

## The Case for a Standard Word Space

Some definitions from *On Human Communication* (Colin Cherry, MIT Press, 1968):

*Sign* a transmission, or construct, by which one organism affects the behaviour of another, in a communication situation.

*Attribute* any property of a phenomenon, thing, event . . . assumed by the observer to be significant.

*Attribute space* the (mathematical) hyperspace, the coordinates of which represent the attributes of some phenomenon. Also called "system space", "phase space", in certain cases.

### *Argument*

When a particular typographical sign, say a lowercase roman s, of a particular sort (set, font) is repeated in the context of a meaningful sequence of signs, say a sentence, we expect the dimensional attributes of the sign to be consistent at every appearance. If it does not appear so, we replace it by a sign of the correct sort. (A sign can be said to be dimensionally consistent with another sign when all the coordinates used to describe the first sign can be mapped, one-to-one, onto all the coordinates used to describe the second sign.)

The particular sign we use to group other signs meaningfully within the context of a sentence is, by convention, the absence of a mark. We call this not-mark sign a "word space." We could replace this sign by a particular sort of mark which we would expect to be dimensionally consistent at every appearance. The fact that we prefer to use a not-mark sign does not change the need for particular signs to be dimensionally consistent.

By establishing a standard for the word space in the context of a sentence, we grant ourselves the freedom to use multiples of the norm for other functional purposes. Alternatively, we are free to continue the irrational practice of horizontal justification.

If we accept the argument for a standard word space and we agree that not-marks in the typographical mode of language are signs of a particular sort, we can go on to examine the implications of the argument for all not-marks which exist in the structure of the language, from the space which occurs between individual marks, upwards.

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## Experimental Use of the Search Task in an Analysis of Type Legibility in Cartography

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Search was used as an experimental task to investigate one aspect of legibility in cartographic typography. Subjects searched a variety of maps under several different conditions. There are four major conclusions from this research. For random search of the maps containing only one typeface, the typographic variation from map to map did not produce a significant effect on average search time. On mixed-type maps, search is slowed if the user has no correct expectation of the appearance of the type in which the target name will appear. On these same maps, search is greatly speeded if the user has a correct expectation of the target name appearance. Search time in a one-name task is less a function of typography than it is of many other factors.

We have shown in two previous articles that legibility in cartography must be evaluated in some way other than with the speed-of-reading and comprehension measures normally used in text legibility studies. Search seems a likely task to use in evaluating map typography, and research was conducted which utilized the search task. This final article considers two major questions:

Part One: Are there type characteristic variations which might affect search time for an *entire map*?

Part Two: Are there type characteristic variations which might affect search times for *individual names*?

The possibility exists that very different, even contradictory, answers might be found for these two questions.

### *Experimental Conditions*

About 300 seventh- and eighth-grade students in Chicago, Illinois, and Lakewood, Ohio, were given lists of place names during individual interviews, and asked to find these names on 9 x 10-inch five-

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TABLE I. Map and Test Characteristics, All Six-name Tests

Type Sample	Map Description	List Description
	<p>Map One. All names in 8-point light sans-serif face (Monsen Light), all capitals.</p>	Typewritten
	<p>Map Two. All names in 8-point light sans-serif face (Monsen Light), capitals and lower-case.</p>	Typewritten
	<p>Map Three. All names set in 10-point serif face (Times Roman), all capitals.</p>	Typewritten
	<p>Map Four. All names set in 10-point serif face (Times Roman), capitals and lower-case.</p>	Typewritten

Type Sample	Map Description	List Description
	<p>Map Five. All names set in 12-point bold sans-serif face (Venus Bold Condensed), capitals and lower-case.</p>	Typewritten
	<p>Map Six. Contains 85 names set in 5-point Monsen Light, capitals and lower-case, and 58 names set in 10-point Monsen Light, capitals and lower-case.</p>	<p>Test 6a: Typewritten Test 6b: List set to match type in which name appears on map. Test 6c: List set to match type in which name appears on map.</p>
	<p>Map Seven. Contains 47 names set in 5-point Monsen Light, 57 names in same face 8-point, and 36 names in same face 13-point, all capitals and lower-case.</p>	<p>Test 7a: Typewritten Test 7b: List set to match type in which name appears on map. Test 7c: List set to match type in which name appears on map.</p>
	<p>Map Eight. Contains 81 names set in 10-point Monsen Light and 58 names in 12-point Venus Bold Condensed, capitals and lower-case.</p>	<p>Test 8a: List set to match type in which name appears on map. Test 8b: Typewritten Test 8c: List set to match type in which name appears on map.</p>

color lithographed maps (hypothetical names on an India base map, where the type was black, and the base area varied from white to brown to blue to green). Subjects were timed until they found the target names, and these times (in seconds) are the basis for all further comparisons. Eight different maps were used (see Table I). Maps One through Five each contain one typeface throughout, with this face varying from map to map. Maps Six, Seven, and Eight each include two or three type variations. The variations incorporated into these eight maps are only a few of the many which could have been tested; they were chosen in order to answer some urgent, practical map-making questions. These questions were specifically directed to an audience of adolescent map users, and included:

1. What is the difference in searching a map with names set in all-capitals and searching one set in the same face, but in capitals and lower-case?
2. What is the difference in searching a map set in a homogeneous stroke-width sans-serif face, and searching one set in a variable stroke serif face?
3. What is the difference in searching a map with names set in a light face and searching a map with names set in a bolder face?
4. What is the difference in searching maps containing all names set in the same typeface, and maps containing mixed typefaces?

While there were only eight maps, there were fourteen tests, since some of the maps could be searched in a variety of ways.

In order to find out about the type variations that might affect the searchability of the entire map (Part One), the six-name search task was used. A subject was timed until he found six names on various maps under a number of different conditions, including typographic variation on the lists searched from and on the maps themselves. In contrast, search times for individual names were measured (Part Two) while subjects searched for one name at a time, the one-name search task.

There was an additional variable which seemed to be relevant to an analysis of cartographic type variation: the possibility that expectation<sup>1</sup> may affect the ease with which names can be found on a map. If the searcher expects a name to appear on a map in a particular typeface, will this expectation also affect search time? An attitude of expectation was controlled by having subjects search from

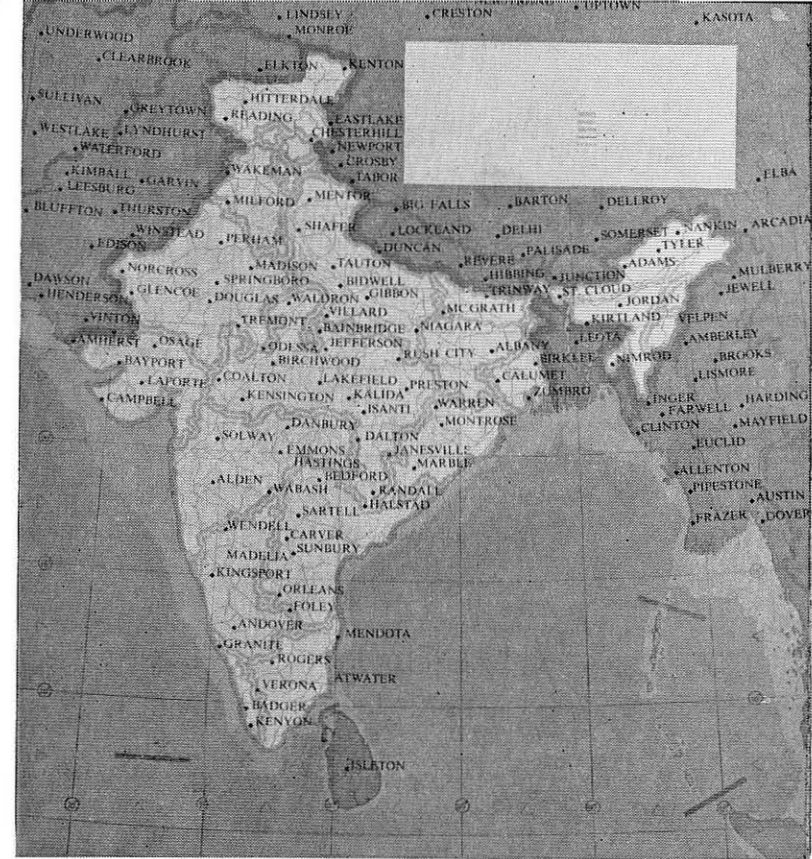


Figure 1. Black and white reproduction of map used in testing.

two forms of lists: (1) from typewritten lists (since the names on the map are hypothetical, this can be assumed to be a “no expectation” condition); (2) from lists set to match the type in which the name appears on the map (subjects could thus be assumed to have an expectation about the appearance of names on the map.)

#### PART ONE: *Searching an Entire Map—Six-name Search Tasks*

There are three kinds of tasks involved in searching an entire map, and we are concerned with their effects on search-time measures (Table I):

*Task One:* Effect of typographic variation when all names on the map are set in one style of type (Tests 1–5).

*Task Two:* Effect of typographic variation when the names on the map are set in *more than one style of type* (called a mixed-type arrangement) and the searching is done from a typewritten list (Tests 6a, 7a, and 8b).

*Task Three:* Effect of typographic variation when the names on the map are set in *more than one style of type*, and the searching is done from a list set to match the map type (Tests 6b, 6c, 7b, 7c, 8a, and 8c).

*Task One: Homogeneous Type Style (Tests 1-5)*

While there is considerable variation in the amount of time it takes individuals to find a total group of six names on a randomly searched 140-name map, modal values do emerge. Frequency distributions of search time responses are near-normal for all tests, though there is the right-skewing that might be expected from the open-ended nature of the task. Medians are therefore usually somewhat lower than means. Table II summarizes pertinent data for Tests 1-5.

From the appearance of the summary statistics and the graphed ranked means (Fig. 2), it is clear that there are no major differences among the five type variations tested, as these differences affect the search time for six names. The largest difference existing in this group is that between Tests 1 and 3 (Monsen Light all-capitals versus Times Roman all-capitals), but a "t" calculation shows that this difference is not statistically significant at the .05 level.

On the basis of these results, two concluding statements can be made:

1. Using the rather ordinary typefaces tested, it is found that no tested type variation significantly speeded or retarded search. In fact, from this particular experimental situation we can say that if the subjects are presented with this map-type arrangement, it will take most (55%) of the subjects two to four minutes to locate any six names.
2. We might further conclude on the basis of this testing that if ease of search is a consideration in map-making, cartographers can feel relatively free to make type choices from a rather wide spectrum of available type. This is *not* to say that all of the type tested is equally "legible"; perhaps if the task had required that subjects turn the map away and accurately re-spell names, or try to remember what names they saw, or some other different (and equally reasonable) map use

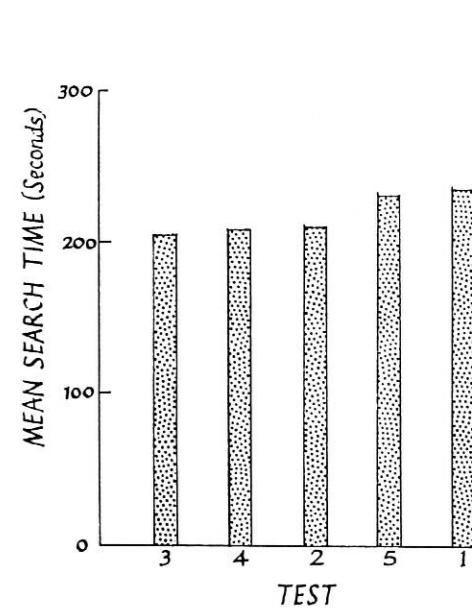


Figure 2. Mean search times, Tests 1 through 5.

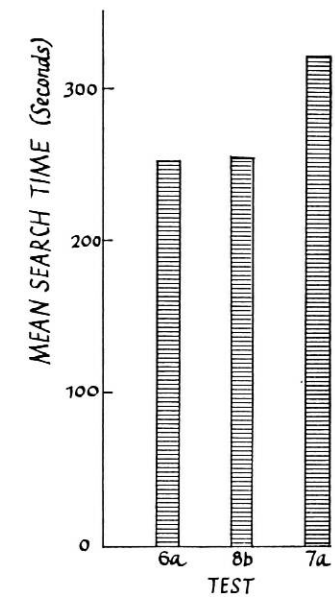


Figure 3. Mean search times, Tests 6a, 8b, and 7a.

TABLE II. Summary: Mean Search Times, Task One—Tests 1 through 5

Test	No. of Ss	Range	Mean (all in seconds)	Std. Dev.	Median
1	37	116-600+	234*	100	205
2	41	55-511	211	101	194
3	39	93-485	206	88	180
4	70	42-623	209	102	190
5	60	84-600+	232*	104	222

\*For Tests 1 and 5, the means were calculated omitting the incompleting tests, there being one in each case.

TABLE III. Summary: Mean Search Times, Task Two—Tests 6a, 7a, 8b

Test	No. of Ss	Range	Mean (all in seconds)	Std. Dev.	Median
6a	29	83-645	253	109	250
7a	56	51-600+*	323	157	311
8b	30	90-600+*	255	98	248

\*Means were computed excluding incompleting tests; there were two of these in 7a, one in 8b.

task, our findings might have been different. This conclusion is *task-specific*.

*Task Two: Mixed-type Maps, Searching Done From Typewritten Lists (Tests 6a, 7a, 8b)*

Search times have increased considerably in this situation (see Table III and Fig. 3). Apparently it takes a greater amount of time to search a mixed-type map than it does to search a single-type map, when there is no advance information or expectation on the appearance of the target names.

The mean search time for Map Seven is extraordinarily high; we note that while Maps Six and Eight contain two type style variations, Map Seven contains three. Exploring the effect of this additional type variation statistically, we find the results to be borderline rather than definitely conclusive. They are, however, strongly suggestive. Future research on this particular matter might be exceptionally valuable; the cartographer should know fairly precisely how much search difficulty he will induce with each additional category of type.

*Task Three: Mixed-type Maps, Searching From Lists Set to Match Map (Tests 6b, 6c, 7b, 7c, 8a, 8c)*

For these tests, search times have dropped markedly from Task Two, and they are generally below Task One as well. Test 8c emerges as a notable exception.

Clearly, an expectation of the exact appearance of the target name facilitates search, no matter what the typographic conditions. With the exception of Test 8c,<sup>2</sup> all of these search times are below those for any other tests.

Looking at the graphed mean search times for *all* tests (Fig. 5), the three kinds of tasks or testing conditions can be seen to group, with the exception of 8c. Discarding the 8c results for a moment, let us find out if there is a statistical basis for this apparent grouping. Clearly there is a common-sense basis for doing so, since the three tasks had already been distinguished from one another. Arranging the test mean scores in three groups (Table V), and then performing an analysis of variance using these mean scores, we find that  $F = 24.4$  and conclude that there is a significant difference among groups above the .01 level.

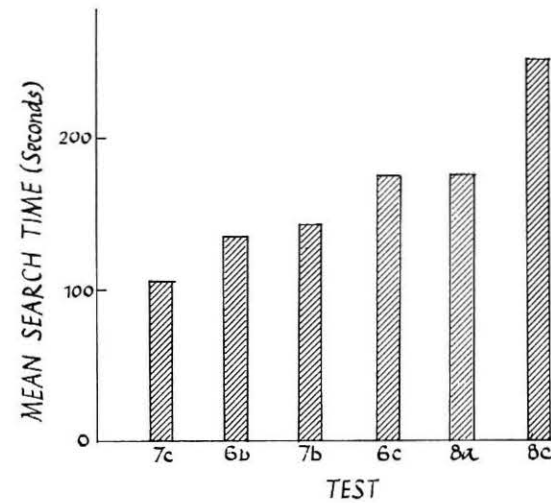


Figure 4. Mean search times, Tests 7c, 6b, 7b, 6c, 8a, and 8c.

TABLE IV. Summary: Mean Search Times, Task Three—Tests 6b, 6c, 7b, 7c, 8a, 8c

Test	No. of Ss	Range	Mean (all in seconds)	Std. Dev.	Median
6b	30	52-341	132	62	118
6c	32	66-440	174	74	165
7b	30	39-352	142	77	127
7c	29	27-273	102	52	94
8a	53	35-600+	176	95	248
8c	29	109-600+	242	99	256

TABLE V. Test Scores Arranged in Groups, by Task

Task One Homogeneous Type		Task Three Mixed-type Maps Set List		Task Two Mixed-type Maps Typewritten List	
Test	Mean Search Time	Test	Mean Search Time	Test	Mean Search Time
3	206	6c	174	6a	253
4	209	7b	142	7a	323
2	211	7c	102	8b	255
5	232	8a	176		
1	234	6b	132		

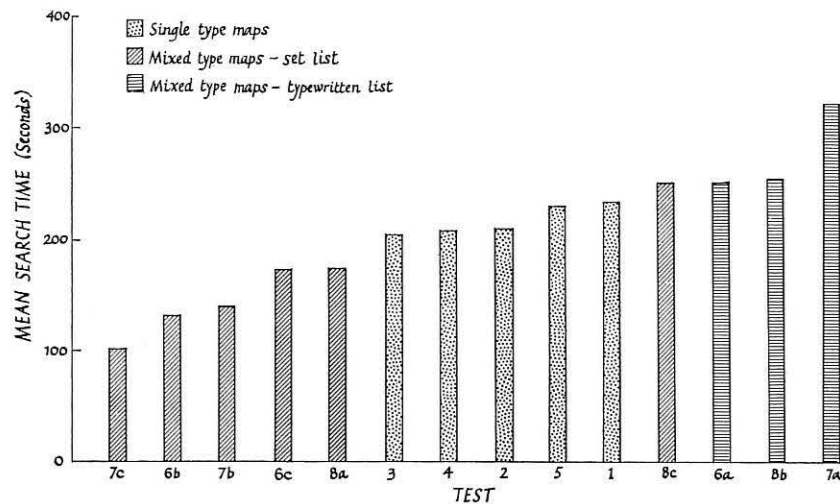


Figure 5. Ranked mean search times, all six-name tests.

#### *Effect of Expectation on Search Task*

We recall that in text legibility research considered in previous articles, differences among type conditions (with speed-of-reading measures) were often considered to be of practical and statistical significance when they were of the order of 5–15%. We were not expecting large differences to emerge from speed-of-search measures, given the enormous variation in individual search patterns. In fact, none were detected in this testing situation, using the given type variations. Yet, in spite of the great within-test variation, very noticeable general patterns do emerge. The difference between finding six names on Map Seven, Test 7c, and six names on Map Seven, Test 7a, is of the order of 300%! The map has not changed, the type has not changed, and the quality of the subjects has not changed. *Only the searcher's expectation about target appearance has changed.* The presence or absence of this expectation, apparently, has far more to do with success in finding names on the map than does any type variation tested.

In the realm of common sense experience, the role of expectation is familiar. When one approaches a reference map, it is very rare that there would be no expectation at all about the appearance of the name sought. The user has read or heard of a town or city—

from the context he makes certain guesses about the nature of its size or importance. A child, of course, would have less such expectation.<sup>3</sup>

In the process of searching for a target name, most of the total search time is spent in rejecting non-target names. Neisser has shown that the rejection of non-target names is a less complete process than is the ultimate recognition of target names.<sup>4</sup> That is, one may reject a name as, "that's not the one I want," without being able to report what the name actually was. There seem to be several levels of processing which may be carried out; if a preliminary processing will give the map user the information he needs, he does not carry the activity further, but goes on to another portion of the display.

From Task One it was concluded that there was no typographic form which was particularly superior to any other in providing cues which would speed the rejection of non-target names. We also observed, in the course of day-to-day testing, a possible explanation for this. When the subjects searched, they very often moved either their index fingers or the grease pencil lightly over the surface of the map. They were not asked to do this, but it seemed a natural response, and it proved helpful to us in observing search patterns. Generally, the course of the finger was a smooth, nearly continuous movement. It would stop momentarily when the subject thought he had found the target name. If he had, the brief pause was converted into the cross-out-the-name response. If he had made an error, he would continue (sometimes after re-checking the list, but sometimes after what appeared to be an internal check). The major point is that the error pauses were most often made when the "error" name had the *same initial letter* as the target name. Both experimenters observed this consistently. It is worth noting in future research, for if the initial letter should be an important cue to aid in deciding whether to "reject" or "examine further," it is fairly easy to understand why Tests 1–5 produced such similar results. Word form (i.e., the shape of the word when it is printed) becomes of little consequence; the serifs, which are thought to unite the word into a unit, are not particularly useful. Levin<sup>5</sup> found that beginning readers rely heavily on the information contained in the first letters of words. In a sense, the map user is more like a beginning reader than he is like the skilled reader of text. This is especially true when all the names on the map are unfamiliar to him, as they were in this testing situation.

But consider now quite another basis for rejecting non-target names. This research indicates that names can be very quickly and thoroughly rejected on other than a letter-by-letter basis. The basis for rejection is the appearance of the name, not its content. Search-time data provide evidence that a non-target name will be far more quickly rejected if it is in a form which the subject knows is not that of the target name.

By providing the searcher with an expectation about the form of the name (Task Three), we have greatly reduced the number of names on the map which he must subject to a more thorough processing.

#### *Theoretical Search Times: Relevant versus Irrelevant Targets*

We can examine our data in more detail to see what quantitative relationships exist among search times in different levels of processing. We can use the terms "relevant" and "irrelevant" targets in this way: *Irrelevant target* = a name set in a perceptibly different typeface from that of the target name. *Relevant target* = any name set in the same typeface as that in which the target name is set.

First, we can assume that an average processing rate for any relevant target can be calculated by using the mean search times obtained from Tests 1-5. The mean of these five means is 218 seconds. Since there were 143 relevant names on each map, and in searching for six targets we can consider the entire map a target which must be processed,<sup>6</sup> this gives a total of 858 names to process. We then find a processing rate to be .254 seconds per relevant name (since all names are set in the same face as the target name, they are all relevant).

It seems reasonable to assume that under testing conditions where (a) there are irrelevant and relevant names on the map, and (b) the searcher knows in advance which face is relevant (i.e., he is searching from a set list) the amount of time it takes him to find the six names will not be proportional to the *total* number of names on the map, but rather, will be approximately proportional to the number of *relevant* names.

Calculating the number of relevant names for each of the 14 tests (multiply the number of names set in the same face as each target times the number of targets set in that face), and then plotting mean

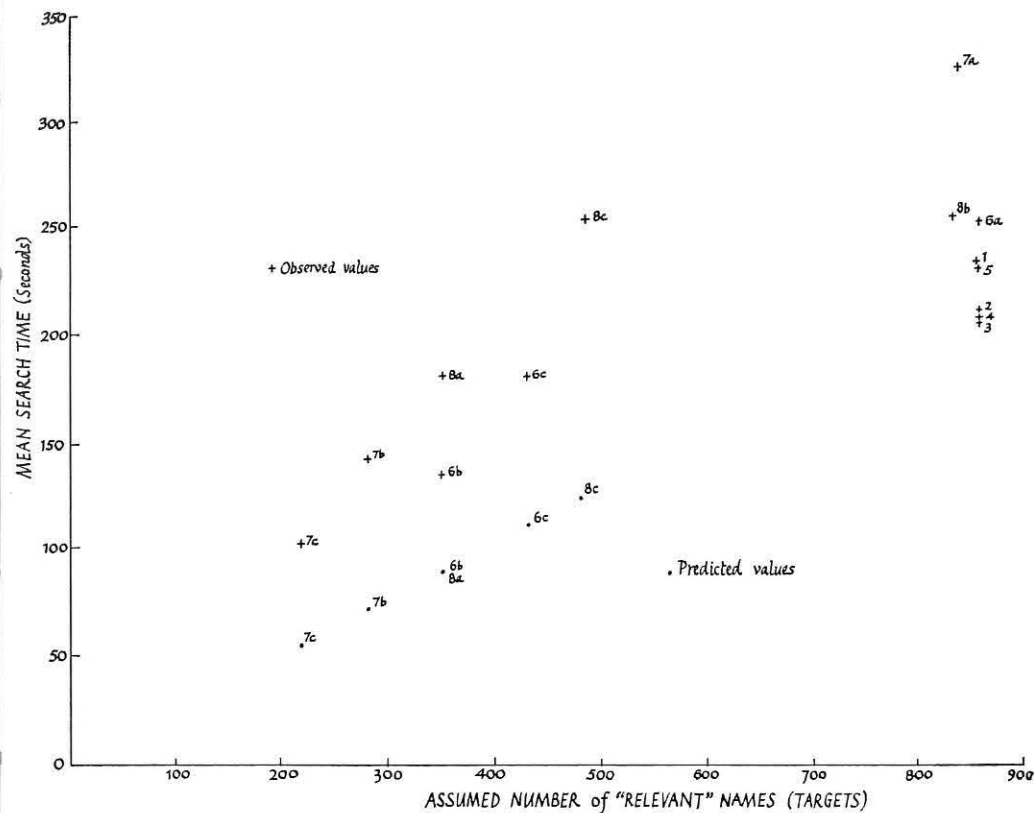


Figure 6. Observed and predicted search times as a function of "relevant" targets.

search times versus relevant names (Fig. 6) it appears that our assumption is true—the search times do vary almost as the number of relevant names. We also can see how our three testing conditions produce rather clearly different results on this graph.

In the calculation of an average processing rate, we assumed that the search times for Tests 1-5 fall on one point rather than being somewhat dispersed as they actually are. If this is a correct assumption, and if it is further assumed that on a mixed-type map the search time is proportional to the number of relevant targets, it should be possible to work backward and *predict* the search times for the mixed-type map as a check on this second assumption.

In order to do this, we can set up a table (Table VI) for all of the tests which involved mixed-type maps and set lists, showing the calculated number of relevant and irrelevant targets, as well as a

calculated theoretical search time (number of names which are relevant targets times .254 seconds per name).

The predicted search times are plotted on the graph (Fig. 6). While they vary in approximately the same fashion as the actual search times, they are consistently *too low*. This can be interpreted to mean that the processing rates for irrelevant targets must also be taken into account. The rate of irrelevant name processing for each test can be calculated from this equation:

$$RST + (IT) (IPR) = ST$$

where, RST = Predicted search time on basis of number of relevant targets

IT = Number of irrelevant targets

IPR = the unknown processing rate for irrelevant targets

ST = Actual mean search time.

Therefore, using the above data in this equation,

$$IPR = \frac{ST - RST}{IT}$$

we obtain the following irrelevant processing rates.

Test 6b: .083 seconds/name

Test 6c: .152 seconds/name

Test 7b: .127 seconds/name

Test 7c: .075 seconds/name

Test 8a: .179 seconds/name

Test 8c: .342 seconds/name

With the exception of Test 8c, the irrelevant target processing rates are found to be well below the relevant processing rate we assumed of .254 seconds/name. There are certain other conclusions which might be drawn from closer observation of these irrelevant processing rates.

First, the rates for tests conducted using Maps Six and Seven seem quite different from those found for the Map Eight tests. This suggests that the distinction between relevant and irrelevant targets when size is the factor has very different effects on search time than does the boldness difference on Map Eight. The reasons for this are certainly not clear, and warrant further investigation. Perhaps the bold face tends to command attention visually, though the subject is

TABLE VI. *Calculated Values: Relevant Targets, Irrelevant Targets, and Theoretical Search Time*

Test Number	Number of categories of type on list	Number of categories of type on map	Number of relevant targets	Number of irrelevant targets	Predicted search time (in seconds)	Actual mean search time (in seconds)
6b	1 (larger)	2	348	510	89	132
6c	2	2	429	429	109	174
7b	3	3	280	560	71	142
7c	1 (largest)	3	216	624	55	102
8a	1 (bold)	2	348	486	89	176
8c	1 (light)	2	486	348	123	242

intellectually aware that it is not relevant. Though this is conjecture, it is clear that processing rates have risen sharply for Map Eight.

Second, the rates for Maps Six and Seven are strikingly similar; it might be possible to assume from this that there is not very much difference in searching a map containing two sizes of type and one with three sizes of type. But how many sizes can occur on a map before the relevant/irrelevant processing rates are affected?

Further, if the rates for Tests 6b, 7c, 6c, and 7b are averaged, we find that the relevant rate is about 2.3 times the irrelevant rate. Working with target (numbers) type-size comparisons of 10-12, 10-14, and 10-18 points, and with a red/black distinction, Beller found that across all conditions average relevant rates were about twice those of irrelevant rates.<sup>7</sup> These factors are surprisingly close.

Third, the irrelevant processing rates for Tests 6b and 7c are nearly identical, while those of 6c and 7b are also similar. Looking at the tests, it becomes clear that there is a logical reason for this pairing. For Tests 6b and 7c, the lists contain only one kind of type; for each of the six target names, the subject can consider the same categories of type irrelevant. However, for Tests 6c and 7b, the subject looks for more than one kind of type; the criterion for irrelevant targets changes during the course of the six-name search task. Notice how the irrelevant processing rate then increases considerably. It apparently takes more effort to reject names when the criterion for rejection varies during the course of the task. We would expect such a practice effect.

PART TWO: *Searching for Individual Names—One-name Task*

The search task proved to be a useful one for analyzing and comparing type characteristics which affect the searchability of the map as a whole. The results of using search time measures for the one-name task, we found to be less directly useful. They serve primarily to underscore the importance of *all* factors related to cartographic lettering, not just the characteristics of the type itself. Environmental contrast, location on the page, location relative to other figure-ground patterns, and other factors affect the amount of time required to find any one name.

There is an additional reason for including these one-name research data; it is an attempt to forestall possible mis-application of conclusions from the six-name task just described. One may *not* say that, "it doesn't matter" what typeface a particular name is set in; the one-name search data show that the "findability" of a *particular* name may indeed be related to its typographic appearance. It must also be remembered that there are many more name-use tasks, besides search, which must be considered in cartography.

Table VII summarizes median search times (in seconds) for each of the names on the maps on which it was to be found. (Each subject was timed while he searched for three names, one on each of three maps.) There is wide subject-to-subject variation in search time, but the distributions of search times do show more or less clear modal groupings.

*Results: One-Name Search*

These data are difficult to discuss in a general way. One must constantly refer to the specific appearance and environment of the name on the map.

For example, "Andover" search times are low for all three maps. It happens to be in a position that was encountered early in the random searching process, and it would have had low scores set in almost any typeface, simply because of its location. "Mayfield," on the other hand, is found easily on two maps, but has rather high median search times on others. On Map Six it is set in the larger type; there seems to be no apparent reason why it should be one of the hardest names to find on Map Three, and one of the easiest on Map Five.

TABLE VII. *Median Search Times (in seconds) for the One-name Task*

Name	Map							
	1	2	3	4	5	6	7	8
Andover	6					12	13	
Barton	38		24		27			
Clinton	22					53	33	
Coalton			23		24	16		24
Gibbon	30		23				27	
Glencoe	18					61	50	
Halstad	20		18		22			
Kensington			36		14	54		
Mayfield			40		18	13		33

There are a few general things which can be said, however. Environmental typographic contrast seems important. There would be evidence for this, for example, in the contrast between search times for "Mayfield" on Maps Three and Six, or "Kensington" on Maps Three (no contrast) and Eight (considerable contrast). Sheer visibility does not place names in the shorter search times category—the names set in Times Roman all-capitals and the names set in Venus Bold Condensed tend to fall about in the middle range; these would seem, *a priori*, to be the most visible type arrangements.

Within the range of type sizes tested, the names set in the largest faces are more easily found than those set in the smallest faces. On Map Six, for example, "Andover," "Coalton," and "Mayfield" are set in 10-point type, while "Clinton," "Glencoe," and "Kensington" are set in 5-point type. The median times for the 5-point names are 53–61–54 seconds. For the 10-point names, the medians are 12–16–13 seconds. In this range, a factor of approximately two for size increase has apparently produced a factor of four reduction in median search time.

Search patterns affect individual name "findability." There are preferred locations, which might also be termed more "accessible" locations. Search patterns were carefully observed during the course of the testing, and there were a few which were most often used. Most subjects started to search either in the Dover-Allenton-Mayfield area or in the Andover area. (Few of the names in other areas had

more than two or three search times under ten seconds.) Virtually no one started in the upper-left hand corner, as might perhaps have been expected if this had been a normal text-reading situation. Figure 7 shows typical patterns of search movement.

Various configurations of the brown-green-blue-white base map affected search patterns noticeably. Searchers tended to confine themselves first to a white area, then to a brown. Names which didn't fall clearly into one or the other tended to be ignored. This situation was accentuated by another search characteristic; names seemed to be examined in five- or six-name clumps, with the subject checking these names as a unit, then moving on to another clump. A name falling between two of these clumps (usually these were related to background) tended to be overlooked repeatedly. "Glencoe" was such a name. The names to the left of it, on the brown, were examined as a group, and the names to the right of it on the green and white were also so examined. "Glencoe" just happened to fall between two natural groupings in the search pattern. "Barton" also seemed to be in such a position.

While the one-name testing did not tell us a great deal that is immediately useful, it did point up how very complex is the relation between the typographic characteristics, the environment in which they occur, and the search process (or any other task) being used. The appearance and utility of the type on a map can be assessed only in the context of the actual position of the type on the map. Relationships seem to be more important than any absolute type characteristics.

#### Overall Conclusions

1. For random search of the five maps containing only one typeface, the typographic variation from map to map did not produce a significant effect on the average search times (six-name task). It seems that the rather ordinary typefaces tested are all about equal in "searchability." The serifs on the Times Roman face did not seem to speed search; the lightness of the sans-serif Monsen Light face did not impede it, nor did the boldness of the Venus Bold Condensed face. The four-point variation in type size from Map One to Map Five had no significant effect on search times.

Given approximately equal search times for two tests which they

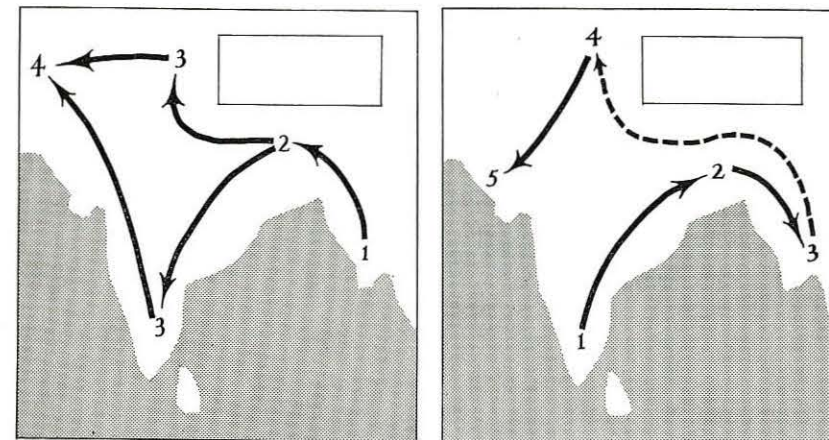


Figure 7. Typical patterns of movement during search.

had taken, subjects often reported that they felt differences in the ease of search, but approximately 50% would choose each of the equal-time tests as "easier." Only when differences approached the order of 30 seconds did subjects consistently pick the shorter test as "the easier."

2. On a mixed-type map (here with two or three different typefaces per map), search is slowed if the user has no correct expectation of the appearance of the type in which the target name will appear. This is the case when he is searching from a typewritten list. That is, if six names are searched for (at random) on a one-type map, and the same six names are searched for on a mixed-type map, search times will be conspicuously longer for the mixed-type map.

3. On mixed-type maps (again, two or three faces per map), search is greatly speeded if the user has a correct expectation of the typographic characteristics of the target names. This is the case when the subject searched from a list set to match the map type. There may be as much as a 300% difference in the time needed to find six names on the same map, depending on whether or not the subject is searching from a set list (compare mean search times for Tests 7a and 7c).

It seems that when a subject has a rather specific expectation about the appearance of the target name, it is almost as if the number of names on the map had been reduced to include only the names set

in the target face ("relevant" names). The search thus takes proportionately less time. The preliminary perceptual-cognitive process which separates the map into "relevant" and "irrelevant" targets takes very little time, compared to the amount of time it takes to decide that a particular name being examined is not the target name. Certain type variations seem to lead to almost spontaneous relevant-irrelevant categorization (as for example, red type versus black type), while other variations are more difficult (10-point versus 12-point type). If the map searcher has an expectation that the target name will appear in a particular visual category, and if the names on the map appear to him to be in distinctly different visual categories, his search will be greatly speeded. On the other hand, if he has not formed an expectation, or worse, has formed an incorrect one, his search will be impeded.

4. When the times are recorded for the one-name search task, it is found that the typography of a particular name is of less importance than are a great many other factors, including figure-ground environment, location on the page, typographic environment and contrast, and so on. Thus, while our data from the six-name search task have shown that it is possible to make general probability statements about the searchability of the *entire* map, it is not possible to do this for an *individual* name.

This study has attempted to throw light on some aspects of cartographic typography, with particular attention to the matter of selecting a task which might be expected to relate to conceptions of cartographic legibility. Search has proved to be a useful, if limited, task for this purpose. It seems clear at this point that text "reading" and map "reading" are not similar insofar as the use of type is concerned, and that results of research in the former cannot be directly applied to the latter.

1. In using the term "expectation" here, we are referring to a very specific expectation of the physical appearance of the type; there is always present a *general* expectation of the letter shapes and the total word shape, but in this discussion, the use of the term "expectation" is limited such that, for example, a subject would know that the target name would occur in bold, black letters of the largest type size, and so on. It is assumed that general expectation would be the same for any one name under all testing conditions.
2. An explanation for the very high 8c scores became apparent during the testing, as we observed the subjects search. Although the subjects *knew* they were looking for the "light" or "thin" or "little" names (as they put it), the bold lettering so commanded their attention that they frequently inspected it in detail, even though they knew they didn't have to.
3. It is interesting to note that in pre-testing with a group of adults, all college graduates, they found the random-search task rather more annoying and stressful than the children did. Apparently the children expect less redundant information on a map, and their ordinary searching activity is probably of a more nearly random nature.
4. Ulric Neisser, "Visual Search," *Scientific American*, CCX (1964), 94-102.
5. Gabrielle Marchbanks and Harry Levin, "Cues By Which Children Recognize Words," *Journal of Educational Psychology*, LVI (1965), 57-61.
6. One does not, of course, always process every name on the map before finding the target name, but since we assume this across all testing it will cancel out in the calculation of rates.
7. Henry K. Beller, *Stages of Processing in Visual Search* (Unpublished doctoral dissertation, Brandeis University, 1968).