

Studies of the Efficiency of Drug Labelling

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Two experiments on the effectiveness of drug-labelling are reported. The first compared typewritten with hand-written labels, and the second compared printed drug-labels varying in type size, form of type, and layout (centered or ranged left). A discrimination-test procedure was employed, the subjects having to select specified labels from a display. The results of the experiments showed (1) that typewritten labels were discriminated more readily than handwritten ones, (2) that labels printed with 10-point type were discriminated more speedily than labels printed with 6-point type, (3) that for labels printed with 6-point type, upper-case letterform was more easily discriminated than lower-case letterform, (4) the layout of the label design had no effect on discrimination.

Over the past few years there has been an increase in the number of people admitted to British hospitals suffering from accidental poisoning. In some cases, this has been due to out-patients making errors when taking medicines prescribed for them; either they have selected the wrong medicine, or they have taken the wrong quantity of the proper medicine (RSPA, 1966).

It has been suggested (Poulton, 1964) that clearer inscriptions would ease the task (a) of selecting the correct preparation, and (b) of reading the directions for use. There has been little evidence produced to support this suggestion. Indeed, there has been remarkably little scientific investigation of the problem of error in drug administration, either in the domestic environment or in hospitals.

Poulton (1964) experimented on a selection of labels which differed in lettering size, color of lettering, and color of the whole label. His results indicated (p. 218) "that inscriptions can be discriminated from each other more quickly either when they are printed in lettering larger than has generally been the practice, or

when the key differences are printed in contrasting colors. A combination of larger lettering in contrasting colors makes for the quickest discrimination. No added advantage is to be gained by printing the complete labels in contrasting colors." The lettering sizes varied in x-height from 1.6 mm. to 2.4 mm. in a series of experiments using labels which indicated different doses of a standard drug, and from 1.9 mm. to 5.9 mm. in experiments using labels bearing the names of different drugs. We suggest that since the number of drugs exceeds the number of discriminable colors (Eriksen and Hake, 1955; Hanes and Rhoades, 1959), a color for each drug is not feasible; however, a system of color-coding which distinguishes a few important groups of drugs could be devised. Alternatively, color-coding could be used to indicate strengths of certain preparations. (This technique is used with insulin preparations, for instance.)

The present experiments compare the discriminability of drug labels of various designs, and form part of a continuing research program being undertaken in the School of Advanced Studies of the Manchester College of Art and Design. The eventual aim of such a project is the production of a system of drug labelling which will minimize the chances of errors in drug administration.

EXPERIMENT I

The labels on drugs obtained from a pharmacist for domestic use tend to be handwritten. It is possible that some errors in administration are due to the difficulty of discriminating these labels. Our initial experiment, therefore, was designed to compare the discriminability of handwritten labels with that of typewritten ones. Bell (1939) reports that typewriting is read more quickly than handwriting when the speed of reading prose is the subject of study, but not when single letters or nonsense syllables are being perceived. Our problem, that of discriminating one out of a set of possible messages, was not considered by Bell.

Method and Procedure

The general method of assessing discriminability was the measurement of time taken to select a specific instruction from a display of different instructions.

Twenty-four students acted as subjects in the experiment. There were two groups of 100 labels, each label being 2 x 1 inches. Ten instructions commonly used on drugs administered by the patient himself were selected. These were:

One tablet three times a day

Two tablets three times a day

One tablet every four hours

Two tablets at once, then one tablet three times a day

One tablet three times a day after food

One tablespoon three times a day after food

One teaspoon three times a day after food

One teaspoon three times a day

One tablespoon three times a day

One tablet two times a day

Each instruction was typewritten onto ten labels, and also handwritten onto ten other labels. Ten people wrote each of the instructions onto a separate label, so that the handwriting of the labels varied. In this way, we hoped, the experimental display would be similar to that which an individual faces when he goes to his bathroom cupboard, for we would expect that most people—having accumulated drugs over a period of time and possibly from different pharmacists—have drugs with labels which have different handwriting on them. A single typewriter face was used for the typewritten instructions, partly for practical reasons and partly because we suspect that there is little difference in the legibility of the common typewriter faces. This assumption is supported by the experience of research comparing the legibility of printing typefaces (Pyke, 1926; Paterson and Tinker, 1932; Tinker, 1963; Poulton, 1965).

We, therefore, had two groups of 100 labels. One group consisted of the ten instructions typewritten ten times; the other group consisted of the ten instructions handwritten ten times. Each group of labels was mounted on a 29½ x 19¼-inch neutral grey board, with a half-inch space between each row and column of labels. The labels were arranged on each board in two 10 x 10 Latin squares, so that no instruction occurred more than once in any one row or any one column.

The 24 subjects were tested singly. Each subject wrote down an

instruction. One of the boards bearing the labels was then exposed, and he selected the ten labels on that board which had the same instruction as he had just written down. Selection was shown by placing a brass ring on the chosen label. Each subject went through this procedure four times, twice on each board. On the board bearing the typewritten instructions he selected the instructions: "One tablet every four hours" and "One teaspoon three times a day." On the board bearing the handwritten instructions he selected: "One tablet three times a day" and "One tablespoon three times a day." The order of presentation was decided from random number tables.

The data recorded was the time between the moment the board was exposed and the moment the last (tenth) ring was placed on the final label.

The subjects were instructed to correct any errors they might have made. If uncorrected errors remained, the row containing the wrongly selected label was indicated; and the time taken to select and correct the error by relocating the ring was recorded and added to the time taken on that trial.

Before the experimental trials, each subject had a practice trial on which he searched for symbols. He was asked to search the boards by a systematic technique of scanning each row, and the practice trial was used to give him the opportunity of using this system. The intention of this procedure was to prevent the subjects changing their searching strategy between trials, since this might have contaminated the results.

Results

The mean time taken to select a typewritten instruction from the display was 43.54 seconds; for the handwritten instructions, the mean time taken was 63.47 seconds. A t-test of the difference between these means indicated that the difference is significant beyond the .01 level. The selection of the handwritten instructions took 45.8% longer than the selection of the typewritten instructions.

The mean number of uncorrected errors made by each subject was 0.42 with the typewritten instructions, and 0.83 with the handwritten ones. The difference between these means is not significant at the .05 level.

Conclusions

The results of this experiment have demonstrated that typewritten instructions are more speedily discriminated than handwritten ones, with no loss in accuracy. We would, therefore, recommend that drug labels which are going from the pharmacy into the home should be typed rather than handwritten.

EXPERIMENT II

The second of our experiments compared the discriminability of printed drug labels of various typographic designs. The following three design features were studied: (a) type size, (b) upper-case and lower-case letters, and (c) ranged left and centered arrangements.

A considerable amount of research has been published which has investigated the legibility of type of various sizes. Paterson and Tinker (1940) compared the speed of reading type of a number of sizes, set in the optimal line length, and with the optimal amount of leading; and found that 9-, 10-, 11-, and 12-point Granjon were equally legible under these conditions. Glanville, Kreezer, and Dallenbach (1946) found that 6-point type was less easily perceived than 12-point type; they used the tachistoscopic method of investigating perceptibility. Other studies are included in Burt (1959) and Zachrisson (1965).

Tinker and Paterson (1932) report that upper-case letters can be read at a greater distance than lower-case. A further study by the same authors (1946) indicated that lower-case letters can be read significantly faster than upper-case. Breland and Breland (1944) found that lower-case letters are more speedily perceived than upper-case.

We have not, in our study of the literature, found the perceptibility of copy which is ranged left compared with that of centered copy. The only relevant research is that concerned with the justification of the right-hand margin of printed material (Hultgren, 1954; Powers, 1962; Fabrizio, Kaplan, and Teal, 1967), and Zachrisson's (1965) comparison of left and right, even and uneven, margins. All these studies have failed to show that justification increases legibility.

None of the experiments mentioned have used selection of one

message from a display as the test of perceptibility. Since we are concerned with this problem, we have performed experiments using this procedure before accepting the validity of the results of other experiments for a selection situation.

Method and Procedure

A similar method to that used in Experiment I was again employed, except that printed labels bearing the name of drugs were used.

Eight groups of 100 labels were formed, there being eight different label designs. The designs differed according to: (a) type size (6-point *or* 10-point), (b) letterform (upper-case *or* lower-case with initial letter only in upper-case), and (c) layout (ranged left *or* centered). Details of each particular design group are shown in Table I.

TABLE I. *Label design, drug names to be selected, and mean selection time*

| <i>Design of Label</i> | | | <i>Names to be Selected</i> | <i>Mean Selection Time in Seconds</i> |
|----------------------------|--------------------------------|-----------------------------|-----------------------------|---------------------------------------|
| <i>Type Size in Points</i> | <i>Ranged Left or Centered</i> | <i>Upper- or Lower-case</i> | | |
| 6 | R/L | UC | Hydroxyzine & Phentolamine | } 24.5 |
| 6 | C | UC | Ultandrell & Zactane | |
| 6 | R/L | LC | Zarontin & Eurermil | } 26.2 |
| 6 | C | LC | Bradasol & Ultandrell | |
| 10 | R/L | UC | Rastinon & Palaprin | } 22.45 |
| 10 | C | UC | Coscopin & Prednisone | |
| 10 | R/L | LC | Palaprin & Bialamicol | } 22.78 |
| 10 | C | LC | Dequadin & Biliodyl | |

Note: Since the data showed that the layout (ranged left or centered) had no significant effect on selection time, the scores for both these layouts were combined.

The specific hypotheses which were being tested were:

1. Ten-point type is discriminated more quickly than 6-point type.
2. Lower-case lettering with upper-case initial letters is perceived more quickly than upper-case lettering, when type point size is held constant.

3. Ranged-left layout gives a more easily perceived presentation of the printed information than centered layout.

Because this experiment concerns the discriminability of printed labels and because nurses are the ones who have to discriminate printed labels at the critical time before administration of a drug to a patient, it was decided to use nurses as subjects. A total of 33 nurses took part.

The labels were printed in Gill Sans, Medium and Bold. Bold type was used for the name of the drug. The other information relating to the strength and quantity of the drug was printed in Medium type. This information remained constant on each label. Gill Sans has been found to be a more legible typeface than some other sans-serif faces (Poulton, 1965). Sans-serif faces are not demonstrably less legible than serified faces, according to a number of criteria of legibility (Poulton, 1965; Zachrisson, 1965).

In each group of 100 labels of the same design, ten drug names were used, each occurring on ten labels of each 100. Drug names were selected randomly from the British Pharmacopoeia list of approved names. The labels printed in 10-point type were $1\frac{3}{8} \times 1\frac{1}{6}$ inches and were arranged on a neutral grey board $23 \times 19\frac{3}{4}$ inches. The labels printed in 6-point type were $1 \times \frac{3}{4}$ inches and were also arranged on a neutral grey board $23 \times 19\frac{3}{4}$ inches.

The size of the label was made proportional to the size of the type (10:6). The size of the board was kept constant, leaving more space between labels on the board bearing 6-point labels than on the board bearing 10-point labels. The board size was maintained for both label sizes so that the total area to be scanned would be the same under both conditions. Each group of 100 labels of the same design was mounted in a 10×10 Latin square; each name appeared only once in each row and column.

The 33 nurses were tested singly. She (or he) wrote down the name of a drug and then selected (from the board of labels presented) those labels bearing the name she had just written. Selection was shown by placing a ring over the chosen label. The time between exposure of the board and selection of the final label was recorded. Each subject had two trials on each board, using a different name on each occasion. Since each subject had two trials on each board, there was a total of 16 trials for each subject. The

order of presentation for each subject was decided from random-number tables. The names to be selected on each board were the only ones having their respective initial letter, so that perception of the correct name was not confused by other names with the same initial. The particular names to be selected from each display are shown in Table I.

Each subject was given a practice trial—searching for symbols—and was asked to scan the display systematically, by looking along the rows of labels beginning at the left-hand side of each row.

Results

The mean selection time for each label design is shown in Table I. The over-all mean score for labels with 10-point type was 22.61 seconds, and for those with 6-point type was 25.24 seconds. The difference between these means is significant beyond the .01 level ($t = 6.43$).

The over-all mean score for upper-case labels was 23.48 seconds, and for lower-case labels was 24.49 seconds. The difference between these means is significant beyond the .05 level. In order to classify the meaning of this result, the relative discriminability of the two letterforms for each type size were compared. The mean score for upper-case 6-point labels was 24.5 seconds and for lower-case 6-point was 26.2 seconds. The difference between these means is significant beyond the .01 level ($t = 3.41$). The difference between the mean score for upper-case 10-point labels (22.45 seconds) and for lower-case 10-point type (22.78 seconds) is not significant at the .05 level.

Conclusions

The results of this experiment show that labels printed in 10-point type are more easily discriminated than labels printed in 6-point type. Upper-case is not superior to lower-case for 10-point type, but is for 6-point type. This result is in line with the findings of previous researchers who have examined the legibility of type of different sizes. The use of upper-case in 6-point type increases the visual size to a very noticeable extent. Since a similar increase in visual size does not influence the discriminability of 10-point type, it would appear that using upper-case 6-point type

has the result of bringing the visual size above the lower boundary of easy discrimination. Research has tended to show that between 8- or 9-point and between 12- or 14-point, type is equally legible. When the size falls below or rises above these limits, legibility diminishes (Paterson and Tinker, 1940). This past work has used normal lower-case print, with upper-case for beginning sentences, names, etc. Nevertheless, 6-point upper-case is less legible than 10-point upper-case or 10-point lower-case, as Table I shows.

With respect to our third hypothesis, the two layouts we compared had no effect on discriminability.

On the basis of these results, we recommend the use of 10-point type for drug labels. With type of this size, whether upper- or lower-case is used does not appear to affect ease of discrimination. Ranging left or centering does not apparently affect legibility; we do not make any recommendations concerning layout. If 6-point type has to be used, it should be all-capital printing, since with type of this size upper-case is more easily perceived than lower-case.

None of the subjects in this experiment made any errors in selection. This may well be the result of nursing training. The student subjects used in our first experiment were less accurate in their selection.

Summary

Two experiments are described, both concerned with the general problem of the design of drug labels. The first experiment compared handwritten instructional labels with typewritten ones, and led us to conclude that pharmacists should use typewritten labels. The second experiment, which compared different label designs for containers of drugs used in hospitals, showed that 10-point type is preferable to 6-point type, since labels printed in 10-point type could be discriminated more speedily than those printed in 6-point type. Ranging left or centering the copy on the label had no measurable effect on discriminability. For 6-point type, upper-case was more easily discriminated than lower-case, but this was not demonstrated for 10-point type.

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