FIVE STUDIES IN PSYCHOLOGY:
METHODOLOGY, DATA ANALYSIS, APPLIED RESEARCH, AND BASIC RESEARCH

in fulfillment of the requirements
of ID 499

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Muncie, Indiana
May, 1988
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ACKNOWLEDGEMENTS

I would like to like to thank all of the people, students and faculty alike, who were able to put up with me during the last four years. I would also like to extend special thanks to Darrell Butler for his invaluable guidance, and to Mrs. Ralph J. Whitinger for the support that helped make the whole educational endeavor possible.
CHAPTER 1
INTRODUCTION

A question that is often posed on college campuses, and probably more often outside of them, concerns the purpose of the undergraduate experience. Why do colleges and universities really exist, and what should they really be trying to accomplish? For some, university life is best defined as a social experience, where one is allowed the opportunity to interact with a variety of new and different people. For others, a university exists to provide direct vocational training, preparing its graduates for the increasingly competitive job market. Finally, more traditional academic purists may look at the undergraduate experience as a quasi-monastic search for knowledge or truth for its own sake. Clearly, the undergraduate years can mean many different things to many different people.

For me, the undergraduate career is one of opportunity -- opportunity to explore individual interests. It is a time when an individual learns to ask questions, explore his curiosities, and search for plausible solutions to his problems. One of the most attractive features of this opportunity is that this exploration is allowed to span a wide range of subject matter. Expansive course offerings and general studies programs have even been created at many universities, Ball State included, in an effort to cater to the diverse nature of undergraduate study. It is within this spirit of diversity that I have developed as a scholar at Ball State University.

During my four years as an undergraduate, I have been actively involved in research in the Department of Psychological
Sciences. Due to fluctuations in my interests and a desire to explore numerous areas, this research has dealt with a variety of issues relevant to psychology. The purpose of this paper, then, is to present the results of these various research efforts.

This volume is somewhat different from more traditional theses or dissertations. In most cases, the thesis or dissertation represents a capstone work that culminates a significant creative research endeavor. The works presented here, however, represent the results of several different research projects spanning more than one area of study. As a result, this collection may seem to be lacking the focus usually found in more traditional theses and dissertations. This is done intentionally, however, to accurately capture the spirit of diversity that I believe is important to undergraduates. A more focused research effort can wait until I pursue a more advanced degree.

This volume contains five research articles that I have played a role in creating during my undergraduate career at Ball State University. Two of them have been published in well-known journals, two were papers presented at regional conferences, and the remaining one is currently under revision for future submission. Each of these papers falls primarily into one of four major categories significant to research psychology: methodology, data analysis, applied research, and basic research. Chapters 2 through 5 in this volume are devoted to addressing each of these four areas. In each chapter, there is a brief introduction to that area and a discussion of the significance of
the work that I have been involved in to that area. This is then followed by the actual paper(s) relevant to that area. Concluding remarks are provided in Chapter 6.
CHAPTER 2
METHODOLOGY

One of the key areas of study in psychology involves research methodology. All scientists are interested in learning how to perform their research more effectively. Psychologists are no exception. Therefore, a great deal of research in psychology is devoted to improving the practice of research itself. In fact, an entire journal, Behavior Research Methods, Instruments, & Computers, is devoted to this issue. Other journals, like Perceptual and Motor Skills, in which the following paper was printed, also publish papers concerning methodology issues.

The present paper is an extension of Butler (1986). In that article, Butler provided evidence that instructions provided to human subjects in psychology experiments can be presented through automated means (e.g., tape recording, written instructions, videotape, etc.) without a loss of clarity or effectiveness. This is an important finding because, previously, many researchers were hesitant to utilize automated instructions, despite the fact that automation can yield great benefits to researchers. These advantages include the minimization of such methodological hazards as experimenter bias, as well as saving the experimenter a great deal of time.

Given the result that automation of instructions is possible, the next obvious question involves how to present those instructions to maximize their effect. Is repeating instructions to subjects helpful in eliminating task-related
errors? Is it wise to use examples when instructing a subject as to how to perform an experimental task? It is questions like these that are confronted in this paper.

INSTRUCTIONS TO HUMAN SUBJECTS: EFFECTS OF REPETITION ON TASK ERRORS

DARRELL L. BUTLER AND STEVEN K. JONES
BALL STATE UNIVERSITY

Summary.--Two experiments investigated the effect of instructional information on task errors. In Exp. 1, the number of repetitions was varied over a wide range to determine the functional relation between effectiveness of instructions and number of repetitions. The form of the repetitions was also varied (rewording of important information versus an example). The relationship between effectiveness and number of repetitions was a negatively accelerated function, and an example was more effective than reworded information, at least when the information was not repeated many times. Exp. 2 was similar to Exp. 1 except that the number of repetitions was a between-subjects variable instead of a within-subjects variable. Exp. 2 confirmed that the function relating effectiveness to number of repetitions is a negatively accelerated function.

Many experiments in psychology rely on pools of subjects, and this reliance may lead to problems. Subjects obtained in this manner typically have little experience with research. They may have difficulty following instructions that seem clear to individuals more familiar with the experimental task. As a result, instructions to these subjects must be carefully designed to communicate effectively the procedures or strategies to be followed.

Two of the basic characteristics of transmission of information are that repetition can increase the probability of information transfer and can increase the probability of retention (Travers, 1973). The exception to this general rule is immediate repetition of the same information, i.e., the classic spacing effect. In a recent study, Butler (1986) found that a single repetition of important information in instructions substantially reduced errors, however, that study did not examine
the effect of more than one repetition.

Some evidence suggests that the format of information may be important. Kammann (1975) found that instructions for using a complex phone system were less comprehensible when written in sentence-paragraph form than when provided in flow-chart form. However, the advantage of flow charts does not appear to generalize to other tasks. Schneiderman, Mayer, McKay, and Heller (1977) did not find an advantage to using flow charts for tasks involving computer programming. One format characteristic that may matter in instructions for an experiment is the occurrence of an example.

The purpose of the present experiments was to investigate the effects of repetitions on task performance. In Exp. 1 the number of repetitions of key information was varied over a wide range to relate the number of repetitions of instructions to frequency of errors in an experiment. A second issue was the effectiveness of using an example in instructions. Exp. 2 was a further examination of the effect of using repetitions and examples in instructions.

**EXPERIMENT 1**

The present experiment was done to determine the relation between the number of times information is repeated in instructions and the number of errors committed. Also, Exp. 1 examined whether an example in the instructions was equivalent to repeating instructions.

**Method**

**Subjects.** Subjects were 79 undergraduate volunteers from
the participant pool.

**Stimuli.**--The task was similar to the sentence-completion task used by Butler (1986). The stimuli were 25 well-known sentences taken from nursery rhymes and stories. For each of the sentences, the last word was replaced by a blank. Sentences were randomly divided into five sets of five sentences. Each set was typed, triple-spaced, on a white sheet of paper 21.7 cm by 14 cm. The statement "DO NOT TURN THE PAGE UNTIL YOU ARE TOLD TO DO SO" was printed at the bottom of each page. Instructions were written in six different ways. Two versions, to be used exclusively as a first page of instructions, stated that the sentence completion should be completed creatively. The instructions reiterated that responses should be creative. The two versions differed in the method used to repeat key information. One defined what was meant by creative responses (i.e., "Remember to write a word that is not the typical way the sentence would be created by others"). The other version provided a negative provided a negative example. Subjects were given the phrase "When it rains ........." and were told not to complete such a sentence with the word "pours." These two versions had the same number of words. The other four versions of the instructions, none of which was to be used as the first page of instructions, informed the subjects that the task was a sentence-completion task and indicated that they should be creative. The sentence instructing subjects to be creative was different for each version. For example, in one, subjects were told, "do not use a word that other people would be likely to
use." Instructions were typed on the same size paper as used for tasks.

Procedure.--Subjects were run in small groups of up to four. All subjects received five versions of instructions and all five sets of the stimuli on a clipboard. Pages of instructions alternated with pages of stimuli. Except for the first page of instructions, the order of stimuli and instructions was randomized independently for each subject. Thirty-nine subjects received the first page of instructions containing the example and the other subjects (40) received the other first page. Basic instructions, such as "Turn to the next page and begin reading the instructions" and "Begin the task as soon as you have completed reading the instructions" were presented by tape recorder. Subjects were given 75 sec. to read each set of instructions and complete the subsequent set of five sentences. They were not allowed to turn back to previous pages at any time.

Results

Two judges agreed 100% on the errors made by subjects. Fig. 2-1 summarizes subjects' performance as a function of trial and type of instruction. The dependent variable is the percent of subjects completing at least one errorless trial. Percentages of each instruction group are shown instead of frequencies to aid visual comparison of groups. Three subjects never reached errorless performance. Their data are not shown in the figure and were not included in the analyses. Had they been, they would have no effect on the over-all shape and little effect on the relative heights of the curves.
Fig 2-1. Cumulative percent of subjects' first errorless trial as a function of trial and type of instructions. Open symbols show instructions that included an example. Filled symbols show instructions that restated important information.
The number of errors decreased with the number of repetitions. An analysis of variance indicated a significant effect of repetitions ($F(4,300)=57.56, p<.001$).

Subjects who were given an example in the instructions made fewer errors than other subjects. Since the distribution of the two instruction groups for first errorless trials were extremely nonnormal, differences associated with type of instruction were examined using the Mann-Whitney U test. There was a significant difference between groups ($U=463.5, p<.01$).

As can be seen in Fig. 2-1, performance was very similar for both groups after Trial 3. For both instruction groups, the percentages of subjects making errors after the third trial was less than 5%.

This experiment indicates that the function relating performance and repetitions of instruction is negatively accelerated. Further, instructions containing an example resulted in fewer errors than those without one. However, only one task was given, and it was the one Butler (1986) found generated relatively large error rates. Most researchers would probably not find the effect of repetitions or examples in their instructions to be as influential as reported here.

Another issue concerning the function shown in Fig. 2-1 involves the meaning of a trial. In this experiment, repetition of instructions was confounded by the tasks being interspersed between the repetitions. Such confounding is not typical in experiments. Although no feedback was provided, working on the sentences may have had some effect. At the very least, the task
so arranged produced a delay between the repetitions. Spaced repetitions often have different effects from massed ones. Exp. 2 was designed to examine the effects of repeating instructions independently of possible spacing effects.

EXPERIMENT 2

Method

Subjects.--Subjects were 111 volunteers, 100 from the subject pool at the University and 11 from sophomore level courses. None had participated in Exp. 1.

Procedure.--The procedure was similar to that used in Exp. 1 with the following changes. Subjects were randomly assigned to one of three groups. Groups differed with respect to the numbers of repetitions in the instructions. One group was told to be creative and was given the same example used in Exp. 1. A second group was given the same information as Group 1, and in addition a second statement that indicated they should "finish the sentence in an imaginative way." The third group received the same information as Group 2, and in addition one more restatement of the goal for the task before they were given the example. Each subject was then given one set of five sentences to complete. The sets of sentences were those used in Exp. 1. Instructions (three types) were crossed with sentence set (five different sets). Approximately equal numbers of subject received each of these instruction/sentence set combinations.

Results

This experiment confirmed the finding that repetition of key
instructions lead to fewer errors. The number of sentences completed uncreatively was 31 (of 185) for the group receiving least repetitive instructions, 13 (of 185) for the group receiving moderately repetitive instructions, and 8 (of 185) for the group receiving the most repetitive instructions. This difference in frequency of errors is significant ($\chi^2(2)=18.63$, p<.001).

This experiment also replicated the finding that the function relating repetition of instruction to errors is negatively accelerated.

Conclusions

These experiments indicate that repetitions and the use of examples can improve the effectiveness of instructions. They suggest that key information should be repeated three times. One of the repetitions should be an example rather than simply a restatement of key information.

REFERENCES


TRAVERS, R.M.W. (1973). *Second handbook of research on*
CHAPTER 3
DATA ANALYSIS

A second key ingredient in research psychology is data analysis. One of the main goals of psychological research is to quantify behavioral phenomena. As a result, researchers in psychology often emerge from experimental settings with stacks and stacks of numbers that must be simplified to be comprehended. This process is the heart of data analysis.

Psychologists and other scientists have used a wide variety of statistical procedures to simplify the analysis of data. Recently, they have turned to computers for assistance in calculating these statistics. As a result, a variety of statistical packages for use on computers have been marketed. The following paper was written to evaluate some of these statistical packages. Specifically, it compares inexpensive (less than $100) packages that compute a wide variety of statistics, and that run on Apple II microcomputers.

A COMPARISON OF INEXPENSIVE STATISTICAL PACKAGES
FOR APPLE II MICROCOMPUTERS

DARRELL L. BUTLER AND STEVEN K. JONES
BALL STATE UNIVERSITY

The purpose of this paper is to describe and compare some inexpensive software packages that calculate a variety of statistics on the Apple II microcomputer. For each package, hardware requirements, program capacity, limitations, constraints, accuracy, editing, error handling, and other features were studied.

The purpose of this paper is to compare inexpensive (less than $100) statistical packages that run on Apple II microcomputers. Several sources were used to find packages, including previous review (e.g., Butler, 1986; Henry & Bauer, 1986), advertisements in numerous journals (e.g., Amstat News), and listings of programs (e.g., Datapro/McGraw-Hill, 1985). Packages that had too little flexibility (e.g., packages from Dynacomp and PARSsoft) were not included. Two of the packages found are no longer on the market: Ustats (Wm. C. Brown Publishers) and Statistics 3.0 (Eduware). Some packages could not be obtained. For unobtained packages, the information included in the present paper is brief (because it is based upon advertisements), and those packages not included in Table 3-1, the primary summary of the reviewed packages.

GENERAL CHARACTERISTICS OF PACKAGES

Table 3-1 summarizes a variety of information about the packages. The features included in the table are described below. For each package, characteristics that are difficult to include in the table are described following the description of
tabled features.

General Features

All of the packages are menu driven, at least for procedure selection. The hardware requirements of the packages are very similar. All worked on an Apple II+, Apple IIe, and Franklin 1200, although some subtle differences in operation were found. Copy-protected programs could not be copied with the standard DOD 3.3 copy program or the Pascal Filer. Error trapping refers to the program containing checks for such conditions as divide by zero and non-numeric data and appropriate handling of such conditions.

Statistics

The statistics calculated by the programs were compared to a list of fundamental statistical routines, those found in at least 10 of 20 general statistics textbooks we examined. The fundamental routines are those listed in Table 3-1. For each statistical routine, the programs' limitations were studied: maximum number of scores, maximum number of cells or groups (where appropriate), and accuracy. Accuracy was examined using the basic technique described by Butler and Eamon (1985). This technique is particularly sensitive to rounding errors, especially those resulting from computing a power of a large number. A number of similar data sets were used. The table shows the maximum number of digits that could be used in any of the data sets to obtain correct statistics.

Speed was not easy to assess. Overall, Statistix was the fastest and Statistics Software for Microcomputers was the
### Table 3-1.

<table>
<thead>
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<th>Requirements, Features, and Limitations of Programs</th>
<th>Programs</th>
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<tr>
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### Statistics

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**OTHER FEATURES**

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<tbody>
<tr>
<td>Log</td>
</tr>
</tbody>
</table>

**Note:** Dep = dependent (e.g., in ANOVA, the number of cases may depend on the number of levels of the independent variable; see text for descriptions of dependencies). ?? = testing was not extensive enough to determine the precise nature of the maximum. --- = not applicable.
slowest. Speeds of the other three programs were approximately the same. However, speed depended upon length of the data set, statistic used, options, and number of consecutive runs of a procedure (i.e., most routines were slower the first time they were run).

**Other Features**

Disk files for all packages were sequential files. All had files with names, structures, or contents that were unique, or specific to the package. Usually these unique files were compatible with a variety of routines within the package. Some of the packages could also save ASCII data-only files or other types of files that could be used by other programs. Statistix's saved data structure contains "dummy" or "grouping" variables as well as data.

Data editing is best when data are numbered and editing is done onscreen, which means that the data is seen during the editing. Transforming variables means to change data values using algebraic expressions.

**UNIQUE PROGRAM CHARACTERISTICS**

Those characteristics of the programs that are difficult to describe in Table 3-1 are described below, package by package. Addresses for suppliers of the programs are provided in the Appendix.

**Key-Stat**

The correlation/regression program is a strength of this package. Output of the regression routine includes descriptive statistics and many intermediate values used in calculating the
correlation coefficient. A scatter plot and regression equation are generated. The best-fitting line can be added to the scatter plot. (Note, the scatter plot is accurate only when the data have four digits or less.)

In addition to the statistics listed in Table 1, Key-Stat has a rather elaborate calculator that simulates a Hewlett-Packard RPN calculator.

Some of the menus (especially the opening menu) are long and use confusing terminology. As a result, it is difficult to find some statistical routines. To aid the user, a separate program is included that helps the user to choose the correct statistical technique. Another inconvenience not apparent in Table 3-1 is that the user must return to the main disk menu before rerunning some of the procedures.

For another review of Key-Stat, see Henry and Bauer (1986).

Statistical Programs for the Apple II

In the ANOVA routines, the number of levels of independent variables and the number of scores per level are interdependent. For example, a one-way between design with two level accepts 500 scores per level, a one-way with four levels accepts 150 scores per level, and a one-way with 20 levels accepts only 7 scores per level.

In addition to the statistics listed in Table 3-1, this package calculates three-way ANOVAS, simple Latin Square ANOVAS, and ANCOVAS with a maximum of 100 cells and 25 scores per cell. The ANOVA routine is accurate to three digits.

The program was originally described in Steinmetz, Romano,
and Patterson (1981). Several procedures have been added since the original publication.

**Statistics Software for Microcomputers**

In the ANOVA routines, the total number of scores allowed is dependent upon the number of cells in the design. For example, a one-way between design with two levels accepts 3,450 total scores, a one-way with five levels accepts 1,700 total scores, and a one-way with 15 levels accepts 625 total scores.

In addition to the statistics listed in Table 3-1, this package can compute multilinear regression and factor analysis.

The programs greatest weakness is in the data input routines. The input routines vary with procedure and all are very slow. The user is forced to start a routine over if any error is made. With the exception of the excellent editor for the descriptive routine, editing is difficult, and the chi-square routine does not allow editing. Calculations are very sluggish. For example, the descriptive statistics program requires approximately 10 min to calculate statistics on 200 data. Note that Table 3-1 indicates that the descriptive statistics can only handle 100 values. That is the number of values the program can process in 3 min. A more patient user may find that the program has great capacity.

**Statistics with Interpretations**

One strength of this package is the output. It includes the statistics and, where appropriate, a verbal statement indicating whether the statistic is significant, the degrees of freedom, the probability of the statistic, and a list of the assumptions of
the test.

In addition to the statistics listed in Table 3-1, Statistics with Interpretations calculates skewness, kurtosis, Cramer's V for contingency tables, and multiple regression regression. However, Cramer's V is only accurate to two digits, and the multiple regression routine is limited to predictors.

At the beginning of each statistical procedure is a list of the procedure's capacity and limitations; then the user has the option to escape, input data from the keyboard, or read data from a disk file.

**Statistix**

Then package is the most comprehensive reviewed here. The output of several of the routines (e.g., ANOVA) is far more complete than any other package reviewed here, and many more options are available (e.g., contrasts). In addition to the statistics described in Table 3-1, this package also computes the following statistical procedures: ANOVA (up to five independent variables), ANCOVA (up to five covariants), principal components (up to 30 predictors, sign test, median test, Kolmogorov Smirnov test, log linear models, McNemar's symmetry test, 11 different statistics on 2x2 tables, the runs test, Wilk-Shapiro/Rankit Plots, and several types of cross tabulations. There is also an extensive procedure for calculating probabilities.

This package is relatively easy to use, but it is a bit more difficult to use than the other packages reviewed here. For example, the ANOVA routines require the user to specify the model and indicate the error term(s). A split-plot factorial design
may be specified as follows:

\[ DV = AB \text{ABC(ERROR)} C \text{C*B(ERROR)} A*C A*B*C(\text{ERROR}), \]

where A, B, and C are dummy variable specifying group membership and DV is the data to be analyzed.

For another review of the package, see Russek-Cohen (1986).

Psychostat-3 (and newer version called Apstat)

Several telephone calls and a written communication to this company were made requesting a review copy. In addition, we offered to purchase a copy if they would refund our money after the review. The company did not cooperate. As a result, the following comments are based upon advertisements of this package.

This package runs on a one-drive Apple II or compatible. It costs $99. Calculations include descriptive statistics, t-tests, ANOVAS (up to five factors and unlimited cases), multiple regressions (up to 25 predictors), and non-parametric statistics. Data editing, transformations, file compatibility with other packages, and graphics (bar graphs and scattergrams) are included in this menu-driven program.

Statcalc

This package costs $100. We did not test it, because no copy was received. However, it is a command language program that accommodates 2,000 data on a 48K, one-drive Apple. There are seven types of commands: (1) input, editing, and display of data; (2) means, variances, t-tests, chi-squares, ranks; (3) plots: scatter plot, triplots, stem and leaf, boxplots, normal plots, histograms; (4) transform and sorting; (5) random number generation; (6) one- and two-way ANOVA, regression, multiple
regression; and (7) DOS commands.

REFERENCES


APPENDIX
Program Suppliers’ Addresses

Key-Stat
Oakleaf Systems
P.O. Box 472
Decorah, IA 52107

Statistical Programs for the Apple II
Michael M. Patterson
College of Osteopathic Medicine
Ohio University
Athens, OH 45701
(614) 593-2337

Statistics Software for Microcomputers
Kern International, Inc.
433 Washington St.
P.O. Box 1029CA
Duxbury, MA 02331
(617) 934-0445

Statistics with Interpretations
Darrell L. Butler
Department of Psychological Science
Ball State University
Muncie, IN 47306
(317) 285-1700

Statistix
NH Analytical Software
801 W. Iowa Ave.
St. Paul, MN 55117
(612) 488-4436

Psychostat-3 (and Apsat)
Statsoft
2832 E. 10th St., Suite 4
Tulsa, OK 74104
(918) 583-4149

Statacalc
Alan J. Lee and Peter McInerney
Department of Mathematics and Statistics
Peter R. Mullins
Department of Community Health
University of Auckland
Private Bag
Auckland, New Zealand
CHAPTER 4
APPLIED RESEARCH

A third major division important to contemporary research psychology is applied research. This area differs from more traditional, basic research (which will be discussed in Chapter 5) in that the primary motivation for its execution is to solve real-world problems, rather than to formulate theory or advance knowledge for its own sake. This type of research has become increasingly important to psychology in recent years. The proliferation of work in the areas of industrial psychology, engineering psychology, and environmental psychology is evidence to this fact. It is also evidence to the fact that the once-formal lines separating academic psychology and disciplines in the world of business, engineering, and architecture have begun to fade.

One specific area of applied psychological research is environmental psychology. This is the study of how individuals react to the natural and built world around them. Clearly, knowledge in this area can have important implications to architects and designers who wish to make their work more desirable for their clientele. Of particular importance is the determination of the relationships between characteristics of a space and human behaviors.

One of the initial challenges in determining the relationship between a space and human behavior is to identify a list of spaces that are relevant (i.e., worthy of further research and consideration). Compiling such a list was the goal of the first paper in this chapter. A second challenge facing
designers is how to utilize this list, along with knowledge of space-behavior relationships, to their advantage. The second paper presented in this chapter is an example of a work dealing with this issue.

The first work that follows, "Common spaces and activities of college students evaluated using a recall method," was originally submitted in its present form to Environment and Behavior. It now appears as if it will be revised and expanded upon before actually being published in this, or another, journal. The second paper of this chapter, "Identification of underlying factors of window preferences," appears in the form in which it was presented at the meeting of the Midwestern Psychological Association, April 28, 1988 in Chicago, IL. It also is being prepared in a form suitable for publication in a psychology journal.
COMMON SPACES AND ACTIVITIES OF COLLEGE STUDENTS
EVALUATED USING A RECALL METHOD

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BALL STATE UNIVERSITY

Two techniques have evolved for studying the relation between spaces and behavior: direct observation and verbal report usually based on memory. A growing body of research is producing evidence that these two techniques produce very similar data. The purpose of the present experiment was to obtain a relatively complete list of typical spaces and behaviors of a college student population using the verbal report method. A total of 374 students participated in two studies. The obtained lists of spaces and behaviors summarized here should be a valuable data base for researchers, engineers, and designers. Overall, the data provide evidence that the best way to know where someone is, is to know what they are doing.

A variety of researchers, engineers, and designers interested in the relation between spaces and human behavior require relatively comprehensive lists of typical spaces and behaviors. Two fundamental techniques have evolved to obtain such information. The first technique (Barker, 1968; Barker and Gump, 1964; Barker and Schoggen, 1973) emphasizes direct observation in natural settings. It is often assumed that this method produces the most reliable and valid description of spaces and activities. A second technique relies on subjects' verbal reports and usually is based upon subjects' memory of spaces and behaviors. Some experimenters (Berk and Berk, 1979; Blum and Candee, 1944) ask subjects to record in a diary booklet where they spend time and what they did in those places. Other researchers (Baird, Noma, Nagy, and Quinn, 1976; Black, 1968; Glaser, 1964; Jacobsen, 1974) ask subjects to complete various types of questionnaires. It is believed by some researchers that
experiments relying on subjects' memory are better thought of as studies of cognitive representations of behavior (Ittleson, Proshansky, Rivlin, and Winkel, 1974).

A growing body of research is producing converging support for the proposition that judgments based upon memory of spaces and behaviors are very similar to observers' judgments of actual spaces and behaviors. Herzog, Kaplan, and Kaplan (1976) presented pictures of familiar places to one group of subjects (the observers) and names (no pictures) of the same places to another group of subjects (memory reporters). They found that judgments of scene complexity and preference of scenes were virtually identical for the two types of stimuli. Baird, Noma, Nagy, and Quinn (1976) compared students' memory of the activity of other students in particular places to observations of student activity in the same places. The two types of data were very highly correlated. Baird, Merrill, and Tannenbaum (1979) compared memory of distances between buildings to actual distances. The power function exponents were both near 1.00 (.97 and .92). Merrill and Baird (1980) compared the aesthetic judgments of environments made by one group of subjects to the aesthetic judgments of a different group required to remember the same environments. They found a strong linear relationship among the two sets of judgments and no significant group differences. In a recent study, Patton, Routh, and Stinard (1986) investigated study conditions on students: quiet, with a radio on, or with a TV on. They found strong positive correlations between stated preferences of study conditions and observed behavior.
While the research described above supports the notion that actual spaces and behaviors are similar to those retrieved from memory, it does not suggest that memory and observation data are identical. On the one hand, it is difficult to eliminate reactivity to an observer. Also certain private settings are practically impossible to observe. On the other hand, responses from memory may involve a certain amount of retrieval failure as well as response biases. What the research described above does suggest is that verbal reports and observations have a strong linear relationship. That is, the spaces that are actually frequented most often and the activities that are actually engaged in most often are the very spaces and activities that are most salient in memory. Thus regardless of whether observations or verbal reports of memory are used, the same spaces and behaviors will predominate the results.

The purpose of this research was to provide a relatively complete list of typical space and behaviors of a college student population using a memory reporting technique. The study was conducted in an effort to provide a data base for researchers, engineers, and designers interested in the relationship between human spaces and behaviors, as well as those interested in understanding their cognitive representations.

Experiment 1: Spaces

Method

Subject. The subjects were 147 female and 72 male undergraduate volunteers from the Ball State University subject pool. All students enrolled in introduction to psychology are
required to engage in two to three hours of extra-classroom activities. One of these activities is participation in the subject pool. The median age was 19. Twelve percent were married and 14% had never lived in a college dormitory.

**Procedure.** Subjects were run in large groups in a large lecture room. They were informed that the purpose of the experiment was to understand where students spent time. Then they were asked to provide their age, sex, marital status, number of children, and indicate if they had ever lived in college dormitories. Students were then asked to "Please name all of the rooms or spaces in which you spend time. Write down the names on the blank page in front of you. You will have only 60 seconds."

Subjects were given 60 seconds instead of 30 seconds (as done in Battig and Montague, 1969) because pilot studies suggested that some students could write for about 60 seconds before stopping to think about responses.

**Results**

A male and a female judge worked together to tabulate responses. All legible responses were included. The two judges eliminated redundant responses of the same subject, combined responses that were synonymous across subjects and, in a few cases, combined responses that were clearly subcategorical. An example of synonymous responses is gym and gymnasium. An example of a subcategory is "outside my house" which was included in the category "outside." The results are summarized below.

**Where students spend time.** The maximum possible frequency is 219. Classroom (171), Bathroom (147), Dormroom (132), Bedroom
(113), Kitchen (107), Dining room (106), Living room (84), Lounge (70), Library (65), Vehicles (58), Outside (53), Gym (40), Family room (37), House/home (37), Hall (30), Mall/store (27), Restaurant (19), Basement (17), Office/Workplace (17), Laundry room (16), Computer work room (10), Garage (10), Student center (8), Theatre/Auditorium (8), Church (7), Elevator (7), Sorority suite (7), Closet (6), Den (6), Studio (5), Stairway (4), Lobby (3), Music room (3), Atrium (1), Barn (1), Break room (1), Darkroom (1), Daycare (1), Foyer (1), Parking lot (1).

Gender Differences. There were a number of gender differences, but overall the data suggest that females and males are more similar than they are different. Gender differences were examined using a normal approximation to the binomial test of the differences between two proportions. A greater percent of males named living room (Z=2.18), House/home (Z=3.39), gym (Z=2.18), basement/attic (Z=2.37), and den (Z=2.27). A greater percent of females named family room (Z=2.35). Interpretation of these differences must be made cautiously because some of these differences appear to involve quantitative, but not qualitative differences between male and females.

Experiment 2: Activities

Method

Subjects. The subjects were 83 male and 72 female undergraduate volunteers from the Ball State University subject pool. The median age was 19 years. Twelve of the males and 12 of the females had never lived in a college dormitory. Six percent of the subjects were married.
**Settings.** In general, settings were selected for Experiment 2 if they were named with high frequency in Experiment 1. Many of the high frequency spaces are found in most houses (i.e., bathroom, bedroom, kitchen, dining room, living room, and family room). Garage was also included for several reasons, but most importantly, to increase the diversity of spaces in the house that would be represented, and to assess the effect of subjects responding to a space indicated very infrequently in Experiment 1. A number of the other high frequency spaces in Experiment 1 are found in most schools (i.e., classroom, dormroom, computer work room, and library). One additional setting was chosen, the office. This seemed to be the one work setting for which most of the students would be familiar. Further, it provided another measure of the effect of using a space indicated infrequently in Experiment 1.

**Procedure.** Subjects were run in large groups as done in Experiment 1. After providing demographic information, they were given the following instructions:

The purpose of this experiment is to find out what behaviors you perform in various living/working spaces. The procedure will be as follows: You will be given the name of a room or space for you to think of. You will be given 60 seconds to write down in the notebook the behaviors that you do, have done, or would do in that space. Write the behaviors in whatever order they happen to occur to you. Please be sure to write down every behavior that you think of for each of the rooms named, even those that may embarrass you. Your name will not appear with your answers, so everything you write will be completely anonymous. If you are asked to think of a room with which you are unfamiliar or have limited experience in, please write the words "NO EXPERIENCE" on the page.
The behaviors are to be written in the notebook, using a different page for each room. Before beginning each listing, please write the name of the room at the top of each page. When you hear the word "stop", you are to stop writing and turn immediately to the next page of the notebook. You will be given the name of another room, and again you are to write as many behaviors performed in that room as you can think of. You are to use a different page of the notebook for each room. Please do not turn back to previous pages at any time. Also, be sure to write the name of the room at the top of each page. Now, if there are no questions, please open your notebook to the first page and get ready for the first room.

Results

Judges tabulated the responses as was done in Experiment 1. Overall, judges determined about 300 different response across spaces. For a number of reasons, behaviors are only reported here if at least four subjects made the response for a particular setting. Based on 95% confidence intervals of a normal distribution, four is the number that indicated a frequency different from zero. Using this shortened list of behaviors, respondents produced 9824 total responses of which there were 123 different behaviors named. They are summarized below.

Bedroom. (Total frequency of responses = 970). Sleep (149), Romantic/Sexual behavior (134), Study/Do homework (88), Dress (79), Listen to music (72), Watch tv (67), Read (61), Rest/Relax (48), Talk (40), Talk on phone (34), Clean/Straighten up (33), Eat (32), Think/Be alone (30), Groom (22), Exercise/Dance (18), Play (14), Undress (13), Change clothes (12), Drink (10), Write (10, Smoke (4).

Bathroom. (Total frequency of response = 846). Use toilet
Shower (129), Brush teeth (93), Do hair (90), Shave (70), Bathe (69), Wash (57), Read (31), Romantic/Sexual behavior (30), Dress (25), Clean bathroom (16), Look in mirror (14), Vomit (10), Undress (8), Get ready (7), Bathe dog (5), Blow nose (5), Listen to music (5), Put in contacts (5), Talk (5), Do laundry (4), Drink (4), Groom (4), Pick zits (4), Take medicine (4), Weigh self (4).

Living Room. (Total frequency of responses = 936). Watch TV/VCR (138), Read (86), Eat (83), Talk (73), Sleep (70), Listen to music (69), Study/Do homework (56), rest/Relax (45), Entertain/Visit (42), Romantic/Sexual behavior (42), Play games/Do Puzzles (39), Talk on phone (29), Clean (28), Party (23), Drink (22), Sit (20), Exercise/Dance (17), Nap (15), Play musical instrument (11), Play with pet (8), Smoke (6), Argue (5), Christmas activities (5), Look out window (4).

Dining Room. (Total frequency of responses = 609). Eat (155), Talk (98), Study/Do homework (61), Play games (60), Drink (40), Clean up after meals (27), Read (26), Romantic/Sexual behavior (20), Clean (19), Talk on phone (14), Rest/Relax (12), Set table (12), Watch TV (12), Listen to music (11), Party (11), Entertain/Visit (6), Prepare food (6), Sit (6), Smoke (5), Sew (4), Sleep (4).

Family room. (Total frequency of responses = 983). Watch TV (131), eat (90), Play games (85), Read (75), Sleep (73), Listen to music (72), Study/Do homework (72), Party (58), Talk (57), Romantic/Sexual behavior (56), Entertain/Visit (32), talk on phone (31), Exercise/Dance (29), Rest/Relax (23), Clean (15),
Play with animals (13), Play with kids (13), Use computer (9),
Sit (8), Watch fire (7), Think (7), Smoke (6), Write (6), Pay
bills (5), Play musical instrument (5), Take drugs (5).

Kitchen. (Total frequency of responses = 837). Eat (141),
Cook/Eat (107), Wash dishes (90), Talk (67), Clean (65), Talk on
phone (64), Prepare food (61), Drink (52), Study/Do homework
(33), Watch TV (21), Play games (17), Listen to music (17),
Romantic/Sexual behavior (16), Feed pets (15), Put away groceries
(14), Read (13), Sit (11), Put dishes away (8), Look in
refrigerator (5), Party (5), Set table (5), Throw away trash (5),
Take cut trash (4).

Garage. (Total frequency of responses = 549). Work on car
(81), Park car (71), Store things (48), Clean garage (44), Build
things (40), Wash/Wax car (25), Exercise (23), Fix things (23),
Work on bike (22), Work (21), Play games (17), Party (16), get
food from freezer (15), Romantic/Sexual behavior (11), Do laundry
(10), Work on cycles (10), Paint (9), Take trash to (9), Do
hobbies (8), Get tools (7), Feed pets (7), Listen to music (7),
Use tools (6), Play (5), Put tools away (5), talk (5), Have
garage sale (4).

Dormroom. (Total frequency of responses = 1225). Study/Do
homework (127), Sleep (126), Eat (114), Romantic/Sexual behavior
(103), Listen to music (93), Party (80), Watch TV (78),
Entertain/Visit (59), Dress (47), Clean (43), Drink (42), Talk on
phone (40), Read (38), Play games (29), Relax/Lounge (29), Talk
(26), Do hair (22), Exercise/Dance (18), Put on make-up (18),
write (18), Smoke (13), Take drugs (12), Argue (9), Cook (9),
Undress (8), Fight (7), Change clothes (5), Decorate (4), Live (4), Type (4).

Classroom. (Total frequency of responses = 955). Listen (103), Sleep (103), Talk (98), Study/Do homework (86), Take notes (80), Read (66), Think (65), Take tests (58), Write (51), Learn (39), Eat (22), Look at people (18), Watch movies (17), Drink (15), Sit (14), Get bored (13), Look around (13), Draw (12), Ask questions (11), Play (11), Meet people (10), Do experiments (10), Listen to music (8), Do work (7), Make fun of professor (7), Flirt (7), Socialize (6), Cause trouble (5).

Computer work room. (Total frequency of responses = 354). Use computer (135), Talk (46), Write (23), Read (21), make printouts (20), study (18), Think (14), Sleep (13), take tests (10), Get help (9), Sit (8), Eat (8), Look at people (6), Goof off (6), Drink (5), Romantic/Sexual behavior (4), Listen (4), Walk (4).

Library. (Total frequency of responses = 870). Study/Do homework (139), Talk/Meet with friends (138), Read (116), Do research (72), Sleep (61), Write (48), Check out books (37), Watch people (26), Make copies (25), Look at A/V materials (24), Look for books (22), Listen to music (22), Get drink 921), Eat (20), Walk (16), Ride elevator (13), Romantic/Sexual behavior (11), Pick up girls (11), Daydream (8), Hang out (8), Smoke (7), Think (7), Look around (6), Draw (4), Pick things up (4), Relax (4).

Office. (Total frequency of responses = 690). Talk (97), Write/Do paperwork (94), Talk on phone (79), Type (56), Work
(46), read (40), Sleep (29), Romantic/Sexual behavior (29), File (21), Drink (20), Eat (19), Have meetings (18), Relax (17), Watch TV (14), Listen to music (13), Sit (12), Study/Do homework (10), Wait (10), Help others (9), Use computer (9), Pick things up (8), Have parties (6), Think (5), take money (5), make copies (4), make deals (4), Observe others (4), Smoke (4), Be silent (4), Walk (4).

Of the 123 different behaviors, 76 were situation specific and 47 occurred in more than one space, that is, they were transituational. The transituational behaviors are summarized below (total frequency in parentheses).

Twelve Spaces. Talk (75).

Eleven Spaces. Read (573), Romantic/Sexual Behavior (456), Listen to music (400), Drink (231).

Ten Spaces. Study (690), Eat (684).

Nine Spaces. Sleep (628).

Eight Spaces. Clean (263).

Seven Spaces. Watch TV (461), Talk on phone (291), Write (250), Party (199), Rest/Relax (178), Sit (79), Smoke (45).

Six Spaces. Play games (247), Think (128).

Five Spaces. Exercise/Dance (105).

Four Spaces. Entertain (139), Look at people (54).

Three Spaces. Use computer (153), Dress (151), Undress (29), Play (27), Walk (24).

Two Spaces. Cook (116), Do hair (112), Listen (107), Take tests (68), Prepare food (67), Type (60), Work (53), Make copies (29), Groom (26), Feed pets (22), Play with pets (21), look
around (18), Help others (18), take drugs (17), Set table (17), Change clothes (17), Play musical instrument (16), Draw (16), Do laundry (14), Argue (14), Pick things up (12).

Comparison of Present Data to Previous Research

Blum and Candee (1944) reported that bedrooms are used for sleeping, reading, talking, and dressing. Similar results were obtained by Berk and Berk (1979), who also used a diary technique. Black's (1968) limited questionnaire indicated that bedrooms are used for sewing, dressing, studying, reading, and being alone. These lists are obviously incomplete. Parsons (1972) provided a more comprehensive list of bedroom behaviors. He argued that there are five major bedroom behaviors (sexual, sleeping, housekeeping, sitting, and observing) and a variety of minor behaviors. Our results are consistent with those of Parsons in that sleep and sex appear to be the most common bedroom behaviors. However, the present results do not support Parson's emphasis on housekeeping, sitting, and observing.

Importantly, the results obtained in the present study contain about the same diversity of behavior as described by Parsons. Also, our results agree with Black's (1968) in that the bedroom appear to play an important role as a place to rest and relax (which can include watching TV or listening to music) and be alone. Our results also agree with the diary studies (Blum and Candee, 1944; Berk and Berk, 1979) except that the diary studies report no romantic/sexual behavior as found here, and report much less "being alone" behavior than found here. Some of these differences may be due to the differences in samples and the
times at which the studies were done, but other differences may reflect important differences in the type of information gained with different techniques.

Black (1968) noted that bathrooms were rarely mentioned in his survey of use of rooms in houses. However, Kira (1976) describes a vast array of bathroom behaviors in his classic work. Overall, our list is similar to, and about as comprehensive as, Kira's. Kira describes five major categories of bathroom behavior (cleaning, elimination, grooming, medical, and miscellaneous). Results here contain a variety of behaviors within each of these categories. One behavior found to be important here, but not discussed much by Kira is romantic/sexual behavior. Also, Kira does not include dressing, undressing, and changing clothes, behaviors named relatively frequently in the present study and in Blum and Candee (1944). Results here also contain a number of trans situational behaviors not discussed at any length by Kira. On the other hand, Kira describes several behaviors that were not found in the present study: soaking dentures, using sun lamp, shining shoes, developing photographic film, douching, and watching TV. Many, if not all, of the behaviors outlined by Kira and not by our subjects are due likely to differences in the samples employed by Kira and this investigation.

Relation to Experiment 1

The total number of behaviors varied widely among spaces. Because this method can be thought of as a free-recall task, it is possible that the frequency of behaviors reported for setting
was related to the frequency with which those settings are reported. Based on this reasoning, spaces named with high frequency in Experiment 1 would be associated with high frequencies of behavior in Experiment 2. To examine this hypothesis, a Pearson correlation was computed between the frequency of naming a space and the frequency of reporting behaviors for that space. The correlation was significant for both males (r(10)=.58, p<.05) and females (r(10)=.56, p<.05). This relationship suggests that there is a cognitive association between where students report spending time and the number of behaviors performed there.

General Discussion

The data obtained in Experiments 1 and 2 provide a relatively comprehensive list of where students spend time and what they do in those spaces. The results obtained in both experiments have strong face validity in terms of their general rank order representation of settings and behaviors of college students. In spite of the potential factors that could have determined subjects' responses (e.g., recency effects, humorous responses, etc.), the results appear to describe reasonably well where students spend their time and what they do in those places. While it is not our contention that the cognitive representation of typical spaces and behaviors assessed here is identical to observation data, we do believe it is a good approximation of actual settings and behaviors of college students. It is hoped that this list provides a valuable data base for many researchers, engineers, and designers. It has already been
useful in our own research on lighting (Butler and Biner, 1987; Biner, Butler, Fischer, and Westergren, in press).

One implication of this work concerns Roger Barker's contention, (Bruner, 1965) that the best way to predict a person's behavior is to know where they are. According to our research, Barker's contention is very reasonable for some spaces, such as the computer work room. In this setting, there is a relatively high probability that the student will be working on a computer (P=.38). Barker's hypothesis does not work as well for any of the other spaces included in this research. For example, consider the dorm room. In this setting, it is likely that a student will be studying (P=.10). Note that it is also likely they will be sleeping (P=.10), eating (P=.09), or engaging in romantic/sexual behavior (P=.08). Thus, the validity of Barker's contention is considerably weakened for spaces that are associated with a diversity of highly probable behaviors.

An alternative viewpoint would be to attempt to predict where someone is from knowledge of what they are doing. Related to this issue, 61.8% of the reported behaviors were situation specific. For these behaviors, one can accurately predict where a person is. Furthermore, some of the transituational behaviors were very likely to occur in one particular space. For example, cooking is a transituational behavior, but there is a probability of .92 that cooking will occur in the kitchen. Thus, the true accuracy for predicting where someone is based upon what they are doing is much better than 61.8%. However, other transituational behaviors were not strongly associated with a given space.
Consider talking. For this behavior, there is a .18, .13, and
and kitchen, respectively. Although being able to predict where
an individual is from knowledge of what they are doing appears to
be relatively accurate, transitiuional behaviors such as talking
lower this accuracy.

While the analysis above suggests that predicting where
someone is (based on what they are doing) is much more accurate
than predicting what someone is doing (based on where they are),
it is not possible to determine which of these theoretical
statements is more valuable from the present research alone. The
probabilities indicated above are undoubtedly sensitive to the
research technique used. Other techniques may find
transitiuional behaviors to be far more prevalent than the
present research suggests. If this is the case, then the present
research is overestimating the strength of the relation between
what someone is doing and where they are.

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IDENTIFICATION OF UNDERLYING FACTORS OF WINDOW PREFERENCES

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There is a widely held belief in the world of architectural design, and in society in general, that people like windows. This notion certainly seems intuitively appealing. A fair amount of research also supports this idea. For example, Wotton and Barkow (1983) and others have shown that daylight from windows is preferred to natural light in such settings as offices, homes, and hospitals. Furthermore, Cuttle (1983) has argued that there is a positive linear relationship between a window’s size and an individual’s preference for it. In other words, large windows are generally preferred over small ones, and, in general, the larger the window, the better. If such a simple relationship truly exists between people’s subjective preference and window size, the job of architects and designers should be fairly easy, at least with respect to window design.

Unfortunately, not all of the evidence suggests that large windows are preferable in all spaces. For example, research on window preferences in classrooms has been somewhat contradictory. Some researchers (e.g., Tikkanen, 1970) report a general preference for classrooms with windows, while others (e.g., Chambers, 1963) found favorable reaction to classrooms without them. Further, in our own preliminary research, we found that students were generally opposed to having windows in their bathroom. These results suggest that window preferences may vary as a function of space. Exploring this hypothesis was one
important aim of this research.

A second goal of this study was to examine the factors that determine why people like windows when they do. Only a few researchers have addressed the underlying factors contributing to window preference judgments, and they have done so, for the most part, in a speculative manner. We feel that a systematic study of the determinant of window preferences is necessary because knowledge of these factors could potentially allow research on window preferences to be generalized to spaces not previously studied.

A final, related goal of this research is to create a theoretical foundation for window preferences. The area of window preferences, like many areas in environmental psychology, is relatively atheoretical. Therefore, despite the fact that there is a great deal of research on window preferences, and the fact that this issue is of great importance to designers, none of the existing knowledge is theoretically based. In other words, none of the previous researchers have offered explanations for why their findings occurred. It is our hope to introduce some theory into this area by building a predictive model of window preferences. This model will be based both on the study of window preferences across spaces and the examination of the factors that contribute to those preferences.

Experiment 1

In Experiment 1, 59 undergraduates responded to a questionnaire asking them to make window preference judgments for each of the following 14 spaces: garage, large lecture hall,
small classroom, bedroom, family room, dining room, living room, 
bathroom at home, public bathroom, kitchen, dormroom, computer 
workroom, library, and office. Notice that this list includes 
both spaces that are residential and nonresidential in nature. 
Previous research (Butler, Biner, & Jones, 1987) has shown that 
each of these spaces is common to the college population.

For each of these 14 spaces, subjects were provided with a 
choice of several possible window configurations. This list was 
created by completely crossing the variables "size of window" 
(small, medium, or large), "transparency" (clear or transparent), 
and "number of walls" (one or more than one). Finally, a "no 
windows" option was added to give 13 possible window 
configurations. For each space, subjects were asked to indicate 
the window configuration that they most preferred (i.e. the best 
window option) and all of the configurations they found 
unacceptable (i.e. the bad window options).

Also on each page, subjects were presented with the 
following list of possible factors influencing the subjects' 
preference judgments: view of outside to see weather, time of 
day, etc.; view of outside to see people and surroundings; 
sunlight for illumination; appearance of objects or people within 
the room; quality and quantity of human interaction within the 
room; mood of individuals within the room; symbol of status or 
social standing; ventilation; temperature control (heat/cold from 
outside); humidity (e.g., from condensation); hearing of outdoor 
noises and sounds; glare and other light-related nuisances; 
feelings of safety and security; privacy; for indoor plants;
limits flexibility of furniture arrangement; and control of dust and/or bacteria. This list was composed of all of the factors that previous authors had speculated to be important. For each space, subjects were to indicate which of the factors from this list they used in forming their window preference judgments.

Subjects completed this entire set of judgments (window preference judgments and indication of factors used) for each of the 14 spaces. All of the subjects were able to complete the entire questionnaire within 30 minutes.

Results indicate that window preferences vary widely across spaces. This result is reflected in Table 4-1. The numbers in Table 4-1 represent the percentage of all subjects who indicated each type of window as their "best" option in each space. For example, 24 percent of the subjects thought that the best window option in the living room would be a large clear window in one wall. If window preferences really do vary across spaces, as we predict, then the percentages for each type of window should vary across spaces (i.e., the numbers in the columns should vary). According to Chi-Square Goodness of Fit tests performed on the raw frequencies, preferences for no windows; all types of clear glass windows; and small, translucent window in one wall all varied significantly across spaces.

It can also be seen from Table 4-1 that, contrary to previous research, large windows were not preferred for the majority of spaces included in this study. The window option considered to be the best by the largest percentage of subjects in each space is circled in the table. Notice that large windows
Table 4-1. Percentage of subject indicating each type of window as their "best window" option.

<table>
<thead>
<tr>
<th>ROOM</th>
<th>clear one wall</th>
<th>clear two or more walls</th>
<th>translucent one wall</th>
<th>translucent two or more walls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>none</td>
<td>small</td>
<td>medium</td>
<td>large</td>
</tr>
<tr>
<td>garage</td>
<td>12</td>
<td>31</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>lecture hall</td>
<td>53</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>small classroom</td>
<td>0</td>
<td>10</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>bedroom</td>
<td>0</td>
<td>12</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>family room</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>46</td>
</tr>
<tr>
<td>dining room</td>
<td>3</td>
<td>5</td>
<td>19</td>
<td>12</td>
</tr>
<tr>
<td>living room</td>
<td>0</td>
<td>2</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>bathroom (home)</td>
<td>17</td>
<td>32</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>bathroom (public)</td>
<td>68</td>
<td>7</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>kitchen</td>
<td>0</td>
<td>10</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>classroom</td>
<td>0</td>
<td>2</td>
<td>20</td>
<td>42</td>
</tr>
<tr>
<td>computer workstation</td>
<td>16</td>
<td>7</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>library</td>
<td>19</td>
<td>2</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>office</td>
<td>0</td>
<td>5</td>
<td>21</td>
<td>17</td>
</tr>
</tbody>
</table>

*Note that due to rounding errors some rows do not sum to 100%.*
(of any type) were the modal response for only three spaces: family room, dormroom, and library. No windows was the modal response for three spaces: lecture hall, public bathroom, and computer workroom. Small windows were the modal response in the garage and the bathroom at home. The factors that subjects reported as influencing their judgments also varied substantially across spaces. These results are summarized in Table 4-2. Here, the numbers represent the percentage of subjects who marked each factor as being important in each space. For example, 95% of the subjects thought that sunlight for illumination was an important consideration when choosing a window in the kitchen. If factors really do vary across spaces, then the percentages listed in each row of the transparency should vary, which they do. In fact, Chi-Square Goodness of Fit tests indicated that all but four of the factors (sunlight, humidity, furniture arrangement, and control of dust/bacteria) varied significantly across spaces.

The results reported here indicate that window preferences vary across spaces and that large windows are not always preferred over small ones. Interestingly, the spaces for which windows were preferred in this study are not necessarily the spaces in which high light levels are desired. For example, Butler and Biner (1987) found that college students prefer bright lights for nearly every activity performed within the bathroom. Yet, in the present study, the majority of college students preferred small windows or even no windows in the bathroom. Therefore, it appears as if window preference judgments can be accurately predicted by lighting level preferences alone.
Table 4-2. Percentage of subjects indicating each factor as important

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>GARAGE</th>
<th>LECTURE HALL</th>
<th>SMALL CLASS</th>
<th>BEDROOM</th>
<th>FAMILY ROOM</th>
<th>DINING ROOM</th>
<th>LIVING ROOM</th>
<th>BATHROOM (HOME)</th>
<th>BATHROOM (PUBLIC)</th>
<th>KITCHEN</th>
<th>DORMROOM</th>
<th>COMPUTER WORK ROOM</th>
<th>LIBRARY</th>
<th>OFFICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>view/temporal</td>
<td>51</td>
<td>44</td>
<td>70</td>
<td>83</td>
<td>88</td>
<td>75</td>
<td>83</td>
<td>22</td>
<td>9</td>
<td>93</td>
<td>95</td>
<td>24</td>
<td>61</td>
<td>80</td>
</tr>
<tr>
<td>view/people</td>
<td>36</td>
<td>35</td>
<td>51</td>
<td>71</td>
<td>80</td>
<td>61</td>
<td>63</td>
<td>5</td>
<td>7</td>
<td>79</td>
<td>93</td>
<td>19</td>
<td>54</td>
<td>64</td>
</tr>
<tr>
<td>sunlight</td>
<td>58</td>
<td>64</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>51</td>
<td>70</td>
<td>64</td>
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<td>95</td>
<td>85</td>
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<td>70</td>
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<td>appearance</td>
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<td>49</td>
<td>49</td>
<td>58</td>
<td>53</td>
<td>19</td>
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<td>50</td>
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<td>interaction</td>
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<td>59</td>
<td>48</td>
<td>56</td>
<td>51</td>
<td>24</td>
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<td>47</td>
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<td>36</td>
<td>61</td>
</tr>
<tr>
<td>task performance</td>
<td>37</td>
<td>58</td>
<td>73</td>
<td>41</td>
<td>44</td>
<td>31</td>
<td>15</td>
<td>34</td>
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<td>78</td>
<td>66</td>
<td>78</td>
<td>80</td>
<td>76</td>
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<tr>
<td>mood</td>
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<td>60</td>
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<td>14</td>
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<td>53</td>
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<td>73</td>
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<td>12</td>
<td>12</td>
<td>10</td>
<td>10</td>
<td>42</td>
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<tr>
<td>ventilation</td>
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<td>48</td>
<td>61</td>
<td>46</td>
<td>31</td>
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<td>44</td>
<td>71</td>
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<td>29</td>
<td>25</td>
<td>36</td>
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<tr>
<td>temperature</td>
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<td>49</td>
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<td>53</td>
<td>63</td>
<td>31</td>
<td>27</td>
<td>34</td>
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<tr>
<td>humidity</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>14</td>
<td>17</td>
<td>12</td>
<td>12</td>
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<td>17</td>
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<td>22</td>
<td>34</td>
<td>26</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>glare</td>
<td>12</td>
<td>20</td>
<td>22</td>
<td>19</td>
<td>17</td>
<td>14</td>
<td>15</td>
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<td>5</td>
<td>16</td>
<td>20</td>
<td>60</td>
<td>39</td>
<td>22</td>
</tr>
<tr>
<td>safety/security</td>
<td>36</td>
<td>7</td>
<td>3</td>
<td>38</td>
<td>20</td>
<td>14</td>
<td>20</td>
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<td>14</td>
<td>36</td>
<td>15</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>privacy</td>
<td>32</td>
<td>31</td>
<td>20</td>
<td>71</td>
<td>22</td>
<td>31</td>
<td>19</td>
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<td>16</td>
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<td>39</td>
<td>32</td>
</tr>
<tr>
<td>plants</td>
<td>2</td>
<td>7</td>
<td>20</td>
<td>34</td>
<td>42</td>
<td>24</td>
<td>46</td>
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<td>2</td>
<td>41</td>
<td>37</td>
<td>7</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>furniture arrange.</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>14</td>
<td>10</td>
<td>5</td>
<td>5</td>
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<td>14</td>
<td>9</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>dust/bacteria</td>
<td>14</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>9</td>
<td>15</td>
<td>19</td>
<td>24</td>
<td>9</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We believe that window preferences can be predicted, however, by considering the other factors (in addition to lighting level preferences) that are important in a given space. The results from Experiment 1 suggest that this may be possible. Recall that this study showed that there are many important factors related to the impact of windows, and that the importance of these factors varied substantially across spaces.

It is our contention that a very simple mathematical equation is one way to approach the problem of window preferences. To predict size of windows, the equation should include both the importance of each factor in a space and the degree to which that factor indicates that windows are desirable. Mathematically, this relationship can be expressed for a given space in the following way:

\[ W = \sum_{\text{factors}} (I_f \times S_f) \]

where \( W \) = window size, \( I \) = the importance of a factor to a given space, and \( S \) = the strength with which the factor indicates the desirability of windows. Experiment 1 was effective in providing information about \( W \) (window size preferences) and \( I \) (importance of factors), but did not provide any data about \( S \) (the relationship between factors and the desirability of windows). Obtaining this type of data was the aim of Experiment 2.

Experiment 2

For Experiment 2, a small brainstorming group generated reasons for wanting or not wanting windows. This list included the 18 factors considered in Experiment 1 as well as 5 others:
appearance of the building from the outside, source of
distraction, to make the space feel larger or more spacious,
emergency escape, and emergency entrance. Each of these 23
factors was typed on a 3" X 5" index card.

Each of 59 subjects (different from those used in Experiment
1) were asked to sort the 23 cards into two piles, one containing
reasons for wanting windows, and one containing reasons for not
wanting windows.

The percent of subjects sorting each factor into reasons for
wanting windows is shown in Table 4-3.

The results from Experiment 2 were combined with the results
of Experiment 1 to test the model of window preferences. The
data on window preferences from Experiment 1 were simplified to a
size judgment for each space. First, a weight was assigned to
each of the possible window configurations: "no windows" was
assigned a 0; "small window in one wall" was assigned a 1;
"medium window in one wall" and "small window in more than one
wall" were assigned a 2; and so on. Next, these weights were
multiplied by the percent of people in Experiment 1 that chose
that window configuration for that space. These products were
then added to give a weighted average for the preferred window
size in that space.

Using the mathematical equation described earlier, the
predicted window size was calculated for each space. This was
done by multiplying the percent of students indicating a given
factor as important (found in Experiment 1) by the percent of
students in Experiment 2 who thought that the factor was a reason
Table 4-3. Percentage of subjects sorting each factor into a pile of reasons to want windows

<table>
<thead>
<tr>
<th>Factors</th>
<th>% sorted into Wanting Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td>ventilation</td>
<td>100</td>
</tr>
<tr>
<td>emergency escape</td>
<td>100</td>
</tr>
<tr>
<td>for plants</td>
<td>98</td>
</tr>
<tr>
<td>space feel spacious</td>
<td>98</td>
</tr>
<tr>
<td>view outside (people)</td>
<td>95</td>
</tr>
<tr>
<td>sunlight</td>
<td>95</td>
</tr>
<tr>
<td>appearance from outside</td>
<td>85</td>
</tr>
<tr>
<td>mood</td>
<td>80</td>
</tr>
<tr>
<td>temperature control</td>
<td>80</td>
</tr>
<tr>
<td>symbol of status</td>
<td>78</td>
</tr>
<tr>
<td>appearance inside</td>
<td>76</td>
</tr>
<tr>
<td>interaction of people</td>
<td>73</td>
</tr>
<tr>
<td>view outside (temporal)</td>
<td>67</td>
</tr>
<tr>
<td>emergency entrance</td>
<td>67</td>
</tr>
<tr>
<td>performance of tasks</td>
<td>59</td>
</tr>
<tr>
<td>dirt/bacteria control</td>
<td>49</td>
</tr>
<tr>
<td>security</td>
<td>47</td>
</tr>
<tr>
<td>humidity</td>
<td>44</td>
</tr>
<tr>
<td>hearing outside</td>
<td>32</td>
</tr>
<tr>
<td>privacy</td>
<td>22</td>
</tr>
<tr>
<td>limits flex. of furniture</td>
<td>10</td>
</tr>
<tr>
<td>distraction</td>
<td>7</td>
</tr>
<tr>
<td>glare</td>
<td>7</td>
</tr>
</tbody>
</table>

*Note that these percentages represent the proportion of subjects indicating that a given factor was a reason for wanting windows.*
to want windows, and then summing over all of the factors for each space.

Therefore, we now have the actual preference judgments from Experiment 1, expressed in a simplified quantitative form, and we also have a set of predicted preference judgments based on our mathematical model. A Pearson correlation coefficient was calculated between these two sets of numbers. This correlation was .88, significant at the .001 level. This suggests that preferences for sizes of windows can indeed be predicted from the factors considered to be important in a given space.

In summary, the experiments reported here were successful in confirming our predictions that window preferences vary across setting, and that the relationship between window preference and window size is not as simple as some research suggested.

Secondly, this research represents what we believe to be the first systematic cross-setting examination of the factors underlying window preferences. Finally, and perhaps most importantly, this research has been successful in generating a simple, yet powerful, theoretical model of window size preferences. It is hoped that this model can serve as a theoretical framework for further study in the area of window preferences.

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CHAPTER 5
BASIC RESEARCH

The final area of research psychology discussed in this volume is basic research. Within this realm, theoretical models are created and tested, knowledge of human behavior is advanced, and the future of psychology is defined. Without basic research, a discussion of methodology, data analysis, or applied research would be practically meaningless. Basic research continues to be the backbone of research psychology, both in the academic setting and outside of it.

One area of particular interest to basic researchers in psychology is visual perception. Within visual perception, an important question is the effect of orientation on the recognition and perception of visual stimuli. An understanding of these effects can contribute to our general understanding of the functioning of the visual system. It can also lead to concrete principles of perception that are of great importance to applied researchers. Examining the effects of orientation and providing a theoretical explanation for these effects are the major goals of the paper that follows.

The following paper, "The use of the perceptual reference frame in judging depicted geometric objects," appears in the form in which it was presented at the meeting of the Midwestern Psychological Association, April 28, 1988, Chicago, IL.
Objects presented in an unfamiliar orientation are typically perceived and recognized with little effort. For example, see Figure 5-1. In this case, most people easily recognize the frog and the birds. However, unfamiliar orientation does affect the perception of some objects. In Figure 5-2, two depicted geometric objects can be seen. Most people see these objects as very different. However, they differ only in orientation. To see this effect, try to hold a memory of the drawing on the left and, then rotate the page 90 degrees to the left. Compare your memory to the re-oriented drawing on the right.

Most research on the effects of unfamiliar orientation has concerned relatively simple two-dimension forms, such as squares and diamonds. The commonly accepted theory of the effect of orientation on simple two-dimensional forms is Rock's (1973, 1983) argument that shape perception occurs within a perceptual reference frame. The major axis of the reference frame determines the perceived top and bottom. Thus, when orientation affects the perceptual reference frame, then the perceptual interpretation and/or recognition can be affected. Thus, the effects of orientation demonstrated in Figure 5-2 are quite strong because the surfaces judged as top in these two drawings are quite different.
A few experiments have examined the effects of unfamiliar orientation using three-dimensional objects or their depictions. The results appear to be consistent with Rock's perceptual reference frame hypothesis. Rock (1973) showed that recognition of faces was impaired when faces were presented upside-down. Kanizsa (1979) showed that the recognition of facially expressed emotion is influenced by orientation. Rock, DiVita, and Barbeito (1981) showed that recognition of three-dimensional, twisted wire forms was reduced when the stimuli were oriented in a way that affected perceived "top."

In a recent Psychological Review article, Corballis (1988) argued that one major way humans recognize shapes involves using frames of reference. Corballis argues that the top-bottom axis is the most important, the front-back axis is probably the next most important, and the right-left axis is probably the least important. However, Corballis states that there is no empirical data specifying the roles of front-back and right-left axes on tasks involving three-dimensional objects.

Although we had finished these experiments before we discovered Corballis' paper, we believe that it provides an important framework for the work described here. One of our goals was to empirically examine the salience and relevance of all three phenomenological axes of the reference system: top-bottom, front-back, and left-right. Based on the literature, we expected top-bottom to be the most salient axis, but we were not sure of the accuracy of Corballis's hypothesis about front-back axis being the next most important.
We were also interested in determining if PERCEPTION of local cues in a stimulus are affected by the frame of reference. Almost all of the research on the effects of orientation has involved RECOGNITION of complete objects. We wanted to see if more local features in objects are influenced substantially by orientation. Such effects have been suggested by at least one researcher and have important consequences for theories of orientation effects. That is, does recognition failure occur because memorial codes contain different reference frames than a stimulus being viewed? Or alternatively, does it occur because a change in orientation affects the coding of specific features in a stimulus?

EXPERIMENT 1

The purpose of this experiment was to determine the functional relation between orientation and judgments of 90 degree angles in ambiguous depicted objects.

The stimuli used in Experiment 1 are shown in Figure 5-3. All of the stimuli had one 105 degree angle that can be seen as a 90 degree angle in the surface of the depicted object. This angle is marked here with a small circle in each stimulus. Eighty undergraduates judged these stimuli in various orientations. They were asked to indicate if the marked angle was 90 degrees in the depicted object. Randomization and other good experiment practices were used.

The results are shown in Figure 5-4. There are two major characteristics of the data worth noting. First, there was a very strong effect of orientation on judgment of the angle
Fig. 5-4. Percentage of 90 degree judgments as a function of orientation

Percent of 90\degree Judgments

Orientation in Degrees
\[ F(3,237) = 225.26, p < .001 \]. For some orientation, only about 10% of the subjects judged the angle to be 90 degree in one of the conditions. For other orientations, 100% of the subjects judged the angle to be 90 degrees. Second, the effect of orientation was very weak with one stimulus -- the most regular stimulus \[ F(21,1659) = 19.19, p < .001 \]. This resistance to orientation effects could be due to familiarity. However, it could also be due to parallel lines in this drawing. Butler and Kring (1987) showed that parallel lines have a strong effect on the perception of 90 degree angles in drawings of objects.

**EXPERIMENT 2**

The purpose of this experiment was to see if the orientation effects found in Experiment 1 could be attributed to a top-bottom axis of a frame of reference. Subjects were asked to judge which part of the depicted objects was the top and which was the front. The stimuli used in Experiment 1 were adapted by labeling surfaces, as shown in Figure 5-5.

Stimuli were presented in various orientations and subjects judged which surface was top and which was front. We then used stepwise multiple regression to examine which type of judgments best predicted the angle judgments in Experiment 1. The results supported the hypothesis that the top-bottom axis is the most salient. The best predictor was the percent of subjects judging surface one as "top" \[ R(91,14) = .60, p < .01 \]. The next best predictor was the percent of subjects judging surface three as "top" \[ R(2,13) = .89, p < .01 \]. The third best predictor was the percent of subjects judging one as "front" \[ R(3,12) = .99, \]
Fig. 5-5. Stimuli used in Experiment 2.
p < .01]. Each of these three predictors added significantly to the multiple regression, and since all three together accounted for 95% of the variance, no further predictors could improve prediction. This analysis suggests that the top-bottom axis is the most salient and important. It further suggests that a front-back axis may be of secondary importance. However, since, right-left judgments were not obtained, this experiment did not discriminate the salience of the front-back axis from the right-left axis.

EXPERIMENT 3

The purpose of this experiment was to more carefully examine the importance of the front-back and the right-left axis of the perceptual reference frame. Depicted solid objects, such as those used in the above experiments, cannot be used because subjects cannot make the necessary perceptual judgments about what is on the back of the objects. Wire objects of the same shapes also cannot be used because they are typically very ambiguous with respect to depth. That is, depth reversals occur spontaneously. A solution is to use transparent objects in which the front and back are less ambiguous than in wire objects (see Figure 5-6).

Subjects were asked to judge angles in the front or back, and on the right or left. Appropriate stimuli were created by "rotating" the original depicted object 180 degrees around a vertical axis and taking a mirror image of the original object and rotated object.
Fig. 5-6. Examples of stimuli used in Experiment 3
The procedure was similar to that used in Experiment 1, except both judgments, and RTs were recorded for the 30 subjects in the present experiment.

First, the percent of 90 degree judgments were analyzed. As found in Experiment 1, there was a substantial effect of orientation on the percent of angles judged to be 90 degrees \( [F(3,81) = 8.89, p<.001] \). However, there were no differences in the percentages for the various conditions in the experiment. In other words, the percentages did not vary as a function of front-back or right-left.

Next, the RTs were examined. Some filtering was done to eliminate extreme RTs. The results are summarized in Figure 5-7. As can be seen in Figure 5-7, there was a substantial effect of orientation. Also, there was a large consistent effect of front versus back. Across orientations, this effect was 285 msec. The results for left versus right are not as convincing. Averaging across conditions, the mean effect of the left-right axis is 2 msec.

**GENERAL DISCUSSION**

One goal of the present experiment was to determine if perception of a local feature of a geometric object was affected by orientation. The answer is clearly yes. This has important consequences for recognition studies. There are two theoretical reasons why re-orientation could produce effects. One is that the organization among features is altered by re-orientation. For example, the nose is no longer below the eyes. The other is that orientation affects the coding of individual features. For
Fig. 5-7. Reaction time as a function of orientation and location of the marked angle.
example, an angle no longer seen as 90 degrees; it is seen as acute. The present research suggests that there are perceptual differences in individual features. Apparently, orientation changes affect angle perceptions in depicted objects making, for example, a nearly rectangular solid appear more or less rhomboid.

The second goal of these experiments was to determine which axes of the reference frame are most salient. These experiments suggest that the vertical axis is most important, the front-back axis is the second most important, and the right-left axis is not very important at all. In other words, our subjects' perception have some analogy to young children trying to put on a pair of shoes. They have no difficulty identifying the top of the shoes from the soles. They also have little trouble identifying the front of the shoe from the back. They do, however, have a great deal of difficulty telling the left shoe from the right one.

One important finding of the present studies is objects that are clearly unaffected by re-orientation may be unaffected as a result of geometric cues rather than familiarity. Clarifying the characteristics of stimuli that resist orientation effects could have important theoretical consequences and could be useful in a number of applied settings.

REFERENCES


CHAPTER 6
POSTSCRIPT

The goal of this volume was to present the results from a number of research projects in which I have been involved during my undergraduate years at Ball State University. It is realized that, taken by themselves, none of these papers are unusually noteworthy. Taken together, however, I think they do accurately represent the diversity of ideas and valuable experiences from which I have attempted to draw during my undergraduate career.

I feel very comfortable with the works in this volume, and with the large breadth of valuable experiences I have had while a student at Ball State University. The research diversity that is so strongly advocated in this volume reflects my definition of undergraduate education. By following through with the goals I had set for my college career, I feel as if I have been relatively successful. I also think my views and my experiences will help guide my thinking during future pursuits.

It is important to remember, however, that the undergraduate experience can mean many different things to the many different people who choose to indulge in it. Therefore, this volume is not intended to be a model by which I hope all undergraduates following me will adhere. In fact, I would not even encourage this approach to students for whom it seemed inappropriate. I would, however, encourage all undergraduates to examine their own definition of the undergraduate experience, whatever it may be, and then to attempt wholeheartedly to satisfy that definition. It is only in this way that this experience can be maximally fulfilling.