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## **The Effects of Entry Arrangement on Search Times: A Cross-Generational Study**

**Margaret Ann Wilkinson, Patricia V. Burt,  
and Mark T. Kinnucan**

*This article describes an experiment to test the effects of a vertical versus a horizontal arrangement of brief structured text entries on known-item search times. Two groups of twelve women university graduates (mean ages—seventy-one years and thirty-three years, respectively) participated by locating and answering factual questions about thesaurus entries arranged in each format. Results showed that differences in search times were proportionately the same for both age groups, that significantly slower search times occurred under the horizontal arrangement, and that no subject judged the horizontal arrangement to be easier to use than the vertical arrangement.*

This experiment was designed to investigate people's abilities to interact with different arrangements of structured textual information. Many information sources present textual information in the form of brief, structured entries, for example, microfiche catalogs, directories, and computer-produced reports. In such works, the entries are sorted alphabetically by the letters in the first item of the entry or numerically by an accession number. The normal arrangement of entries has been to lay them out vertically in columns. The user reads from the top to the bottom of the page in the first column and then moves to the top of the second column and reads down to the bottom of the page and so on (see figure 1).

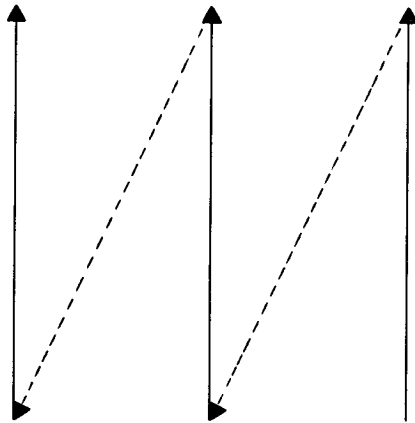
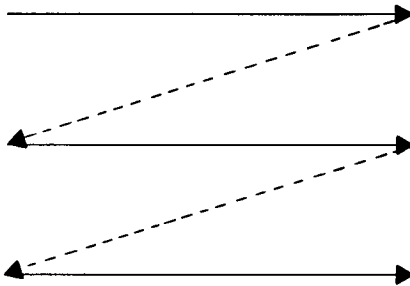
Widespread use of computer technology, however, has led to a different arrangement of entries (see figure 2). In this arrangement of data, the entries appear to be in columns but are actually in rows, and the

alphabetization proceeds horizontally rather than vertically. Perhaps to facilitate computer data entry or storage or because of printer limitations, this latter arrangement seems to be occurring more often within reference tools and finding aids. In the horizontal arrangement, the entries line up directly above and below each other, so that the entire page takes on the appearance of a grid of entries. Because of this grid appearance, it may not be apparent to the user that a horizontal arrangement of entries is being used. This problem occurs less frequently with the vertical arrangement. In most vertical arrangements, entries in adjacent columns do not consistently begin on the same line; thus, the impression of a grid is not made.

Although many researchers have studied people's perceptions of text, these studies have dealt either with how people read or with their comprehension and memory for text. The linguistic materials investigated

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Fig. 1. *Columnar Order.*Fig. 2. *Tabular Order.*

have varied from individual letters to sentences, paragraphs, and short articles or stories. For example, Wright surveyed research on the comprehension of technical information from prose.<sup>1</sup> Very little research has been done, however, on searching for information in short, structured entries such as those investigated in the present study.

Although there seems to be no previous research that varied the arrangement of *textual* entries, some attention has been given to comparisons of vertical and horizontal arrangements of numbers,<sup>2</sup> individual words,<sup>3</sup> and tabulated information.<sup>4</sup> The work most similar to the topic of the present study is that of Sprent and others.<sup>5</sup> They devised two different versions of a bus timetable for a single route in Derbyshire, England. The standard version had the different runs along that route across the top of the timetable and the stops down the left

side. The reflected version had the runs on the side of the timetable and the stops across the top. Sprent and others found that students read faster and made fewer errors using the reflected timetable, especially after a little practice. They related this result to the relative ease of scanning the table in its different formats, concluding that horizontal scanning is easier than vertical scanning. It is important to keep in mind, however, that since Sprent and others were studying the use of a *table*, rows and columns were meaningful in both arrangements of the timetable. In the present study the arrangements are *not* tabular; the entries are arranged either in columns or in rows but not in both at once.

Frequently, people seeking information about a *known* item do not take time to learn to use an information source that they perceive to be straightforward. Information seekers look for a target item in the location where they expect to find it and, if it is not found, assume that the item is not contained in the source. Apparently, people rarely consider the possibility that the arrangement of entries in a source might not be the one that they were expecting, nor do they confirm their understanding of the source. Producers of information sources would do well to use an arrangement that matches users' expectations, or they should at least provide prominent, clear instructions alerting users to an unusual format.

To explore the generality of our results, two age groups were selected for our study: senior citizens and younger adults. The aspect of interest was not the overall ability of the groups' members to find information in the entries, but whether, in comparison to the horizontal arrangement, the vertical arrangement of the entries facilitated or hindered the search for one age group more than the other. This type of study has been labeled "person by treatment interaction" research.<sup>6</sup>

Most of the research on age differences in cognitive tasks has dealt with memory differences. For example, Waddell and Rogoff asked middle-aged and older women to complete a spatial memory task involving toylike objects that, in one condition, comprised a model of a village.<sup>7</sup> In a second condition, the same objects were placed

randomly in a bank of cubicles, and the subjects were asked to re-create a previously viewed arrangement of the objects. No performance differences between the age groups occurred in the contextually organized condition (the village). In the non-contextually organized condition (the cubicles), the middle-aged group outperformed the older group. It appears that the middle-aged group created their own strategies to deal with the noncontextually organized material, whereas the older group was more overwhelmed by the complexity of that task. Howell also showed that familiarity can ameliorate a memory deficit in older individuals.<sup>8</sup> She prepared three sets of cards: meaningless patterns, objects from the 1908 Sears Roebuck catalog, and pictures of modern items. The recognition scores of the older group (mean age sixty-nine) were significantly lower than the scores of the younger group (mean age twenty-eight) for the meaningless patterns and for the complex modern items, but their scores were about the same on the Sears catalog items. The results of both these memory studies suggest that the performance of older subjects degrades more than that of younger subjects in unfamiliar situations. In the present study, the horizontal arrangement is presumed to be the less familiar situation, suggesting that if the finding task relies on memory, the horizontal arrangement might be more troublesome for the older subjects.

When one is interested in age differences, usually either a longitudinal or a cross-sectional study is undertaken. In a longitudinal study, the same people are tested at two or more different points in their lives. But, when the age differences span several decades, longitudinal studies are impractical. Thus, the present study was designed to be cross-sectional, in which two or more different groups, each composed of subjects in a different age bracket, are tested at the same time. However, as Schaie and Strother pointed out, the problem with a cross-sectional design is that "differences between age groups therefore could be a function of actual age differences, or they could be a function of differences between cohorts, or due to both age and cohort differences."<sup>9</sup> As used here, a

cohort is a group of people born around the same time and thus tending to share similar events in their lives. Schaie and Strother tested several cognitive abilities using a "cross-sequential" methodology designed to separate age and cohort differences. Of the areas they tested, the one that is closest to the kind of cognition involved in our study was personal perceptual rigidity, i.e., the ability to adjust readily to changes in cognitive patterns. Their study indicated that the difference in rigidity between the groups of subjects can probably be attributed to both age and cohort differences. This could suggest that any differences in search times in this study might be related more to generational differences (age group, in our study) than to actual age.

The hypotheses this study tests, then, relate to possible age differences in the effects of the arrangement of entries on finding information in a printed source. Specifically, we first hypothesize that subjects expect to and do find information faster in a vertical alphabetical arrangement of short structured text entries than in a horizontal alphabetical arrangement. Second, we suggest that when faced with an organization other than the usual columnar style, subjects become disoriented and find information more slowly. Third, we suggest that the age of an individual makes no difference to the initial disorientation when faced with an unfamiliar arrangement; that is, the proportional difference in search times between horizontal and vertical text arrangements will not be significantly greater for older subjects than for younger subjects. Fourth, we suggest that library reference experience will facilitate the search for information under both text arrangements, thus yielding shorter search times for those subjects with experience than for those without such experience.

## METHOD

### Subjects

A total of twenty-four subjects participated in the experiment. Subjects were selected on the basis of age to form two groups of twelve subjects each. The older group was solicited from an organization of women university graduates. The average

age of this group was seventy-one years, with an age range from fifty-nine to seventy-nine years. The younger group consisted of twelve women students in a school of library and information science. The average age of the students was thirty-three years, with a range from twenty-three to forty-five years. For reasons of availability, only women were invited to participate in the study. Subjects were screened for auditory and visual acuity at a level sufficient to perform the task.

Subjects were further classified as either having or not having library reference experience. Library experience was judged to be present where there was more than two years professional service dealing directly with library patrons. Five of the older women and five of the younger women had library experience according to this criterion.

#### Materials

To simulate the situation of a user looking for specific textual information in a reference context, an instrument was designed that required subjects to find a particular entry. Thesaurus entries were arranged in two presentations: a vertical alphabetical order and a horizontal alphabetical order (see figures 3 and 4). Subjects were asked to respond to five types of queries that required finding the appropriate thesaurus term in the listing and reading a specific item of information from the text of the entry (see appendix A). These queries varied

in terms of what information it was necessary to obtain from the entry in order to answer the question. The types of query were the same for all sheets, and the queries themselves were identical for vertical and horizontal arrangements of the same letter.

Entries were taken from the *Thesaurus of ERIC Descriptors*, which was selected because it contains textual information of an appropriately simple nature in an easily understood and relatively standard format (see figures 5 and 6).<sup>10</sup> It was thought that none of the subjects would be familiar with the use of this thesaurus. In fact, only one of the twenty-four subjects knew that the entries were from the ERIC thesaurus, although she had not used the thesaurus.

Entries were chosen from the ERIC thesaurus under three randomly selected letters (*F*, *M*, and *U*). Twenty-one entries, including six cross-references, were chosen for each initial letter. Entries were chosen that would permit the composition of both horizontal and vertical alphabetical arrangements of all twenty-one entries on a single sheet of paper. Due to the small print in the original ERIC publications, the entries were enlarged. They were then arranged in three columns for the vertical alphabetization and in rows of three entries for the horizontal alphabetization. This resulted in a total of six different presentation sheets (three letters multiplied by two arrangements). Page headings, footnotes, and other identifying material were not included in the test sheets.

<b>FAMILY HEALTH</b>	<b>Family Living</b>	<b>FAMILY STRUCTURE</b>
text of entry	text of entry	text of entry
<b>FAMILY INCOME</b>	<b>Family Management</b>	<b>Family Unity</b>
text of entry	text of entry	text of entry
<b>FAMILY INVOLVEMENT</b>	<b>FAMILY PLANNING</b>	<b>Fantasy Play</b>
text of entry	text of entry	text of entry

Fig. 3. Example of Vertical Presentation.

<b>FAMILY HEALTH</b>	<b>FAMILY INCOME</b>	<b>FAMILY INVOLVEMENT</b>
(text of entry)	(text of entry)	(text of entry)
<b>Family Living</b>	<b>Family Management</b>	<b>Family Trees</b>
(text of entry)	(text of entry)	(text of entry)
<b>FARM VISITS</b>	<b>FARMERS</b>	<b>FASCISM</b>
(text of entry)	(text of entry)	(text of entry)

Fig. 4. Example of Horizontal Presentation.

## Unskilled Labor (1966 1980)

### Use UNSKILLED WORKERS

Fig. 5. Example of a Cross-Reference (ERIC 1986).

**FAMILY SCHOOL RELATIONSHIP** Jul. 1986  
 CIJE: 243 RIE: 422 GC: 330  
 UF Home School Relationship  
 School Family Relationship  
 School Home Relationship  
 NT Parent School Relationship  
 BT Relationship  
 RT Culture Conflict  
 Family (Sociological Unit)  
 Politics of Education  
 etc.

Fig. 6. Example of Main Thesaurus Entry (ERIC 1986).

### Procedure

To begin the experiment, each subject was shown a sample sheet containing an example of a full thesaurus entry and an example of a cross-reference, as in figure 3, but the parts of each entry were labeled in these examples. The subject was asked to familiarize herself with the entries and was encouraged to ask questions about them. Sample questions were given so that the subject could practice the method of response. During the test, the labeled examples were available for further reference. It was emphasized at the outset that what was being tested was not comprehension or memory but simply the speed at which they could locate information under two different presentations. Subjects were not told that the presentations were in alphabetical order, nor were they told that the presentations were horizontally or vertically arranged.

Each subject responded to five queries about the entries on a horizontally arranged sheet and to five queries about the entries on a vertically arranged sheet. For a given subject, the entries on the horizontal sheet were different from the entries on the vertical sheet. For example, the horizontal sheet for a given subject might contain the entries beginning with *F*, while the vertical sheet would contain the entries beginning with *M*. Another subject might get "*U* horizontal" and "*F* vertical," and so on. The presentation order was randomized so that half the subjects in each age group received a horizontal arrangement first and half received a vertical arrangement first.

Each subject determined the order in which queries were presented by selecting successively from the five question cards for her first arrangement. The query order selected for the first arrangement was used again for the second.

To begin the testing itself, the example sheet was placed adjacent to the subject for easy reference. The first test sheet was placed in a closed folder in front of the subject. After the subject had selected a question card, the researcher read the question aloud. The subject could ask for clarification or to have the question repeated or could consult the example sheet to deter-

mine the location of similar information in the sample entry. When the subject felt ready to respond, she was instructed to open the folder, locate the appropriate entry, read aloud the required information, and then close the folder. Subjects were instructed to respond as fast as possible but to make sure they had found the correct answer. It was emphasized that the important factor was the difference in the times between the two presentations and that the absolute times on each were not of interest in this study. The procedure was then repeated with the remaining questions for the first sheet. The second sheet was then placed in the closed folder, and the questions appropriate to that sheet were asked.

Times were recorded to the hundredth of a second using a stopwatch, with timing beginning when the subject opened the folder and continuing until the subject read the response from the sheet. If the subject found the wrong entry, the response was marked incorrect and the corresponding time was not included in the analysis. There were very few wrong answers. For each subject, averages of response times for correct answers were calculated separately for the horizontal and vertical arrangements.

After the test queries had been administered, the subjects were asked to complete a brief questionnaire (see appendix B). Subjects reported their ages and any previous library reference experience and indicated whether they had noticed any difference in the arrangements.

For practical reasons, the age groups were tested in different environments, but the methodology used was the same for all subjects. The researchers visited each of the older subjects in her own home at a time of the subject's choosing. The younger students were tested one at a time in the office of one of the researchers.

### Results

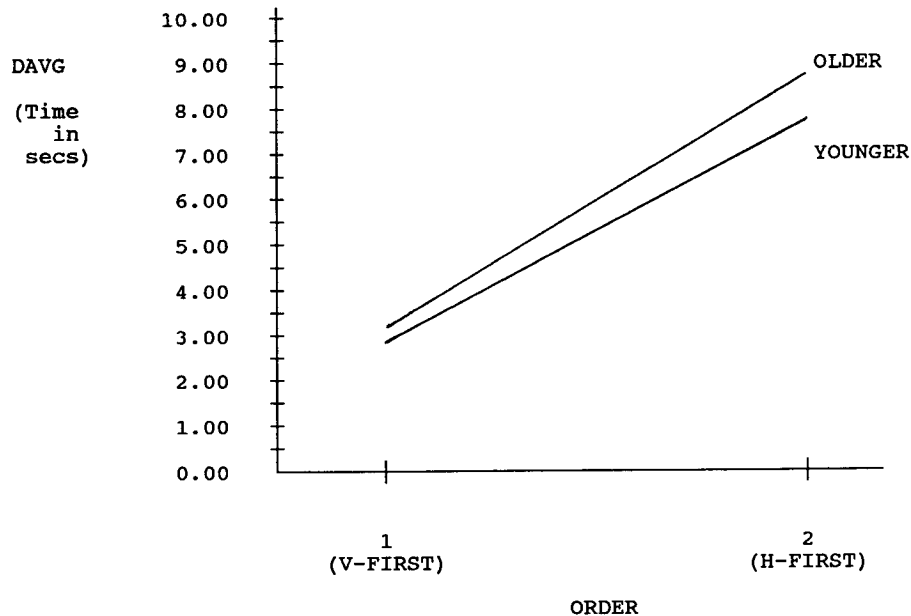
Since the factor of greatest interest was the effect on search times of an unfamiliar arrangement of entries, the initial analysis had to address the question of whether there *was* a significant difference in the search times between the horizontal and vertical presentations. If so, then subse-

quent analysis should consider the consistency and direction of that difference, as well as the effect of the other variables in the experiment. The important data unit for analysis, then, was the *difference* in time for each subject rather than the actual times themselves. This difference was calculated for each subject by subtracting the average time taken on the vertical arrangement from the average time taken on the horizontal arrangement. This difference score was analyzed in a two-way analysis of variance (ANOVA) in which the independent variables were age group (older versus younger) and order of presentation (horizontal first versus vertical first). In this analysis, comparing the times with the horizontal arrangement to the times with the vertical arrangement is accomplished by testing the null hypothesis that the average value of the difference score is equal to zero.

Figure 7 shows the average difference scores for the two age groups. The ANOVA

confirmed that the average difference score was significantly greater than zero ( $F = 19.3$ ;  $df = 1,20$ ;  $p < .001$ ;  $MSe = 40.2$ ).

Performance times for both age groups were affected equally by the horizontal arrangement. That is, the difference scores for the older group were substantially the same as the difference scores for the younger group ( $F < 1$ , n.s.). The data show that twenty of the twenty-four averages are positive, indicating that most of the subjects in both groups were faster with the vertical arrangement than with the horizontal arrangement. Regression analysis confirmed that age had no significant correlation with difference scores. And the order of presentation had only a marginal effect on the difference scores ( $F = 4.2$ ;  $df = 1,20$ ;  $p < .06$ ;  $MSe = 40.2$ ). Subjects who faced the vertical arrangement first were less slow with the horizontal arrangement than subjects who faced the horizontal arrangement first. When the vertical presentation came first, the mean difference score was 3.02



DAVG represents the average difference, in seconds, between finding times for the horizontal presentation and the vertical presentation. ORDER (V-FIRST) and ORDER (H-FIRST) represent the groups that received the vertical presentation first and the horizontal presentation first, respectively.

Fig. 7. Effect of Age and Order of Presentation on Difference Scores.



seconds; whereas when the horizontal presentation came first, the mean difference score was 8.34 seconds.

Chi-square tests were performed to determine if age group, order of presentation, or library reference experience were related either to judgment of relative ease of use or to noticing a difference between arrangements—and whether ease of use and noticing a difference were related. Most of these tests showed no significance, except for judgment of ease of use, which *was* significantly related both to age group and to noticing a difference in arrangements. Nine of twelve younger subjects found the vertical arrangement easier to use than the horizontal arrangement, while only four of the twelve older subjects found the vertical arrangement easier ( $\chi^2 = 4.2$ ;  $df = 1$ ;  $p < .05$ ). No subject in either group rated the horizontal arrangement easier; rather, the subjects who did not rate the vertical organization easier said there was no difference between the arrangements. In addition, those subjects who judged the vertical arrangement to be easier were much more likely to have noticed a difference between the arrangements. Eleven of the thirteen subjects who judged the vertical to be easier noticed a difference between the arrangements, while only three of the eleven subjects who rated both arrangements the same in ease of use noticed a difference ( $\chi^2 = 5.9$ ;  $df = 1$ ;  $p < .02$ ).

### DISCUSSION

The arrangement of the entries *did* make a difference. Subjects found information faster when the entries were presented in the vertical arrangement than they did when the presentation was horizontal, regardless of any other factor. When subjects were asked to give their opinions of the arrangements, no subject judged the horizontal arrangement to be easier than the vertical arrangement, although thirteen subjects found the vertical arrangement to be easier (eleven found no difference in ease of use). These findings support the first hypothesis that people expect and are more comfortable with a text organization that is in vertical alphabetical columns.

The second hypothesis, that an organization of text other than vertical disorients

people and causes them to have difficulties extracting information, is supported by the overall slower times for the horizontal presentation. It is also supported by the finding that when the horizontal presentation was given first, the difference in scores between horizontal and vertical was greater than for the group where the vertical was presented first. This suggests that there was an adverse overall effect on performance from being exposed to the horizontal arrangement first. It was noted during the test administration that those subjects who received the horizontal arrangement first appeared disoriented throughout the test, even when they turned to the vertical arrangement, whereas subjects who first had the vertical arrangement did not. Subjects who received the horizontal arrangement first frequently did not recognize the vertical order of the second arrangement, although they performed faster with the second, vertical arrangement.

Results also showed support for the third hypothesis, that there is *no* effect of age upon disorientation caused by an unexpected arrangement of text entries. The difference in performance times for finding information in text organized vertically and horizontally was the same proportionately for younger people as for older. Regression analysis showed no significant correlation between age in years and the average difference in scores. Age group was not a factor in noticing a difference between the presentations. In fact, the only area in which age group was significant was in the articulation of a judgment regarding ease of use. Younger subjects were more likely to state that the vertical arrangement was easier to use, while the older subjects were more likely to state that both arrangements were equally easy. This may be explained partly by a reluctance, expressed by some older subjects, to admit that any part of the test was difficult in any way.

Interestingly, only fourteen of the twenty-four subjects noticed a difference in the two arrangements. Of these fourteen, however, only four were able to accurately articulate what the difference was. Two noticed the difference during the test, and the other two only realized it when answer-

ing the questionnaire. Some of those who did not accurately articulate the difference suggested that there was *no* order in what was actually the horizontal arrangement. Others suggested that what was in fact the horizontal arrangement differed from the vertical in that it contained more information.

Regarding the fourth hypothesis, prior experience *did* prove to be significant in our study. However, contrary to our expectations, in the only area where experience was significant, the younger people with experience performed more slowly with the horizontal presentation than did younger people without experience. Experience made no difference to the older people's results. It is possible that the younger women with library experience had more rigid expectations than the older women with experience who had perhaps long since tempered any rigidity through the necessity to adapt to significant changes in libraries over the years. It should be noted, however, that only a rough assessment of prior experience was made. Further investigation might provide useful insights into the possible effects of experience in this area.

In a larger study it might be interesting to analyze the possible effect of the type and order of questions. We used five types of questions presented in a random order. It is possible that the type of question affected the response times in either or both of the

alphabetical arrangements. The responses to questions on cross-references seemed to come more slowly than responses to other types of questions, perhaps because the cross-references are smaller entries and may be harder to find. The raw data does show some variation along these lines, but the number of cases is too small to be reliable.

In conclusion, we must reiterate that our study was limited in its scope (only twenty-four subjects, all women and all university graduates) and therefore limited in the generalizability of its results. However, our results do indicate a significant effect of the arrangement of entries on search times, regardless of age. Several subjects needed to be reassured between questions that the information they were seeking really was contained on the test sheets. In a real situation, these users would not have persevered long enough to find what they were seeking. Producers of information sources and those providing access to them might be well advised to take note of this finding and either format the sources in the "usual" arrangement or alert potential users to the presence of an "unusual" format. It is possible that individuals with less academic experience might experience a greater degree of difficulty than the subjects in this study. Further testing with larger and different populations would be necessary to test whether these results have a broader applicability. ■ ■

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#### APPENDIX A. QUERY TYPES FOR TEST SHEETS

(Terms in capitals vary according to the test letter selected)

Type 1

What is the month and year beside the term MIGRANT WORKERS?

Type 2

What is the date range associated with the term FAMILY MANAGEMENT?

Type 3

What is the number after the CIJE code associated with the term UNWRITTEN LANGUAGES?

Type 4

What is the FIRST RELATED term, code RT, listed under the term MIGRATION PATTERNS?

Type 5

What is the BROADER term, code BT, listed under the term FAMILY STRUCTURE?

#### APPENDIX B. QUESTIONNAIRE—BACKGROUND INFORMATION

The following information is required in order to analyse the results of the information retrieval test you have just completed.

Please do NOT write your name anywhere on this sheet. Your responses will be kept confidential and separate from the consent form that you signed.

1. Please indicate your age in years, as of your last birthday.

\_\_\_\_\_

2. (a) Have you ever worked in a library or information centre?

YES \_\_\_\_\_ NO \_\_\_\_\_

If your response to this question is YES, please continue with questions 2(b) - 2(d).  
If your response to this question is NO, please continue with question 3.

2(b) How many years (approximately) did you work in this capacity?

\_\_\_\_\_

2(c) What position(s) did you hold? Please list briefly.

\_\_\_\_\_  
\_\_\_\_\_

2(d) In your position(s) did you have direct contact with the patrons of the library or information centre?

YES \_\_\_\_\_ NO \_\_\_\_\_

3. Did you notice a difference between the two presentations?

YES \_\_\_\_\_ NO \_\_\_\_\_

If YES, what was the difference?

\_\_\_\_\_

4. Please indicate which format you found easier to use.

FORMAT ONE \_\_\_\_\_ FORMAT TWO \_\_\_\_\_ NO DIFFERENCE \_\_\_\_\_

5. On the following scale please indicate the strength of your preference for the format you found easier.

1 2 3 4 5  
a little easier a lot easier

THANK YOU FOR PARTICIPATING IN THIS STUDY.