J. Pharm. Pharmacol., 1964, **16**, 213–219 Received November 28, 1963

Research Papers

Identifying the names and dosage of drugs

E. C. POULTON

Printing the different doses of a drug (morphine sulphate) larger or in different colours on labels was found to increase the rate at which they could be discriminated from each other by students. Rate of discrimination was measured by the mean time taken both to sort packs of labels, and to search among a matrix of labels. Printing the different doses of an antibiotic preparation (Pro-stabillin-A.S.) in large numerals of different colour made them as quick to discriminate from each other as were different coloured labels. It is believed that changes of this kind in printing could ease the job of finding the required medical preparation, and might reduce the number of instances in which the wrong preparation is given in error.

EVERY year instances are reported of patients receiving the wrong medical preparations. They have come to light either because the error was brought to the attention of the coroner, or because a claim was made for damages. The number which never come to light may be greater. The author believes that in many of these instances the error need not have occurred had the names and dosage of the drugs been clearer. For even if all those concerned had failed to read the label, a brief glance might then have suggested that all was not well, and a proper check instigated.

Clearer inscriptions would also ease the job of finding the correct medical preparation, especially when the illumination is poor. The need is illustrated by the statement of a district supervisor that it was her habit to purchase each of the standard drugs used by her midwives from a different drug firm. Thus the different colour and design of label conventionally used by each company helped the midwives to distinguish between the drugs in poor illumination.

Very little experimental work appears to have been published which is directly relevant to the needs of rapid and correct identification. The number of colours which can be unambiguously identified ranges from about 17 for unpractised people (Eriksen & Hake, 1955), to about 50 for the highly practised (Hanes & Rhoades, 1959). The identification of drugs and dosage by colour is thus of value principally to people who handle a very limited number of preparations. Colour coding is being used successfully for gas cylinders, for different types of insulin, and for local anaesthetics used by dentists. But the diversity of medical interest means that colour by itself cannot be a sufficient method of identification for general use, because there are unlikely to be adequate variations available to avoid duplication and its concomitant dangers.

The experiments reported here were designed to investigate the effects of the size and colour of inscriptions upon the ease with which they could be distinguished. Two different experimental techniques for measuring discriminability were used: sorting and searching.

From the Medical Research Council, Applied Psychology Research Unit, Cambridge.

Method

EXPERIMENTAL SUBJECTS

These were male undergraduates of Cambridge University. A separate group of 10 or 12 men was used for each experiment.

EXPERIMENTAL MATERIALS

The labels were all 3 × 2 inches. They represented either the fronts of cartons containing six 'viules', or the labels stuck onto bottles. In *Experiments* 1–3, 5 series of labels were examined as listed in Table 1.

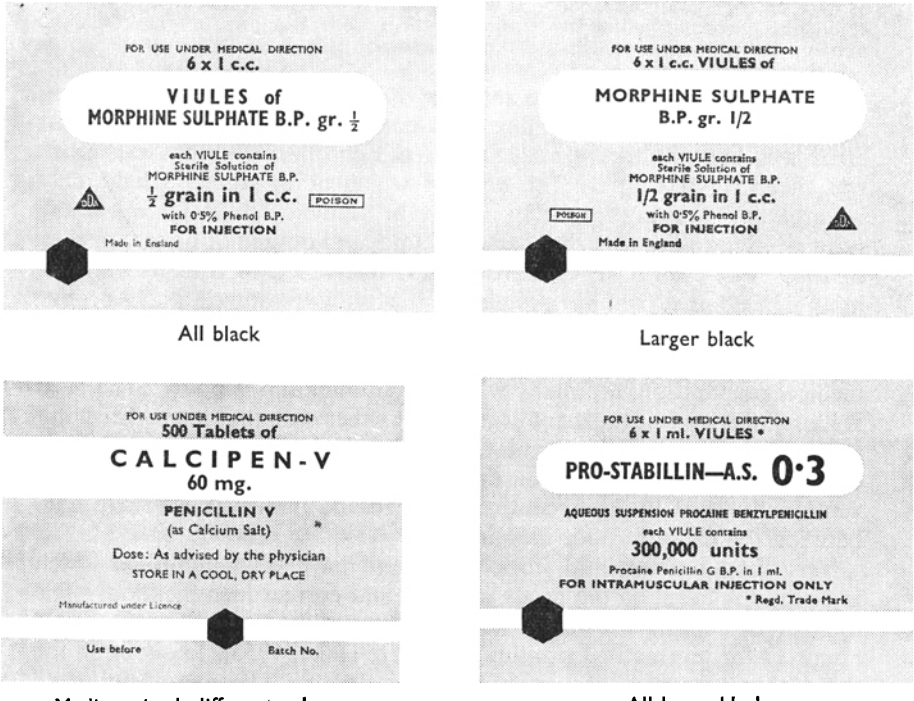

FIG. 1. Some examples of labels used. All 2/3 original size. See text and Tables 1 and 2.

Each series contained 5 doses. The labels were all Cambridge blue except for a white area normally $2\frac{1}{2} \times \frac{1}{2}$ inches. Here "MORPHINE SULPHATE" was printed in black on one line in capital letters 2·3 mm high, and generally on the line below: "B.P. gr." followed by the dose in grains: 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$. The colours in which the doses were printed, and the heights of the numerals used in the fractions, are listed in Table 1.

The numeral 1 of the "gr. 1" was always 2·4 mm high. For the fractions the numerator was normally printed directly above the denominator, separated from it by a horizontal line whose length varied from 1·2 to 2·0 mm; but for the "larger-black" series the numerator

and denominator were on the same line, separated by an oblique line 3·3 mm long, e.g. 1/2. In the "all different colours" series, gr. 1 was red, gr. ½ light green, gr. ⅓ middle blue, gr. ¼ light brown, and gr. ⅙ was black. In the "some different colours" series, gr. 1 and gr. ⅙ were both black, gr. ⅓ and gr. ¼ were both red, and gr. ½ was light green.

The "all black" series was actually in use, and the layout of these labels was different. The drug name and dose were always printed on a single line. For the gr. 1 label the white area was consequently reduced to a width of ⅜ inch. For the remaining labels "VIULES OF" was printed on the white area above the drug and dose. For the gr. ½ and ⅓ all the capitals were taller, 2·9 instead of 2·3 mm high. On the blue area of the labels was always printed the remaining details required either by law or by the convention of the company.

For *Experiment* 4, six series were used, each having three doses. The colours and the heights of the numerals are listed in Table 2. The series of "small different colours" contained the light green gr. ½, the middle blue gr. ⅓, and the red gr. ⅙ of the morphine sulphate labels used in the previous experiments.

In the three series of large numerals, black, red, and different colours, the numerals 0·3, 0·6 and 0·9, were 5·9 mm high. They were printed at the end of the same line as the name of the drug: "PRO-STABILLIN—A.S." (Aqueous suspension of procaine benzylpenicillin) which was in black capitals 3 mm high. The black numerals, which are the ones currently in use, were printed towards the end of a white area 2½ × ⅜ inches. The different colours series, which were the same as for the morphine sulphate labels, light green, red and middle blue, and the red series had a wider area of white 2½ × ½ inches.

The series of "medium-sized different colours" had a white area 3 × ⅜ inches. On this was printed "CALCIPEN—V" (penicillin V as calcium salt) in capital letters 3 mm high, and on the line below the dose in numerals 2·9 mm high. For the 60 mg label the name and dose were both black; for the 125 mg label both were light green, and for the 250 mg label the name was in black and the dose in red.

Of the different coloured labels, "SULPHADIMIDINE SUSPENSION" was printed in black capitals 3 mm high on a white area 3 × ⅜ inches extending across an otherwise Cambridge-blue label. "SULPHAGUANIDINE SUSPENSION" was printed similarly on a yellow label. "TRIPLE SULPHONAMIDES SUSPENSION" (sulphathiazole, sulphanilamide and sulphadimidine) was printed in middle-blue capital letters 2·4 mm high. "SUSPENSION" was on the white area below, and the rest of the label was pink.

For the *Sorting* Experiments 1 and 2, packs of 60 cards were prepared for each series, containing 12 specimens of each of the five doses. The cards were arranged in random order, but were all the same way up. French chalk was used to prevent the cards from sticking together. The cards had to be sorted into two tins, each 4½ × 4½ and 1¾ inches deep, one for selected the other for discarded cards. The tins were placed side by side on a table in front of the student.

For the *Searching* Experiment 3, the packs of cards were arranged in a 6 × 10 matrix for each series on sheets of black cardboard 20 × 25 inches so that there was a black margin of about ¼ inch separating each card from the next. The arrangement was random apart from the following restrictions: (*a*) every row of six cards contained at least one card of each of the five kinds; (*b*) every column of 10 cards contained two cards of each kind; and (*c*) two cards of the same kind could not be adjacent in a row or column.

For the *Searching* Experiment 4 a pack of 36 cards was prepared for each of the six series, and contained 12 specimens of each of the three kinds of label in the series. The pack was arranged in a 6 × 6 matrix on a sheet of black cardboard 20 × 15 inches. The arrangement was random apart from the restriction that every row and column contained two cards of each kind. For both searching experiments (3 and 4) twelve brass-coloured curtain rings 1 inch in diameter had to be placed on the 12 selected cards of one kind.

Illumination during all the experiments was either by good daylight from an adjacent window, or by a 60-watt anglepoise lamp located about 2 ft 6 inches directly above the display.

EXPERIMENTAL DESIGN

In Experiments 1–3, the five series of labels and five doses were arranged in a graecolatin square (Fisher, 1935). This meant that each student discriminated each dose only once, and worked with each series only once. Five students were needed to examine every combination of dose and series. A second five students performed the same conditions in the reverse order to the first five students. A corresponding design was used in Experiment 4 for the six series of labels and three kinds of label within each series. This called for two subgroups each of six students.

PROCEDURE

In the *Sorting* Experiment 1 the student held a pack of cards with the faces upwards. At a signal from the experimenter he had to sort the 12 cards of one particular dose into the left hand tin, and the remainder into the other tin. He was told to work as quickly as he could without making any errors. The experimenter timed him with a stop watch. When he had finished he was told how long he had taken, and the cards were inspected for errors. He was then given the next pack to sort.

The procedure was identical for Experiment 2, except that (*a*) the pack of cards had to be held face downwards, so that the student could not look at the next card while disposing of the previous one; and (*b*) he was told that if he noticed that he had put a card in the wrong tin, he was to remove it and put it in the correct tin. As a result there were never any errors at the end of a trial.

In the *Searching* Experiments 3 and 4 the student held 12 curtain rings, and had to place one on each card of a particular kind. He was told to work as quickly as he could without missing any of the 12 specified cards. The experimenter again timed him, and told him at the end how long he

had taken. Errors never occurred. The experiment was preceded by a practice to teach him the search systematically, taking each row or column in turn. Unsystematic searching was found to give very variable times, since the student might have to search the whole display a second time in order to locate the last specified card. The practice was on a matrix of the same size as the experimental matrices, but carrying simple shapes instead of cards. The student practised placing rings first on one shape and then on another, until he had been convinced of the necessity of a systematic strategy. The average practice was 1·5 trials.

Results

The mean times taken are given in Tables 1 and 2. Analysis of variance showed that differences as great as those between the means of Experiment 2 would occur by chance less often than once in 1,000 experiments.

TABLE 1. MEAN TIME TAKEN TO IDENTIFY DOSES OF MORPHINE SULPHATE

Printing of doses Series	Numeral height in mm	Sorting (sec per card)		Searching (sec per ring)
		Face up Exp. 1	Face down Exp. 2	Exp. 3
All black	1·6	0·77	1·27	1·96
All red	1·9	0·74	1·22	1·78
Larger black	2·4	0·82	1·12	1·63
Some different colours	1·9	0·77	1·13	1·46
All different colours	1·9	0·67	1·14	1·40
0·5% point for the reliability of differences		0·16	0·10	0·28

TABLE 2. MEAN TIME TAKEN TO IDENTIFY LABELS

Printing of doses Series	Numeral height in mm	Searching (sec per ring) Exp. 4
All large red	5·9	1·06
All large black	5·9	0·97
Small different colours	1·9	0·90
Medium sized different colours	2·8	0·87
Large different colours	5·9	0·77
Different coloured labels	—	0·78
0·3% point for the reliability of differences	—	0·20

The same held for Experiments 3 and 4, but differences as large as those between the means of Experiment 1 would occur by chance more often than once in 20 experiments. This is indicated in the bottom line of the tables by an estimate of the size of the smallest difference between any two means in the corresponding column which can be accepted as reliable statistically. The probability level of 5% which is accepted by convention has been divided by 10 in Table 1 since there are 10 possible comparisons, and by 15 in Table 2.

The results of Experiments 2 and 3 in Table 1 show that discrimination took longest with the "all black" series at present in use, and reliably less time was taken both with larger black numerals and with numerals

printed in different colours. The slight advantage in Experiment 3 of different colours over size was not reliable statistically. There was virtually no difference between the series containing some different colours and the series containing all different colours.

The results of Experiment 4 in Table 2 show that large numerals printed in different colours were reliably quicker to discriminate from each other than were large numerals printed all in one colour, either black or red. They were in fact discriminated as quickly as were complete labels printed in different colours. The slight advantage shown by doses printed in small or medium-sized numerals of different colours, over doses printed large in a single colour, was not reliable statistically.

There were no errors in Experiments 2–4. In the *SEARCHING* Experiments 3 and 4 this was presumbly because the student could see where he had put his rings. In the *SORTING* Experiment 2 it was because he never made an error without spotting it at once, and had been instructed to correct any error he spotted. There were altogether six errors in the sorting Experiment 1. All involved failing to select one of the 12 cards which had to be picked out from the rest. Half the errors were for the "all red" numerals, but the overall number is too small to allow statistical treatment.

Discussion

The results show that inscriptions can be discriminated from each other more quickly either when they are printed in lettering larger than has generally been the practice (Table 1), or when the key differences are printed in contrasting colours (Tables 1 and 2). A combination of larger lettering in contrasting colours makes for the quickest discrimination (Table 2). No added advantage is to be gained by printing the complete labels in contrasting colours.

When only three different colours were used for the five doses of morphine sulphate (Table 1, Some different colours), the doses were discriminated from each other about as quickly as when five different colours were used (Table 1, All different colours). This suggests that the students cannot have been using colour alone as a basis for their discriminations, but rather a combination of colour and dose.

Sorting with the cards held face downwards in Experiment 2 was about equally sensitive to the differences in printing as was searching in Experiment 3. However, sorting with the cards held face upwards in Experiment 1 did not discriminate very adequately between the five series. This was presumably because with the cards held face upwards the student could be deciding where to place the next card while he was disposing of the last. Thus sorting time was determined almost entirely by the relatively long movement time, which was the same for all conditions, and hardly at all by the differences in the time needed to discriminate between the different inscriptions. An earlier pilot experiment, using a separate group of 17 students, also failed to discriminate between the series. Here the cards had to be sorted into five tins, each labelled with one of the cards, and ordered by dose from gr. 1 on the left to gr. $\frac{1}{6}$ on

the right. The overriding difficulty appeared to be to remember the correct location of the tins without having to check their labels each time, a difficulty which was shared by all five series.

Acknowledgements. I am most grateful to Dr. B. Garforth, Deputy Production Manager of the Fine Chemical Department of Boots Pure Drug Co., Ltd., for discussing these problems with me and for providing the labels used in the experiments. Financial support from the Medical Research Council is also gratefully acknowledged.

References

Eriksen, C. W. & Hake, H. W. (1955). *J. exp. Psychol.*, **50**, 153–160.
Fisher, R. A. (1935). *The Design of Experiments*, Edinburgh: Oliver & Boyd.
Hanes, R. M. & Rhoades, M. V. (1959). *J. opt. Soc. Amer.*, **49**, 1060–1064.