic beat is followed than when the action is natural. The better writers show greater power of adaptation than the poor writers in this respect, however.

An investigation of the accuracy with which the imposed beat is followed reveals the fact that the poorer adult writers are less accurate than the older children, while the better writers show comparatively high ability to follow the rhythmic beat closely (Diagram II). In general the better writers and older children are able to anticipate the beat while the poorer writers and young children show a distinct tendency to lag behind the beat. The arm is found to be less accurate than the fingers in attaining the rhythmic pace set, except in the case of the younger children, who have not yet gained control of the finger muscles to the same degree as those who are older.

The imposed rhythm is found to increase the proportionate amount of time spent at rest for all groups, but this is especially notable in the case of the younger children, and when finger movement is used. The total duration of the stroke is increased, but the time spent on the stroke proper tends to remain constant.

In the second experiment the handwriting movement of 20 different subjects was investigated in a great deal of detail. Seven of the subjects were children ranging in ages from 7 to 16 years. Six of the remaining number, who were adults, were poor writers and seven were good writers as judged by the degree of evident coordination in their writing. Each subject wrote an indirect running oval and the majority wrote a sentence so that a study might be made of a simple repetitive form as well as a sample of characteristic penmanship.

In Figure I is given a reproduction of the written record of the 7-year-old child in making a running oval, with the successive 50th-second intervals indicated by the spaces between the cross bars.

The irregularity in form and in progression is evident. The poor organization of speed of movement is made very clear in Diagram III where the speed curve is in part compared with the curve of a record for the same exercise as made by a good adult writer. In the former

DIAGRAM III.—COMPARISON OF SPEED CURVES OF THE YOUNG CHILD AND GOOD ADULT WRITER IN WRITING THE RUNNING OVAL.

there is no even progression of speed, and no adaptation of speed to the form to be produced, as in the latter. Also the many changes of speed are almost beyond comprehension and offer quite a contrast to the regular rise and fall of speed at the middle and end of strokes respectively which characterize the adult record.

Speed curves as thus constructed yield readily to rhythmic analysis since the number of units of time spent on each stroke can be accurately computed. An analysis of the records for the repetitive forms showed that the good writers among the adults made less variation from their average length of time both on the up stroke and down stroke as well as on the total of both than the poor writers, but very poor writers may show better natural rhythm than most of the good writers. The children, although in some cases showing a high degree of rhythm, are on the whole comparatively low in this respect.

When the records made in the writing of words were analyzed the rhythm was found to be very much lower, due undoubtedly to the irregularity in the

length of strokes being constructed, as well as their complexity. While the individuals tend to give the same average length of time to strokes in the two writings of the same word or different words, the tendency is to devote unequal amounts of time to the respective strokes within a word. In general, the longer strokes receive the greater time emphasis, although this proportion is modified by the complexity of the stroke.

Ovals were analyzed to see what was the effect of curvature on the speed attained within the stroke. In Figure II is shown a portion of an oval broken up for measurement into seven arced segments having their centers of radiation in order as indicated by the numerals 1 to 7. It is notable that the radial lengths differ greatly. In the complete form of this particular oval the correlation between radial length and

FIGURE ONE
*Writing of Seven Year Old Child Showing
Comparative Distances Covered in each 50% of a Second*

FIGURE TWO
*Showing Method of Analyzing Curve
into Arced Segments*

maximum speed within the arc for 33 segments was found to be very high by the Spearman Rank Method, the coefficient being 0.96. The line of regression however indicates a curved rather than a straight line relationship with a falling off in the regular increment of speed after a certain radial length has been reached, and a tendency for the rate to reach a fixed limit as the arc approaches a straight line form. This relation was found to be quite generally characteristic of the subjects. The poorer writers and children show very much lower correlation between the maximum speed and curvature of the arc than do the good writers and also exhibit a more marked tendency to slow down the speed relative to the increase of the radial length of the arc.

If, as the strokes decrease in curvature, the maximum speed within the stroke were to remain constant, the time must be the variable, varying directly with the radial length of the stroke in case the stroke

resembles a simple arc. But were the speed to vary in exact proportion as the radial length the time would remain constant. The closer approach to this constancy on the part of the good writers indicates a marked tendency toward temporal rhythm. If the strokes used in writing could be so made as to be perfectly arced segments, it is possible that they might be constructed in about the same length of time regardless of size or degree of curvature. But the form of the written word does not ordinarily yield to such simple temporal analysis.

Experimentation with a few subjects in the following of a rhythmic beat while writing words showed that a writer with habituated speed and rhythm would be slowed down by any beat that was slow enough to be consciously followed. The regularity of time thus induced in the successive strokes was also in marked contrast to the normal behavior of the subject, or of any one else examined, and resulted in uncertainties of speed progress which affected harmfully the quality of the written form.

The fluency, freedom and smoothness of movement which characterizes the good writer generally is the fundamental "rhythm" of handwriting. It is due to the unhampered interaction and coordination of the fingers and arm as free swinging levers, and with a ready control of the motor elements at every instant, so there is a definite relation between the form being constructed and the speed and time relationships.

The use of the rhythmic guide in penmanship instruction must be carefully supervised and scientifically directed. The value of such a guide in the early years is unquestioned, as an aid in organizing the writing into unit strokes, and also as an aid in facile movement. For purposes of temporal rhythmitization of movement an imposed rhythm is not thoroughly adaptable to the process of constructing word forms, but may be used to better advantage with simple repetitive forms. After the subject has developed habits of natural rhythm the use of the rhythmic guide may result in a retardation of speed and a detrimental effect on form. Little is known as to the extent to which an imposed rhythm may be acquired as a fixed habit by practice. It appears that its chief value must lie in the development of a smoothly regulated type of movement in which the writer has a controlled adjustment of speed to form. The training process must involve due consideration of all the muscles naturally used in handwriting, as well as all individual differences due to age and natural tendencies to rhythmic movement.