XXI. PRACTICE IN ASSOCIATING NUMBER-NAMES WITH NUMBER-SYMBOLS¹

BY WARNER BROWN

. In a recent study² the writer employed the difference between the time required to perceive and name a series of colors and the time required to read the same color-names when they are printed out in type as a typical instance of the general rule that it takes longer to perceive and name a simple object than to perceive and name a word. At that time reference was made to an experiment by Bourdon in which the time for calling out the number of points of light in a small group was said to be no greater than the time for naming the corresponding arabic numeral.³ On the basis of this experiment Bourdon argues that the process of perceiving a small number of points as a number is no more complicated than the process of perceiving the symbol of the number. If this is correct it means that it is possible in this case to associate the name of an object with the object itself as quickly as with the symbol of the name and this would make it seem probable that the association processes in color-naming involve difficulties peculiar to themselves and are not typical of the general situation in which simple objects are perceived and named.

What follows is an attempt to discover whether number-naming is really a process which is free from the time-consuming difficulties of color-naming. A practice experiment was devised in which number-naming was subjected to the same analysis that was applied in the previous case to color-naming. The material for the experiment was all prepared with the typewriter. It consisted of four sheets, each con-

¹ Studies from the Psychological Laboratory of the University of California.

² This REVIEW, p. 45.

³ *Rev. philos.*, Vol. 65, 1908, p. 426.

taining ten lines of ten items. The first sheet contained the type-written words *one, two, three, and four*. There were 25 words of each sort, arranged in irregular order with not more than 3 nor less than 2 of a kind to a line. Four different sets of sequences of words were used to prevent memorization of any particular sequence. The lines were separated by triple space and the words were separated from each other by the space of three letters. The second sheet contained the arabic numerals corresponding to the words of the first sheet so arranged that each symbol occupied a position, which was relatively the same as the center of the corresponding word in the sheet of words. In this way the eye-movement factor was kept as nearly constant as possible. The third sheet (known as 'dots') was made up of dots arranged to represent the numbers as follows: *one* was represented by a *period*; *two* by a *colon*; *three* by a colon with a period after it; *four* by two colons. The fourth sheet represented the numbers by an appropriate number of oblique strokes ('scores') made with the key used in printing fractions on the typewriter.

The time was measured which was required to read aloud the one hundred items on each of these sheets. The sheets were read one after the other in the order given above, and then all four were read again, so that the time stated for each sheet on each day of practice is the average of two records, the first and fifth, second and sixth, etc.¹

The accompanying table gives the results of eleven days' practice with this material on the part of twenty-four students. None of these students knew the real purpose of the experiment. They were all encouraged in the supposition, which came naturally to all of them, that they would be able with practice to read the "dots" or "scores" as fast as the words or symbols.

¹ The experiment with colors referred to above, made it clear that there is no considerable difference in time between successive trials on the same day. The average time for naming 100 colors was found to be 42.3, 42.3, 43.0, and 42.8 seconds for 4 successive trials; the time for 4 successive trials of reading 100 words was 29.0, 30.4, 29.9, and 30.5 seconds. There can be no serious objection, therefore, to comparing the rate of reading one sheet with the rate of reading another sheet when their sequence is the same each time. It is understood, of course, that the order of the items on the sheet is different on successive sheets.

TABLE FOR ELEVEN DAYS OF PRACTICE ON THE PART OF 24 PERSONS, SHOWING THE AVERAGE TIME REQUIRED TO NAME 100 ITEMS PRESENTED AS WORDS, AS ARABIC NUMERALS, AS GROUPS OF DOTS, OR AS GROUPS OF SCORES; AND SHOWING FURTHER THE RATIO OBTAINED BY DIVIDING THE TIME FOR THE ARABIC NUMERALS INTO THE TIME FOR EACH OF THE OTHER PERFORMANCES.

Day	Word	Arabic	Dot	Score	Ratio of Arabic to:		
					Word	Dot	Score
1	30.1	27.8	39.6	36.0	1.08	1.42	1.29
2	28.9	26.5	35.9	34.2	1.09	1.35	1.29
3	27.6	25.8	34.4	33.2	1.07	1.33	1.29
4	27.1	25.0	34.7	32.5	1.08	1.39	1.30
5	26.6	25.0	34.0	32.4	1.06	1.36	1.29
6	26.5	24.7	33.0	31.7	1.07	1.34	1.28
7	26.3	24.3	32.3	30.5	1.08	1.33	1.25
8	25.7	24.2	31.8	30.9	1.06	1.32	1.27
9	25.5	23.8	31.9	31.0	1.07	1.34	1.30
10	25.1	23.6	31.2	30.4	1.07	1.32	1.29
11	25.0	23.4	30.9	29.9	1.07	1.32	1.28

The result shows that the time required to perceive and name the number of a small group of marks is longer than the time required to perceive and name the corresponding word or the arabic symbol of the number. In this respect the results agree perfectly with the experiment in naming colors, and support the general dictum that the naming of objects is slower than the naming of words.¹

The same peculiar inhibitions appear in the reading of the "dots" or "scores" which are encountered in color-naming. Some persons are more troubled by the "dots" and others find more difficulty in the case of the "scores" but no one notes any considerable disturbance of this kind in the case of the words or arabic symbols.

This experiment agrees with color-naming in the essential point that the ratio between the time required to name an object and the time required to name its symbol resists the

¹ As a matter of fact Bourdon's statement that the dots are named as fast as the symbols does not seem to be fully supported even by his own figures. His interpretation of his data raised a doubt which the results of the present experiment tend to clear away. There is no striking conflict between the original data of the two experiments. The method of serial reactions which has been used in the present case undoubtedly tends to magnify the loss of time in the association process and might reasonably be expected to show a greater difference in time between the two processes than would be shown by Bourdon's method of single reactions. But it is not probable that the serial reactions would show a difference unless the single reactions also gave some difference and as a matter of fact Bourdon's reactions do give some difference.

action of practice. This seems to argue in both cases that previous practice is not the basis of the relative rapidity of the latter process. So, too, the fact that the process of naming the symbol is itself capable of a very material improvement through practice precludes our speaking of it as automatic in comparison with another process (the slower one of naming the object) which improves no faster. It does not appear probable that differences in previous practice have much to do with the relative speed of the two processes.

The present experiment confirms the inference drawn from one part of the color experiment that phonetic symbols such as letters do not seem to be responsible for the advantage in speed of one association process over the other. It might be thought that the sight of the different letters would guide the complex movements of the vocal organs in uttering the word, and so facilitate the reaction to a word, but it appears that the words with their phonetic symbols can not be read quite as fast as the arbitrary arabic symbols which contain no phonetic elements. This is true for nearly every individual person and in spite of the fact that the spacing of the words and figures on the page gave nearly normal conditions of eye-movement for the words and rather unusual conditions for the arabic symbols.

In conclusion it may be said that the causes of the delay of the association processes in naming a simple object remain as obscure as ever. But on the negative side it seems clear that the greater speed with which words are named does not depend upon an advantage in practice and does not depend upon the suggestiveness of the letters in the words.