SPELLING ERRORS AND THE SERIAL-POSITION EFFECT[1]

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The relative frequencies of spelling errors as a function of letter position have been examined for 7-, 9-, and 11-letter words selected at random from the Thorndike-Lorge word list. These were administered to 150 8th graders, 158 10th graders, and 89 junior college freshmen, respectively. The distribution of errors according to letter position was found to closely approximate the classical, skewed, bow-shaped, serial-position curve for errors generally found in serial rote learning. Other features in common between spelling and serial learning were discussed. It is suggested that a theory of serial learning and of the serial-position effect may be germane to the psychology of spelling.

Perusal of the research on spelling reveals that this subject has been traditionally dominated more by a linguistic than by a psychological orientation (Horn, 1960). Spelling difficulties have been analyzed largely in terms of phonetics, syllabication, parts of speech, and frequency of word usage. Spelling research is also predominantly characterized by a rather simple, unanalytical, correlational approach. Relationships have been found between measures of spelling ability and measures of reading, MA, IQ, achievement in various school subjects, and numerous other variables (Horn, 1960). Seldom, however, is spelling studied as a learning phenomenon or examined in terms of principles derived from the experimental psychology of learning. The investigator has conceived of what might be called a psychological theory of spelling based

primarily on concepts in learning theory. The purpose of the present investigation is to examine only one aspect of the formulation, viz., the serial-position effect. The similarity of the distribution of spelling errors, when errors are plotted according to their position in the word, to the distribution of errors in serial rote learning—the so-called serial-position effect—has never before been noted. The correspondence between spelling and serial learning would seem to offer some clues concerning the nature of spelling errors.

When a series of words, nonsense syllables, symbols, or figures is learned, the errors made before mastery are distributed according to the position of each item in the series, producing the familiar, skewed, bow-shaped serial-position curve. Various theories have been proposed to account for this phenomenon (Jensen, 1962a; McGeoch & Irion, 1952, pp. 125-134) Since a word consists of a series of letters, and since spelling a word consists of putting each let-

ter in its proper order, we might ask whether the serial position effect, which is generally manifested in every form of serial learning investigated in the laboratory, is also manifested in spelling. If so, the distribution of spelling errors should be similar to the serial-position curves produced by the serial learning of other materials. That is to say, errors should generally be most frequent in the middle of a word, with fewest errors at the beginning and end of the word. That spelling errors occur more frequently in the middle of words has probably been noted before, but apparently not with sufficient precision to reveal the more subtle features of the serial-position effect.

Variations in the shape of the serial-position curve are mainly a function of the number of items in the series. The curve for a short series is markedly skewed, with the largest proportion of errors occurring well past the middle of the series. As the series becomes longer, the serial-position curve becomes more symmetrical (McGeoch & Irion, 1952, p. 123). It would be interesting indeed if this were found to be the case also for the distribution of spelling errors in words of different lengths. The present investigation was addressed to this question.

METHOD

Spelling

So that word selection would be unbiased with respect to the purpose of the present study, every 7-letter, 9-letter, and 11-letter word of the Thorndike-Lorge word list (1944, pp. 1-208) was typed on a slip of paper. The slips were thoroughly shuffled to eliminate alphabetical order, and then 75 eight-item word lists were made up separately for 7-, 9-, and 11-letter words by drawing the words at random from the total word pool. Foreign words and proper nouns were eliminated.

In order to maximize spelling errors while at the same time presenting words that were reasonably familiar to the subjects, it was decided to give the 7-letter words only to the eighth graders ($N = 150$), the 9-letter words only to tenth graders ($N = 148$), and the 11-letter words only to junior college freshmen ($N = 89$).

The spelling tests were selected at random from all the eight-item spelling lists. Every eighth grader was given 24 7-letter words, every tenth grader was given 24 9-letter words, but different lists were used in different classes, so the total number of different 9-letter words was 96. Each of the junior college students was given 48 11-letter words.

The subjects had mimeographed forms on which to print the words. For a 7-letter word, for example, a row of seven adjacent squares was provided, with the instructions to put one letter in each square. Similar forms were used for 9- and 11-letter words. This procedure permitted the position of each spelling error to be easily tabulated.

For all groups of subjects, the words were read aloud by the regular classroom teacher in the fashion of the usual spelling test. Students were not given the words for study before the test. Neither the teachers nor the students knew the purpose of the test.

Serial Learning

To permit a detailed comparison between the position of errors in spelling and in serial rote learning, serial learning data were obtained. Sixty subjects (college students) learned by the anticipation method a nine-item serial list composed of nine colored geometric forms: triangles, squares, and circles, colored red, blue, and yellow. The stimuli were projected automatically one at a time at a 3-second rate with a 6-second intertrial interval. (A detailed description of the apparatus is given elsewhere—Jensen, Collins, & Vreeland, 1962.) Never were figures of the same shape or color adjacent in the series. A green light of 3-seconds duration served as the signal for the subject to anticipate the first item in the series. Subjects responded by saying "red triangle, blue square," etc. All subjects learned to a criterion of one perfect trial. Two different orders of stimuli were used, with 30 subjects assigned to each order.

RESULTS

All the serial-position curves are presented as the percentage of total errors that occur at each serial position, so that the area under all the curves is the

same. This method of presentation was adopted since the interest here does not concern the absolute number of errors but only the relative shapes of the curves for serial learning errors and for spelling errors. For the color-form serial-learning data, the percentage of errors at each position was determined for each subject individually and then averaged over all subjects, in order to weight each subject equally in the group curve. A similar method was applied to the spelling data. Since some words were misspelled much more frequently than others, the percentage of errors at each position was determined for each word and these were averaged over all words so that every word is weighted equally in the final curve.

Figure 1 shows the distribution of errors as a function of letter position for 96 9-letter words and for the serial position of errors made by 60 subjects in learning the color-form series. Both curves evince the essential features of the serial-position effect, that is, a bowed curve with the greater proportion of errors occurring after the middle position. The intraclass correlation between the pairs of data points for the two curves may be regarded as an index of the degree of similarity in the shapes of the curves (Haggard, 1958). The intraclass r was .81 between the spelling and the color-form curves. When the curves produced by the two serial orders of the color-form test were intercorrelated, the r was .96, which may be regarded as an equivalent-forms reliability of the shape of the serial-position curve.

The error curves for 7- and 11-letter words are shown in Figure 2. These curves closely resemble serial-position curves found in the literature on serial learning (Jensen, 1962a; McGeoch & Irion, 1952, p. 123) with the degree of skewness varying as a function of the number of items in the series. The peak of errors for a 7-item list is generally at
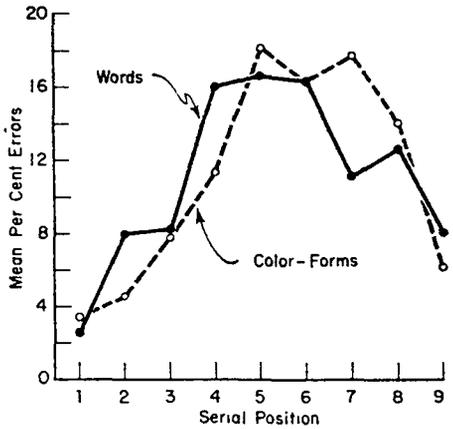
FIG. 1. Serial-position curves for errors in nine-item color-form serial learning (60 subjects) and for spelling errors in nine-letter words. (The latter is based on a total of 3,864 spelling errors, i.e., incorrect letters, made on 96 words by 148 tenth graders.)

Position 5, and for an 11-item list it is at Position 7. The spelling errors conform perfectly to these expectations.

Since the usual method of learning to spell words is not the anticipation method generally used in serial learning experiments, but involves simultaneous viewing of all the letters in the word, one might ask if learning the color-forms by this method also evinces the serial-position effect. If it did not, it would
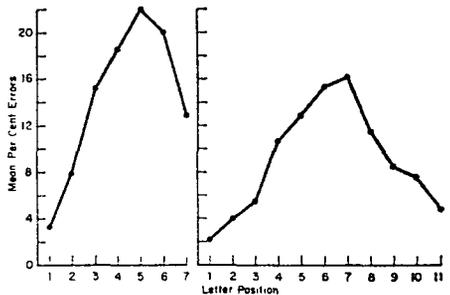
FIG. 2. Serial-position curves for errors in 7- and 11-letter words. (The curve for 7-letter words is based on a total of 1,546 spelling errors made on 24 words by 150 eighth graders. The 11-letter curve is based on a total of 2,262 spelling errors made on 48 words by 89 junior college freshmen.)

be doubtful that the resemblance of the error curves for spelling to those of serial learning was indicative of a common psychological process underlying both forms of learning. To investigate this question, an additional 30 subjects (college students) were given a color-form test that involved simultaneous presentation of all the items in the series. Nine colored plastic forms (red triangle, green square, blue triangle, yellow diamond, red circle, yellow triangle, blue circle, pink square, and green diamond) were placed in a row before the subject. After the subject had studied the order of the objects for 10 seconds, the objects were disarranged haphazardly and the subject was asked to rearrange them in the proper order. This procedure was repeated, always with the same serial arrangement of the objects, until the subject learned to reconstruct their order perfectly. There was a different order for each subject.

Figure 3 shows the serial-position curve obtained by this method of simultaneous presentation. It may be regarded as a spatial, rather than the usual temporal, form of serial learning. The serial-position effect clearly is not limited to learning by the anticipation method (Jensen, 1962b). It should be noted that the curve in Figure 3 more closely resembles the curve for misspellings in words in Figure 1 than does the serial anticipation curve in Figure 1. In brief, the distribution of spelling errors more closely corresponds to the spatial serial-position effect than to the temporal. This is what we would expect, since the letters of words are viewed simultaneously as in the spatial serial learning procedure. The intraclass correlation between the words curve in Figure 1 and the curve in Figure 3 is .90, which indicates a degree of correspondence between these curves that is almost as high as the "reliability" of the curves would permit.

DISCUSSION

A strictly linguistic, rather than psychological, interpretation of these findings is not readily apparent. The obvious linguistic explanation of these results is in terms of the relative easiness of spelling the common prefixes and suffixes in words, which would tend to make for fewer spelling errors at the beginnings and ends of words having these elements. This explanation is unconvincing for several reasons. If prefixes and suffixes, most of which are composed of two or three letters, are learned as units, and if these prefixes and suffixes account for the shape of the error curve, then we should expect quite a differently shaped curve than was actually found in the present study. Each of the first three and last three letter positions should have an almost uniformly small proportion of errors. Furthermore, the differences in the skewness of curves for words of different lengths would be difficult to explain by the prefix-suffix hypothesis. It is apparent that even if the first and last three positions of the error curves are ignored, the middle portion of the word still manifests the bowed serial-position
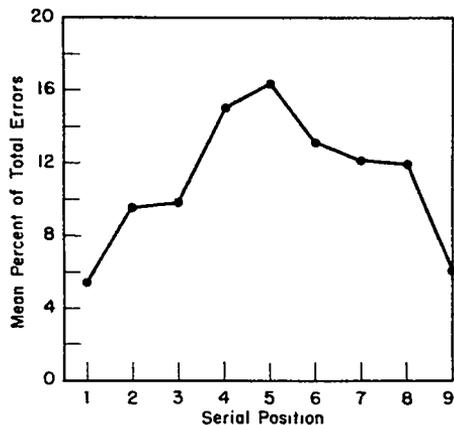
FIG. 3. The serial-position curve for errors on a spatial serial learning task in which all nine items were presented simultaneously on each trial (30 subjects).

effect. Note the curve for 11-letter words in Figure 2; even without the first and last three positions the errors are distributed in a fashion typical of serial-position curves. Furthermore, only a small proportion of the words used in this study had either suffixes or prefixes. Using as a criterion a list of 46 common Greek and Latin prefixes (McCrimmon, 1950, p. 186), it was found that only 16% of the 9-letter words had prefixes. The mean number of errors on the first three positions for these words was 5.60; for nonprefix words the mean number of errors was 6.80. This small difference, in addition to the fact that only 16% of the words had prefixes, could not account for the markedly bow-shaped error curves found in the present study.

It is not claimed that spelling errors are solely a function of serial position. Certainly some words are phonetically more difficult than others, and this factor is undoubtedly a large source of spelling errors. Each word has its own peculiar difficulties, and it appears that these difficulties can occur at any letter position in the word. It is only when the errors that are peculiar to individual words are "averaged out" by combining the position errors of a large number of words, as was done in the present experiment, that the distribution of errors associated with the serial-position effect becomes evident. Thus, a phonetically difficult element is probably more or less difficult according to its position in the word.

There is still another interesting point of correspondence between spelling and serial learning. A number of studies (reviewed by Horn, 1960, pp. 1346-1347) have found that emphasizing difficult parts of words, in presenting the words in a lesson, by underlining, writing the letters in capitals, using bold-faced type, etc., is of little or no value in increasing the probability that the word will be spelled correctly. Emphasis of particular letters in a word corresponds to the so-called von Restorff procedure in serial learning, in which an item in the series is perceptually emphasized in some manner. The emphasized item is usually learned more readily than would be a nonemphasized item in the same position, but the difficulty of learning the list as a whole remains the same as if no item had been emphasized (Jensen, 1962c; Newman & Saltz, 1958). When errors are reduced at one position, they are correspondingly increased at other positions, so that there is no overall advantage from emphasizing a particular element in the series. This seems to be true in spelling as well as in serial learning.

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