THE EFFECTS OF LIST ORGANIZATION ON SEARCH TIMES

Robert Murphy, Roya Megan Sarwary, Deidre Rogers, Ramadevi Gurijala
San Jose State University
ISE 212, Summer 2004

Introduction

For over 30 years, it has been known that additional information on the items and their relations enhances memory when learning lists (Engelkamp and Zimmer, 2001). Tulving & Pearlstone (1966), found that cue recall was higher than non-cued recall. For example, relational encoding of words is improved when lists are categorically structured rather than unstructured (Kintch, 1970). Hunt and Einstein (1981), found that when categorical list structure and instructions were manipulated either to focus on item information (by a pleasantness rating) or on relational information (by a sorting task), increasing item and relational information increased free recall. Visual information foraging is affected by information scent (local cues, such as bolded category headings, used to navigate toward distal information sources) and the visual density of the item searched (Pirolli, Card, & Wege, 2001).

Many work activities require workers to research and quickly locate information during the course of their workday. Some examples of jobs responsibilities requiring research are answering 911 calls and quickly finding the appropriate protocol to use in a given emergency situation, locating the correct personnel within an organization, finding policy and procedure information within a employee handbook, and when information searching on the world wide web.

The time involved in doing these types of information foraging has implications on worker's productivity as well as in the quality of work product. Business bears the costs of excessive visual foraging. In particular, there is a body of research supporting the use of focusing tools and contextual/relational information to assist workers with rapid information location and recall (Pirolli, ET AL, 2001 & Engelkamp & Zimmer, 2001). Human visual searching reacts to the number, density, kinds, and distribution of elements in the visual field, among other things (Pirolli, Et Al, 2001). High information scent, such as bolded categories, should ideally provide the cues needed to rapidly access desired information, eliminating costly visual searches.

In this study we will evaluate the effect of list organization on user's speed in identifying items within the lists. Alphabetization and randomization will be applied to both categorized and non-categorized lists. The presence or absence of information scents may affect subjects ability to reach their

information goals, by narrowing or broadening the region to be investigated, enabling some items to pop-out from the display. In addition, we will also evaluate whether a greater number of words in an item to be identified, affects search time.

Method

In this experiment, we recorded the subject's time spent finding textbook titles from various lists of textbooks. Book lists varied in organization by simple lists, and categorized list, and each of these were then alphabetized or randomized. The book titles to search for varied by short titles, and by long titles. We had eight different trials. Each subject completed two passes of the eight trails, presented in random order. Time was recorded in seconds, errors were also recorded. Results for various tasks will be compared to determine any effect of list organization on list search time.

Subjects

Five subjects, three female and two male participated, all of them right handed, aged 23 to 48. One subject was a professor with a Ph.D., the others were university graduate students. University degrees of the subjects were, Physics, Human Factors and Ergonomics, Industrial Engineering, Cognitive Science, and Psychology. No participants indicated a problem with using a pencil. For three of the subjects, English was their primary language.

Apparatus

Four different lists of books were used (see Appendix 1-4). Lists were generated in the English language, using Microsoft Excel. The font used was 12 point Times New Roman. A .25 in. square box is displayed to the left of the book titles, for the subject to indicate their selection. The categorized lists used the same font and size, but bolded, for the category headers.

The topics selected for the textbook titles were, Computer Science and Engineering, Art, Psychology and Biology. 32 titles were used, eight for each category, four long titles, and four short titles.

Task 1 used a non-categorized, randomized list. Task 2 used a non-categorized, alphabetized list. Task 3 used a categorized, randomized list. Task 4 used a categorized, alphabetized list.

Book titles were presented on 6 in. x 1.25 in. pieces of paper, using 14 point Times New Roman.

A stopwatch was used to calculate the time of completion for each trial. A mechanical pencil was used to place a checkmark in front the selected book, after finding the title from the lists.

Definition of Variables

The independent variables manipulated were the list organization (defined above as Tasks 1-4) and book titles to search for. Book titles to search for were divided into two groups, long titles (3 or fewer main words), and long titles (4 or more main words). The dependent variables measured were the time of completion for each trail and the number of errors made.

Controls

In an effort to eliminated memory and rehearsal, the eight trials were presented in random order. The subject was not allowed to see the book titles before the trails began. All trials of the experiment were conducted in one session, under similar circumstances. The same experimenter measured time for all the trials. Instructions were written out and read to each subject. Experimental material was presented in text (computer generated) format. All subjects were college/university graduates. Experimental material (topic of lists - textbook titles), was selected due to familiarity to college graduates.

For two subjects, English was not their primary language. We did not consider this a factor, because they were studying or teaching in a graduate university environment, using the English language. Analysis was within-subject, and any effect this may have had would hold across all of the subject's trials.

Procedure

The subject was seated comfortably at a table, and asked questions regarding age, highest educational degree obtained, academic field, whether they have problem using a pencil, and if English was their primary language. One experimenter read the instructions to the subject (see Appendix 5).

An experimenter placed a book list and a randomly chosen book title in front of the subject, and at the same time, said the word “begin.” The timer would begin timing at that point. The subject would search for the book title and place a checkmark in the appropriate box, indicated their selection. The timer would stop when the subject made their checkmark. Time and errors were recorded.

Experimental Design

This is a multiple level (2 x 2 x 2), within subject design. At the highest level is the distinction between presenting data in a single list, or grouped by category. Each of these are divided into random and alphabetical order (indicated by Tasks 1-4). The third level of design is the stimuli, or length of book title presented to the participant. For each list presented (Task 1-4), either a long search title (a) or a short search title (b) was presented also, which results in a total of eight tasks. Five subjects completed two trials of each task (in random order), resulting in 80 data points collected. This design is displayed in Table 1.

List	Random (Task 1)	Long Title (a)
		Short Title (b)
	Alpha (Task 2)	Long Title (a)
		Short Title (b)
Category/Groups	Random (Task 3)	Long Title (a)
		Short Title (b)
	Alpha (Task 4)	Long Title (a)
		Short Title (b)

Table 1.

Results

The data collected for this experiment is in Appendix 6. Boxplots of means for all subjects for each task were plotted first (see Chart 1). A general trend is observed, with higher means for random tasks (Task 1 and Task 3) than the respective alphabetized tasks (Task 2 and Task 4). Outliers are also identified in this chart.

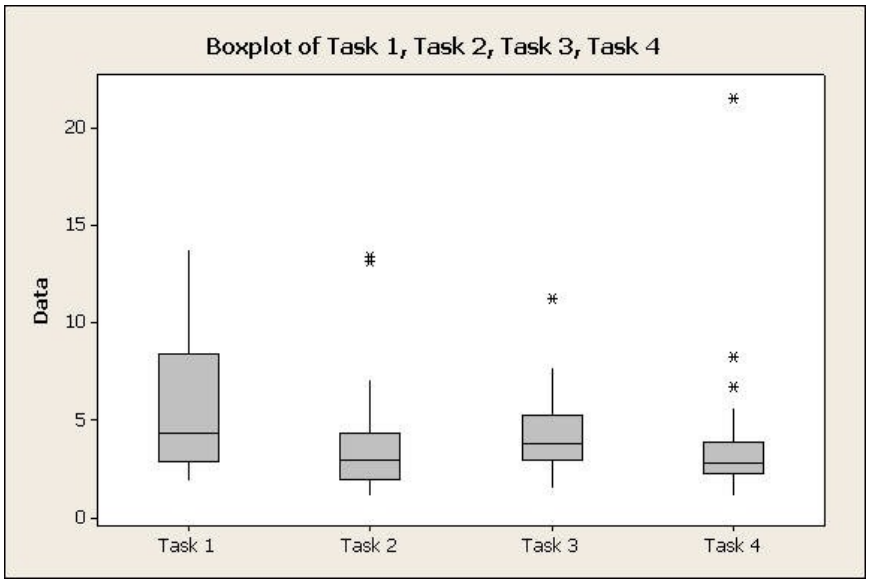

Chart 1.

The data points identified as outliers in Chart 1 (as asterisks) were removed. These were identified as Task 2, points 13.43 and 13.17; Task 3, point 11.27; Task 4, points 6.71, 8.25 and 21.54. Overall means, using updated data, for each of the four main tasks are displayed in Chart 2. Task 1 had a mean of 5.00 sec., Task 2 had a mean of 3.02 sec., Task 3 had a mean of 3.98 sec., and Task 4 had a mean of 2.80 sec. The percentage difference between the Random List (Task 1) and the Alphabetical List (Task 2) is 40%, the percentage difference between the Random Group (Task 3) and the Alphabetical Group (Task 4) is 30%.

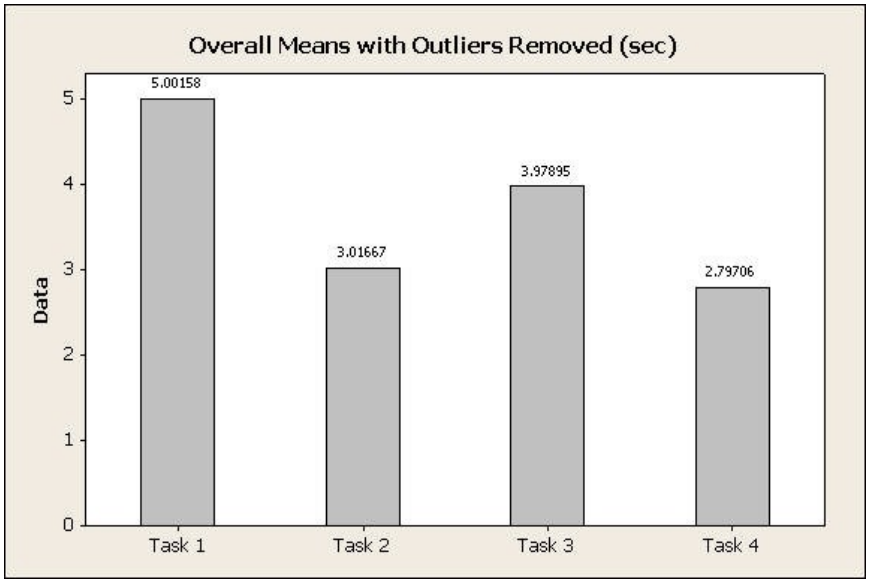

Chart 2

Individual subject means for each task were plotted (see Chart 3). A general trend for each subject is observed, with lower speeds for alphabetized lists (Task 2 and Task 4), as compared to the random lists (Task 1 and Task 3). Subject 2 had a greater difference from Random List (Task 1) to Alphabetized List (Task 2).

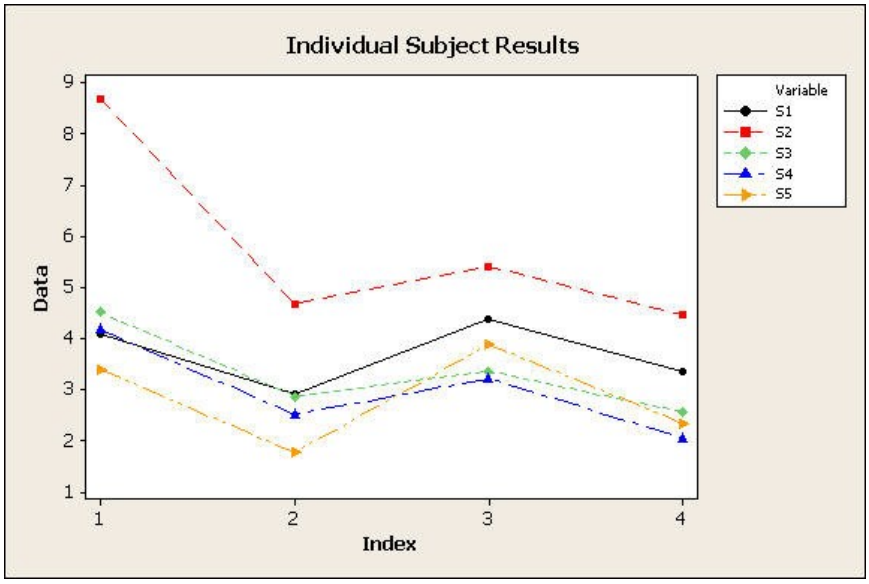

Chart 3

Two-sample t-Tests were conducted on various combinations of tasks, using overall means with outliers removed, to determine statistical significance between these tasks.

	N	Means	SDs	P-Value
List vs.	37	4.04	2.36	.189
Group	36	3.42	1.52	
List Random vs.	19	5.00	2.65	.009
List Alpha	18	3.02	1.48	
Group Random vs.	19	3.98	1.68	.015
Group Alpha	17	2.80	1.03	
List Random vs.	19	5.00	2.65	.166
Group Random	19	3.98	1.68	
List Alpha vs.	18	3.02	1.48	.614
Group Alpha	17	2.80	1.03	
Long Titles vs.	35	4.17	1.95	.070
Short Titles	38	3.33	1.99	

Statistically significant differences are indicated with a P-Value of <.05. The comparisons falling within this value are between List Random vs. List Alpha and between Group Random vs. Group Alpha. A difference (as measure with P-Value) between Long Titles vs. Short Titles is considerably low, but not enough to claim statistical significance.

Errors

Only two errors were observed during the experiment. One error was due to the participant's not fully understanding the task, and the second error was due to a participant selecting a similarly named, but incorrect book title. Due to the quantity and nature of these errors, no analysis was conducted which included error data.

Discussion

Our results indicate a difference in search times between alphabetized and randomized lists, alphabetized lists having shorter search times. This applies to both simple lists and categorized lists. The percent of difference in search times was greater when a simple list is used.

This point indicates a greater benefit to alphabetizing longer lists, than shorter lists, by the fact that the category lists used, were composed of several short lists. Alphabetizing shorter lists does not appear to have the same benefit, because the number of choices to scan and identify one's selection in, is shorter, and not as time consuming to scan, as longer lists.

Some difference was seen between the stimuli of presenting long title vs. short titles to search for, short titles having a lower mean time, but not statistically significant. This may be due to the idea that people may only use the first one or two words of the title to search for.

Little differences was see between long lists in general, and categorized lists in general, due to this experiment's variations of each of these categories. Only slight differences were seen between simple lists and grouped or categorized lists, in both random or alphabetized orders.

A factor not controlled in this experiment was the position of the title to search for, within the presented lists. It was observed, that more titles for Subject 2 appeared to be at the bottom of the presented lists than for other subjects. This may explain the high mean(s) for Subject 1 as displayed in Chart 3. We intentionally randomized the titles the subjects were to search for, although controlling and manipulating their position within the list, may provide more accurate results.

Some limitations we worked within are the limited number and variety of subjects, and the limited list of items we created. Further experimentation may include more subjects from a wider background of professional fields, vary the length of lists, vary the topics, and possibly test variations within real-world contexts. As previously mentioned, 911 operators may need to scan lists to find the appropriate response or protocol, and search times or methods may be affected by the stress one is under.

Organization of lists can be varied further by including frequency of use, and testing benefits of alphabetization and frequency of use, against various list lengths, identifying an optimum range for either organization style.

In conclusion, we've shown that alphabetizing lists does decrease search times within that list, with more benefit to longer lists than shorter lists.

Appendix 1: Task 1 – Book Title List

- [ ] Human Anatomy Update
- [ ] Short Protocols in Molecular Biology
- [ ] Data Analysis Tools for DNA Microarrays
- [ ] Keys to Drawing
- [ ] The Art Lesson
- [ ] Art up close
- [ ] Drawing for Dummies
- [ ] The Psychology of winning
- [ ] Inside Relational Databases
- [ ] Handbook of Children Psychology
- [ ] C Programming Language
- [ ] Abnormal Psychology
- [ ] Your Career in Psychology: Industrial/Organizational Psychology
- [ ] Digital Analog Communications Systems
- [ ] Human Molecular Genetics
- [ ] Microsoft Office Project 2003
- [ ] The New Drawing on the Right Side of the Brain
- [ ] Linear System Theory and Design
- [ ] Pencil Magic: Landscape Drawing Techniques
- [ ] Harmonic Proportion and Form in Nature, Art and Architecture
- [ ] Discovery of the Child
- [ ] Introduction to Microsoft Office Project 2003
- [ ] Principles of Human Anatomy
- [ ] The Anger Habit: Proven Principles to Calm the Stormy Mind
- [ ] Access 2003 Bible
- [ ] Cognitive Therapy in Groups: Guidelines and Resources for Practice
- [ ] Introduction to the Molecular Biology of the Cell
- [ ] Biology: A Guide to the Natural World
- [ ] Drawing in Construction: Swift perspective, sketches and outlines
- [ ] Molecular Biology of the Gene
- [ ] Basic Fundamentals of Database Systems
- [ ] Influence: The Psychology of Persuasion

Appendix 2: Task 2 Book Title List

- [ ] Abnormal Psychology

- [ ] Access 2003 Bible
- [ ] Art up close
- [ ] Basic Fundamentals of Database Systems
- [ ] Biology: A Guide to the Natural World
- [ ] C Programming Language
- [ ] Cognitive Therapy in Groups: Guidelines and Resources for Practice
- [ ] Data Analysis Tools for DNA Microarrays
- [ ] Digital Analog Communications Systems
- [ ] Discovery of the Child
- [ ] Drawing for Dummies
- [ ] Drawing in Construction: Swift perspective, sketches and outlines
- [ ] Handbook of Children Psychology
- [ ] Harmonic Proportion and Form in Nature, Art and Architecture
- [ ] Human Anatomy Update
- [ ] Human Molecular Genetics
- [ ] Influence: The Psychology of Persuasion
- [ ] Inside Relational Databases
- [ ] Introduction to Microsoft Office Project 2003
- [ ] Introduction to the Molecular Biology of the Cell
- [ ] Keys to Drawing
- [ ] Linear System Theory and Design
- [ ] Microsoft Office Project 2003
- [ ] Molecular Biology of the Gene
- [ ] Pencil Magic: Landscape Drawing Techniques
- [ ] Principles of Human Anatomy
- [ ] Short Protocols in Molecular Biology
- [ ] The Anger Habit: Proven Principles to Calm the Stormy Mind
- [ ] The Art Lesson
- [ ] The New Drawing on the Right Side of the Brain
- [ ] The Psychology of winning
- [ ] Your Career in Psychology: Industrial/Organizational Psychology

Appendix 3: Task 3 Book Title List

Computer Science/ Engineering

- [ ] Inside Relational Databases
- [ ] Basic Fundamentals of Database Systems
- [ ] Microsoft Office Project 2003

- [ ] Digital Analog Communications Systems
- [ ] Access 2003 Bible
- [ ] Linear System Theory and Design
- [ ] C Programming Language
- [ ] Introduction to Microsoft Office Project 2003

Art

- [ ] Pencil Magic: Landscape Drawing Techniques
- [ ] Drawing for Dummies
- [ ] The Art Lesson
- [ ] Harmonic Proportion and Form in Nature, Art and Architecture
- [ ] Drawing in Construction: Swift perspective, sketches and outlines
- [ ] Keys to Drawing
- [ ] The New Drawing on the Right Side of the Brain
- [ ] Art up close

Psychology

- [ ] Handbook of Children Psychology
- [ ] The Anger Habit: Proven Principles to Calm the Stormy Mind
- [ ] Cognitive Therapy in Groups: Guidelines and Resources for Practice
- [ ] Your Career in Psychology: Industrial/Organizational Psychology
- [ ] Influence: The Psychology of Persuasion
- [ ] Discovery of the Child
- [ ] The Psychology of winning
- [ ] Abnormal Psychology

Biology

- [ ] Human Anatomy Update
- [ ] Principles of Human Anatomy
- [ ] Molecular Biology of the Gene
- [ ] Human Molecular Genetics
- [ ] Short Protocols in Molecular Biology
- [ ] Biology: A Guide to the Natural World
- [ ] Introduction to the Molecular Biology of the Cell
- [ ] Data Analysis Tools for DNA Microarrays

Appendix 4: Task 4 Book Title List

Art

- [ ] Art up close
- [ ] Drawing for Dummies
- [ ] Drawing in Construction: Swift perspective, sketches and outlines
- [ ] Harmonic Proportion and Form in Nature, Art and Architecture
- [ ] Keys to Drawing
- [ ] Pencil Magic: Landscape Drawing Techniques

- [ ] The Art Lesson
- [ ] The New Drawing on the Right Side of the Brain

Biology

- [ ] Biology: A Guide to the Natural World
- [ ] Data Analysis Tools for DNA Microarrays
- [ ] Human Anatomy Update
- [ ] Human Molecular Genetics
- [ ] Introduction to the Molecular Biology of the Cell
- [ ] Molecular Biology of the Gene
- [ ] Principles of Human Anatomy
- [ ] Short Protocols in Molecular Biology

Computer Science/ Engineering

- [ ] Access 2003 Bible
- [ ] Basic Fundamentals of Database Systems
- [ ] C Programming Language
- [ ] Digital Analog Communications Systems
- [ ] Inside Relational Databases
- [ ] Introduction to Microsoft Office Project 2003
- [ ] Linear System Theory and Design
- [ ] Microsoft Office Project 2003

Psychology

- [ ] Abnormal Psychology
- [ ] Cognitive Therapy in Groups: Guidelines and Resources for Practice
- [ ] Discovery of the Child
- [ ] Handbook of Children Psychology
- [ ] Influence: The Psychology of Persuasion
- [ ] The Anger Habit: Proven Principles to Calm the Stormy Mind
- [ ] The Psychology of winning
- [ ] Your Career in Psychology: Industrial/Organizational Psychology

Appendix 5: Instructions

Thank you for participating.

For each task, you will be presented with a list of book titles, and one book title to find within the list.

Please have a pencil in your hand, ready to begin the task.

The papers will be placed in front of you, at the same time the administrator will say "begin".

Using the pencil, place a check in the box next to the book title, after you find it.

Please be as quick and accurate as possible.

Appendix 6: Results

	1_a	**1_b**	**2_a**	**2_b**	**3_a**	**3_b**	**4_a**	**4_b**
S1	3.58	2.81	3.95	2.27	2.95	4.08	3.95	2.36
S1	4.94	5.01	3.41	2.01	6.89	3.58	3.68	3.39
S2	8.48	8.76	7.14	4.45	7.76	4.83	5.66	8.25
S2	8.32	9.22	4.56	2.56	11.27	3.66	21.54	3.25
S3	3.80	13.76	13.43	4.12	3.56	3.10	6.71	2.29
S3	6.54	3.22	2.00	2.49	5.03	1.75	2.69	2.70

S4	2.34	9.43	3.44	3.64	5.36	1.54	2.80	1.52
S4	1.90	3.05	1.10	1.84	3.97	2.00	2.76	1.13
S5	5.60	1.92	13.17	2.17	2.33	3.00	2.94	2.02
S5	2.70	3.41	1.89	1.26	5.81	4.40	2.23	2.18

References

Engelkamp, J. & Zimmer, H. (2001). Categorical and order information in free recall of action phrases. *Psicológica*, 22, 71-96.

Hunt, R.R. & Einstein, G.O. (1981). Relational and item specific information in memory. *Journal of Verbal Learning and Verbal Behavior*, 20, 497-514.

Kintsch, W. (1970). Models for free recall and recognition. In D.A. Norman (Ed.), *Models of human memory*. New Yourk: Academic Press.

Pirolli, P. Card, S. & Van Der Wege, M. (2001). Visual information foraging in a focus + context visualization. *CHI 2001*, Seattle.

Tulving, E. & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. *Journal of Verbal Learning and Verbal Behavior*, 5, 381-391.