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Expected Locations of Digits and Letters on Ten-Button Keysets [1]

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Although keysets are used on a great variety of machine devices—computers, coding devices, and communications equipment—there appear to be few systematic studies concerned with the design factors that make keysets easy or hard to use. The study reported here deals with one aspect of keyset design, viz., the locations of numbers and letters on individual keys. In addition, we are concerned here with a particular class of keysets—ten-button sets used by long-distance telephone operators—but the results probably can be generalized to other practical situations.

In making long-distance calls, telephone operators use a set of ten keys, arranged in two vertical rows of five, with letters and numbers on the keys as shown in Fig. 1.

To complete a call, the operator usually keys a letter-number combination which looks like this:

815 RE 4–0267

The patterns of errors made by operators suggest that a different arrangement of the letters and numbers on the keys, or of the keys themselves, might help to reduce errors As a first step in the determination of the best arrangement of the keys and of the letters and numbers on them, we decided to find out where people say they would *expect* to find letters and numbers on six different keyset configurations, only one of which resembles the present set (see Fig. 3).

This is not an unusual approach in psychology. There are studies (1, 2) which show that learning is more rapid and errors are fewer for tasks in which the stimuli and required responses are in an "expected" relation than in those where they are not. If people have definite expectancies about the locations of numbers and letters on keysets, this would provide some rationale for the selection of particular keysets to be used in further operational tests.

The specific problem investigated had three parts:

1. Where do people expect to find numbers on each of six configurations of ten keys?
2. Where do people expect to find letters on each of six configurations of ten keys?
3. Where do people expect to find letters on each of six configurations of ten keys, given certain preferred number arrangements already on the keys?

Method

Subjects. The subjects for this experiment were classified according to (*a*) age, (*b*) sex, (*c*) previous experience on keysets such as appear on computing machines, typewriters, and musical instruments. Three hundred *Ss* were used, one hundred to answer each of the three questions, each one hundred chosen as in Table 1

Test Materials. The test materials consisted of booklets containing circles arranged in each of the six configurations shown in the top row of Fig. 3. Each configuration appeared on a separate page In Part I, a random arrangement of the digits 0 to 9 was printed on the page opposite each configuration of circles In Parts II and III a random arrangement of the alphabet (except the letters Q and Z) was printed on the page opposite each configuration For Part III only the booklets used configurations with numbers already printed in the circles (see Fig 2) The numbering arrangements selected were

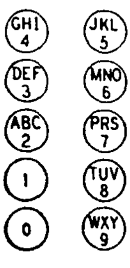

Fig 1 Arrangement of letters and numbers on a toll operator's keyset.

[1] This study was done at the Bell Telephone Laboratories

Table 1

Each of the Three Groups of 100 Subjects Was Composed of Sampling Subgroups Containing the Frequencies Shown Here

	Men			Women		
Age	20–30	30–40	Above 40	20–30	30–40	Above 40
Naive	8	9	8	8	9	8
Experienced	8	9	8	8	9	8

some of the most commonly chosen ones, as determined in Part I

For all parts, each configuration of keys appeared first in a set of one hundred booklets either six or seven times. Also for each group of one hundred booklets, there were equal, or as nearly equal as possible, numbers of the sets of letters (or numbers) beginning with each letter (or number) Each number or letter beginning a set appeared opposite each configuration of keys an equal number of times

Procedure. The experimenter read to each *S* instructions for filling out the booklets In Part I the instructions told the subject to· (*a*) Put only one number on each circle (*b*) Place the first number appearing in the list (opposite the circles) on a circle first, the second number appearing in the list on a circle next, etc (*c*) Place the numbers on the circles in the order in which he would like to use them if he had to key numbers all day long The instructions particularly stressed that the *S* should forget about any keyset arrangements which he may have seen in the past, and that the numbers (or letters) should be placed on the keys where he would *expect* to find them, in the most *natural* arrangement. (*d*) Fill the first configuration of circles first, then go to the next one.

In Part II the instructions were the same as those for Part I except. (*a*) The instructions did not specify the number of letters that the subject should place on one circle (*b*) All instructions were given in terms of letters, rather than numbers In Part III the instructions were the same as those in Part II except that the subjects were told that numbers already had been placed on the keyset

Subjects were given unlimited time, and were allowed to erase previous selections if they changed their minds part way through a page.

Results

Part I. The most frequently chosen number arrangements are shown in Fig. 3. The outstanding feature of the first choices is that the numbers are placed in order in horizontal rows, beginning with the top row. In the arrangements where there is an "extra" circle, the zero is placed in that circle. In the arrangements where there is no extra circle, the

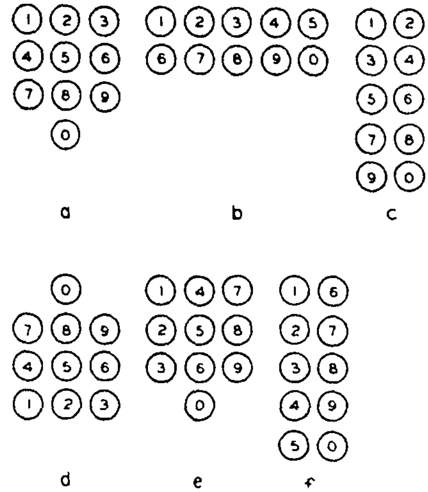

FIG 2 Configurations and number arrangements tested in Part III.

0 always follows the 9; it never precedes the 1

The second most frequent kind of choice generally has numbers in vertical rows, increasing from top to bottom. Numbering plans which arrange the numbers in horizontal rows, starting with the bottom row, are next most common.

Chi-square tests show that: (*a*) There were no statistically significant differences between the age groups in numbering arrangements for any of the six configurations. (*b*) There were no statistically significant differences between naive and experienced subjects in number arrangements for any of the six configurations. (*c*) There were statistically significant differences (at $.01 > p > .001$) between men and women in numbering arrangements for each of the four configurations containing three rows of circles with one extra circle (the men chose the preferred arrangements more often than did the women); there were no significant differences between the sexes on the other two configurations of keys.

Part II. The most frequently chosen lettering system agreed with the most common numbering system (see Fig. 3), i.e., the letters were placed in order in horizontal rows beginning with the top row. No matter what the configuration of keys, this lettering system was chosen by approximately one-third of the one hundred subjects. There were usu-

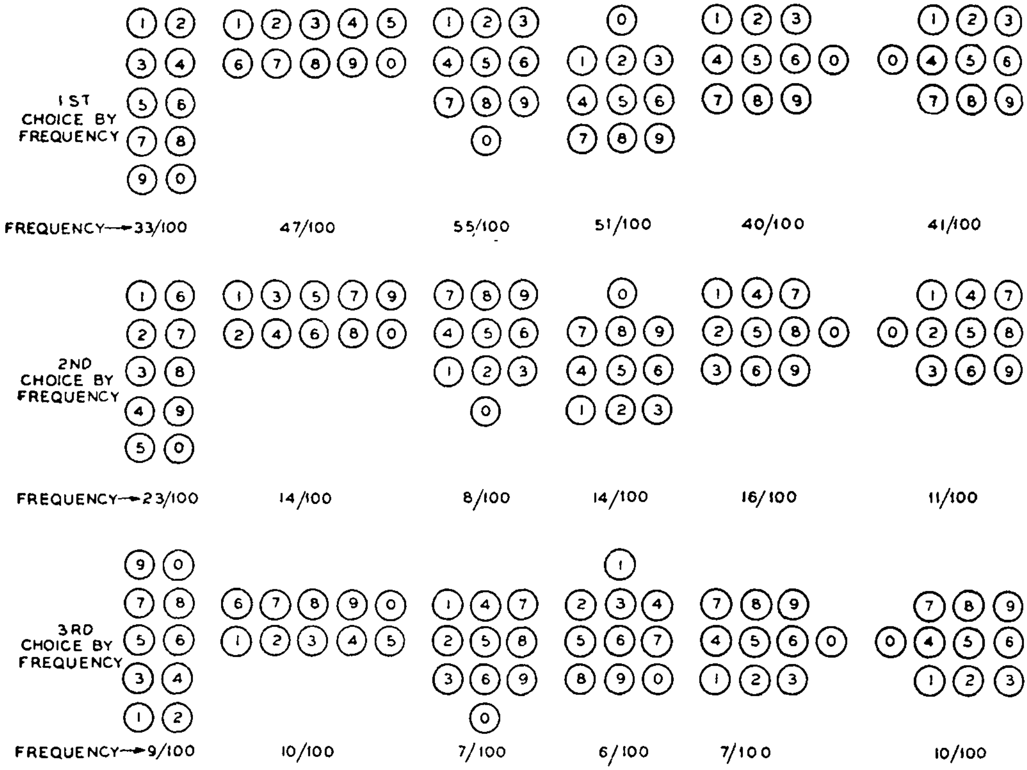

FIG. 3. First three choices by frequency for number arrangements on each of the six configurations tested in Part I

ally two or three letters in order on each circle. In the configurations where the "extra" circle is at the top, the first letters were placed in that circle; if the "extra" circle is at the bottom, the last letters were placed in that circle. If the "extra" circle is to one side of the others, letters were either placed in it filling it out as if it were an ordinary part of the horizontal row in which it lies, or the last letters were placed in it.

There were no statistically significant differences in lettering arrangements on any of the six configurations between (*a*) men and women, (*b*) naive and experienced subjects, (*c*) subjects in the three age groups.

Part III. Three of the configurations used in Part III (*a*, *b*, and *c* in Fig. 2) contain the number arrangements chosen most often by the Part I group for each of the three major classes of keyset design (that is, two vertical rows of five keys, two horizontal rows of five keys, and a 3 × 3 configuration with an odd key). For these three configurations, the most frequently chosen lettering system was the same as found in Part II, i.e., the letters were placed in order in horizontal rows, beginning with the top row. This lettering system was chosen for each arrangement by approximately one-half of the total group.

There were no significant differences between the choices of (*a*) men and women, (*b*) naive and experienced subjects, (*c*) the different age groups.

The other three configurations used in Part III (*d*, *e*, and *f* in Fig. 2) were selected because they represent some numbering arrangements which were chosen with fairly high frequency in Part I but which are markedly different from the most commonly selected ones. For these three configurations, the group was almost equally divided between a lettering system which followed the number arrangement on the keys (putting two or three letters in order on each key) and the lettering system which appeared most frequently on the other configurations in Part

III (in order in horizontal rows, beginning with the top row). Each of these alternative systems was chosen for each configuration by approximately one-third of the group.

According to chi-square tests, there were no significant differences between lettering arrangements chosen by (*a*) men and women, (*b*) naive and experienced subjects, (*c*) different age groups of subjects.

An incidental finding was that no subject arranged the numbers or the letters as they are now arranged on the keyset.

Discussion

The most obvious finding of this study is that people arrange numbers and letters in the order in which they normally read. This is true for all configurations of keys, for both numbers and letters, and for both experienced and inexperienced subjects. Of the several calculating devices we have been able to look at, only one (the IBM card punch) uses an arrangement which is highly preferred in this study. It resembles the pattern illustrated as the fourth from the left in the top row of Fig. 3. Two other calculators have keysets resembling the third from the left in the second row of Fig. 3. These are the multiplier keys on the Friden calculator and the keyset of the Remington Rand adding machine. Most other calculators have their keys reading upward in vertical rows of ten. In all of these, the "0" customarily is placed below the "1," a placement which was seldom found in our tests.

Of course, we have no assurance that these differences between calculator keysets are of any practical importance. In fact, our study of expectancies can be considered only a first step toward finding the keyset which would give the fewest errors and shortest keying times. The next logical step would be to test some most-frequently chosen letter and number arrangements against some of the least-frequently chosen ones in an actual keying situation.

A final word is in order concerning the greater consistency the men showed in choosing number arrangements. We believe that this may reflect a difference in experience between the two groups which was not taken into account in selecting our samples Virtually all of the men had technical training and were either engineers or their assistants, while most of the women were typists, clerical help, or maintenance people unexposed to any sort of technical training. Thus even our "inexperienced" men undoubtedly had greater familiarity with number systems and the arrangement of numbers on graphs and other displays than the corresponding group of women.

Summary and Conclusions

This experiment attempted to find out where people expect to find letters and numbers on each of six configurations of ten keys each. Three hundred *Ss*, stratified according to age, sex, and previous experience on keysets, were asked to write on diagrams of keysets either numbers or letters in the arrangements that they felt were most natural. Our results show:

1. People expect to find numbers on keysets arranged in left-to-right order in horizontal rows starting with the top row, for all of the six configurations of keys.
2. People expect to find letters on the keyset arranged in left-to-right order, with two or three letters in order on each key, in horizontal rows, starting with the top row, for all of the six configurations of keys tested.
3. With numbers already on the keyset: (*a*) People expect to find the letters arranged in horizontal rows, beginning with the top row, for those patterns in which the numbers are arranged that way. (*b*) When the numbers are arranged in patterns not having numbers in order in horizontal rows (beginning with the top row), people are equally divided between lettering arrangements following the numbering pattern and lettering as in (*a*) above even though this conflicts with the numbering arrangement.

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