Applied Ergonomics 1977, 8.2, 73–77

Searching for names in two city street maps

R.J. Phillips and Liza Noyes

Department of Psychology, University College, London

Two experiments investigated the speed with which names could be found on maps from two London street atlases. Differences in grid referencing between the maps accounted for large differences in search times. However, small statistically significant differences were still present when grid references were not being used, and these cannot be explained in terms of map scale, nor in terms of greater familiarity with the faster map. Several design differences could have contributed to this effect and it is likely that the use of lower case type on the faster map was an important factor. Implications for the map designer are discussed.

Introduction

There is no doubt that visual search is an important skill in any type of map reading. Locating features on a map can be as time consuming as interpreting them, and with more complicated maps the search problem deserves careful attention by the map designer. Bartz (1969, 1970) has argued that a search task is the most appropriate way of evaluating type legibility on a map.

When using a city street atlas the map reader sometimes has to locate one street among many thousands of others and so the search task is particularly difficult. This study looks at the way two London street atlases have tackled this design problem, both in the way streets are depicted and in the grid referencing system used.

Geographer's A to Z and *Nicholson's Street Finder* are similar publications in that they both cover most of the Greater London area. Both show central London on an enlarged scale, although this study is only concerned with the outer areas where the scale for *Street Finder* is 1:20 000 and for *A to Z* is 1:25 300, and where maps are printed in black only. Table 1 and Fig. 1 show that there are large differences between the two maps, the 1974 paperback editions of which were employed for the present experiments. It must be emphasised that this study does not attempt a complete evaluation of the two atlases, but simply looks at one aspect of them, the time it takes to find a street.

Experiment 1

Here three types of search task were used: (1) searching for a particular street within an area 1 km square, (2) searching for a street in a whole page taken from the atlas, knowing the grid reference of the street, and (3) finding the grid reference of a street in a section of the index, and then finding it on a page taken from the atlas. These tasks were chosen to compare the atlases in several respects: the speed of searching on the map, the efficiency of the grid referencing system, and the efficiency of the index.

Subjects were 12 men and 12 women, all of whom were students from University College London. Six men and six women were assigned randomly to the two types of map. They were tested individually and all followed an identical procedure. In all, the same 15 questions (specifying tasks to be carried out with the maps), the same areas and the same streets were used for both types of map. The areas were

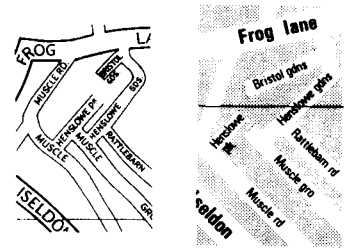

Fig. 1 Small areas of map drawn in the style of Street Finder (right) and A to Z (left). The reader is referred to the original publications for a more accurate picture

chosen at random, although none were used which overlapped a page in either atlas. Nor was any area used which showed very few features. On the first question, subjects were shown a map depicting an area 1 km square, mounted on a card, and with the name of a street typed above it in lower case letters. They were told to search quickly, pointing to the street on the map as soon as they found it. A stopwatch was used to time the period from the card being exposed to the subject's response. The next four questions were similar to the first. For the following five questions a different procedure was used. The subjects were given a street and its grid reference, for example, 'Remington Street 4B', and they searched a whole page taken from the atlas. In the final five questions, subjects were given a street and its district, for example, 'Leaside Avenue, N10', which they looked up in a column taken from the atlas index, and then located the street on a page using the grid reference.

At the end of the session subjects were asked whether they already knew any of the streets for which they had been asked to search. Their replies indicated that no one knew any street well enough to affect the search times.

Table 2 shows the mean search times for the two types of map on each question. On 13 out of 15 of the questions, the times for *Street Finder* are shorter than for *A to Z*. Totals for each type of question were compared using two-tailed Mann-Whitney U tests. On questions 1 to 5 the difference between the maps was not statistically significant, but on the other questions, differences were highly significant.

When searching for a name in a small area of map, (see the results for questions 1 to 5 in Table 2), *Street Finder* appears to be faster. However, two out of the five questions show results in the opposite direction. Furthermore, on the total search time taken over all five questions the difference between the maps is not statistically significant. With the other types of question *Street Finder* is, without doubt, faster.

In questions 6 to 10, subjects looked for a street knowing its grid reference. On average, subjects took 12 s longer to find a street on *A to Z* than on *Street Finder*. This difference is almost certainly due to the different grid referencing systems used in the atlases (see Table 1). While a grid reference for *A to Z* locates an area of about 0·77 km^2, *Street Finder* locates an area of about 0·03 km^2. The effect of grid size has been neatly demonstrated in an experiment by Stilitz (1976). Subjects looked for streets on a large format 1:12 500 map of Jerusalem and the shortest times were recorded when the map had a 0·5 km grid square, and times increased when either a coarser or a finer grid was used. A second experiment suggested that search times could be split into two parts: the time taken to locate a grid square and the time taken to find a street within a square. These results imply that as the size of grid increases the first time should decrease and the second increase. The converse should be the case when grid size is decreased. This results in a U-shaped relationship between grid size and search time.

Table 1: Some important differences between *A to Z* and *Street Finder*

Design features	A to Z	Street Finder
Scale	1: 25 300	1:20 000
Lettering style	Hand lettered capitals	Univers, lower case with an initial capital
Street casing	Bordering lines	Background of a dot screen, streets white
Grid lines	Grid squares are 31 by 39 mm corresponding to 0·78 by 0·99 km. The lines are broken across lettering	Grid squares are 37 by 45 mm corresponding to 0·74 by 0·90 km, but the index locates an area 9 mm square corresponding to 0·18 km square. Lines are not broken across type

In the last five questions, subjects were also using grid references but they had the additional task of finding the street in the index. It is possible that the faster times found with *Street Finder* were due entirely to the difference in grid referencing demonstrated in the previous questions. However, comparing the two types of map, the mean difference in search times for questions 6 to 10 was 12·1 s, but this increased to 15·2 s for questions 11 to 15. This increase could be due to advantages in the design of the index for *Street Finder*, but without further data it is impossible to be sure of this.

In real life, people may often prefer to search for a street knowing its general area, rather than looking it up in the index, and it was true for both atlases that times for searching within a 1 km square were shorter than times when the names were looked up in the index. Given a real index, where considerable time would be spent in finding the right page, it is clear that people's general strategy is right: when the rough location of a street is known there is no advantage in using the index.

The results of the first five questions suggested that searching a 1 km square may be faster on *Street Finder* than on *A to Z*, and it is possible that this difference was due to the slightly larger scale employed on *Street Finder*. This possibility was tested in a second experiment. As before, 1 km squares of map were used, but for *Street Finder* these were photographically reduced to the same scale as *A to Z*. It is, of course, bad design practice to change a map's scale by simple photographic reduction but in this case the change is quite small. If *Street Finder* were still faster than *A to Z*, despite the disadvantage of being reduced to an inappropriate scale, some other explanation would be needed.

Experiment 2

One hundred and thirty-two first year London undergraduates doing a geography course were tested as a group and were randomly assigned to work with either *Street Finder* or *A to Z*. Those using *A to Z* received a booklet including a page with 12 areas taken from the atlas, each depicting an area 1 km square, and with the name of a street above each, set in 8 point lower case Baskerville. The pages for *Street Finder* were similar, using the same streets, but the maps were photographically reduced to a scale of about 1:25 300. Subjects were given 3 min to locate as many streets as possible, marking the street on the map when they found it. They were told to tackle the areas in numbered

Table 2: The results of Experiment 1. Mean times are shown in seconds with standard deviations in parentheses

Question		Mean time with *Street Finder*	Mean time with *A to Z*	Two-tailed Mann-Whitney U test
Searching for a name in a 1 km square	1.	6·0 (1·9)	10·9 (6·0)	
	2.	10·8 (6·2)	12·3 (6·4)	
	3.	9·5 (8·4)	30·2 (23·0)	
	4.	15·7 (17·0)	10·5 (5·8)	
	5.	14·9 (13·2)	13·1 (11·9)	U = 44; n = 12, 12;
	Total	56·9 (23·9)	77·0 (33·1)	p > ·1 (not sig.)
Searching on a page knowing the grid reference	6.	8·7 (6·1)	15·7 (7·1)	
	7.	6·4 (1·6)	25·9 (18·0)	
	8.	5·8 (1·0)	27·8 (12·4)	
	9.	5·5 (1·3)	10·5 (7·5)	
	10.	6·2 (1·3)	13·5 (5·7)	U = 2; n = 12, 12;
	Total	32·6 (8·8)	93·4 (37·7)	p < ·001
Finding the grid reference in an index and searching	11.	15·6 (11·4)	22·3 (5·3)	
	12.	14·6 (6·4)	26·5 (16·0)	
	13.	14·6 (6·6)	35·1 (12·7)	
	14.	19·4 (17·8)	38·6 (27·6)	
	15.	12·0 (3·6)	29·7 (19·4)	U = 13; n = 12, 12;
	Total	76·2 (29·1)	152·2 (44·4)	p < ·001

order, but they could skip past an item which they found difficult. After the test, they answered a questionnaire to discover whether they already knew any streets they had been asked to locate, and to find out about their use of street maps in general.

The results were eliminated of seven subjects who failed to follow the instructions and of eight subjects who already knew one or more of the target streets. The remaining 117 were aged between 18 and 22. The 30 men and 26 women who used *A to Z* maps found a mean of 8·2 streets (SD = 2·5), while the 39 men and 22 women who used *Street Finder* found a mean of 9·7 (SD = 2·2), and this difference is statistically significant ($t = 3·5$, $df = 115$, $p < ·001$, two tail). It is clear that even when *Street Finder* is reduced to the same scale as *A to Z*, locating a street on *Street Finder* is significantly faster. The difference between men and women was not statistically significant ($t = 1·5$, $df = 115$, $p > ·1$).

The questionnaire given after the test asked subjects how often they used a city street map, either in London or elsewhere. Three per cent answered 'never', 10% answered 'about once a year', 45% answered 'about once a month', 34% answered 'about once a week', and 7% answered 'more than once a week'. The correlation between this question and the score on the test was low ($r = 0·10$). However, it was found that men used street maps significantly more often than women ($r = 0·19$, $p < ·05$, two tail).

Another question asked, 'Which London street map do you use most frequently?', and this was followed by a list of possible answers. Seventy four per cent answered *A to Z* while only 6% answered *Street Finder*, suggesting that it is not possible to explain the results of the experiment in terms of greater familiarity with *Street Finder*. Ten per cent reported using another London street atlas, *London Street by Street*, which is closer in design to *A to Z* than to *Street Finder*. While there is no doubt that most subjects had used *A to Z* in the past, Londoners use 'A to Z' as a generic term for a street atlas, and it is possible that some subjects answered 'A to Z' when they could not remember which atlas they had used.

Discussion

Experiments 1 and 2 demonstrated that *Street Finder* is superior to *A to Z* on two types of search task, searching a small area of map and searching with a grid reference. It is, of course, possible that *A to Z* is superior to *Street Finder* on other kinds of map reading task and, indeed, *Street Finder* has been criticised for navigation purposes because of the way streets have been straightened. *A to Z* is clearer than *Street Finder* in labelling long roads from beginning to end, and this may also aid navigation, although there has been no experimental study of these points.

The aim of this paper is not to evaluate the two atlases, but to investigate their differences in the hope of discovering useful cartographic design principles. There is little doubt why *Street Finder* is superior when a grid reference is used, the search is narrowed down to a much smaller area. But why is *Street Finder* faster when searching a 1 km square? The questionnaire showed that more subjects had used *A to Z* previously and so familiarity cannot be the explanation. The hypothesis tested in Experiment 2 was that the difference was due to scale, but this also must be rejected. There are three other differences in design, one or more of which could have caused the difference in speed. First, there is the different style of casing used in the two maps (bordering lines or dot screen). Second, there is the fact that street names on *Street Finder* are generally straighter than those on *A to Z*. Third, there is the lettering style itself which differs in several respects between the maps.

In *A to Z*, streets are cased with lines, while in *Street Finder* they are white areas against the background of a dot

screen. The names on *A to Z* are lettered in a size which brings them close to the bordering lines. On *Street Finder*, however, there is a larger space between the letters and the beginning of the dot screen. Can these design differences account for the difference in search speeds? In searching for names, peripheral vision is important. It is used in locating the beginning of a name and some names may be eliminated even though they never fall on the most sensitive part of the eye, the fovea. Previous research has shown that when letters are to be identified in peripheral vision, anything in the vicinity of the letter can have an interfering effect. For example, an isolated letter in peripheral vision is much easier to recognise than the same letter flanked by other letters (see Woodworth and Schlosberg, 1954, p 104). Just as these flanking letters have an interfering effect, it is possible that the bordering lines on *A to Z* interfere with the name. However, this is not a likely explanation. An experiment by Shaw and Weigel (1973) has shown that, in identifying letters in peripheral vision, a solid black bar has no interfering effect, accuracy is the same when the bar is replaced by a blank space. This suggests that interference is only caused by features with a number of lines and edges, like letters themselves, and therefore the bordering lines on *A to Z* are unlikely to have interfered with the perception of letters. But it is still possible that casing style affects the ease with which the beginning of names can be located. Although intuition suggests that the close proximity of lettering and lines on *A to Z* could interfere with the location of names, the lack of any relevant research makes this difficult to justify, and it is still possible that the screen dots on *Street Finder* could be a greater source of interference.

Many of the roads on *Street Finder* have been straightened to avoid the use of curved type. This has some disadvantages, for example, a road called 'Hillside Crescent' appears unexpectedly angular. However, we are not used to reading words where the letters are arranged along a curve, and this unfamiliarity may reduce our efficiency in searching for names. An experiment by Foster and Kirkland (1971) has compared the use of curved and straight print on two versions of a monochrome map. Searching for straight names was significantly faster, although it is possible that the difference was due to the slant rather than the curvature of the names: straightening the names had also made many of them horizontal. The absence of curved names on *Street Finder* may have contributed to the faster search times, but it cannot completely explain them: the proportion of names which differ in this way is far too small.

The lettering style differs considerably between the two atlases. An experiment on the legibility of type on conventional maps (Phillips, Noyes and Audley, 1977) investigated the effect of type style on the speed of searching for names. Typeface and typeweight had little effect on search speed, but size and case had significant effects: 8 point was superior to 6 point and lower case type with an initial capital was superior to capitals of the same point size.

Differences in average size of lettering cannot account for the differences in search speed: in Experiment 2 the average size of capital letters was similar on the two types of map. However, *A to Z* uses capitals and *Street Finder* uses lower case. Phillips *et al* (op cit) found that when names were easily pronounceable, and when they were initially read in lower case type (as in these experiments), search speeds were 13% faster with the lower case type than with capitals. The difference between conditions found in Experiment 2 was about 18% and so the difference in case appears to go some way towards explaining the difference in search speed. It is possible that printing the names above the maps in lower case type has enlarged the difference. If these names above the maps had been capitals the legibility experiment would still have predicted faster search with lower case type on the map, but with a difference of only 6%.

While the average size of lettering is unlikely to have affected search speed, the maps differ in the number of sizes used. *Street Finder* employs only two sizes, while the hand lettered names on *A to Z* come in a wide range of sizes. Bartz (1970) has compared search speeds on maps where names appeared either in one size, or in several sizes. When the subject knew the size of the target, search was faster on the map employing a number of sizes. But when the size of the target was not known, the single size map produced faster times. In the street map experiments and, often when using street maps in every day life, the map reader does not know the importance of a street and so is unable to predict the lettering size used on the map. In this situation it is probable that names are found faster when there are only two sizes, as on *Street Finder*, than when there are several sizes, as on *A to Z*.

To summarise, four factors may have contributed to faster search speeds on *Street Finder:* straighter names, lower case type, fewer size categories, and the use of lower case type in presenting target names. The last factor is not a consequence of design differences between the maps, but results from the experimental method used in the present investigations. However, it can be argued that addresses generally appear in lower case type or in hand-writing, and therefore lower case presentation is the more typical. Other legibility data suggest that even if capitals had been used, the advantage of *Street Finder* would still remain.

This study has investigated the way map design affects search speed in street maps and, while it is by no means a complete investigation of the subject, it suggests two design factors which are of particular importance: the cell size of the grid referencing system and the case used for type or lettering. It would be interesting to take the investigation further and create hybrid maps, for example, by using the type from *Street Finder* with the casing of *A to Z*. This would give more precise information about exactly what aspects of maps affect search speed.

It would not be difficult for the map designer to carry out a similar study to compare, for example, old and new versions of the same map. Our approach differs from that of Bartholomew and Kinniburgh (1973) who discussed the compilation of a city plan of Edinburgh, applying ideas drawn from communication theory, *gestalt* psychology and the study of mental maps.

Although their approach was original and stimulating, it has the drawback of using theory which is difficult to interpret on specific points of map design. Our approach has been a functional one: how well does a map fulfil some of the purposes for which it was designed? Can the map reader use it efficiently?

Cartographic theory of the kind employed by Bartholomew and Kinniburgh is a potentially valuable aid to map design

but theory needs to be supported by evidence, and without data to prove that a particular theoretical approach really does lead to the design of more efficient maps, it is inevitable that this year's cartographic theory will soon be dismissed as last year's cartographic fashion.

Note

This work forms part of the Social Science Research Council project HR2917/1 awarded to Prof R.J.Audley and Mr R.J. Phillips. We gratefully acknowledge the Council's financial support.

This work has been carried out independently of the Geographers' Map Co Ltd and Robert Nicholson Publications. The authors have no connection with these companies.

References

Bartholomew, J.C., and Kinniburgh, I.A.G.
1973 *Cartographic Journal,* **10**, 59–62. The factor of awareness.

Bartz, B.S.
1969 *Journal of Typographic Research,* **3**, 387–398. Search: an approach to cartographic type legibility.

Bartz, B.S.
1970 *Cartographic Journal,* **7**, 103–112. Experimental use of the search task in an analysis of type legibility in cartography.

Foster, J.J., and Kirkland, W.
1971 *Bulletin of the Society of University Cartographers,* **6**, 40–45. Experimental studies of map typography.

Phillips, R.J., Noyes, L., and Audley, R.J.
1977 *Ergonomics,* in press. The legibility of type on maps.

Shaw, P., and Weigel, G.A.
1973 *Perception and Psychophysics,* **14**, 117–124. Effects of bars and blanks on recognition of words and non-words embedded in a row of letters.

Stilitz, I.
1976 Target location in an urban map as a function of grid size and road density. Unpublished manuscript.

Woodworth, R.S., and Schlosberg, H.
1954 "Experimental Psychology." Third edition. New York: Holt.

ERRATUM.

This error appeared in the journal but has been corrected in this reprint,

Figure 1.
The words "left" and "right" should be reversed.