LABORATORY MANUAL

PRINCIPLES OF PSYCHOLOGY: EXPERIMENTAL FOUNDATIONS

PSYCHOLOGY 122
2001

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Principles of Psychology: Experimental Foundations

St. Olaf College
Psychology 122

Table of Contents

Introduction

In this section of the Psychology 122 Laboratory Manual, we will introduce you to the organization of the laboratory component of the course, and the contents of this manual.

Laboratory Organization/Schedule

During the first laboratory session your lab will be subdivided into two sections (A1 / A2 for Tuesday labs, or B1 / B2 for Wednesday labs). This division will set the lab schedule that you will follow for the remainder of the semester. Content of the laboratory curriculum is identical for all sections; only the sequence differs.

Preceptors

At the top of the lab schedule sheet you will find the name of the preceptor who will be with your group for the duration of the semester. The preceptors are upper-class students in psychology who have indicated an interest in teaching, either in secondary school or college. They will be primarily responsible for teaching and grading each of the labs, although a faculty member will be present in the laboratory at all times to answer questions and assist the preceptor should questions arise. The preceptors will grade laboratory work, with supervision by the faculty. Please note that preceptors are more than laboratory assistants; they are students registered for an upper level class on laboratory teaching and they work closely and meet frequently with each other and with the four faculty participating in the course. They teach one laboratory section and move with this section from one laboratory to another week by week, working first with one faculty member in one space, and then with another faculty member in another space. They are the only teacher who stays with the class throughout the semester.

Grading

Your grade in Psychology 122 is earned through completion of the class component (59.45%) and the laboratory component (40.55%). The following table shows how all points are allocated:

Class Component	Number	Item	Pts each	Total	% of Grade	% of Grade
	3	Exams	150	450	41.47	
	9	Quizzes	5	45	4.15	
	1	Final	150	150	13.82	59.45
Lab						
Component	1	Lab exam	100	100	9.22	
	1	Lab notebook	150	150	13.82	
	1	Poster display	100	100	9.22	
	9	Citation skeletons	10	90	8.29	40.55
		TOTAL		1085		100.00

Research: Setting, Design, and Data Collection

Scientific research always consists of three components: a research setting, a research design, and a data-collection technique. Let's look briefly at each of these components.

In the traditional experimental approach to research, behavior is studied in a controlled laboratory setting in which variables are manipulated and isolated. It is important to realize, however, that observations of behavior in natural settings often influence the hypotheses that are tested in laboratories. Therefore, research is often conducted in natural settings ("the field"). The naturalistic approach is also valuable because it enables researchers to study people or animals and their behavior in complex, real-life situations.

There are three basic types of research designs. The experimental method systematically investigates one or more dependent variables by manipulating one or more elements in the environment (the independent variables). Comparing the effectiveness of two different methods for teaching children to do math is an example of an experiment, but children must be randomly assigned to the two groups in order for the experiment to be considered valid. A correlational study attempts to discern a connection between two or more variables. A strong correlation implies a connection between variables; it does not indicate causation. As an example, the association between parents' discipline styles and the psychological development of their children is almost always studied using a correlational approach; that is, families are studied as they are, rather than being told by a researcher how to behave. A descriptive study describes a specific phenomenon without systematically investigating relationships between variables. Descriptive studies are often useful when a researcher is beginning to learn about the phenomenon. For example, researchers interested in children's reactions to being dropped off or picked up at daycare may simply observe these situations and describe what they see. Information from a descriptive study is often a good source of ideas for correlational studies and experiments.

There are two types of data-collection methods: self-report and observational. Self-report methods rely on subjects to provide information upon the request of the researcher. Questionnaires and interviews are typical of this method. Observational techniques do not rely on subjects' self-descriptions for data collection. Instead, the researcher makes observations in a consistent and objective manner.

This diagram in Figure 1 outlines how these three components can be combined. For example, the lower right-hand box in front designates a descriptive study, conducted in the field, that obtains its data via observation.

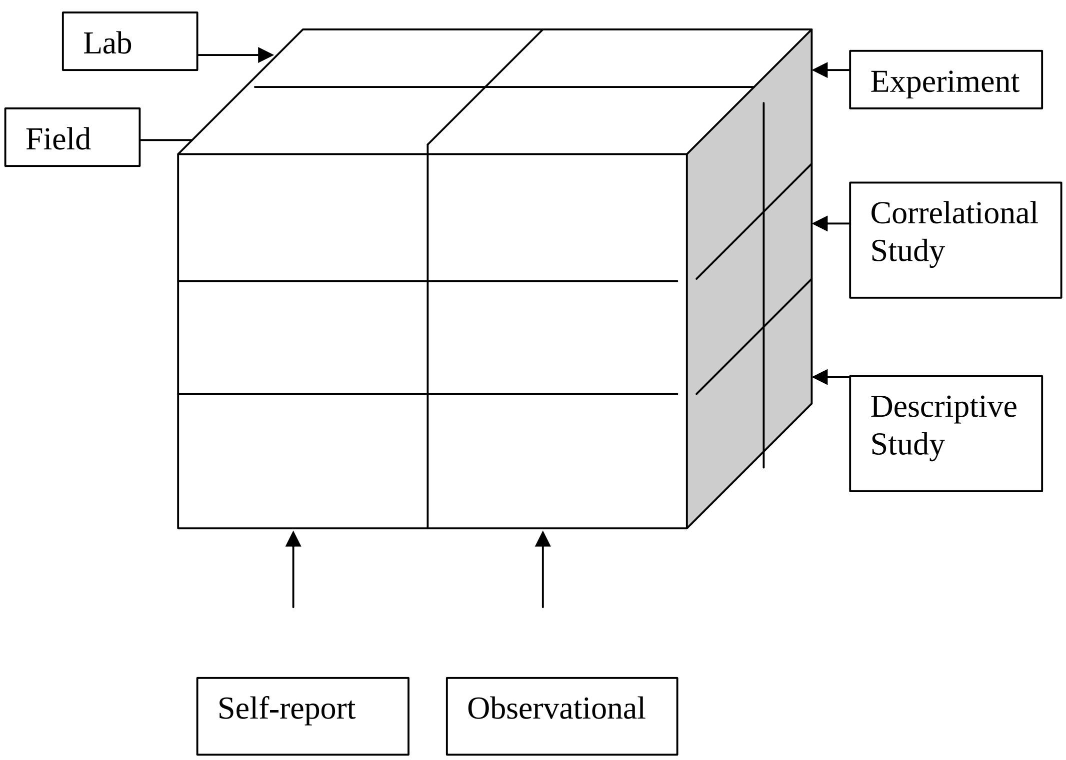


Figure 1. Three dimensions of research strategy (Gray, 1991)

Citation Skeletons

In Psychology 122 we hope to develop your reading/thinking skills in dealing with the psychological literature. We also wish to prepare you for each week's lab. To that end, a sequenced set of activities will be part of the laboratory program. Pre-laboratory assignments will be assigned for labs 2-9. These assignments are lab specific and need to be completed before attending lab every week. **Individuals who do not complete the pre-labs may not attend the lab until they do**. No Exceptions!

These assignments, known as "Citation Skeletons" will help you analyze and remember the main ideas of assigned pre-laboratory readings. They will also require you to read your lab manual before coming to lab. A sample "Citation Skeleton" is reproduced below. Point values for each part are also indicated.

☐ **1. Reference** :(As illustrated in the references section of each lab)-**.5 point**

☐ **2. Institutional Affiliation of first author:** (Often listed on first page of article itself)-**.5 point**

☐ **3. Type of article or chapter:** (e.g., research study; literature review; popular press article)-**.5 point**

☐ **4. Goal of article:** (What are they trying to do?)-**.5 point**

For Review articles: Skip to backside of Citation Skeleton, and fill that out.
For Research Studies: Fill out the following, plus backside of Citation Skeleton. [If the research article describes several studies, pick one to use in filling out the rest of the material of this Citation Skeleton]

☐ **5. Sample and size:** (If an empirical study, this information usually found in Methods section)-**.5 point**

☐ **6. List terms defined conceptually**; (Usually found in Introduction or Discussion sections)-**.5 point**

☐ **7. Operational definition of one key concept** (Usually found in methods section; vital to collecting data)-**.5 point**

☐ **8. Design:** (Usually found in Methods section)-**.5 point**

☐ **9. Procedure:** (Usually found in Methods section)-**.5 point**

10. Findings/Results: (Usually found in Results section; state in narrative form)-**.5 point**

11. Steps or conclusions suggested by the article: (Usually found in the Discussion section; what do the data mean?)-**1 point**

12 Criticisms of the article: (What might have been done better? What limitations exist in the study?)-**.5 point**

15. So what next? (Give some ideas for further research that could be done. What would you like to investigate further?)-**.5 point**

16. **Lab-specific question 1**:-**1.5 points**

17. **Lab-specific question 2**: **1.5 points**

Laboratory Notebook

Each student will need to purchase an 80-sheet AMPAD # 26-252 Composition Book (lined, not graph paper) with sewn-in pages to serve as a laboratory notebook. It is available from the bookstore for about $2.00. You will also need to purchase rubber cement to use to paste data into your notebook (NOTEBOOKS WILL NOT BE ALLOWED TO HAVE ANY LOOSE MATERIAL IN THEM). As soon as you get your notebook, put your name on it, and then number each side of each page in the upper right corner. You will number pages consecutively up to 160. Your notebook will be used to take notes during each laboratory period, and also for preparation of a formal write-up of each laboratory experiment. The “notes” section will be used for informal recording of data, comments, etc.   Start each lab on a new page, and include title of the lab, date, and names of lab partners. “Formal” write-up of each lab will be done using the pages immediately after the “notes” section. For each lab, you will be expected to include the following information in your Formal write-up:

INFORMAL WRITE-UP

- Notes: This section contains any rough notes that you make during the lab exercise (data, pictures, facts, etc.). Answers to critical thinking questions also belong in this section. Your preceptor should be able to easily identify these answers.

FORMAL WRITE-UP

- Introduction: Here, you introduce the problem to be investigated, comment briefly on the assigned reading, and use it to develop a hypothesis for the week’s experiment.
- Method: includes a statement regarding your experimental subjects, materials or apparatus, and procedures.
- Results: This section is for your data, which may be displayed numerically, graphically, with tables, and with figures. All graphs tables and figures need to be labeled. Narratively describe your data in this section. Save explanation of the findings for the Discussion section.
- Discussion: In this section, you reflect on the results of your study, and interpret your findings in relation to your initial expectations. It is also important to integrate your findings with the topic(s) discussed in the “Required Lab Reading.” That is, how do your findings relate to what you included about the readings in your Introduction section? You may also need to answer one or more of the discussion questions. This section should also include possible sources of error and ideas for future research.

There is no required length for lab write-ups, but the maximum is 8 pages per lab, so carefully choose what you are going to write. You should be as concise as possible, but need to include all relevant information. Do not ramble on to fill up space. Meaningless paragraphs will not impress your preceptor.

Poster Display

Student lab groups will prepare a poster display of the play project for presentation at the final lab sessions. You are required to use a poster dimensioned 22 x 28 inches. You may choose to purchase whatever color poster board you wish from the Bookstore supply, but you must use one 22 x 28 inches. As you will see later, the play project runs through the most of the semester, and serves as an integrating laboratory experience. For the fieldwork portion of this project you will be given a letter of introduction that you may show in case anyone questions your activity.

Laboratory Examination

There will be a laboratory examination at the end of the semester. You will be asked to use the skills you have developed in the 122 lab in developing/evaluating the design of an experiment, define some terms from lab, etc. Additional details will be forthcoming.

The Laboratory Manual

Each of the laboratory exercises in this manual has been prepared according to a standard format:

Introduction: The purpose of the laboratory is introduced. Basic concepts are discussed. The framework for the laboratory (i.e., where it "fits" in the domain of psychology) is established.

Objectives: This is a bulleted list of the specific objectives of each exercise. As you conduct and write up each experiment, you should refer back to this list and comment (in your lab notebook) on your findings in the context of these objectives.

Terms: This is a list of important terms for each laboratory. You will need to master this vocabulary in order to appreciate fully each laboratory exercise. Mastery of these terms is vital for successful completion of the lab final examination.

Critical Thinking Questions: Throughout the lab you will come across questions that are surrounded by a box and are labeled with a ***CT*** symbol.

CT	**Why do you think there is no sound from the station?**

These are critical thinking questions, and serve to broaden and deepen your understanding of the laboratory exercise. All of these questions should be clearly labeled and answered **in the notes section** of your lab write-up

Methods: The specific details to be followed in each exercise are included in this section. Careful reading prior to each lab period (as well as willingness to ask the Preceptor or Professor in lab) will facilitate data collection, analysis, etc. In most cases, the Methods are further subdivided into the following three subsections:

- Participants/Subjects– Description of (human) participants or (infrahuman) subjects.

- Materials/Apparatus – Materials and/or apparatus used in the experiment. Research reports include this information so that someone else will be able to replicate your study.

- Procedure – These are the specific procedures/steps you should follow as you carry out your study. These procedures also reveal another aspect of the report, one that will enable replication.

Discussion Questions: Each lab concludes with discussion questions that will help you contemplate your laboratory exercise. All discussion questions should be answered in the discussion section of your laboratory write-up, unless otherwise specified by your preceptor. Preceptors may choose to address the questions as a class, or may have you complete only a few of the questions. Preceptors will specifically state which questions must be answered for each lab.

References: We have included several different forms of reference material for you.

Required Lab Reading: This is the article you are to have read prior to each laboratory period. It is also the article, which will be the basis for your "Citation Skeleton." These articles can be obtained from the reserve desk in Rolvaag Library. You are also expected to incorporate appropriate reference to this article in your report write-up. This article reference is highlighted in the laboratory manual by a gray box, e.g.:

Guttman, N. & Kalish, H.I. (1966). Experiments in discrimination. In T. Verhave (Ed.), *The Experimental Analysis of Behavior* (pp. 209-216). New York: Appleton-Century-Crofts.

Suggested Readings: This is a list of other resources (books, journal articles), which you may wish to explore should you wish to better understand in the area of investigation, which is covered, by each laboratory.

Web Links – For many lab, a few annotated links are provided to World Wide Web pages with material relevant to the investigation. Just type the URL (e.g., http://www.med.harvard.edu/AANLIB/ into your favorite browser (Netscape Navigator or Internet Explorer) and examine this potentially helpful (and in many cases, fascinating) material.

Lab Procedure Questions

At various points in the procedure of the laboratory exercises, you will find questions. These questions will be written in bold and answers to them must be included in the *Notes* section of your lab write-up.

The faculty and preceptors wish you the best with this course. Please do not hesitate to contact us with any suggestions for improvements!

Welcome to the fascinating world of psychology!

Observing Children's Play Behavior

Dana Gross

Introduction

This lab will prepare you to carry out an observational, descriptive study of children's play in a naturalistic setting (figure 1). In the traditional experimental approach to research, behavior is studied in a controlled laboratory setting in which variables are manipulated and isolated. It is important to realize, however, that observations of behavior in natural settings often influence the hypotheses that are tested in laboratories. Therefore, research is often conducted in natural settings ("the field"). The naturalistic approach is also valuable because it enables researchers to study people or animals and their behavior in complex, real-life situations.

Your play project is a combination of descriptive and correlational research designs. Initially, you may not have a strong hypothesis about how age or gender will be related to play behavior (descriptive). As you read the research literature on your chosen topic, however, and do a preliminary observation, you may begin to develop hypotheses. Eventually, by focusing on just one play behavior as a function of children's age or gender, your project will become a correlational study.

Defining Play

While we all probably recognize play behavior when it occurs, we may have difficulty trying to define it. In their (1983) literature review, Rubin, Fein, and Vandenberg list the following characteristics to distinguish play from other activities:

1. It is intrinsically motivated.
2. It is characterized by attention to means rather than ends.
3. It is distinguished from exploratory behavior: the emphasis is on "what can I do with this object?" rather than "what is this object and what can it do?"
4. It is characterized by nonliterality or pretense.
5. It is free from externally applied rules (in contrast to games).
6. The participant is actively engaged (in contrast to day-dreaming or idling)

Developmentally, play serves a variety of roles. Play has been demonstrated to be an effective vehicle for psychosocial development. In play, children learn to interact with others and behave according to pre-established rules. Play has also been cited as a tool that children use for morality development. Developmental psychologists Jean Piaget and Lev Vygotsky asserted that social play helps the child gain an advanced understanding of rules and socialization. Additional functions of play include exercising newly developed physical and cognitive abilities as well as providing a behavior that children can use to cope with traumatic events (Gray, 1991).

Researchers have identified several sub-types of play, which include rough-and-tumble-play (horseplay), constructive play (making things for fun), formal games (games and sports with designated rules), and pretend play (portraying imaginary roles). Pretend play is of particular interest to developmental psychologists due to its prevalence, and its role in cognitive and psychosocial development (Gray, 1991).

Pretend Play: What is it?
Pretend play is also referred to as symbolic play and is a ubiquitous part of childhood. "Pretend play consists in part of detaching behavioral routines and objects from their customary, real-life situational and motivational contexts and using them in a playful fashion. The child who really goes to sleep usually does so in bed, at bedtime, and when sleepy. The child who pretends to go to sleep will do so in other places, times, and psychological states; the routine is disconnected from its usual situational and psychological context" (Flavell, Miller, and Miller, 1993, p. 82).

"Children can pretend about either the identity or a property of an object, oneself, another person, an event or action, or a situation" (Flavell et al., 1993, p. 82). The fact that children in all cultures appear to engage in spontaneous pretend play, although the adults in those cultures never teach them how to do it, has led some psychologists to suggest that pretense may be a biologically evolved activity, like language.

Children can engage in solitary pretending or in shared, cooperative pretend play, which is also known as sociodramatic play. Parents do not teach their children how to pretend, but they do engage in pretense with their children; parents' presence changes children's pretend play.

At what age(s) does play occur?
Play usually emerges during the first year of life. Pretend play begins to emerge during the second year of life and is seen primarily between the ages of 1 and 6 years. Before 12 months, most children are incapable of pretend play; after 6 years, children more frequently engage in formal games. Play lasts the duration of an individual’s life, although its purpose, form, and prevalence fluctuate (Papalia, Olds, & Feldman, 2001).

How do play and pretend play change with age?
The play actions of very young children are brief and may be difficult to identify. Pretend play can be particularly difficult to identify. Younger children "activate" toys or even ordinary household objects; they frequently play by themselves or parallel to other children engaged in similar forms of pretense. With age, children show that they know they are pretending. Older children negotiate and develop interconnected play themes with other children and discuss the role each child will adopt. They do this by making verbal declarations about their actions ("I'm a doctor!") and about those of their play partners ("You be the dog!").

Examples of Play
- Solitary Play:
  - Puzzles
  - Playing solitaire
  - Video games
  - Dressing Barbie
  - Shooting hoops
  - Roller-skating
- Cooperative Play:
  - Playing soccer

Tag
Hide and Seek
Building a tree house
Duck, duck, gray duck

- **Examples of Pretend Play**
  - Solitary pretend play:
    - pushing dolls in baby carriages
    - feeding dolls or teddy bears
    - pushing toy trains around a track while saying "chugga chugga choo choo"
    - making a train out of Legos
    - drinking from an empty cup
    - talking on a toy telephone
  - Sociodramatic play:
    - playing tea party with another child
    - adopting roles in a family where each child pretends to be a different member of the family
    - making breakfast with other children, using empty bowls, glasses, and cups
    - visiting the doctor

Objectives

- To learn about techniques for observing behavior in naturalistic settings
- To discuss and define play
- To lay the groundwork for a semester-long observational study of children's play

Terms

Experiment

Correlational study

Descriptive study

Self-report method

Observational method

Behavior

Narrative account

Event sampling

Naturalistic observation

Observer bias

Operational definition

Play

Pretend play / symbolic play

Sociodramatic play

States versus events

Methods

Materials

Video: "Observing Behavior in Natural Settings"
Information sheets about the snow monkeys in the video
Pre-observation worksheet
Data sheet for recording observations

PART 1
Observing Behavior in Natural Settings: Video

CT	**Define "state" and "event." What kinds of states did you see in the video? What sorts of events were shown? Why do you think researchers distinguish between states and events?**

PART 2
Techniques for Naturalistic Observation:
Video: Observing Behavior in Natural Settings

Observer Bias

When we observe the behavior of people and animals, we do more than passively watch what they are doing--we make interpretations and draw inferences. These observer biases reflect our own background and beliefs about the behavior we are studying.

A narrative account is an objective record of the setting, participants, and behaviors observed. Use the space below to make notes for a narrative account of the snow monkeys' behavior. Describe what you see.

a. Setting

b. Participants

c. Behaviors

> ***CT*** **Would you like to carry out observational research using only narrative accounts? Why or why not? What are some of the advantages and limitations of this technique?**

Sampling Methods

When making observations in naturalistic settings, we strive to gather data that are representative of our subjects' usual behaviors. We might use narrative accounts, but, as we just learned, these accounts may not be very precise and are often difficult to compare with those of different observers. By watching the snow monkeys again, we learn about and practice using a more systematic method, event sampling. In event sampling, observers record the occurrence of particular behaviors each time they occur. To study a particular behavior displayed by the snow monkeys, look at your narrative account and identify several behaviors you might study. List the behaviors you might study.

1.

2.

3.

When researchers observe behavior in natural settings, they take steps to ensure that their observations are as systematic and objective as possible. If naturalistic observations are carefully planned and carried out, the data collected are just as scientific as data collected in a laboratory setting. In order to preserve the reliability and validity of the data, psychologists often develop an <u>operational definition</u> to aid them in their research. An operational definition defines the criteria for the behavior being observed. The operational definition for “a monkey eating a banana” could be defined as: “When a monkey intentionally places a banana in his/her mouth and swallows it.” Such a definition would help distinguish between incidents where a banana is placed in the monkey’s mouth by another monkey or other such ambiguities. A good operational definition allows a researcher to distinguish between relevant observations and those that should be discarded or ignored.

Event Sampling

Now choose a single behavior from your narrative account and write an operational definition for it below. Be as specific, concrete, and objective as possible.

Share your operational definition with your assigned group of three people. Then choose one person's operational definition to use as we watch the video a second time. Write that operational definition below.

As we watch the video a second time, count the number of times the behavior is displayed by the monkeys in the video and record this number below.

Number of times behavior was observed by

Observer 1 ________ Observer 2 ____________ Observer 3 ____________

CT	**Calculate the mean (average) for the number of times the behavior was observed by your group members? How does your mean compare to the data recorded by individual group members? What does this tell you about your operational definition?**

PART 3
Thinking about Play: Discussion

Based on the article you read in preparation for today's lab and previous experience, what is a possible definition for play?

As we watch the video examples of children at play, try to come up with some behaviors you might examine or research questions you might ask in a study of children's play.

PART 4
Developing a Specific Research Question about Play

During the remainder of lab today, work in research groups to begin planning a specific study of children's play. The requirements for the study that you design and carry out are as follows:

- **It must be observational.** In other words, you must study the world and the people in it just as they are, without interfering or otherwise changing the situation.

- **It must compare the play of two groups.** You may choose to study either (a) gender differences OR (b) age differences. For gender, there are just two groups to compare; for age, you will have to choose two different age groups (e.g., preschoolers vs. school age children). Determining the gender of the children you observe should be easy, but you will have to estimate children's ages if you choose to study age differences.

- **It must use event sampling.** Choose a single behavior -- or event -- to focus on, just as we did in lab today when we watched the videotape. Focusing on one child at a time, record every occurrence of this behavior during the time that you observe that child. Then focus on another child in the setting and record every occurrence of the behavior displayed by that child. Continue event sampling in this way until you have observed 10 children in each group. **Record your data on the following data sheet.**

- **It must include 10 children per group.** If you decide to study gender, observe 10 boys and 10 girls; if you choose age, observe a 10 younger and 10 older children. There are many ways to obtain your total of 10 children per age/gender. If you observe children in a relatively crowded setting, such as a playground, Legoland, or day care center, you might be able to do all of your observations in just one or two visits. If you study smaller groups of children, or even children playing alone, it may take a bit more time. In all cases, however, you should watch each child for approximately 5-10 minutes. Note the occurrence (or non-occurrence) of the play behavior your group is looking for.

- **It must be unobtrusive.** You must not alter the research environment.

- **Do not study multiple children simultaneously.** You should attempt to observe one child at a time. Studying many children in a single 5- to 10-minute data collection period will result in missed observations, which will drastically increase the variability of your data. Be sure to use the same length of observation for each child. Decide ahead of time how long you will observe each child.

- **All members of the group should be present for all stages of the play project.** It will be difficult for all members of the group to analyze the data and answer questions by professors at the poster presentation if an individual is missing from any stage of the project.

- **It is STRONGLY recommended that you choose children who are between 2 and 10 years of age.** It will be difficult to detect play behavior in children who are under two, and older children will usually be involved in formal games.

- **Do not investigate play behavior that consists of formal games.** The event sampling method is an extremely poor means of analyzing such play behavior.

During the last part of lab today, each group will briefly share its initial ideas for the project. The rest of the class will give feedback to each group by responding, asking questions, or making suggestions.

The Pre-Observation Worksheet should help you keep track of the requirements for this project. **Give the completed worksheet to your preceptor before the information literacy lab so that it can be reviewed and approved before you begin your study**. **Also take note of the following project progression chart.**

The information provided about play at the beginning of this lab unit, the assigned reading for this lab, and the sources listed at the end of that handout will be helpful in suggesting possible research questions about children's play.

Before you begin collecting your data, your group may wish to make a preliminary visit to the setting in which you plan to carry out your observations. During that visit, take notes about the setting, participants, and any play behaviors you observe.

Discussion Questions

1. Why do children play? In what ways might children's play contribute to their development? Putting this another way, what might happen -- in both the short- and long-term -- to a child who never played?

2. Research suggests that all immature mammals, as well as birds and even some reptiles, engage in play. How is children's play behavior different from the play behavior exhibited by nonhuman animals? How are children's play and other animals' play similar?

References

Required Lab Reading

Brownlee, S. (1997, February 3). The case for frivolity: Play isn't just fun. Young animals can't do without it. *U. S. News & World Report, 122*(4), 45-49.

Suggested Readings

Bretherton, I. (Ed.). (1984). *Symbolic play: The development of social understanding.* Orlando, FL: Academic Press.

Flavell, J. H., Miller, P. H., & Miller, S. A. (1993). *Cognitive development (3rd ed.).* Englewood Cliffs, NJ: Prentice Hall.

Fromberg, D. P., & Bergen, D. (Eds.). (1998). *Garland reference library of social science: Vol. 970. Play from birth to twelve and beyond: Contexts, perspectives, and meanings.* Levittown, PA: Garland. [This encyclopedia presents essays by experts on pedagogy, anthropology, ethnology, history, philosophy, and psychology. Here you will find why play is important to developing mathematical thinking, promoting social skills, constructing games, and stimulating creativity.]

Gray, P. (1991). *Psychology (2nd ed.)* New York, NY: Worth.

Haight, W. L., & Miller, P. J. (1993). *Pretending at home: Early development in a sociocultural context.* Albany, NY: State University of New York Press. [Tracing the development of pretend play in nine children growing up in educated, middle-class European American families, this text shows how pretend play is embedded in distinct sociocultural contexts.]

Papalia, D.E., Olds, S.W., & Feldman, R.D. (2001). *Human development (8th ed.).* Boston, MA: McGraw-Hill.

Rubin, K. H., Fein, G. G., & Vandenberg, B. (1983). Play. In P. H. Mussen (Series Ed.) & E. M. Hetherington (Vol. Ed.), *Handbook of child psychology: Vol. 4. Socialization, personality, and social development* (4th ed., pp. 694-774). New York: Wiley.

Sawyer, R. K. (1996). *Pretend play as improvisation: Conversation in the preschool classroom*. Hillsdale, NJ: Erlbaum. [Sociodramatic play, or role play, encourages children's imaginations to have free reign.]

Slade, A. & Wolf, D. P. (Ed.) (1994). *Children at play: Clinical and developmental approaches to meaning and representation*. Oxford, UK: Oxford University Press.

Stambak, M., & Sinclair, H. (Eds.). (1993). *Pretend play among 3-year-olds.* Hillsdale, NJ: Erlbaum.

Sutton-Smith, B. (1998). *The ambiguity of play*. Cambridge, MA: Harvard University Press. [Sutton-Smith studies play through the disciplines of

biology, psychology, education, metaphysics, mathematics, and sociology.]

Web links

Children's Folk Games
http://www.geocities.com/Athens/Styx/6504/home.html

Children's Museum of Indianapolis: Playscape exhibit
http://www.childrensmuseum.org/playscap.htm

Children's Play Panel
http://www.ilam.co.uk/polchild.htm

Dr. Toy's Internet Guide
http://www.drtoy.com

Family Childcare Newsletter, Issue No. 118, March 1997
http://www.mes.umn.edu/Documents/F/A/FA1036.txt

Games Kids Play
http://www.gameskidsplay.net

The Institute for Play
http://www.instituteforplay.com

International Association for the Child's right to Play
http://www.ipausa.org

Nature of Children's Play
http://ericps.ed.uiuc.edu/npin/respar/texts/fampeer/nature.html

Preschoolers' pretend play--or improv--develops social, conversational skills
http://wupa.wustl.edu/nai/feature/1997/Mar97-Improv.html

Pretend play as improvisation: Conversation in the preschool classroom
(book published by Lawrence Erlbaum Associates)
http://www.artsci.wustl.edu/~ksawyer/play.htm

TASP: The Association for the Study of Play
http://www.csuchico.edu/phed/tasp

Information Literacy and Psychological Science

Elizabeth O. Hutchins

Introduction

Rapid Growth of Psychological Research

A rapidly growing body of psychological research is now accessible in an increasingly wide array of reference works, indexes, databases, and web sites. Studying psychology effectively requires researchers to integrate previous research into their own work. To do so, they need to comprehend the "flow of information"; learn how to design effective research strategies; identify key psychological terms for their research; become familiar with general and specialized psychology reference works; and locate, retrieve, and evaluate material on a specific topic in the library.

Flow of Information

The key to conducting successful psychological research is in understanding the "flow of information" i.e. how an idea moves through the discipline's literature. The *information flow* evolves from a specific idea, through the stage of discussion, and to print and electronic sources. As the *research* becomes more focused, it moves from the examination of general works to subject specific resources that examine the key idea. The flow of information is illustrated in Figure 1.

Evolution of Idea	**Research Resources & Search Strategy**
Scholar with idea	Directories
Invisible college	E-mail, Listservs, Internet / Web
Journal article / Conference Paper	Indexes, Abstracts, & Citation Indexes
Review Article	Annual Review of Psychology (and others)
Books	On-line catalog via Library of Congress Subject Headings (LCSH)
Subject Bibliography	Subject Bibliography
Encyclopedia Article	Encyclopedia, Handbook, Dictionary, Text

Figure 1. Flow of Information

Reference Collection

In spite of the extraordinary increase of psychological indexes, databases, networks, and web sites, classical psychology reference sources remain important. For this reason, the reference collection often continues to be the best starting point for research. It enables one to gain an overview of a topic and become familiar with research conducted by others in this area. This collection provides access to encyclopedias, subject dictionaries, bibliographies, biographical sources, statistical data, and / or print indexes.

Electronic Databases

Electronic databases, which have usually derived from print indexes, enable researchers to find published materials (articles, book reviews, and book chapters) on a particular subject area. Most databases offer the same features and functions, although they may be designed differently. For example, PsycINFO citations consist of *records* that include all the key information about an article or book chapter. Individual units of information are *fields*. Some of the fields in the PsycINFO database include TI: Title, AU: Author, SO: Source, PY: Publication Year, AB: Abstract, and DE: Descriptors.

Example: The following example illustrates key fields in a PsycINFO record. Explanation notes are provided in italics.

TI: Title **[*Title of the article.*]**
Observations of aggressive and nonaggressive children on the school playground
AU: Author
Pepler, Debra J; Craig, Wendy M; Roberts, William L
AF: Author Affiliation **[*Organization with which authors are associated professionally*.]**
York U, LaMarsh Ctr for Research on Violence & Conflict Resolution, North York, ON, Canada
SO: Source **[*Title of the journal, conference report, or book*.]**
Merrill-Palmer Quarterly. Vol 44(1), Jan 1998, pp. 55-76
IS: ISSN [***Journal code identification used for requesting an interlibrary loan article****.]*
0272-930X
AB: Abstract **[*Summary of document*.]**
Naturalistic observations were made of 17 aggressive and 22 nonaggressive children in Grades 1 to 6, filmed with video cameras and remote microphones on school playgrounds. Observers coded interactive behaviors, affective valence, and play states. Aggressive children displayed more verbal and physical aggression, more prosocial behaviors, and higher rates of interaction than did nonaggressive children…. (c)
1998 APA / PsycINFO, all rights reserved)
LA: Language
English
PY: Publication Year
1998
PT: Publication Type
Journal Article; Empirical Study
DE: Descriptors [***Terms from Thesaurus of Psychological Index Terms*]**
*Aggressiveness; *Antisocial Behavior; *Childhood Play Behavior; *Peer Relations; *Prosocial Behavior; Childhood; School Age Children
ID: Identifiers **[*Key words/phrases included in the article.*]**
prosocial & antisocial peer interactions on school playground; aggressive vs. nonaggressive 6.7-12.8 yr olds
PO: Population
Human; Male; Female; Childhood (birth-12 yrs); School Age (6-12 yrs)

Controlled Vocabulary

On-line catalogs and electronic databases frequently use controlled vocabulary. Controlled vocabulary is a *set of specified terms* used by experts to describe an article or book. Researchers need to utilize the controlled vocabulary terms in their search for the most appropriate books and journal articles. In PsycINFO these terms are called *descriptors.*

To find controlled vocabulary, you need to consult a list of terms or a thesaurus. For example, the Library of Congress Subject Headings ("Red Books") provide the search terms for SAGE (St. Olaf College's online catalog). The Thesaurus of Psychological Index Terms provides the terms for PsycINFO.

Controlled vocabulary appears in the *subject headings* in SAGE and *descriptors* in PsycINFO.

Search Strategy

Your research strategy, which will evolve from an idea you wish to explore, should be approached in several steps. Select a topic and formulate a hypothesis.

> Example: Aggressive children play with their peers with more antisocial behavior than do non-aggressive children.

1. Identify & underline the main ideas in your hypothesis.
2. Select the key words in your research question to use as possible search terms.

> Example: aggressive, children, play, peers,

3. Find synonyms for these terms. This step will be key in allowing you a broad literature search. If you are searching on a database that has *controlled vocabulary,* such as SAGE or PsycINFO, be sure to check the subject headings / descriptors that will offer additional search terms.

Example:	Variable A		Variable B		Variable C
	aggressiveness		children		peer relations
	OR		OR		OR
	antisocial behavior	AND	childhood	AND	friendship

4. Combine the terms you have selected by using Boolean logic.

> Example: (aggressiveness OR antisocial behavior) AND (children OR childhood) AND (peer relations or friendship)

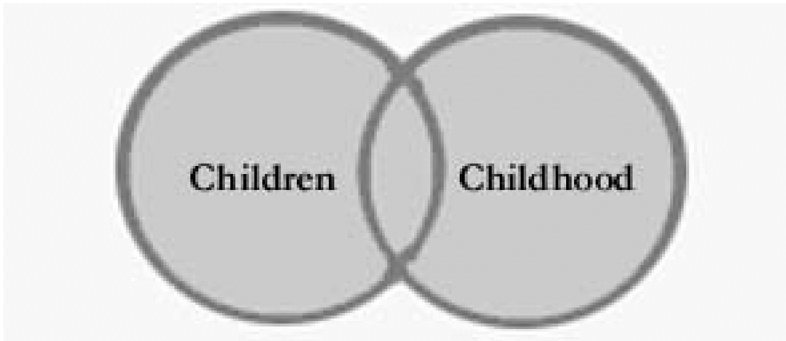
5. Locate additional relevant descriptors in a useful article and narrow your search further by using field codes.

More about Boolean Logic

Using Boolean logic, you may design a research strategy that matches your hypothesis. You do this by combining terms (either key words or controlled vocabulary) into sets.

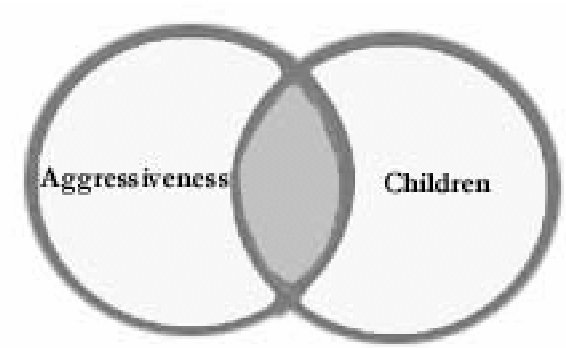
If you wish to search as widely as possible on a topic, combine synonyms for your key concepts by inserting the word OR. This search will retrieve records with any one, all, or a combination of the search concepts you specify. Whenever you add a term connected by OR, you *broaden your search.*

If you write
"children OR childhood"
you will find *any* article using either or both of the terms "children" or "childhood."



If you wish to *narrow* your search, use the word AND. This search will retrieve records that include all the search terms you specify. Each term you connect with AND must appear in the retrieved record. Whenever you add a term connected by AND, you *narrow* your search. The final result of a search using AND includes only the area where the concepts overlap.

If you write
"aggressiveness AND children"
you will find only those articles that include both of the terms "aggressiveness" and "children."



Your final search may combine both strategies.

You search statement
"aggressiveness AND (children or childhood)"

Now look again at the search you could have compiled with variables from the descriptor field of your selected article:

(aggressiveness or antisocial behavior) AND (children or childhood) AND (peer relations or friendship)

Lab Objectives

? To integrate library research and resources with psychological investigations
? To comprehend and utilize the flow of information
? To design and develop effective research strategies appropriate to psychological investigation
? To identify and use psychological descriptors / subject headings
? To locate, retrieve, and evaluate library resources, using the topic of children's play as the basis for independent field research
- To develop and refine a hypothesis
? To lay the foundation for future research in psychology and other related fields

Terms

American Psychological Association (APA) style

Boolean logic

Cambridge Scientific Abstracts (CSA)

Controlled vocabulary

Descriptor

Electronic databases

Encyclopedia of Psychology

Expanded Academic ASAP

Fields

Flow of information

The Gale Encyclopedia of Psychology

Interlibrary loan (ILL)

Keyword search

PsycINFO

Records

Reference collection

Reference librarian

Sage

Scholarly journal

Search strategy

Subject heading

Subject search

Thesaurus of Psychological Index Terms

Uniform Resource Locator (URL)

World Wide Web (WWW)

Method

During this lab, a reference librarian will introduce you to research strategies and library resources. You will receive information about sources that are essential for completing this lab. **Use this time to ask the reference librarian *any* questions you have about the library!**

During the second part of the lab, you will actively explore some research materials available in the library and answer a set of questions that will help you learn how to use these resources. Ideally the sources you locate will help you with your observational research project. You may decide to refine your ideas about your project based on your discoveries from this lab. In some cases, you may wish to broaden your topic and, in others, you may wish to narrow it.

Record answers to questions in the space provided. Your formal lab report for this lab will differ significantly from the other labs. Your preceptor will tell you what needs to be put in your notebook.

Materials

Cambridge Scientific Abstracts (CSA)
Encyclopedia of Psychology
Expanded Academic ASAP
The Gale Encyclopedia of Psychology
PsycINFO
Sage
Thesaurus of Psychological Index Terms
World Wide Web (WWW)

PART 1
Information Literacy Skills

Procedure

1. The Information Literacy Lab will be held in Rolvaag 477 or 277 (to be announced). Bring your lab notebook, lab manual, and citation skeleton to the lab.

2. After the librarian's demonstration, you will work in your research groups to find the answers to the following questions. Your group's play topic should be the focus of your search. Be sure *each* member of your research group feels comfortable in using all of the following reference resources.

3. Make notes as you search for answers.

Library Exercise

A. Select Search Terms

1. State the hypothesis of your observational research project.

2. Identify and underline the main concepts in your research question, i.e., the different elements of your hypothesis.

3. Write down your key terms and any synonyms that seem appropriate for these concepts. As you examine the following resources, continue to add to this list of terms.

B. Encyclopedias

Articles in encyclopedias give you a general overview of your topic. They also frequently offer bibliographies of relevant articles and books.

1. Compare and contrast the entries under “Play” in the following encyclopedias:
   Encyclopedia of Psychology (R. R. BF 31 .E52 2000)
   The Gale Encyclopedia of Psychology (R. R BF31 .G35 1996)

   a. Similarities:

   b. Differences:

c. Strengths of each source:

C. Thesaurus

1. Look up the two entries “Play Behavior (Childhood)” and "Play Development (Childhood)" in the following thesaurus:

   Thesaurus of Psychological Index Terms (R. R. BF 1.P655)

   Record the correct index term for each one of these entries. These cross-referenced terms are indicated by **Use**.

   a. ______________________ b.______________________

   Now look under these correct term headings. What are three other related subject terms (indicated by **R**) you might use for *your* research topic?

   1. ____________________________

   2. ____________________________

   3. ____________________________

2. How is a thesaurus (i.e., a list of controlled vocabulary) helpful?

CT	**Why do you think students and faculty often ignore the thesaurus**?

D. SAGE

To find the St. Olaf Catalog (SAGE), go on the home page of the St. Olaf College Libraries: http://www.stolaf.edu/library/

Then click SAGE: Our Library Catalog: http://sage.stolaf.edu/

1. Search for books on “play” in *both* the SUBJECT and KEYWORD search mode.

•

   a. Why are there many more entries (“hits”) in a KeyWORD search than in a SUBJECT search?

   b. Which search mode (SUBJECT or KeyWORD) is a more useful way to find books on play? Why?

2. Start another KeyWORD search. Add an additional word related to *your* research question that will narrow the KeyWORD search on “play” [e.g., “play AND pretend”]. You may also add synonyms if your second word narrows the search too much [e.g., “play AND (pretend or symbolic)”].

   a. Which terms did you select to search for materials about your project?

   b. Which subject headings listed at the bottom of the entry in SAGE would be useful ones for your project? These headings are *Library of Congress Subject Headings*. [Hint: In the text version of SAGE, use the "M" key to scroll through the entry to find the subject headings.]

   c. Select one of the books you found about play and list it, using APA style

E. *PsycINFO*

PsycINFO [On-line] indexes journals, book chapters, technical reports, and dissertations on psychology and related disciplines from 1887 - present. It corresponds to the print version of *Psychological Abstracts* [R.R. BF1 .P6]. The web edition is accessed via *Cambridge Scientific Abstracts.*

To search *PsycINFO*,

- Go to the Library Home Page: http://www.stolaf.edu/library
- Click on "Find Articles and More…"
- Click on "Find Indexes & Databases by Title"
- Click on “P”

- Scroll down and select *PsycINFO*
- Check *PsycINFO* 1984-Current
- Go to Advanced Search
- Note: For guidelines on searching *PsycINFO*, go to *Cambridge Scientific Abstracts* under "Find Indexes & Databases by Title" and click on "Search Tips" http://www.stolaf.edu/library/research/articles/csasearch.html.

1. Locate two relevant articles

    a. Find two articles related to your research question. These articles should have been published within the last 5 years and, if possible, owned by St. Olaf or Carleton. [Hint: Click on "Locate Document" to see if either college owns the journal.]

    b. *Print one of the selections, including both the citation and the abstract.* Attach the printout to the appropriate page(s) in your lab notebook.

    c. List below the citations to the two articles in APA style. *After the citation, indicate if the journal is at St. Olaf or Carleton*

        1.

        2.

2. List three more specific subject headings that might be helpful with your project? [Hint: Look for the descriptors (DE=descriptor) at the end of the useful article citations.]

    a.

    b.

    c.

3. *Record the search statement*, on the left-hand side of the search screen, which found the citations to these articles.

4. What might be the advantage and/or disadvantage of using a specialized database such as *PsycINFO* instead of a general index such as *Expanded Academic Index*?

F. *Expanded Academic Index* (Optional)
This database is a good source of full-text articles. If a journal article you find in *PsycINFO* is NOT at St. Olaf or Carleton, before you request Interlibrary Loan (ILL) you may wish to conduct an *advanced search* by author and title in EA-ASAP to see if there may be a full-text version online. You may record your results below. Please note that EA-ASAP defaults to *scholarly* articles. To get to EA-ASAP from the St. Olaf College Libraries home page:

- Go to "Find Articles & More…"
- "General"
- "General & Basic"
- *Expanded Academic ASAP*

Journal articles found in EA-ASAP (Use APA style.):

a.

b.

G. World Wide Web (WWW) (If you have time.)
Psychology web sites are available from numerous sources.

- See below for suggested web links.

- Search Engines may also useful. Try *Dogpile*: http://www.dogpile.com/ (searches many databases simultaneously), *Northern Light*: http://nlresearch.northernlight.com/research.html (be sure to limit to web sites), *Altavista*: http://www.altavista.com/, *Google:* http://www.google.com or *Yahoo*: http://www.yahoo.com/ (a directory of web sites). In Yahoo, go to the Social Science section and then to the Psychology subsection.

1. Using the Web links below or a search engine, find one web site with material related to your research question

2. Record this web site using the correct APA format for web citations. [Note: this format may be found online at *Electronic Reference Formats Recommended by the American Psychological Association*, which is available via the Library Home Page. Go to "Instruction Guides" and click on “Style Manuals & Citation Guides." http://www.apastyle.org/elecref.html

3. Now evaluate the web site by using the “Evaluating Web Sites” guidelines, which may be found online under the Library Home Page “Instruction Guides” section. http://www.stolaf.edu/library/instruction/evaluation.htm
   Answer the questions: Why will the site you found be useful? Is it popular or scholarly? How do you know? Who is responsible for this site? When was it last updated? If there are links to other sites, are these relevant for your research and why?

Web Links

Psychweb http://www.psychweb.com/
Provides links to other psychology-related sites and scholarly resources. Click on "Mega Sites" to find other sources.

Social Psychology Network http://www.socialpsychology.org/
A comprehensive source of social psychology links, with additional general psychology options.

Psych Web created by Russell E. Dewey http://www.psywww.com/
Contains a large amount of information about resources, departments, areas, discussion groups, & various other information.

St. Olaf Psychology Department http://www.stolaf.edu/depts/psych

PART 2
Revision of Play Lab Hypothesis

Look back at your hypothesis about children's play. If you wish to, revise your proposal, reflecting your thoughts and the discoveries from your library research. Revision of your proposal is optional (provided your pre-existing proposal has been approved). **If you do this, submit the updated version of your proposal to your preceptor.** When you feel your library work supports your research proposal and your project has been approved, you are ready to begin your field observations.

PART 3

Topic for Critical Thinking

Outline the steps you would take to design a research project focused on the concept of play that is set in another culture and / or seen through the eyes of a different discipline (e.g., sociology, art, history, or biology). Provide a basic hypothesis or question. Design a search strategy. Find research material on your topic. Specify why you selected it and how it might be valuable.

References

Required Lab Reading

Brownlee, S. (1997, February 3). The case for frivolity: Play isn't just fun. Young animals can't do without it. *U. S. News & World Report, 122(4*), 45-49.

Suggested Readings

Fister, B. (1992). The research process of undergraduate students. *Journal of Academic Librarianship, 18(3),* 163-169. [This article explores ways in which student research processes compare and contrast with the search strategies that are often introduced in bibliographic instruction. Fourteen undergraduate students who were interviewed describe how they formulated the focus for their projects, gathered evidence, \ subsequently revised their focus, and translated their research discoveries into writing.]

American Psychological Association. (2001). *Publication Manual of the American Psychological Association*. (5th ed.). Washington, DC: Author. [This manual includes most up-to-date information on APA style guidelines, incorporating coverage of technological publications, case studies, and more. Indispensable research resource.]

Reed, J. G., & Baxter, P. M. (1992*). Library use: A handbook for psychology* (2nd ed.). Washington, DC: American Psychological Association. [This respected text offers a thorough introduction to library research and information sources. It covers library organization, defines research topics and strategies, and describes key psychological resources.]

Neuropsychology: Handedness

Bonnie S. Sherman

Introduction

It is curious that while most people become what we call "right-handed," a few people persist in being "left-handed," despite societal pressures to conform. We employ the right hand to swear on the Bible, to salute, and to shake hands. Even our language conveys the notion that "left" is less acceptable than "right." Expressions like "out in left field" or "having two left feet" and words for left we've taken from other languages like "gauche," "sinister," and "maladroit" suggest the negative, while "adroit," "dexterous," and being at "the right-hand of God" imply the positive. So why do some of us seem to choose this awkward, more difficult path of being left-handed?

Perhaps the choice is not simple; left-handers may be responding to strong genetic pressures. Yet interestingly there is no known simple genetic code for handedness, and monozygotic twins with identical genetic make-up are not especially likely to be concordant for handedness (Halpern and Coren, 1990).

Perhaps the left-handed path is chosen early, too early to be in response to these cultural factors. Michel (1981), for example, has noticed that newborns in the first couple of days after birth lie with their heads turned mostly in one direction. About two-thirds of them choose turning to the right. Five months later those same infants who had turned their heads to the right were reaching for things with their right hands, while the infants who had turned mostly to the left were reaching with their left hands.

This and other behaviors interacting with genetics may result in different cortical organizations for right- and left-handers. If so, researchers then ask what the difference is and how that difference might show up in brain anatomy. There are a number of studies that show anatomical differences; the differences are small and not dramatic, but they provide researchers with a few pieces of a puzzle still remaining to be solved.

Below are some facts (Springer and Deutsch, 1993) about handedness that may provide starting points for discussion.

1. Most human beings, about 90%, use their right hands for writing and other skilled, one-handed activities. This has been true since prehistoric times. Nevertheless, a small percentage of the population is left-handed in a right-handed world.

2. The incidence of left-handedness is higher in males than in females.

3. The probability of two right-handed people having a left-handed child is 0.02. It rises to 0.17 if one parent is left-handed and to 0.46 if both are left-handed.

4. Hemispheric asymmetry: 95% of right-handers have speech localized to the left hemisphere, and 70% of left-handers have speech localized to the left hemisphere. There is considerable bilateral speech representation in the remaining 30% of left-

handers; that is, there is less evidence of asymmetry in left-handers. There is also a higher incidence of stuttering in strongly left-handers than in strong right-handers.

5. Some clinical data suggest a positive correlation between handedness and early brain damage. In one of these studies, most of the left-handers with evidence of early damage to the left cerebral hemisphere showed evidence of language in the right hemisphere, whereas left-handers with no signs of early cortical damage had left-hemisphere language. Left-handers have a better prognosis for recovery from aphasia after a stroke than do right-handers.

6. The rate of immune disorders is 2.5 times greater in strongly oriented left-handers than in right-handers. The incidence of learning disorders for left-handers is 10 times greater.

7. More than 2.5% of right-handers live to the age of 90, whereas fewer than 0.5% of the left-handers reach 90. The mean age for death of right-handers is 75.34 years; for left-handers, it was 66.2 years.

Objectives

- To consider ways of defining and testing handedness
- To discriminate between functional and structural asymmetry
- To learn some of the basic anatomy of the human brain and look for differences between individuals
- To examine some sensitivities in brain development
- To investigate the relationship of handedness and brain structure

Terms

The following terms are described in detail in the **Methods** section:

Brain stem

Cerebellum

Cerebral cortex

Corpus callosum
    Isthmus of corpus callosum: **posterior 1/3** minus **posterior 1/5**

Fissure(s):
    Sylvian or lateral fissure

    Longitudinal fissure--right and left cerebral hemispheres

Frontal lobe

Gray matter

Gyrus / gyri

Lateral ventricles--occipital horns of lateral ventricle

Motor cortex of the precentral gyrus

Occipital lobes

Parietal lobe– Parietal operculum

Pyramidal system

Somatosensory cortex of the postcentral gyrus

Spinal cord

Sulcus / sulci

Precentral sulcus

Central sulcus

Postcentral sulcus

Temporal lobe

White matter

Method

Materials

Edinburgh Handedness Inventory--located at the end of this section
Handedness Scale--located at the end of this section
human brain tissue
dissection trays
dissection kits
latex gloves
lab coats
rulers
graph paper
1500 ml beakers
1000 ml graduated cylinders
masking tape
video (*The Mind: Development*)

PART 1
What Does It Mean to Be Functionally Asymmetrical?

CT	**What constitutes handedness? How would you define it and measure it?**

A number of tests have been written to measure handedness. Complete the following tests, score your individual results, and then put your data on the board so the results of the entire group can be viewed.

1. Edinburgh Handedness Inventory (at the end of this lab unit)

2. Handedness Scale (to be given to you by your preceptor)

CT	**In comparing your handedness tests, do you find the scores for individuals the same on both tests? Why might you expect to find differences? How does the definition of handedness determine your results?**

CT	**Looking at the results of your lab colleagues, where does your score fall? What might the reasons for this be? Was there an overall trend in the scores?**

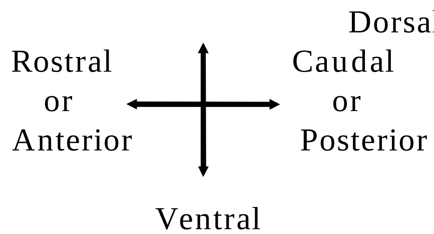
PART 2
Basic Brain Anatomy and Individual Differences

1. You will be examining human brain tissue. These brain specimens are from people who donated their remains to the medical school at the University of Minnesota. First-year medical students dissected the brains, and we have them this year for study. Treat them with respect; they are gifts to us for our education.

2. Select latex gloves that fit your hands and put them on. [Non-latex gloves are available for anyone who has a latex allergy.] You will be working with the brain that is on a tray at your research group's station.

3. Some helpful directional terms to aid in your dissection (you <u>do not</u> have to memorize these):
   <u>Dorsal</u> refers to the top or back of the nervous system.
   <u>Ventral</u> refers to the front or bottom.
   <u>Lateral</u> means toward the side or away from the midline.
   <u>Medial</u> means toward the middle or the midline.

Anterior means toward the head (words with the same meaning are rostral and cephalic).
Posterior means toward the tail (same as caudal)
Superior refers to something that is located above.
Inferior refers to something that is located below.
Unilateral indicates involvement of only half of the brain.
Bilateral indicates the involvement of both hemispheres.
Ipsilateral refers to the same side of the brain.
Contralateral refers to the opposite side of the brain.



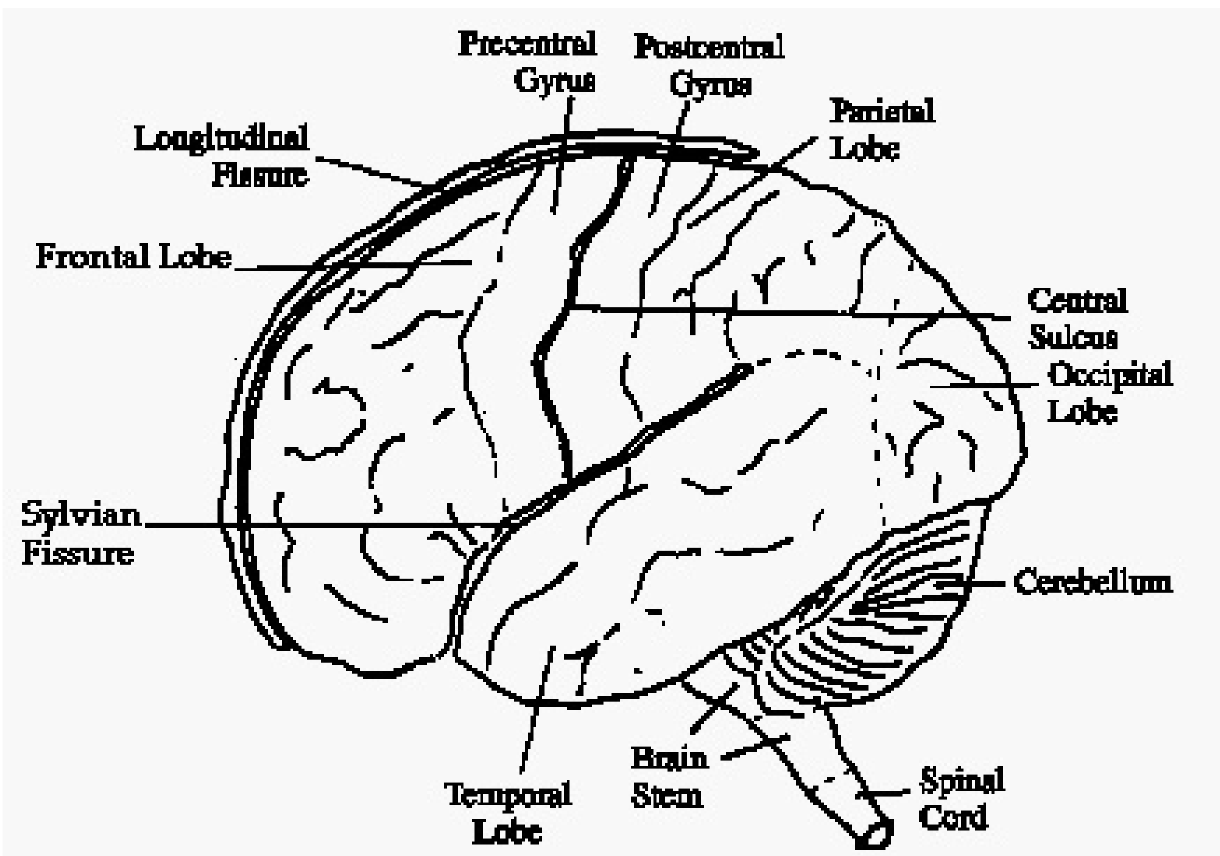


Figure 1. Structural landmarks and functional areas of the human brain

4. Note that the brain is narrower at the front (or rostral portion) and at the back (or caudal portion). Attached at the base is a structure called the CEREBELLUM. This “little brain” is involved in the maintenance of equilibrium and coordination.

5. Place the brain with its right side resting against the tray. Most of the brain seen from this view is the left cerebral hemisphere (Figure 1). Both the left and right

cerebral hemispheres are composed of a superficial layer of GRAY MATTER (called the CEREBRAL CORTEX) that covers a core of WHITE MATTER. Note that the tissue may not look very gray because the preservation may have changed it somewhat in color and texture. You should, however, be able to distinguish gray matter from white matter, as the white matter is still rather white.

6. Examine some of the sections of the two brains that have been “sliced” and are available at the front of the lab. The outer bark, or gray matter, (the cortex) is quite thin. The gray matter consists of the cell bodies of the neurons. Most of the inner tissue is white matter, the neural fibers or axons that make the connections within the nervous system.

7. Note that the gray matter of the cortex comprises many convolutions and depressions, the result of which is to make GYRI or ridges (GYRUS, singular) and SULCI or clefts or grooves (SULCUS, singular). The total surface area of the cortex is about a square meter. The average thickness is about 2.5 mm; however, it is usually thicker in the gyri of the convolutions than in the sulci. It is thickest (4.5 mm) in the MOTOR CORTEX of the PRECENTRAL GYRUS and thinnest in the visual cortex of the OCCIPITAL LOBE (1.5 mm).

8. The deepest and longest grooves are called FISSURES. These are grooves that are deep enough to indent the ventricles beneath the cortex; this distinguishes them from sulci. Note that the RIGHT and LEFT CEREBRAL HEMISPHERES are separated by a very deep indentation called the LONGITUDINAL FISSURE. Find this fissure. Now locate the SYLVIAN FISSURE or LATERAL FISSURE, which begins in a cleft on the anterior, inferior surface of the cortex. (This has been named for François Sylvius, a seventeenth century anatomist.) Place your probe or your gloved finger in this fissure and notice its depth.

9. Now find the TEMPORAL LOBE. Lobes are not functional regions but convenient anatomical regions. They are named after skull bones under which they are found. The temporal lobe is just beneath, or inferior to, the Sylvian fissure, which you have found. Check the location on the diagram.

10. Now locate the FRONTAL LOBE at the anterior part of the brain. To expose the sulcus that forms the posterior boundary of the frontal lobe, note that there are three somewhat parallel sulci that run from the upper, or superior, surface of the brain around almost to the Sylvian fissure. Locate these three sulci on your brain specimen. These are the PRECENTRAL, CENTRAL, and POSTCENTRAL SULCI. The CENTRAL SULCUS forms the posterior boundary of the frontal lobe. It curves toward the posterior part of the brain as it moves medially across the superior surface of the cortex. It is just visible on the medial view.

11. These three sulci enclose two gyri, the PRECENTRAL and POSTCENTRAL GYRI. The PRECENTRAL GYRUS is the gyrus farthest back on the frontal lobe; it is the MOTOR CORTEX of the brain (and is the thickest part of the cortex). Hand movements

originate here. The POSTCENTRAL GYRUS is the somatosensory cortex, the area that receives sensory input from the skin including the hands.

12. When you find these gyri on your brain specimen, stop and look at these same features on another brain. Interestingly, like the rest of our bodies, different brains tend to look somewhat different. There is <u>some</u> variation between the location of these features on the two sides of a single individual's brain and <u>substantial</u> variation in both the location and the size and exact structure of the gyri and sulci in the brains of different individuals. Sometimes it is difficult to locate features on a different brain.

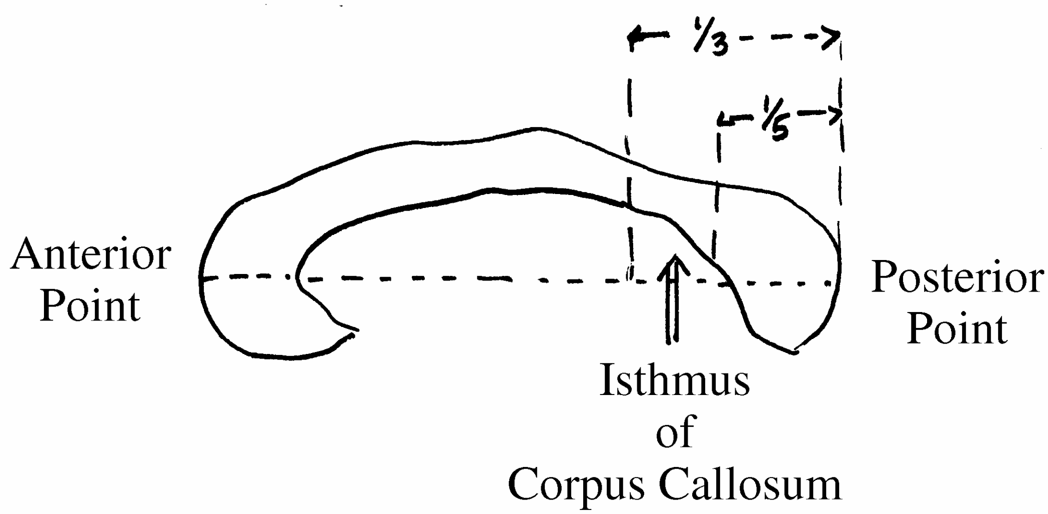
    Make note of some of the differences you observe in the space below.

13. The lobe directly behind the frontal lobe is the PARIETAL LOBE. The most anterior gyrus of the parietal lobe is the POSTCENTRAL GYRUS that you have located in #10 above. The parietal lobe is bounded anteriorly by the frontal lobe, posteriorly by the occipital lobe, and along the inferior border and laterally by the temporal lobe. Note that where the parietal lobe meets the Sylvian fissure, its cortex turns under a bit; this area is the PARIETAL OPERCULUM. Much of the border between the parietal, occipital, and temporal lobes is indefinite. These are called transition areas because definite boundaries are lacking.

14. The OCCIPITAL LOBES are posterior to the parietal lobes and form the most caudal portion of the cortex. The extreme posterior end of the occipital lobe of the cortex is often referred to as the occipital pole. The occipital lobe is involved in vision. Remember the cortex is thinnest in the occipital lobe.

15. Examine a brain that has been cut along the longitudinal fissure. The tissue that has been cut is the CORPUS CALLOSUM, a stout band of fibers or axons that connect the two cerebral cortices. Look at the cross-sectional diagram of the corpus callosum to locate the ISTHMUS of the corpus callosum. The isthmus has no clear anatomical boundaries; it is defined by the following formula:

    caudal 1/3 minus **caudal 1/5** of the corpus callosum



16. Now note that all the structures you have been examining are in the uppermost region of the brain. There is also tissue in the center of the brain and in a narrow column that extends down from the brain (the SPINAL CORD). Just above the cut end of the spinal cord, the cord widens. Here major neural fibers descending from the brain to the hands and other body areas cross from one side of the body to the other. The crossing enlarges the cord. There are two longitudinal fiber bundles that resemble narrow elongated pyramids; they make up the PYRAMIDAL SYSTEM.

17. Finally, note in the *National Geographic* article diagrams that within each of the cerebral hemispheres there are open spaces that are filled with a cerebral fluid. These are called VENTRICLES. There is a model of the ventricles in the front of the lab for you to examine. The posterior portion of these are the OCCIPITAL HORNS. Note that this model was cast from a particular brain; it is not a stylized model. You can see the asymmetry in the horns.

PART 3
Investigating the Relationship of Handedness and Brain Structure.

Below are some findings from research literature. Read and discuss the information in your research groups.

A. Variations in Anatomical Asymmetry

"A general pattern of hemispheric specialization, in which linguistic-sequential and spatial tasks are more accurately processed in the left and right hemispheres, respectively, exists for most people, but the pattern may vary in both direction and degree" (Witelson, 1985, p. 665).

Following are some variations found by researchers investigating this topic:

1. Variation in the corpus callosum

a. In a study of 300 cases, the cross-sectional (or midsagittal area, the cross-section along the longitudinal fissure) of the corpus callosum was 11%, (0.75 cm^2) greater in left-handed and ambidextrous subjects than in right-handed subjects (Witelson, 1985). If the difference were due to the number of fibers, it would represent some 25 million fibers. (Kolb & Whishaw, 1990; Blinkov & Glezer, 1968). (Recall that the corpus callosum develops its shape and position before birth.)
b. The overall size of the corpus callosum is larger in men than in women; this is proportionate to the overall larger brain size of men. In contrast, the area of the isthmus is larger in women; this difference is accentuated when the isthmus is considered relative to the overall area of the corpus callosum. In males, the size of the corpus callosum is correlated with handedness; the isthmus is smaller in right-handed men than in non-right-handed men. Handedness and the size of the corpus callosum are not correlated in women (Witelson, 1989).

2. Variation in the Sylvian fissure on the left and right side of the brain
   Ratcliffe (1980) and his colleagues found that left-handers and right-handers with left hemisphere speech had an average right-left difference of 27° in the angle with which blood vessels (the middle cerebral arteries) leave the lateral, or Sylvian fissure. For left- or right-handers with speech in the right hemisphere, or with bilateral speech, the mean difference was 0°. This is one datum that suggests that left-handers have reduced asymmetry compared to right-handers.

3. Variation in gray matter and blood flow
   In regional blood flow studies, Gur (1982) found more gray matter in left-handers than in right-handers. The total blood volume in the right hemisphere is greater than in the left hemisphere in 62% of right-handers. However, the total blood volume of the left hemisphere is greater than in the right hemisphere in 64% of left-handers (Carmon et. al., 1972).

4. Variation in lateral ventricles
   The occipital horns of the lateral ventricles were longer on the left side than on the right in 87% of right-handed subjects. (In left-handers, the occipital horns tend to be equal or to have an equal chance of the right or left horn being longer) (Witelson, 1980).

5. Variation in relative size of hand-brain connections
   a. Volumetric measurements show that right-handed individuals have larger right hands than left hands. In contrast, the hands of left-handers are much more nearly symmetrical (Purves, White and Andrews, 1994).
   b. Yakovlev and Rakic (1966) found that in 80% of the cases the pyramidal tract descending to the right hand contains more fibers than does the same tract going to the left hand.
   c. Note the histological (tissue) asymmetry was discussed in your required lab reading (White et. al., 1994). This is a difference in motor and somatosensory

(body sensation) cortex, that is in regions that may move the hand, or bring in sensations from the hand.

B. Variations in Functional Asymmetry

1. Bihemispheric representation
   Left-handers, as a group, have greater bilateral representation of cognitive functioning than do right-handers (Bryden, 1982). Right-handers are more likely to carry out tasks such as speaking, writing, solving a spatial puzzle, etc. in a single hemisphere (either right or left), while left-handers may carry out a test with input from both hemispheres.
2. Other factors
   Different patterns of hemispheric functional organization may be related to handedness, but also to other variables, such as sex, brain damage, or cognitive disorders.

PART 4
Investigating the Relationship between Handedness and Anatomical Structure

A. As illustrated by the preceding findings, considerable effort has been made to discover systematic differences in handedness that might accompany specific patterns of handedness. In this part of the laboratory investigation you are asked to develop a procedure that investigates one of these anatomical differences. You may design your own method, or utilize one of the following. **Record all data and answers to questions in your lab notebook.**

Example 1: Corpus Callosum size vs. Handedness and Gender

Part b in finding 1 under “Variations in Anatomical Asymmetry” describes discrepancies in corpus callosum size between genders. It states that in males the size of a portion of the corpus callosum is correlated with handedness (the isthmus is smaller in right-handed men). Therefore, if you know you are investigating a male brain, you may be able to ascertain the handedness of the individual. The area of the isthmus can be effectively measured with a ruler and graph paper, in a brain that has been cut along the longitudinal fissure.

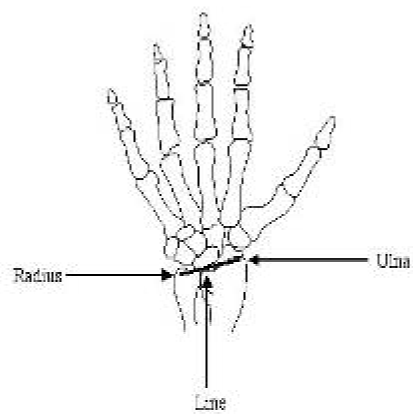
1. Trace the outline of the corpus callosum onto a piece of scrap paper.
2. Determine which section of the trace corresponds to the isthmus (see diagram on page for details)
3. Trace the isthmus area onto a piece of graph paper.
4. Using the graph paper, estimate the area of the isthmus. Be sure to specify units.

Measure the area of the isthmus of all brains present and make a chart listing the data obtained for each one. What preliminary conclusions can you draw from the data?

Example 2: Left and Right Hand Volume vs. Handedness
Part a in finding 5 under “Variation in relative size of hand-brain connections” describes asymmetry in hand size in right-handed individuals. An easy way to measure the

volume of an object is to submerge it in water and measure the amount of water displaced by it. Volume measurements must be made with a high degree of precision to ensure that any difference will be observable. This can easily be accomplished by following this procedure:

1. Locate the ends of your radius and ulna (the two bones of your forearm). This feels like a rounded bump on both sides of each wrist (one bump for each bone). Draw a line with a pen connecting them.



Left Hand

2. Fill a large graduated cylinder (at least 1000-ml) with an exact amount of water. Try to aim for a volume between 580 and 620 ml. Record the amount of water added to the nearest mL. You can do this by approximation based on the existing gradations.

3. Add the water from the cylinder to a large beaker (at least 1000 ml). Place a piece of masking tape longitudinally along the upper half of the beaker.

4. Place the hand (record if it is the right or left) into the beaker. Submerge the hand up to the line on the wrist. Spread your fingers slightly to ensure that water comes in contact with all of the hand. Make a mark on the masking tape at the level the water reaches while the hand is submerged. Remove your hand.

5. With the graduated cylinder, or another beaker, add water to the mark on the masking tape.

6. Pour the water from the beaker (it should now be at the level of the mark on the tape) into the empty graduated cylinder. Record the resulting volume.

7. Subtract your initial volume (step 2) from the final volume (step 6). This is the volume of the hand that was submerged.

8. Repeat steps 1-7 for the other hand.

9. Divide the volume for the right hand by that obtained for the left. Subtract this number from 1 and multiply by 100. Take the absolute value of this percent. This is the percent increase in volume of the right hand over the left.

   Also subtract the volume of the left hand from the volume of the right hand and divide that by the sum of the two volumes. This is either negative or positive depending on which is the larger hand. Compare this number with your handedness scores.

10. Was your result what you expected based on the researcher's findings?

Example 3: Develop your own scientific investigation

Using information from the introduction or *part 3*, develop your own scientific investigation of handedness variation as a function of anatomical differences. You must then carry out the investigation using materials that are available to you in the laboratory. Be sure to define the procedure, record your data, and compare your findings with previous research.

PART 5
Sensitivities in Brain Development

> The video segment on development shows some dramatic effects on fetal brain development resulting from (1) radiation and (2) a chemical insult, (alcohol). As you watch the video, notice how the neurons respond to these insults.

Discussion Questions

1. Consider the relationship among nature, nurture, and development. Looking back on the statistics about left-handers, variations in anatomy, and neural development, how might these factors contribute to the handedness of an individual?

2. You have been examining the biological foundation for the aspect of mental life and/or behavior that we call handedness. What does it mean to look at non-mental processes (anatomy) that effect mental processes?

References

Required Lab Reading

White, L. E., Lucas, G., Richards, A., & Purves, D. (1994). Cerebral asymmetry and handedness. *Nature, 368*, 197–198.

Additional reference article to read and <u>bring to lab</u> (in Rolvaag Library on three-day reserve):

Swerdlow, J. L. (1995, June). Quiet miracles of the brain. *National Geographic, 187*, 2–41.

Suggested Readings

Gardner, H. (1974). *The shattered mind: The person after brain damage.* New York: Vintage Books. [Howard Gardner explains and illustrates through case narratives of brain-damaged patients the relationship between mind and brain. Of particular interest, here is Gardner's first case, Peter Franklin, the non-right-hander who suffered a stroke.]

Springer, S. P., & Duetsch, G. (1993). *Left brain, right brain* (4th ed.). New York: Freeman. [A highly readable text that considers differences, similarities, and interactions between the cerebral hemispheres. Chapter 5 presents data on left-handedness and the brain.]

References Cited

Blinkov, S. M., Glezer, I. I. (1968). *The human brain in figures and tables.* New York: Plenum.

Bryden, M. P. (1982). *Laterality.* New York: Academic Press.

Carmon, A., Harishanu, Y., Lowinger, E., & Lavy, S. (1972). Asymmetries in cerebral blood volume and cerebral dominance. *Behavioral Biology, 7,* 853-859.

Gur, R. C., Gur, R. E., Obrist, W. D., Hungerbuhler, J. P., Younkin, D., Rosen, A.D., Skolnick, B.E., & Reivich, M. (1982). Sex and handedness differences in cerebral blood flow during rest and cognitive activity. *Science, 217,* 659-660.

Halprin, D. F., & Coren, S. (1990). Laterality and longevity: Is left-handedness associated with a younger age at death? In S. Coren (Ed.*), Left-handedness: Behavorial implications and anomalies.* Amsterdam: North Holland Publishers.

Michel, G. F. (1981). Right-handedness: A consequence of infant supine head-orientation preference? *Science, 212,* 685-687.

Oldfield, R.C. (1971). The assessment and analysis of handedness: The Edinburgh inventory. *Neuropsychologia, 9*, 97-113.

Ratcliffe, F., Dila, C., Taylor, L, & Milner, B. (1980). The morphological asymmetry of the hemispheres and cerebral dominance for speech: A possible relationship. *Brain and Language, 11,* 87-98.

Springer, S. P., & Deutsch, G. (1993). *Left brain, right brain* (4th ed.) New York: Freeman and Co.

Witelson, S. F. (1985). The brain connection: The corpus callosum is larger in left-handers. *Science, 229,* 665-668.

Witelson, S. F. (1989). Hand and sex differences in the isthmus and genu of the human corpus callosum: A postmortem morphological study. *Brain, 112,* 799-835.

Yakovlev, P. I., & Rakic, P. (1966). Patterns of decussation of bulbar pyramids and distribution of pyramidal tracts on two sides of the spinal cord. *Transactions of the American Neurological Association, 91*, 366-367.

Web Links

Genetics of handedness

http://duke.usask.ca/~elias/left

A short article discussing the ways in which left-handedness may be under genetic control.

Primate handedness and brain lateralization

http://www.indiana.edu/~primate/index.html

This site gives a thorough hand-preference questionnaire. It asks what hand/eye/foot you use for a variety of tasks and gives you a chance to submit your responses to an ongoing research project.

Handedness Scale

The instructions are: " I want to see how well you can follow directions. Listen carefully and make sure you do exactly as I say. If you don't understand something, or if you want me to repeat it; just ask."

1. Fold your hands like this. (Demonstration of folding with interlocking fingers, dominant hand is indicated by outermost thumb.) One measure.

2. Draw a circle. Now draw a circle using your other hand. Then do it with both hands holding the pencil at the same time. Record on your data sheet the hand that was used first, and the hand that made the circle that is most accurately drawn. Two measures.

3. Stand up and hop. Record which leg was used to hop. One measure.

4. Hold a pencil in your hand about eight or ten inches in front of the center of your face. Close one eye. Next, open that eye and close the other eye. Which eye was closed when the pencil seemed to look higher? One measure.

5. Stand up. Close your eyes and put your feet together. Now lift up your arms and hold them straight out in front of you. Holding your arms steady, open your eyes and note which arm is higher. Record the arm that is raised higher. One measure.

6. Fold your arms in front of your chest. [Demonstrate] Record the arm that is on top. One measure.

7. On a piece of paper in front of you, write your name in the best penmanship that you possess. Note the direction that your head is tilted and record the opposite, dominant eye. One measure.

8. Kneel down on one knee. Record the knee that was used. One measure.

9. Pick up your pencil and hold it at arms length in front of you. Hold it such that, in your line of view, it covers the vertical line drawn on the whiteboard at the front of the room. Now draw the pencil slowly toward your face, always keeping it covering the line on the board. You may be aware of two images, but keep the pencil covering the line with the image that covers this better. Keep moving the pencil toward your face until it touches. Then note the side of the nose to which the pencil has been brought. Record this side of the face, (or this eye). One measure.

10. Stand up and take three steps forward. Stop. Now take three steps back without turning around. Record the foot that you used first walking forward and the foot used first walking back. Two measures.

11. Pick up one of the long dowels provided and pretend that it is a rifle. Aim it as though you were going to shoot me. Then record the hand that was used for the trigger and the eye that was used for sighting. Two measures.

12. On the paper in front of you, write your name. Now write your name again with your other hand. Now write your name with both hands holding the pencil at the same time. Record the hand that you used first and the hand that made the better penmanship. Two measures.

13. Take a sheet of paper and roll it into a tube like this. Now hold the tube to your eye with one hand so you can see the red spot on the whiteboard. Record which hand was used and which eye was used. Two measures.

14. Drop a paper clip to the floor and cover it quickly with your foot. Record which foot was used and which hand was used to drop the paper clip.

15. Take one of the dowels and pretend (only) to swing it as a bat, or use it as a handle of a mop or broom. Record the hand that is used as the power hand for the swing. One measure.

Handedness Scale
Recording Sheet

1.	________________	
2.	________________	________________
3.	________________	
4.	________________	________________
5.	________________	
6.	________________	
7.	________________	
8.	________________	
9.	________________	
10.	________________	________________
11.	________________	________________
12.	________________	________________
13.	________________	________________
14.	________________	________________
15.	________________	

Edinburgh Handedness Inventory *

M. R. C. Speech and Communication Research Unit

Name: Date of Birth: Sex:

Have you ever had any tendency to left-handedness? YES NO

Please indicate your preferences in the use of hands in the following activities by putting **+** in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, put **++**. If in any case you are really indifferent, put **+** in both columns.

Some of the activities require both hands. In these cases, the part of the task or object, for which hand-preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		Right	**Left**
1.	Writing	______	______
2.	Drawing	______	______
3.	Throwing	______	______
4.	Scissors	______	______
5.	Comb	______	______
6.	Toothbrush	______	______
7.	Knife (without fork)	______	______
8.	Spoon	______	______
9.	Hammer	______	______
10.	Screwdriver	______	______
11.	Tennis Racket	______	______
13.	Cricket bat (lower hand)	______	______
14.	Golf Club (lower hand)	______	______
15.	Broom (upper hand)	______	______
16.	Rake (upper hand)	______	______
17.	Striking match (match)	______	______
18.	Opening box (lid)	______	______
19.	Dealing cards (card being dealt)	______	______
20.	Threading needle (needle or thread according to which is moved)	______	______
40.	Which foot do you prefer to kick with?	______	______
41.	Which eye do you use when using only one?	______	______

Note: The numbering in this questionnaire reflects the numbering in the original test. Questions 21 through 39 were not included in the final scale.

*Reprinted from NEUROPSYCHOLOGIA, Vol 9, Oldfield, R.C. "The assessment and analysis of handedness: The Edinburgh inventory," 1 scale only, pp 110-111, 1971, with permission from Elsevier

Psychopharmacology of Spatial Learning

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Introduction

Learning fixed locations in our daily environment is deceptively simple. Recall for a moment your first few days on campus. After walking around just a few times, you were probably able to find your way to and from the cafeteria, gym, bookstore, and library. Since you probably spent little, if any, time consciously memorizing the routes you took to those places, you were probably unaware that you learned much in those walks. But you learned a great deal about the relative location of places in your new world. You did so using a process called *spatial learning*, which is distinctly different from the kind of learning you depend upon to pass exams.

Unlike rote learning or other means of learning new voluntary behaviors (e.g., *operant conditioning*), spatial learning occurs almost automatically in all mammals studied. It develops very rapidly, requires no reinforcement, and rarely entails conscious thought (see Barnes, 1988, and Sherry et al., 1992). That may reflect our evolutionary history, in which survival depended on a special ability to form *cognitive maps* indicating the locations of food, water, and escape routes from predators. Even today, in a more civilized world, we suffer greatly when our spatial learning ability begins to fail. That occurs to some extent with advanced aging (see Gage et al., 1988 and Ordy et al., 1988). It occurs more dramatically in Alzheimer's disease (see DSM IV). Indeed, an early and characteristic sign of that disorder is disorientation in space causing the afflicted person trouble finding his or her way to and from work (Henderson et al., 1989; Binetti et al., 1998).

You can appreciate now why an understanding of spatial learning is important for both academic and medical reasons. The medical reasons alone explain the urgency of learning the biological basis of spatial learning. Such knowledge is necessary to find ways of reducing or even stopping the spatial disorientation experienced with advanced aging and especially with the onset of Alzheimer's disease. Research to date indicates a number of changes in brain processes that may account for spatial disorientation, one of the most prominent of which is a reduction in content and release of a neurotransmitter called *acetylcholine* (ACh) in a brain structure called the *hippocampal formation* (see Barnes, 1988 and Sherry et al., 1992; Stancampiano et al., 1999; Fadda et al., 2000). ACh is released in that structure by axon terminals of neurons in another brain structure called the septal area. When the number of those septal neurons decline in the course of aging or Alzheimer's disease, less ACh is released in the hippocampal formation. When the decline becomes marked, impairments develop in hippocampal formation functions such as formation of long-term spatial memories. That view is consistent with many studies in experimental animals (Gage et al., 1988, Ordy et al., 1988, Muir, 1997; Stancampiano et al., 1999; Fadda et al., 2000).

ACh released in the hippocampal formation influence its functions because neurons there have binding sites (i.e., *receptors*) for ACh embedded in their cell membranes. There are two different types of cholinergic (i.e., ACh-binding) receptors, namely nicotinic and *muscarinic receptors*. Both types are found in the hippocampal formation. In this laboratory, you will perform an experiment on tame laboratory animals to determine if muscarinic receptors contribute to spatial learning and memory processes. You will use *behavioral testing* and *psychopharmacology* to test whether or not spatial learning and memory are affected by administration of *scopolamine*, a drug selectively blocking muscarinic receptors for a short period without causing any harm to the experimental animals. (Definitions of all italicized terms are given at the end of this lab.)

Objectives

• To explore the behavioral features and biological basis of spatial learning abilities in a model mammalian species (i.e., the laboratory rat).

• To gain experience performing an experiment to answer a basic question in psychology, in this case how we learn the location of places in our daily environment.

• To learn the value of behavioral testing methods in determining an animal's learning capacity and the value of psychopharmacology in determining which brain processes are critical to that capacity.

• To discover the importance of acetylcholine in learning and remembering locations in our environment and how the loss of that substance in Alzheimer's disease could explain a key symptom of that disorder.

• To become aware that behavior is the product of brain processes, especially those involved in chemical communication among neurons.

Hypothesis and Identification of Variables

Every experiment tests a hypothesis. Our experiment will test the hypothesis that a subject's ability to learn a new location in its environment is impaired by a drug blocking muscarinic receptors. To test a hypothesis, we must choose a research strategy, which requires a choice of (1) a research design, (2) a research setting, and (3) a data collection method. For this experiment the following choices have been made:

Our research design is experimental, comparing two groups of subjects (one given a drug blocking muscarinic receptors and a control group given no drug).

Our research setting is a laboratory, allowing us to test subjects under controlled conditions.
Our data collection method is behavioral observation of performance speed in a water maze.

DT

What is an independent variable? What is the independent variable for this experiment?

What is a dependent variable? What is the dependent variable in this experiment?

A research strategy cannot be used, however, without making further choices about how the experiment will be run. What subjects will we use? How will we measure their ability to learn a new location? How will we selectively block muscarinic receptors? Those questions are answered in our methods section, which allow others to repeat the experiment and thus check our results.

Methods

Subjects

Since our study requires manipulating brain processes, we must use laboratory animals for ethical reasons. Our choice is one of the most common of all non-human subjects in experimental psychology, namely albino rats. They are a good choice, because they are easy and inexpensive to house, have brains that serve as a good model of the mammalian brain, and have well-developed spatial learning abilities. Albino rats are also very tame and thus safe to handle freely without gloves so long as you don't grab them suddenly or squeeze them around the neck.

We will use young female rats of the Sprague-Dawley strain (200-225 grams in weight). We choose young animals because they have a greater tendency to explore their environment actively and hence tend to learn its spatial features more rapidly. We use females because they are more likely to display the drug effect we will explore (e.g., Berger-Sweeney et al., 1995).

Materials

Since we obviously lack the option of communicating with the rats by means of language, we must rely upon behavioral testing to determine how they learn the location of a new place in their environment. For testing spatial learning abilities, psychologists often use mazes. They are essentially puzzle boxes in which many different paths may be followed, only one of which leads all the way from the start box to the goal box without dead-end detours. Our maze is a modified version of the water maze introduced by Richard Morris (1984) for testing spatial learning and memory in rats, which are good swimmers. Our water maze is a galvanized pool 1.5 meters in diameter and 0.6 meters deep. In a predetermined quadrant of the pool stands a platform 13 centimeters wide. Only by climbing onto the platform can a rat escape from the water and rest safely. The platform is thus the goal of the water maze for a rat swimming in it. The animal cannot locate the platform visually during test trials because the platform lies below the surface of the water and because both the pool and the platform are painted flat black.

Try to understand why such a maze is so well suited to studying spatial learning. Only when the rat has truly learned the location of the platform with respect to fixed, visible landmarks around the pool can it quickly and reliably escape the water no matter where it is placed along the wall of the pool at the start of each trial. It cannot do that merely by learning to look for the platform (since that is invisible) or by learning to repeat a standard set of movements (since a different set is required from different starting points around the pool). Quick, reliable navigation through the water maze is thus a measure of learning a location in space, not of some other strategy for finding the platform.

We will use a *latency measurement* as an indicator of learning in the water maze. It is defined as the mean time required for a rat to travel from the edge of the pool to the platform across seven trials.

Testing Procedure

Before the lab session, the student preceptor will set up the Morris water maze and fill it with water at room temperature. The preceptor will also and color-code the bottles with the two substances (drug or non-drug) to be injected, so that only he or she knows which one contains the drug being used to test our hypothesis.

<u>Scopolamine Injection</u>. At the beginning of the lab session, the instructor will randomly assign each of six rats calmed by petting to one of two groups. Those in one group will be injected with the muscarinic receptor blocker scopolamine (1 mg/kg body weight) dissolved in a 0.9% salt solution (i.e., saline). Those in the other group will be injected with an equal volume of the saline solution alone. Both types of injection will be made into the intraperitoneal (i.e., abdominal) cavity. The injections will be given "blind" in the sense that neither you nor the instructor will know which animal receives the drug or just saline. (Neither injection should harm the animals. Saline is similar to normal body fluids. Scopolamine in the dose used is metabolized and cleared from the body in less than a day without damaging any of its tissues or processes.)

The 20 minutes required for the drug to have its effect on the brain will be used to provide an introduction to the hypothesis under study. Toward the end of that time, those taking the lab will break up into six teams identified by number. Each team will be given lab coats and then assigned one of the rats and shown how to handle it properly. The animal should be held comfortably on one arm and gently petted for a few minutes to become comfortable with its new handlers.

Behavioral Testing. Once each team has comforted its animal, testing will begin. As with the injections, the testing will be done "blind" so that none of the teams know whether its animal received the drug or the saline solution. With only one water maze, the teams must take turns testing their animals. Team 1 will start. Using a random number table, Team 1 will decide in which of the four quadrants of the pool to place the platform. That placement will not be changed for all trials run by that team. Using a random number table again, the starting position for the first trial will be chosen among the four quadrants of the pool. All team members will take positions around the pool as visual cues for their rat and maintain those positions on all trials of their animal. One member of the team will then place the rat at the edge of the water maze facing the side of the pool. Another member of the team will be prepared to record the time the animal was placed in the water and the time when it climbed onto the platform. The rat should be allowed to remain on the platform for 20 seconds to help it learn its location with respect to other landmarks in the room.

If the rat does not reach the platform in 90 seconds after being placed in the water, it should be lifted out of the water, placed on the platform, and kept there for the standard 20 seconds. At the end of a trial, a team member will pick up the wet rat and dry it in a towel, holding it for much of the time (a rest period of 90 seconds) before the next trial. Each team will run their animal in the water maze seven times in a row, each trial ending with 20 seconds on the platform and a subsequent 90-second period for further rest and drying.

During the rest period, the remainder of the team should record the location of the platform, the starting location of the rat, and the time it took the rat to swim to the platform. If the rat did not reach that goal by the 90-second limit, team members should simply record 90+ seconds. In addition to running times, descriptive observations should be made on any changes in the swimming pattern of each rat over its seven trials, especially noting differences between aimless versus platform-directed swimming.

Team 2 can begin its first trial once Team 1 finishes its seventh trial. As with the first team, Team 2 must start by deciding where to place the platform and where to put its rat into the pool. All the instructions given above for Team 1 should be followed. This procedure should be followed until all six teams have run their animals in the maze, each for seven trials.

Data Analysis. For each rat, there should be 7 data points for the time it took to swim from the side of the water maze to the platform. Three of the rats received injections from the same bottle, whereas the other three received injections from a different bottle. Group the data on rats injected from the same color-coded bottle. Calculate the mean and standard deviation of the latency measurements for animals in same group. Run a t-test to determine whether the difference in means between the groups is significant. The preceptor will then remove the color bands from the injection bottles to reveal which group actually received scopolamine. If our hypothesis is correct, you should find that (1) there is a significant difference in mean latency between the groups and that (2) the group with the higher mean (i.e., the one in which animals took longer on average to find the platform) was the one given scopolamine.

DT	**In what way(s) is spatial learning different from operant conditioning?** **Why is it important to run a drug study in a "double-blind" manner? Why do we not use double-blind techniques in other situations?**

Discussion Questions

1. If the two animal groups you tested differed significantly in time to swim the water maze, what does that imply about the relationship between brain function and behavior?

2. If your results were consistent with the hypothesis tested, what implications does that have for possible treatments of Alzheimer's disease?

3. If you found no significant difference between the animal groups in this experiment, does that necessarily mean the hypothesis was wrong? Did you observe anything during the experiment that might provide an alternative explanation for such a negative result?

4. How do you feel about using animals in research? Are there any conditions you feel must be met before such research should be conducted?

Definition of Terms

Acetylcholine: a neurotransmitter important in many brain functions, including learning and memory processes.

Behavioral testing: observation of overt behaviors under controlled conditions used to infer mental processes.

Cognitive maps: mental imagery used to remember the relative location of fixed places in our environment.

Hippocampal formation: an extension of the cerebral cortex in the temporal lobe critical in forming long-term explicit (= declarative) memories.

Latency measurement: a delay interval between starting and finishing a task (e.g., the time taken to swim from the start point to the submerged platform in the Morris water maze).

Muscarinic receptor: one of two types of acetylcholine receptor. It preferentially binds a drug called muscarine. The other type of acetylcholine receptor is called *nicotinic*, which preferentially binds a drug called nicotine.

Morris water maze: a behavioral testing apparatus consisting of a water pool in which the location of the goal (a submerged platform on which to rest) can only be remembered by learning the platform's relative location to fixed visual cues around the pool.

Neurotransmitter: a molecule released by a neuron to transmit its signals to other neurons across synaptic gaps.

Psychopharmacology: the study of drug effects on overt behavior and mental processes.

Receptors: proteins (usually membrane-bound) specialized to bind with only one type or family of molecules (e.g., muscarinic receptors).

Scopolamine: a drug binding to muscarinic (but not nicotinic) receptors. It thus prevents acetylcholine released in the brain from binding and activating muscarinic receptors.

Spatial learning: the process of learning the relative location of fixed places in our environment.

References

Required Lab Reading

Buresova, O., Bolhuis, J. J., & Bures, J. (1986). Differential effects of cholinergic blockade on performance of rats in the water tank navigation task and in a radial water maze. *Behavioral Neuroscience, 100*, 476-482.

Fadda, F., Cocco, S., & Stancampiano, R. (2000). Hippocampal acetylcholine release correlates with spatial learning performance in freely moving rats. *NeuroReport*, *11*, 2265-2269.

Frick, K. M., Baxter, M. G., Markowska, A. L., Olton, D. S., & Price, D. L. (1995). Age-related spatial reference and working memory deficits assessed in the water maze. *Neurobiology of Aging, 16*, 149-160.

Sirvio, J. (1999). Strategies that support declining cholinergic neurotransmission in Alzheimer's disease patients. *Gerontology*, *45* (suppl. 1), 3-14.

Suggested Readings

Barnes, C.A. (1988). Spatial learning and memory processes: the search for their neurobiological mechanisms in the rat. *Trends in Neuroscience, 11*, 163-169.

Berger-Sweeney, J., Arnold, A., Gabeau, D., & Mills, J. (1995). Sex differences in learning and memory in mice: effects of sequence of testing and cholinergic blockade. *Behavioral Neuroscience,109*, 859-873.

Binetti, G., Cappa, S.F., Magni, E., Padovani, A., Bianchetti, A., & Trabucchi, M. (1998). Visual and spatial perception in the early phase of Alzheimer's disease. *Neuropsychology*, *12*, 29-33.

Buresova, O., Bolhuis, J.J., & Bures, J. (1986). Differential effects of cholinergic blockade on performance of rats in the water tank navigation task and in a radial water maze. *Behavioral Neuroscience, 100,* 476-482.

American Psychiatric Association. (1994). *Diagnostic and statistics manual of mental disorders,* (4th ed.) Washington, DC: Author.

Fadda, F., Cocco, S., & Stancampiano, R. (2000). Hippocampal acetylcholine release correlates with spatial learning performance in freely moving rats. *NeuroReport*, *11*, 2265-2269.

Frick, K.M., Baxter, M.G., Markowska, A.L., Olton, D.S., & Price, D.L. (1995). Age related spatial reference and working memory deficits assessed in the water maze. *Neurobiology of Aging, 16*, 149-160.

Gage, F.H., Chen, K.S., Buzsaki, G., & Armstrong, D. (1988). Experimental approaches to age-related cognitive impairments. *Neurobiology of Aging, 9,* 645-655.

Henderson, V.W., Mack, W., & Williams, B.W. (1989). Spatial disorientation in Alzheimer's disease. *Archives of Neurology*, *46*, 391-394.

Lawrence, A.D. & Sahakian, B.J. (1998). The cognitive psychopharmacology of Alzheimer's disease: focus on cholinergic systems. *Neurochemical Research*, *23*, 787-794.

Ordy, J.M., Thomas, G.J., Volpe, B.T., Dunlap, W.P., & Colombo, P.M. (1988). An animal model of human-type memory loss based on aging, lesion, forebrain ischemia and drug studies with the rat. *Neurobiology of Aging, 9,* 667-683.

Morris, R. (1984). Developments of a water-maze procedure for studying spatial learning in the rat. *Journal of Neuroscience Methods, 11,* 47-60.

Muir, J.L. (1997) Acetylcholine, aging, and Alzheimer's disease. *Pharmacology, Biochemistry & Behavior, 56,* 687-696.

Sherry, D.F., Jacobs, L.F., & Gaulin, J.C. (1992). Spatial memory and adaptive specialization of the hippocampus. *Trends in Neuroscience, 15*, 298-303.

Stancampiano, R., Cocco, S., Cugusi, C., Sarais, L., and Fadda, F. (1999). Serotonin and acetylcholine release response in the rat hippocampus during a spatial memory task. *Neuroscience*, *89*, 1135-1143.

Attention and Brain Activity

Howard Thorsheim,

Introduction

Attention

The major concept of the lab is ***attention***. Attention is vital for our survival. Without attention, the rest of the information-processing system is at a disadvantage. Because of the importance of attention in education, athletics, business, advertising, and mental health, researchers around the world are devoting considerable time to better understanding the relationship between attention and brain activity.

Attention is an important stage in the information processing system. The following stages of the information processing system are highlighted in Figure 1:

a. Stimuli from external environment
b. Sensory memory
c. Attention
d. Response-produced stimuli (proprioception; thoughts; images)

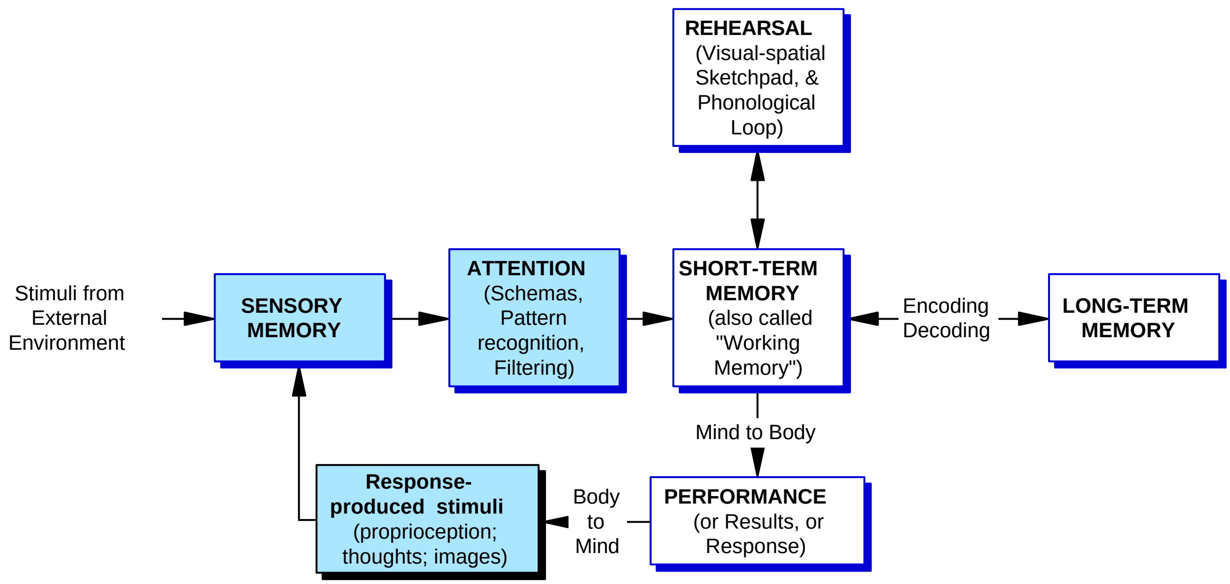


Figure 1. The Information-processing system

The laboratory today will focus on the highlighted boxes in the Information Processing System (Figure 1). The plain, white boxes will not be the focus of today's lab.

Interconnectedness of all Scientific Fields

A major objective of Psychology 122 is to provide a taste of what science is truly about. Science is a way of knowing and learning from experience through making observations in order to discover causes of events. These observations are not just any kind of observations, but rather very careful observations, made with much thought beforehand. These observations may be made in a natural environment; for example, naturalistic observation of play behavior.

Another kind of experience that is planned in advance is called an experiment. In an experiment special care is taken to limit or hold constant variables that could confuse the observations being made—this is called experimental control. Another way scientists speak of these sources of confusion is to call them sources of confounding.

Today's lab is a good example of how all sciences are interrelated. We will draw on several sciences, psychology, biology, chemistry and physics.

Psychology: We will focus on behavior, both physical and mental behavior.

Biology: We will need to know something about the biological structure and function of the brain.

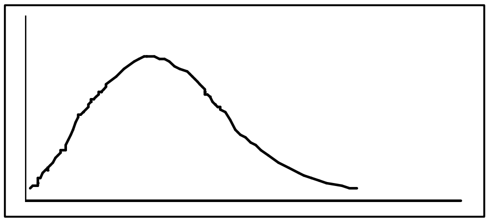
Chemistry: We will need to know about the chemical reactions that result in transmission along nerves, the active and passive flow of ions across the membrane of the nerve axon, which we call the action potential.

Physics: We will need to know about waves (specifically brain waves), how they are described, measured, and the units of measurement used to compare them.

Psycho-physiology vs. Physiological-Psychology

By now you are familiar with the terms independent variable and dependent variable. To review, the independent variable (IV) is the condition the researcher manipulates, changes or observes. The dependent variable (DV) is what the researcher observes, to see what effect on it was caused by or is related to the IV.
The relationship between independent and dependent variables is called a functional relationship. These relationships are shown by plotting the two variables on an X-Y pair of axes of a graph. The independent variable is on the horizontal axis (abscissa), and the dependent variable is on the vertical axis (ordinate), for example:

(Dependent variable
On the Ordinate)



Independent variable on the abscissa

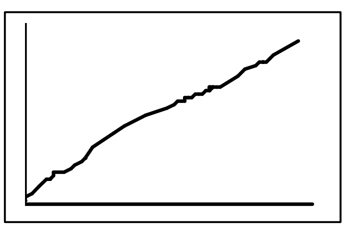
Table 1: Contrast of Psychophysiology and Physiological Psychology

Psycho Physiology		**Physiological Psychology**	
Independent Variable	Dependent Variable	Independent Variable	Dependent Variable
A **psychological** variable we manipulate, change, or observe. It may be a causal variable	Some kind of **physiological** response related to or caused by the independent variable	A **physiological** variable we manipulate, change, or observe. It may be a causal variable	Some kind of **psychological** response related to or caused by the independent variable
Example: ATTENTION: This is a **psychological** variable	Example: BRAIN WAVE CHANGE. This is a **physiological** variable	Example: BRAIN STIMULATION. This is a **physiological** variable	Example: CHANGE IN ATTENTION. This is a **psychological** variable

In both psychophysiology and physiological psychology, we plot the independent variable on the abscissa, and the dependent variable on the ordinate. What differs is what those independent and dependent variables are. Observe the following two illustrations closely:

<u>Psychophysiology</u>

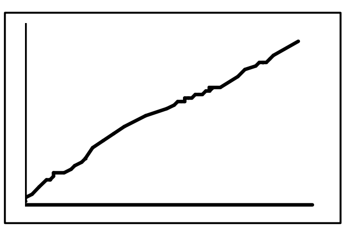
(**Physiological**
Dependent variable
On the Ordinate)



Psychological Independent variable on the abscissa

<u>Physiological Psychology</u>

(**Psychological**
Dependent variable
On the Ordinate)



Physiological Independent variable on the abscissa

Now let us proceed to the dependent variable we will observe today, the electroencephalogram, or brain wave, as it is commonly known.

The Electroencephalogram
The electroencephalogram (EEG) is the record of brain-wave activity. It is recorded easily and nonintrusively from the human brain via gold electrodes placed on the surface of the scalp. As shown in Figure 2, the commonly obtained alpha waves of 8-13 Hz recorded over the occipital lobes{xe "occipital lobes"} of the brain (when eyes are closed) are reduced in amplitude and increased in frequency when visual stimulation occurs (i.e., when eyes are open).

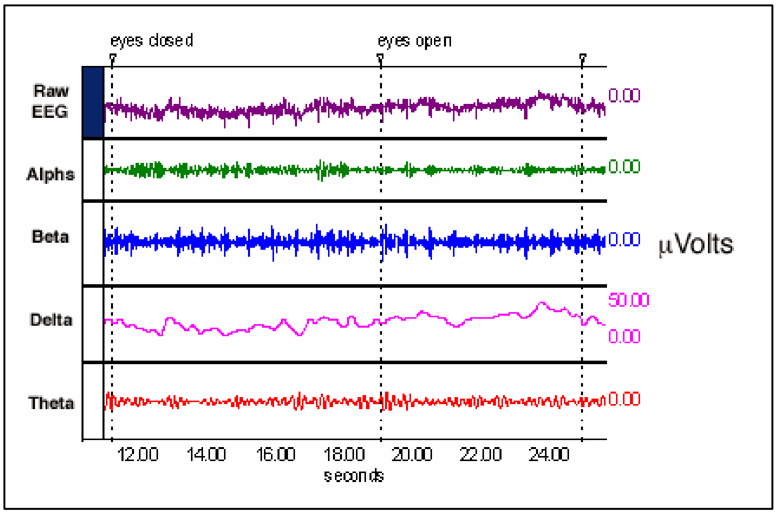


Figure 2. More alpha waves with eyes closed than with eyes open

The alpha rhythm{xe "alpha rhythm"} is "blocked" when visual stimulation occurs and is replaced by the faster, lower amplitude beta rhythm. A more current term for the same phenomenon is "desynchronization{xe "desynchronization"}." Alpha blocking{xe "alpha blocking"} is an increase in frequency{xe "frequency"} and a decrease in amplitude {xe "amplitude "}of the alpha rhythm during visual stimulation (i.e., when eyes are open). Visual sensory information achieved by having one's eyes open causes the alpha waves to be "blocked."

You may find it interestingly counterintuitive when you discover that brain attention is represented by small, fast beta waves, whereas inattention is represented by large, but slow, alpha waves. (If this interests you, ask more about it.)

Source of Alpha Waves. The neural activity denoted by the alpha rhythm results from some kind of coordinated electrical activity in the cortex. Ganong {xe "Ganong "}(1965, p. 128) attributed the source of the rhythmicity to electrical dipoles (dipoles are like the north and south ends of a magnet) {xe "dipoles"} formed between dendrites and cell bodies in the cerebral cortex{xe "cerebral cortex"**}**. "Current" flows back and forth, in the words of Ganong, through the extracellular fluid that serves as a volume conductor (that is, electrical activity is going on around the neurons as well as inside them). The "current" is a flow of ions that increases and decreases as a result of the activity of excitatory and inhibitory nerve endings that terminate on the dendrites. The activity of these dendrites is increased or decreased by activity in the brainstem ascending reticular activating system**{**xe "ascending reticular activating system"**}** (ARAS**{**xe "ARAS"**}**).

Objectives

• To investigate ways to measure attention by measuring brain activity
• To learn the basic skills of electroencephalography (EEG)
• To identify the difference between alpha and beta brain waves, using criteria of frequency and amplitude
• To understand the difference between paying attention to one's internal thinking (a *rejection task* that involves rejection of external stimuli) and paying attention to external environmental stimuli (an *intake task* that involves intake of external stimuli)
• To understand the Faraday Cage and the BioPac Equipment. (If time is available, you may be able to explore some of the sophisticated digital approaches we use in later courses.)

Issues to investigate

You will compare EEG waveforms under eyes-open and eyes-closed conditions and discuss with your lab partners the evidence you have found for alpha blocking during visual attention. You will be asked to consider how you might test to see if imagery (*internal* visualizing) might reveal itself as similar to or different from direct visual stimulation. You will also be asked to explore the relationship between stimuli in other sensory modalities (hearing, touch, etc.) and "alpha blocking" and to discuss what it might mean if you find evidence for or against your hypotheses.


Figure 3. Learning in this investigative laboratory will include the following:
Left picture: Measuring to place EEG electrodes at the O1 and O2 Occipital positions on participant's scalp.
Right picture: Approximate location for O1 and O2 electrode placement

Terms

60-Hertz Noise	Action Potential	Alpha waves
Artifact	Attention	Beta waves
Calibration curve	Confounding	Delta waves
Electroencephalogram	Experiment	Experimental Control
Faraday Cage	Hertz (Hz)	Impedance
Informed consent	Microvolt	Mu
Naturalistic Observation	Occipital lobes	Sensory memory
Ten-twenty system	Theta waves	Variables (Dependent and Independent)
Volt	< "less than"	~ "approximately"

Some key definitions

Alpha and beta electroencephalogram waves are distinguished by two independent criteria:

(a) Frequency (alpha waves are 8-13 Hz; beta waves are 13-30 Hz)

(b) Amplitude (alpha waves are 20-100 microvolts; beta waves are <20 microvolts).

**Note: Hz stands for Hertz, the unit of measure for "cycles per second."

- Beta waves{xe "Beta waves"} (14-30 Hz; <20 microvolts) are associated with alert wakefulness and cognitive processing. You are likely producing beta waves now as you are reading. Rapid-eye-movement (REM) sleep is also associated with similar low-amplitude, irregular activity.
- Alpha waves{xe "Alpha waves"} (8-13 Hz, 20-60 microvolts) are associated with relaxation, meditation, and drowsiness. Zen Buddhist monks, when meditating, produce alpha waves.
- Theta waves{xe "Theta waves"} (4-7 Hz, ~20-100 microvolts) are associated with sleep states, as well as being implicated in creative processing and problem solving.
- Delta waves{xe "Delta waves"} (.5-3.5 Hz, 20-200 microvolts) are associated with deep sleep. Some research indicates that humans need to spend time in deep sleep when certain restorative processes of the body occur.

Method

Participants

Lab participants will work in two-person teams. One person will be the participant, while the other person will be engaged in conducting the investigations and recording observations. Both members of the two-person team will share their observations, notes, and data with each other.

Materials

Faraday Cage
BioPac Equipment
Grass Instruments EC5 gold electrodes (see Figure 4)
Grass Instruments impedance meter (see Figure 5)

Alcohol-acetone Prep Pads
Rubber gloves (Latex-free gloves are an option)


Figure 4. (Left) Recording electrode; reference electrode
Figure 5. (Right) Impedance meter; (Grass Instruments model F-EZM5)


Figure 6. (Left) Cleansing the area before placing electrodes.
Figure 7. (Right) Pressing the electrodes in place on scalp to ensure good contact.

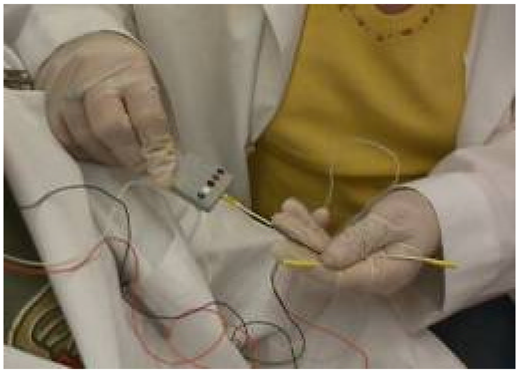



Figure 8. (Left) Placing the electrodes in the Safe Sockets.
Figure 9. (Right) Washing the paste from the electrodes. (Note: When washing ear clip sensors, only remove one at a time to keep the clip from being lost.)

Hints for obtaining optimal data:

1) Good electrode contact is essential to minimize “noise” and increase signal amplitude.
2) The subject should try relaxation techniques, such as concentrating on breathing slowly or relaxing muscles.

3) The subject should remain still, and especially, keep facial muscles still.
4) During the “eyes open” segment, subject should not blink.

Logging your Work:

Good research practice includes keeping track of every time you use your equipment. Find the lab log in the top drawer of your workstation. Find the next blank log sheet and write down today’s date, your names as researchers, and what you will be doing. For example, “we will be doing the ‘attention and brain behavior’ labs.” Then, during your labs make notes on the log page how the labs went for you, difficulties you figured out how to overcome, tips you might have for others, any problems with the equipment, etc.

Procedure

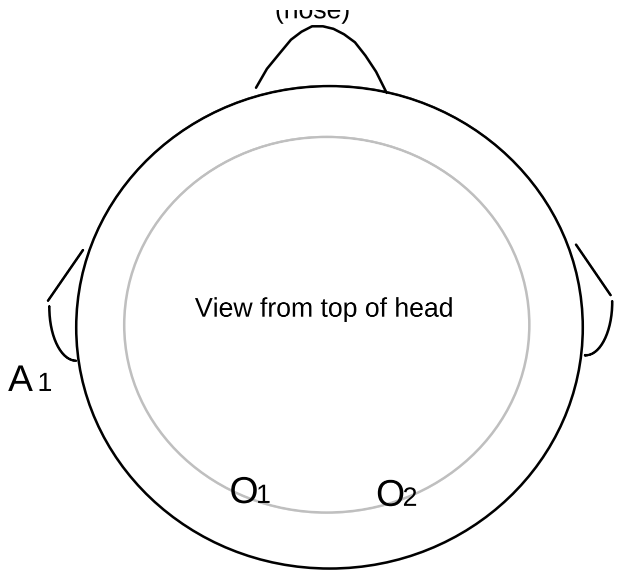
1. Bring your lab notebook, handout for the lab and citation skeleton (which will be collected at the beginning of the period) to the lab. All other belongings (coats, backpacks, heavy sweaters, etc.) should be stored in another room. (To be specified)

2. Use of laboratory coats is mandatory in the psychophysiology lab to protect your clothing against electrode paste and Cetylcide disinfectant. Select a white lab coat for the lab. There are four sizes: small, medium, large, extra large. The smallest are to the left on the pegs in the Observation Room. The mediums should be in the middle, the largest to the right.

3. Form teams of two persons. Each team will have an electrode kit to share containing two recording electrodes per person and one reference electrode.

4. When lab starts, your preceptor will introduce you to the Faraday Cage, a "specialized instrument" used to make electronic measurements that are free of electronic noise from car ignitions, motors, static, or other such sources.

   a. Please read the booklet "Story of the Faraday Cage." This information will be on the Lab Final. We will not be using the Faraday Cage for lab today because our measurements will not require such sensitive recording. It is important to know that, like many psychophysiological labs in the world, our psychology department has a Faraday Cage. Whereas often such cages look like "cages" and are somewhat austere in appearance, ours is specially designed to look like a "screen porch" to reduce participant anxiety.
   b. The “radio test” should be done by every student. While standing near the Faraday Cage, put on the radio earphones and listen to the AM station. Then go inside the Cage. (The signal from the broadcast station has been stopped by the Faraday Cage.)



CT	**Why is there no sound from the station?**

5. The instructor will demonstrate the procedure for placing electrodes on the scalp for electroencephalograph bipolar readings, using the international scientific 10-20 system. (This activity is preceded by going through an "informed consent" process.) Take notes so you can repeat the process on your own.

Figure 10. International (10-20) system for Electrode placement for EEG (you will be placing electrodes at O_1, O_2, and A_1)

6. Turn the computer ON.

7. Make sure the BioPac MP30 unit is OFF; that is, no green lights are on in the front of the MP30 box.

8. Plug the equipment in as follows, making sure the labels face up
   BSL 3 Electrode Lead Electrode for Safe Socket (SS1LA) goes to Channel 1

9. Turn the MP30 Data Acquisition Unit ON. The switch to turn the unit on is located on the back left corner.

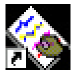
10. Have the subject assume a relaxing position.

11. Clean electrode loci on the scalp and ear lobe (VERY important for good results!)

12. Place electrodes with electrode paste in the cup, and cover electrode with gauze.

13. Check <u>impedance</u> to see that it is less than 10,000 ohms (VERY important for good results!)

14. Connect electrodes to the BSL 3 Lead Electrode for Safe Sockets (SS1lA)

15. Start the  Biopac Student Lab. 3.6.6.lnk program.

16. Choose **Lesson 3 (LO3-EEG-1).**

17. Type in your file name. Click **OK.**

18. Review Fig. 10 to ensure the electrodes leads are properly placed, and that the electrode assembly is plugged into Channel 1.

19. Click on **Calibrate**. An error message will appear if the BioPac accessories are not plugged into the proper channels.

20. If no error message, click on **OK**

21. **Check** your calibration data. If yours is similar to Figure 11, proceed to Data Recording. If your data differ from Figure 11, **Redo Calibration.**

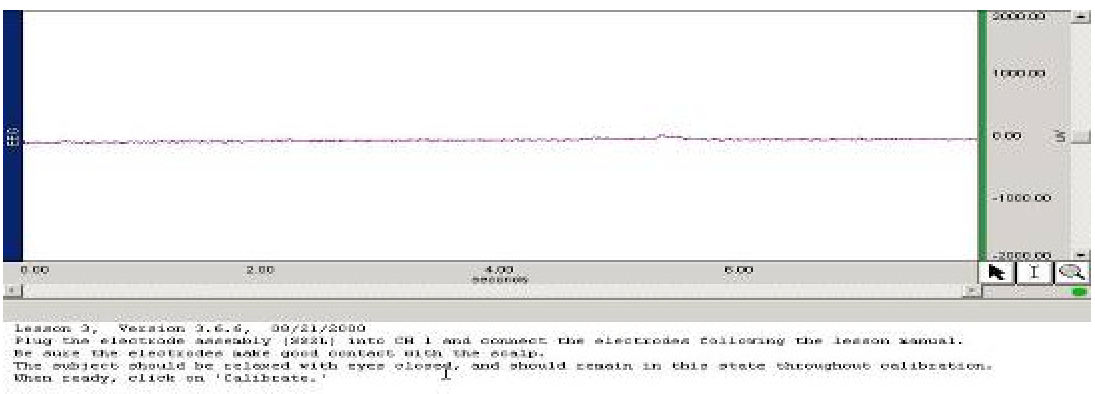


Figure 11. Typical calibration wave from the BioPac Student Lab program.

22. You will be shown some typical signals, and a volunteer participant will be asked to demonstrate what the lab teams will do. Follow these steps carefully:
    a. Prepare for the recording.
    b. Click on Record.
        The director should instruct the subject to remain relaxed but, as directed, open and close their eyes. The director should also insert markers when the eyes close, open, close, etc.
    c. The participant should spend at least 10 seconds in each condition (10 sec eyes closed, 10sec eyes open, etc)

** Be sure to insert marker, the F9 key, for each event during the study. Also type a brief explanation of what the marker stands for so you will remember it, and refer to it later.

d. Have the participant:

-close and open eyes (to show alpha to beta transition)
-grit teeth (to show electromyogram muscle action potential "artifacts" from jaw muscle motor neurons.
-move head to show "sensor pops"
-close eyes (so that alpha appears) and visualize an image
-determine the kinds of stimuli you would like to investigate (e.g., auditory, olfactory, imagery, and touch) and hypothesize whether or not you would see "attention" revealed in the brain wave. ("Attention" = alpha changing to <u>alpha with beta components mixed in</u>, even when the eyes are closed.)

23. Click on stop only when you have completed investigating **ALL** conditions. You will learn how to operate the "record / stop" buttons, as well as waveform horizontal, waveform vertical, zoom, zoom previous, and F9.
24. Review data using the above keys. Click redo if your data do not look right.

25. Click on the frequency buttons in the following sequence;
    a. Beta
    b. Alpha
    c. Theta
    d. Delta

26. Review the data on the screen

27. Partners will rotate, testing one participant at a time, and collect their data. When each participant's data have been recorded, print the graph following these steps:
    a. File menu
    b. Print and then print graph
    c. Click ok.

Print out part of the EEG recordings, trim to fit, and paste them into your lab notebook using rubber cement.

The following points should be labeled:

Alpha and beta waves
Artifacts (and what they are)
Eyes open and closed
Any mental tasks you asked participant to do

<u>CT</u>	**If brain waves relate to your level of attention, what might various brain-wave rhythms mean for learning? Or for remembering?**

28. Clean up your participant, and clean up the electrodes, using hot water and a Toothbrush (go back and review what caption of figure 9 said about how to prevent losing ear clips); then disinfect the sensors by dipping them in Cetylcide for 6 seconds; then rinse them in hot water, allowing the sensors to air dry. (Show your electrodes to your preceptor when you come back to check that there is NO residual of electrode paste. If there is, you must go back and reclean them).

29. Please remember <u>at all times</u> to keep your workstation **Neat**. At all times, put all scrap in the trash receptacle. Ask your preceptor any procedural questions as you are hooking up your participants. Watch for and correct any deviations from correct procedure that you notice.

30. Remember to log all observations in your lab notebooks. Do not depend on your memory. This information is important and will be helpful in your lab write-ups. Note correct procedures, as well as incorrect procedures. In research, we learn when procedures don't work out as we had planned and when we notice new details about procedures.
    a) Discuss how many physiograph samples you believe you need to record in order to achieve reliable samples.
    b) Measure frequencies and amplitudes during each sample, and compute the mean frequency and mean amplitude for the eyes-open and eyes-closed conditions. Enter the data in your lab notebook.
    c) As time allows, explore other options for quantifying your data.

Reminder about Lab Logs

Take out the lab log once again and add any comments you can about how the equipment or software worked, or anything else about the BioPac workstation. Be sure to note any problems with the equipment. (Review the earlier part of this lab write-up to see what kinds of things to enter in the log)

Discussion Questions

Topic 1: Training brain waves
What would be some consequences if you were able to control your own brain waves? How might you be able to train yourself to have certain kinds of brain rhythms?

Topic 2: Brain waves--An internal clock?
Might the brain wave serve as the "tick-tock" of your internal clock that keeps track of time when performing music, playing a sport, or waiting for a friend? Why do you suppose time seems to fly when you're having a good time? What might your brain waves be doing?

Topic 3: Brain waves and learning
If brain waves relate to your level of attention, what difference might various brain-wave rhythms make for learning? Or for remembering?

Topic 4: Brain waves and business
Might performance efficiency be improved if people could know what their brain waves were doing? How might the attention-getting value of ads be predicted in advance, using brain waves?

Topic 5: Biofeedback
How could people know what their brain-wave patterns are? How could that be useful to them?

Topic 6: Stress
Stress is a major killer of people during their adult lives. What have you learned in this lab that could help people keep self-control by knowing when they are stressed or relaxed?

Topic 7: EEG and treatment of ADHD
How might what you have learned in this lab be used to diagnose and treat people who are suffering from attention deficit and hyperactivity disorders?

References

Required Lab Reading

Andreassi, J. L. (1995). The EEG and behavior: Sensation, attention, perception, conditioning, and sleep. In J. L. Andreassi (Ed.) *Psychophysiology: Human behavior and physiological responses* (pp. 50-54). Hillsdale, NJ: Erlbaum.

Suggested Readings (Also on reserve in the Library)

Greene, W. A. (1994). Biofeedback. In *Encyclopedia of Psychology* (Vol. 3, pp. 164-166). New York: Wiley. [This is the best article to read first for a broad understanding of biofeedback and the operant conditioning of one's own brain waves, as well as self-control and other physiological events inside one's body.]

Jasper, H. (1958). The ten-twenty system of the international federation. *Electroencephalography and Clinical Neurophysiology, 10*, 371-375. [This classic article explains the world-famous way of systematizing the placement of sensors.]

Petersen, I., Herberts, P., Kadefors, R., Persson, J., Ragnarson, K., & Tengroth, B. (1981). The measurement, evaluation, and importance of electroencephalography in arduous industrial work. In L. Lennart (Ed.), *Society, stress, and disease: Vol. 4. Working life* (pp. 145-161). Oxford: Oxford University Press. [Applications of scientific findings are important, as shown by this article in which brain waves are used to study performance in the workplace.]

Triesman, M., Cook, N., Naish, P. L. N., & MacCrone, J. K. (1994). The internal clock: Electroencephalographic evidence for oscillatory processes underlying time perception. *The Quarterly Journal of Experimental Psychology, 47A(2)*, 241-289. [This is the best recent article discussing the idea of how brain waves may be involved in helping us keep track of time. The "internal clock" that allows us to keep track of time is a key to many kinds of human performance, including musical and esthetic performances. In searching for the basis of this "internal clock," brain waves have been identified as likely candidates for the "tick-tock" of the clock.]

Web links

EEG Biofeedback

http://www.eegspectrum.com/

[Good example of a commercial use of EEG biofeedback, plus lots of links to a number of other sources]

International Journal of Psychophysiology

http://www.hhpub.com/journals/jop

[Take a look at the hot topics and current research in the area of psychophysiology.]

The Psychophysiology WWW Directory

http://www.gsu.edu/%7Epsyejv/psyphy.html

[A great directory of links to sites concerning worldwide research and findings in the field of psychophysiology.]

Statistics Follow-up on Play Lab

Dana Gross

There are three kinds of lies: lies, damned lies, and statistics.
--Disraeli

Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write.
--H. G. Wells

Introduction

In your group's study of children's play, you used event sampling to record the occurrence of a particular behavior. The results of the event sampling tell you the total number of behaviors that occurred. While you were collecting your data, you may have noticed differences between your two groups. In this lab you will learn about descriptive statistics -- techniques for examining patterns and relationships in your data, and examining and comparing distributions. You will also discover how the variation of your data, the number of subjects you have, and the presence of outliers can affect these patterns and distributions. Finally, your group will plot your findings graphically and present your results as a poster.

StatView (the computer program you will use) enables you to determine (a) an overall arithmetic mean for the play behavior you focused on and (b) the means for each of your two groups (younger vs. older children or boys vs. girls). It will also give you an indication of the variability within each group.

Objectives

- To learn about the arithmetic mean and the indications of variability associated with it
- To analyze the data you have collected in your observational study of children's play behavior
- To use StatView to create a data file and compute descriptive statistics
- To use StatView to learn about techniques for graphically plotting data
- To develop a strategy for sharing the results of your observational study of children's play in a poster

Terms

Box plot

Cell bar plot

Data file

Descriptive statistics

Histogram

Mean

Median

Mode

Normal distribution

Outlier

Quartile

Range

Scattergram

Standard deviation

Variability

Methods

Materials

Data sheet used to record observations (1 per research team)
StatView statistics program
Computer disk (1 per research team)
Statistics Video "Why Use Statistics? Describing Data"

Note: It is important to bring your own disk to save your results from this lab

PART 1
Statistics Video, "Why Use Statistics?: Describing Data"

This video should solidify the concepts of the arithmetic mean, standard deviation, and a normal distribution that were introduced in lecture and covered in Peter Gray's *Psychology*, A1-A9.

CT	**The data from your Play Project are quantitative. Suggest a way to gather qualitative data for the Play Project, using the same general topic you chose.**

PART 2
Descriptive Statistics Using Play Project Data

Procedure

Opening StatView

1. The StatView program is located in the Psychology space in Sven. (To get to Sven, select the Chooser from the Apple menu. Select Software Servers and choose Sven.

You will need to type in your email user name and password. After doing this, find the Sven.MAIN icon on your computer's desktop and open it up. Within the Shared Spaces folder, open the Psychology folder.)

2. Within the Psychology folder , you can reach StatView by opening the following folders: (1) Applications, and (2) Statistics.
3. After you open the Statistics folder, launch the StatView program by double-clicking on the multi-colored StatView alias icon. (Be patient; it takes a while to load.)

Creating a Data File

Data files in StatView look like Charts A and B, which are shown below. The first sample data file shows how data for a study of age differences in pretend play would be organized. The second sample shows how data for a study of gender differences in pretend play would be organized. In both sample data files, the independent variable (either Age or Gender) is recorded in one column and the dependent variable (pretend play) is recorded in the other column. If you follow the steps below, the data file your group creates today should look like these data files.

	Age	Pretend Play	Input Column
1	Younger	4.000	
2	Younger	4.000	
3	Younger	5.000	
4	Younger	7.000	
5	Younger	7.000	
6	Younger	9.000	
7	Younger	8.000	
8	Younger	8.000	
9	Younger	9.000	
10	Younger	7.000	
11	Older	3.000	
12	Older	2.000	
13	Older	1.000	
14	Older	4.000	
15	Older	2.000	
16	Older	2.000	
17	Older	2.000	
18	Older	5.000	
19	Older	0.000	
20	Older	3.000	

Chart A

	Gender	Petend Play	Input Column
1	Boys	8.000	
2	Boys	9.000	
3	Boys	4.000	
4	Boys	7.000	
5	Boys	8.000	
6	Boys	8.000	
7	Boys	4.000	
8	Boys	6.000	
9	Boys	6.000	
10	Boys	8.000	
11	Girls	3.000	
12	Girls	4.000	
13	Girls	3.000	
14	Girls	4.000	
15	Girls	4.000	
16	Girls	4.000	
17	Girls	2.000	
18	Girls	1.000	
19	Girls	0.000	
20	Girls	5.000	

Chart B

- After opening the StatView program, choose the New option from the File menu. Untitled Dataset #1 appears on your screen, providing you with one column in which to enter your data.
- Move the cursor arrow to the words Input Column, click, and then type the name of your group (Age OR Gender).
- The title you have just typed appears at the top of the column. A new input column appears to the right of the column you have just labeled.
- In the second input column, type the name of the play behavior your group observed. (Put the arrow on Input Column, click, and type.)
- It is now time to enter your data. (Note: An empty input column appears to the right of your last data column. Disregard this empty column.)

Preparing for Data Entry

4. Before entering your data, you need to specify the type of data being entered. The default setting is real, which is appropriate for your second data column (i.e., the play behavior you observed). The first data column, however, needs to be changed to category data.
5. To do this, move the cursor to the box where the word real appears.
6. Hold down the mouse button and move the cursor arrow to the word category when it appears.
7. When you do this, a new box called Choose Category appears.
8. Choose the New button to label the first data column category.
9. An Edit Category dialog box will appear. In the box titled Group Label, type in the name of one half of your group. (For example, if your grouping variable is Age, type in "Younger.") Then choose the Add button or just hit return.

10. Then type in the name of the other half of your group. (In this example, type in "Older.") Then choose the Add button (or just hit return) again.
11. Now select the Done button and StatView returns you to the data file.

Entering Your Data

4. You are now ready to enter the data you collected. Refer to the sample data file in this handout.
5. At the lower edge of your dataset, you will see a shaded row. This is where you enter subject data. More shaded rows will appear as you enter data.
6. For each child you observed, you need to enter the data you obtained on his/her (a) group category (Age OR Gender) and (b) number of target play behaviors he/she exhibited. (If the child did not exhibit the behavior, you should enter 0.) Click the shaded cell in the column (e.g., the Age column) where you wish to enter data. Type the category (e.g., "y" for "younger").
7. When you have entered the data for all the children in your sample, you are ready to perform the analysis of your data.
8. Save your data file and the results you obtain on your disk.

Descriptive Statistics

Describing Your Data Numerically

Descriptive statistics are a numerical summary of the data in your data file. Descriptive statistics fall into three categories:

• measures of central tendency, which give an idea of the average value of a number or other quantity (e.g., mean, median, mode)

• measures of variability, which convey whether most measurements are clustered within a narrow range of values or spread over a large range (e.g., minimum, maximum, range, variance, standard deviation)

• measures of an overall distribution property indicated by a single number (e.g., skewness, kurtosis)

For the play project, you will focus on the first two of these categories -- measures of central tendency and measures of variability.

Example of descriptive statistics for Age

The descriptive statistics show that the overall mean (combining younger and older children) for pretend play was 4.60. The standard deviation and standard error are measures of variability around the mean. The count is the number of children in the data file, in this case 20 children. The minimum (0) and the maximum (9) show the range of pretend play behaviors observed. The # missing (0) shows that there are no missing data in the data file.

Descriptive Statistics

	Pretend Play
Mean	4.600
Std. Dev.	2.780
Std. Error	.622
Count	20
Minimum	0.000
Maximum	9.000
# Missing	0

Example of descriptive statistics for Gender

The descriptive statistics show that the overall mean (combining boys and girls) for pretend play was 4.90. The standard deviation and standard error are measures of variability around the mean. The count is the number of children in the data file. The minimum (0) and maximum (9) show the range of pretend play behaviors observed. The # missing (0) shows that there are no missing data in the data file.

Descriptive Statistics

	Pretend Play
Mean	4.900
Std. Dev.	2.532
Std. Error	.566
Count	20
Minimum	0.000
Maximum	9.000
# Missing	0

1. To compute descriptive statistics for your entire sample, select the Analyze menu and choose the option called Descriptive Statistics.
2. A box appears asking you to select a variable to be described.
3. In the right-hand box, your variables are listed. Choose (double click) the dependent variable, and then click OK or just hit return.
4. StatView creates a new Untitled View containing your descriptive statistics.
5. Print a copy of this view for each member of your group and save it on your disk.

Fill in the blanks in the tables below with information from your group's data.

Descriptive Statistics

	Play Behavior
Mean	
Std. Dev.	
Std. Error	
Count	
Minimum	
Maximum	
# Missing	

CT **Observe the descriptive statistics for your study. Are you surprised by what you see, or does it confirm your expectations?**

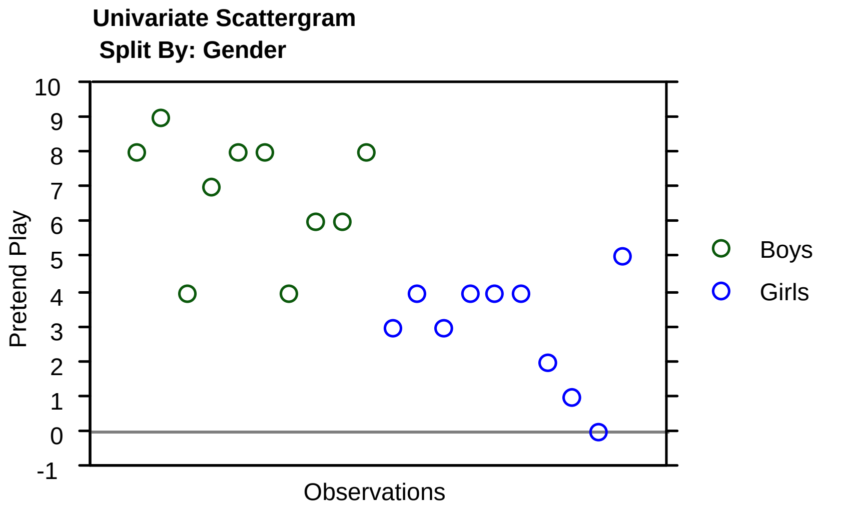
PART 3
Plots of Data

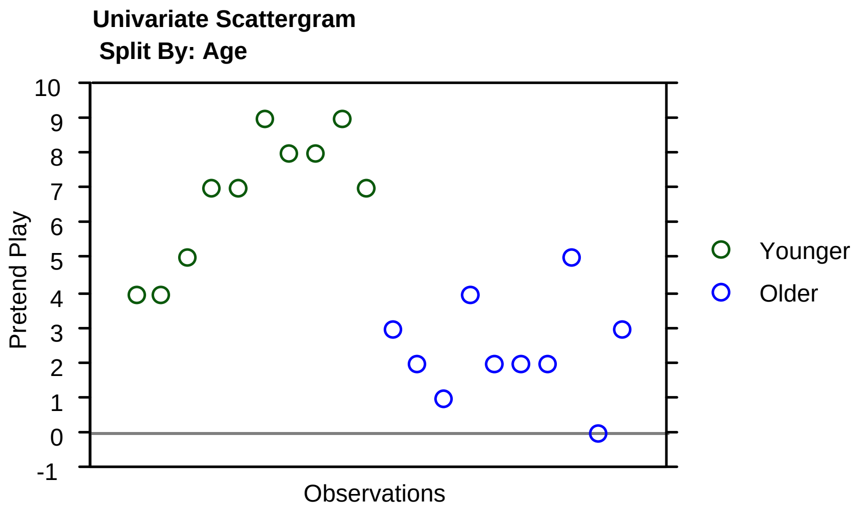
Describing Your Data Graphically
Plots provide an effective way of looking at data to complement a numerical analysis. They allow you to see patterns and relationships among variables, spot outliers (extreme scores), examine and compare distributions of groups, and help you check assumptions about your data. Plots also offer a graphic way of presenting your analysis results, which aids you in communicating information about your data to others. Print out copies of your graphs and save them on your disc.

Graph 1: Univariate Plot
Univariate plots show the distribution of a variable in a one-dimensional plot with a single numeric axis, the Y-axis. Each observation is plotted along the horizontal axis in the sequence the data appears in the dataset. In StatView, you can display the observations as points in a scattergram, as points connected by lines in a line chart, or as bars in a bar chart. You can also distinguish different groups (e.g., boys vs. girls) in the plot.

To create a univariate plot of your data:
1. Select Graphs from the Analyze menu; then choose the option called Univariate Scattergram.
2. When the Univariate Plot box appears, select the dependent variable (the play behavior you studied).
3. Split the scattergram by your grouping variable by selecting the independent variable (either Gender or Age). Click OK. The two different groups should be

distinguished by different plotting symbols on the scattergram. Your graph should look like the examples below.





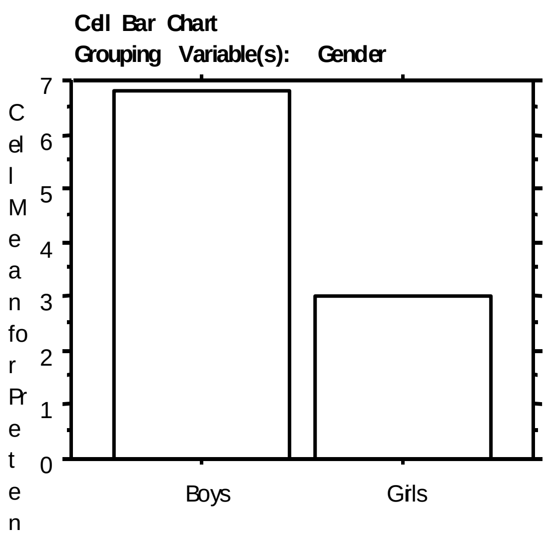
CT	**Do the distributions for each of your groups seem to be similar or different from each other?**

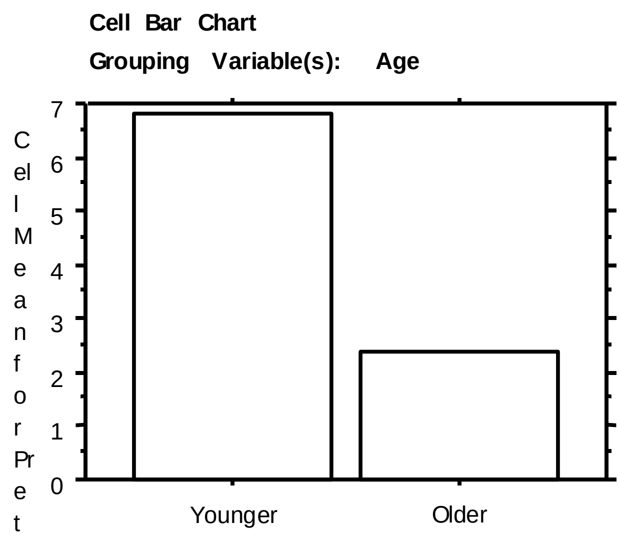
Graph 2: Cell Bar Chart

An easy way to plot and compare data for two groups (e.g., boys vs. girls) is to construct a bar chart. In a bar chart each group is represented by a bar with a height equal in magnitude to some measure of that variable. One of the most effective measurements in event sampling is the mean.

To construct a bar chart for your data make sure your view window for analyzing data is open. This is the same window in which you performed your descriptive statistics.

1. In the left-hand column, scroll down until you see Cell Plots. Click on the arrow to bring down the menu.
2. Double click on the Bar Chart option.
3. When the Cell Plot dialog box appears, click OK.
4. In your variable browser box, select your grouping or nominal variable (Age or Gender) and then click Add.
5. Then, in your variable browser box, select your play behavior or continuous variable and then click Add.
6. Your bar graph should then be complete. It should look similar to the examples below.





CT	**Does the cell bar chart for your data seem to support your interpretation of the univariate plot?**

Graph 3: Histogram

Histograms are a way of showing the distribution of data in comparison to the normal curve. The abscissa is divided into multiple numerical classes of increasing magnitude. Over each class, a bar appears equal in height to the frequency of that class. Histograms are an effective way to notice outliers.

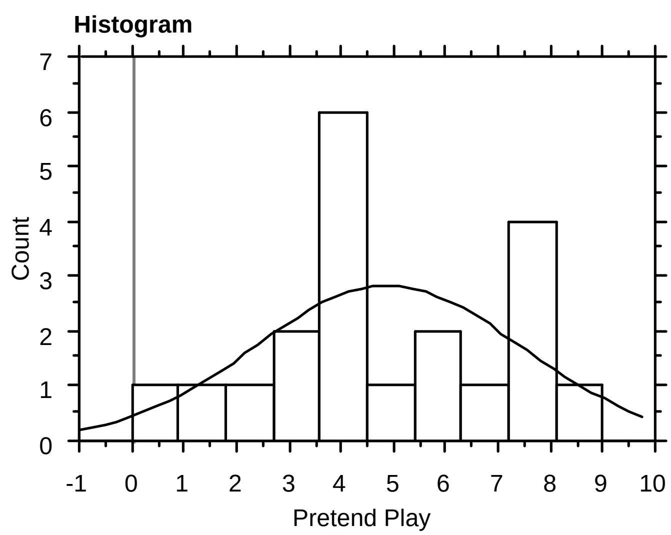
To construct a histogram for your data, make sure your view window for analyzing data is open. This is the same window you used to construct your bar graph.

1. In the left-hand column, scroll down to Frequency Distribution and click on the arrow to see the drop down menu.
2. Double click on Histogram.

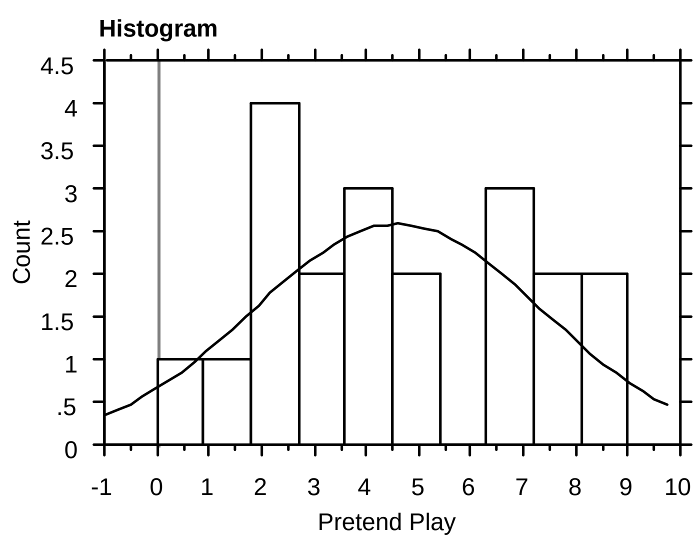
3. When the Frequency Distribution dialog box appears, make the following changes:
    a) in the box labeled Number of Intervals, enter the maximum number of events any child had, regardless of which of your two groups they belonged too.
    b) Click on the gray box labeled Show Normal Comparison. A check should appear.
    c) Click OK.

4. You should see an incomplete box on your screen.
5. In your variable browser box, select your continuous (play behavior) variable and then click Add.
6. Your graph should appear, along with the normal curve. It should be similar to the examples below.

Age:



Gender:



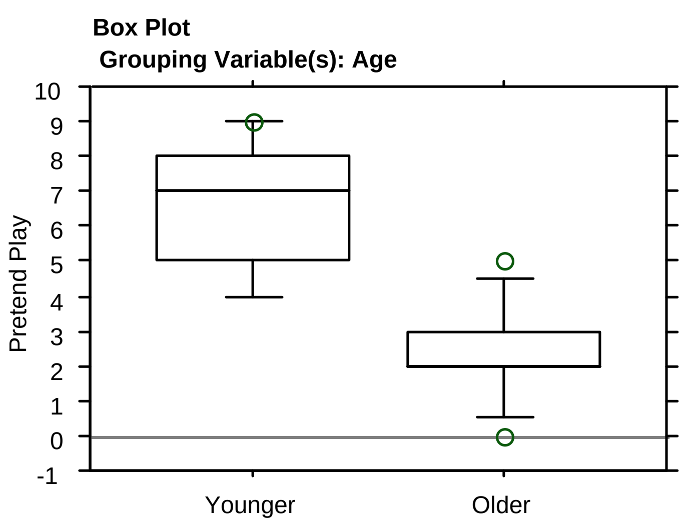
CT	**Based on the histogram for your data, does the play behavior you observed appear to be normally distributed?**

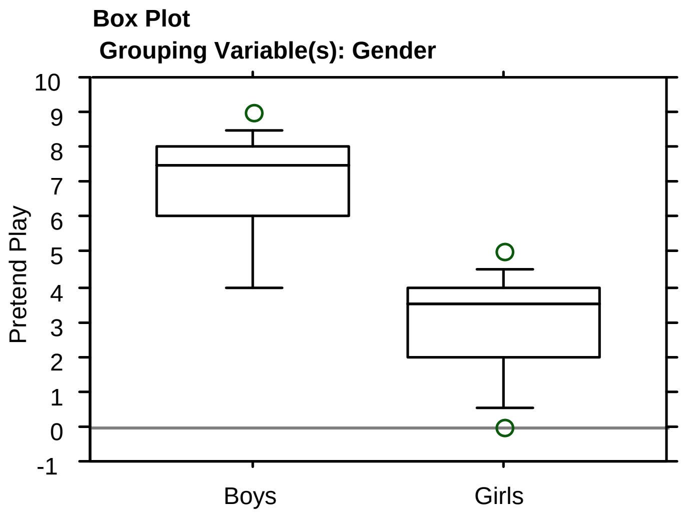
Graph 4: Box Plot

Data that contain outliers may be measured more effectively by the median and its respective tests, than by the mean. A box plot measures the distribution of the data based on the median rather than the mean. The bar within the box represents the median while the edges of the box represent the quartiles. The lines outside of the box, at the edge of the figure, measure the spread.

To construct your own box plot:

1. From the Analyze Menus, choose Graphs, then Box Plot.
2. In your variable browser box, select your continuous (play behavior) variable.
3. Next select your nominal (grouping) variable for the axis variable. Click OK.
4. Your graph should now have two box plots on it, one for each of your groups. It should be similar to the examples below.





Part 4
The Effects of Fluctuations in Data

Statistical results are greatly affected by several characteristics of the data. These characteristics include: 1) sample size 2) standard deviation and 3) the presence of data points that differ drastically from the mean (outliers). We will manipulate these three characteristics to test their effect on your results. NOTE: **This is simply an investigation of the mechanics behind data distributions. It is never acceptable to alter scientifically derived data in order to obtain significance.**

Record the necessary data and answers in your lab notebook. Print out copies of your graphs and results and save them on your disc.

Experiment 1: Altering the sample size

Start a new table of data. Pretend every child you studied is one of three children who all behaved in exactly the same manner. Therefore, for every one data point you originally had, you now have three. For example if you had the original data points:

1,4,3,2,5,4,3,4,5,3,2 (so the first child had 1 event, the second child had 4, etc.), your new data points would be:

1,1,1,4,4,4,3,3,3,2,2,2,5,5,5,4,4,4,3,3,3,4,4,4,5,5,5,3,3,3,2,2,2 (so now the first **three** children had 1 event, the next **three** had 4 events, etc.)

Using these new, altered data, repeat the descriptive statistics and the plots you created with your actual data.

CT	**What do you notice about the mean and the variability? Are they the same or different as before?**

CT	**How do the graphical representations compare to those derived from your original data?**

Experiment 2: Increasing the standard deviation

As shown in the statistics video, standard deviation measures how far values lie from the mean in a distribution. It is calculated using the following equation:

$$S=\sqrt{1/(n-1)\,\Sigma\,(x_1 - x)^2}$$

For each subject in your study, square the number of events recorded. For example, if subject one had three events originally, he / she would now have nine events (3^2).

Do this for all subjects and run your descriptive statistics and plots again.

CT	**What was the effect on your descriptive statistics?**

CT	**How do these graphical representations compare to those derived from your original data?**

Experiment 3: Outlier Exercise

1. Identify which of your two groups had the larger mean. Add 3 subjects to that group. These three "new" subjects should each have zero behavioral events.

Repeat the descriptive statistics and the plots with this new data set.

CT	**What effect did this have on your data?**

CT	**How do these graphical representations compare to those derived from your original data?**

2. Instead of adding three new subjects with values of zero, now add one subject who has 40 events.

Repeat your descriptive statistics and the plots again

CT	**What effect did this value have on your data?**

CT	**How do these graphical representations compare to those derived from your original data?**

Results

In APA-style research reports, results of statistical analyses appear in the Results section. Your poster should include numerical descriptions of your findings: the arithmetic mean, standard deviation, and the range of the data. Your poster should also include two graphic descriptions of your results: the cell bar chart and one of the other graphs (your group can choose the second graph of its choice).

Sharing the results

When sharing the results of investigative research, the outcomes of statistical analyses are always presented within a context. As a result of reading journal articles throughout the semester, you know that psychologists follow conventions of APA style when presenting the context for their findings. Information in APA-style publications is organized into a number of distinct sections: abstract, introduction, method, results, discussion, and references. These conventions are also used in posters reporting the results of empirical studies. Your group's objective during the remainder of this lab is to determine how you will present the results of your study in a poster.

Six Basic Steps for an Effective Poster Presentation

1. Define your audience
   To ensure that your poster communicates as effectively as possible, it is important to understand who your audience is. Consider that the audience
   - may not be as familiar with your topic as you are
   - must be drawn in with your key findings
   - has only a short time to look at your poster

2. Gather the content for your poster
   Divide the information you have gathered into the following sections:
   - Title: name of project/poster, contributors, name of class, college
   - Introduction: description of the topic, relevant previous research (cite the author(s) and year of publication), hypothesis, operational definition
   - Method: **brief** description of the process (use separate subheadings for: participants, materials, and procedure) Make sure that your poster has a "Method" label for this section.
   - Results: summary descriptive statistics and plots of your data (Do <u>not</u> include the raw data file from your study.) For <u>each group</u> you studied, your poster should include the arithmetic mean, standard deviation, and the range of the data. Include your <u>cell bar chart</u> and <u>one of the other graphs</u> (your group is free

to choose which of the other graphs to include). You **should not** interpret your results or explain what they imply—just state what they are. Make sure that your poster has a "Results" label for this section. In addition, graphs and figures need to be labeled; be sure to label both axes on all graphs.

- Discussion: interpretation and discussion of key results, a few easily remembered conclusions, topics for additional research, possible sources of error. Relate your findings to the research described in the Introduction by making explicit comparisons. Cite sources using APA style: author(s) and year of publication. Make sure that your poster has a "Discussion" label for this section.
- References: references for cited material in APA style. Make sure that your poster has a "References" label for this section.

Note: The posters will be graded by both preceptors from your section (A or B) and the four faculty members responsible for running the labs. In addition to the content, be thoughtful about the overall presentation -- neatness, readability, clarity, balance, and aesthetics!

3. Make a heading and statement for each section. Take each of the sections and summarize its content. Each section should be divided into three categories.
   - Heading: title
   - Statement: clear and succinct text relating to the heading
   - Support material: documentation, photographs, maps, diagrams, charts, illustrations, etc.

4. Eliminate noise

   After making the first draft of the poster, significant editing will probably be needed.
   - Think about what will be most interesting to your fellow researchers.
   - Pare down the detail, eliminating all but the vital elements.
   - Reduce your information to brief, legible statements--EVERYTHING should be legible from 3 feet away!
   - Use supporting material to encourage and facilitate understanding.

5. Find your focus

   Because your audience has limited time to view your poster, ask yourself about the main points you would want the observer to come away with. There may be extra information you would like to have available; you can put together a sheet of more in-depth descriptions for those interested.

6. Put the poster together.

Discussion Questions

1. Based on the previous exercises, what three factors affect statistical outcomes? Which factor most prominently affected your data? How would you control for this if you were to repeat your study?

2. Which graphic representation do you find most informative? Explain why you prefer this one to the others.

References

Required Lab Reading

Paulos, J. A. (1990). Pseudoscience. In *Innumeracy: Mathematical illiteracy and its consequences* (pp. 49-71). New York: Vintage.

Suggested Readings

Gonick, L., Smith, W., and Smith, W. (1993). *The cartoon guide to statistics.* New York: HarperCollins. [These inspired cartoons simplify the confusing concepts of statistics.]

Huff, D., & Geis, I. (1993). *How to lie with statistics.* New York: Norton. [This 1954 classic, which has been reissued, informs the statistically naive about the way advertisers, government, and the media can mislead their audiences through the misuse of statistics.]

Paulos, J. A. (1990). *Innumeracy: Mathematical illiteracy and its consequences.* New York: Vintage. [Paulos examines many aspects of popular culture, from stock scams and newspaper psychics to diet and medical claims to demonstrate the popular misconceptions resulting from the inability to deal with large numbers, probability, and ratios.]

Paulos, J. A. (1996). *A mathematician reads the newspaper.* New York: Anchor. [This humorous book reveals the hidden mathematical angles in media stories.]

http://www.stats.org/ Statistical Assessment Service. [The Statistical Assessment Service (STATS) is a non-partisan, non-profit research organization in Washington, D.C. STATS is devoted to the accurate use of scientific and social research in public policy debate. STATS serves as a resource for journalists by providing timely and well-researched analysis of current statistical and scientific disputes.]

Sensation and Perception: Illusions

Bonnie S. Sherman

Introduction

Illusions are a function of our neuroanatomy and physiology. They are real; we see them, feel them, and / or hear them. The largest visual illusion that has been created in the United States is in St. Louis, Missouri. The St. Louis Arch, which stretches over downtown St. Louis, is as wide as it is high. However, even after measuring the height and width and "seeing" that these dimensions are the same, the height of the arch still "looks" greater than the width. The illusion persists in spite of knowledge. It is as if one part of the mind is unable to use the information that arises in another part.

"Certainty of knowledge" may be a cognitive illusion, just as the St. Louis Arch is a visual illusion.

Objectives

- to examine illusions
- to define an illusion, noting that illusions can be auditory or tactile as well as visual
- to measure an illusion
- to investigate the extent to which we can control our response to an illusion

Terms

Vase-face (figure-ground)

Escher drawings (figure-ground)

Ponzo illusion

Müller-Lyer illusion

Garbage can illusion (also known as the vertical-horizontal illusion)

Disappearing prong

Illusory cube

Illusory contours

Poggendorf illusion

Irradiation illusion

Twisted cord illusion

Zöllner illusion

MacKay effect

Pitch paradox

Cognitive illusion

McGurk effect

PART 1
Illusion Slides

CT

What is an illusion?

CT

In what way(s) might you categorize different illusions?

CT

Can you measure an illusion? If not, why not? If so, how would you measure it? What would the measurement mean?

PART 2
Investigation of the Müller-Lyer or Garbage Can Illusion

Method

Materials

Illusion boards portray the Müller-Lyer and garbage can illusions. One line present on a sliding strip of wood can be adjusted until the two lines appear to be the same length. On the reverse side of the board, a scale in centimeters (cm) permits measurement of the physical degree and of the direction from equality.

Procedure

Create a hypothesis that suggests the following:

1. which type of line will be perceived as longer AND/OR
2. whether repeated trials will affect the amount of error AND/OR
3. whether you are measuring the degree to which you normally experience an illusion or the degree to which you can compensate for it

Plan your group's procedure so you answer your hypothesis. Work in teams of three persons, rotating so each person plays each of the three roles. Choose the illusion with which you would like to experiment.

- Researcher A will create a list of different lengths for presentation and will manipulate the apparatus as described below.
- Researcher B will be the participant.
- Researcher C will record the data and compute the average error.

Before beginning the experiment, Researcher A determines five starting points for the presentation of the illusion. Those starting points are recorded in four different orders, for a total of 20 points. To begin the trials, Researcher A adjusts the movable line to the first of the five predetermined starting points.

Researcher B sits before the apparatus. Researcher B's job is to adjust the apparatus until the lines are perceived to be equal (that is, until they look equal). Researcher B should make adjustments until the lines look the same; after he / she has removed hands from the apparatus, the apparatus should be left as it is. Or Researcher B may make the adjustment, sit back and reconsider, and then make finer adjustments if desired. Researcher B should determine his / her criterion for adjusting the apparatus and use the same criterion for all 20 settings.

Researcher C records the amount of error (to the nearest 0.1 cm). This is determined by reading the sliding scale on the back of the apparatus. The magnitude of the error should be noted as being "positive" (+) or "negative" (-).

At no point does one researcher give information to another. Researcher B sets the apparatus for each trial, but is not given any feedback as to performance--no smile, laugh, or nod should reveal how accurate or inaccurate the measurement is.

After completing the first set of five, repeat the procedure three more times using the different orders of the same five starting points which Researcher A has listed. Now rotate and repeat the procedure so each group member performs each role at least once. When finished, you may share your data with each other.

Interview each researcher to see what he / she did while playing the role of the participant. How did he / she decide where to place the sliding board? Note differences in the group.

Researcher A:

Researcher B:

Researcher C:

Compute the average error, using absolute values, for each researcher and share your tabulated results with the instructor and preceptor, and then finally with the other four groups in the laboratory.

CT	**Did you measure the illusion, or did you measure how well you could compensate for the illusion?** **When you were the participant, did you maintain your criterion throughout the measurement sequence?**

PART 3
Making an Illusion

Now that you have been exposed to several different types of illusions, move back into your groups of three and create your own illusion. It can be cognitive, auditory, or visual. Be inventive.

PART 4
Video

This video presents some of the illusions developed by M. C. Escher (1898-1972). As you watch the illusions unfold in the video, pay attention to the different techniques he is using to create illusions. For example, does he use a figure-ground technique? Are any of the techniques you saw in the initial slide presentation evident here?

Discussion Questions

1. Provide additional examples of illusions.

2. List and comment on questions you had before, during, or after the lab. Make them into testable hypotheses.

3. Is there value in an illusion? How might an illusion be selected by natural selection?

4. To what extent does perception reflect reality?

References

Required Lab Reading

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1977). Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology:*

Human Perception and Performance, 3(4), 552-564.

Optical illusions
http://home.wanadoo.nl/hans.kuiper/optillus.htm
[Hans Kuiper's web pages show some of the optical illusions shown in lab, plus a number of new ones such as the Regibald Neal's Illusions and the optical illusions of three-in-one comprising Neal's illusions, the Zöllner illusions, and the Poggendorff-effect all in one frame.]

Suggested Readings

Piattelli-Palmarini, M. (1994). *Inevitable illusions* (M. Piattelli-Palmarini & K. Botsford, Trans.). New York: John Wiley & Sons. [Piattelli-Palmarini talks about "tunnel vision," cognitive situations that play tricks on us; "they play the same trick on everyone, and *each time in exactly the same way*" (p. ix). He begins with geographical illusions, such as the common thought that Reno, Nevada, is to the east of Los Angeles. After showing many other cognitive illusions, he ends with "a super-tunnel," in which even the "best trained minds get trapped" (p. 161).]

Hoots, R. A. (1993, December). Motion illusions. *The Science Teacher,* 16-21. [This article gives templates for making a number of motion illusions: paper movies, spinning illusions, Fechner's colors, and a magic lift box in which a person appears to walk on air.]

Porac, C. (1994). Decrement and the illusions of the Müller-Lyer figure. *Perceptual and Motor Skills, 79,* 707-717. [Clare Porac explores decrement in the Müller-Lyer illusions, a systemic, time-related reduction in the illusion's magnitude. Although she finds this in the "wings-out" variant for a number of subjects, she does not find it for all, and she finds almost no decrement in the "wings-in" variants. What causes the decrement process?]

References for Illusions Slides

Coren, S., & Girgus, J. S. (1978*). Seeing is deceiving: The psychology of visual illusions.* Hillsdale, NJ: Erlbaum.

Gleitman, H. (1995*). Psychology* (4th ed.). New York: Norton.

Goldstein, E. B. (1994). *Psychology*. Pacific Grove, CA: Brooks/Cole.

Goldstein, E. B. (1996). *Sensation and perception* (4th ed.). New York: Brooks/Cole.

Hanson, N. R. (1961). *Patterns of discovery: An inquiry into the conceptual foundations of science.* London: Cambridge.

Held, R. (1974). *Image, object and illusion: Readings from Scientific American.* Pacific Grove, CA: Freeman.

Levine, M. W., & Shefner, J. M. (1991). *Fundamentals of sensation and perception.* Pacific Grove, CA: Brooks / Cole.

Luckiesh, M. (1965). *Visual illusions: Their causes, characteristics and applications.* New York: Dover.

Myers, D. G. (1995). *Psychology* (4th ed.). New York: Worth.

Pentagram. (1992). *Pentamagic.* New York: Simon and Schuster.

Rock, I. (1984). *Perception.* New York: Scientific American Books.

Roediger, H. L. III, Capaldi, E. D., Paris, S. G., Polivy, J., & Herman, C. P. (1996). *Psychology* (4th ed.). St. Paul, MN: West.

Schattschneider, D. (1990). *Visions of symmetry: Notebooks, periodic drawings, and related work of M. C. Escher.* New York: Freeman.

Schiffman, H. R. (1990). *Sensation and perception: An integrated approach.* New York: John Wiley.

Schiffman, H. R. (1996). *Sensation and perception: An integrated approach.* New York: John Wiley.

Tolansky, S. (1964). *Optical illusions.* Oxford: Pergamon Press.

Web Link

Illusionism

http: / / abstract-art.com / ron_davis /

[This is Ron Davis' artwork in a variety of media from watercolor to 3-D plastic forms. He quotes his son's statement, "When the illusion is lost, the art is hard to find." Note the term illusionism.]

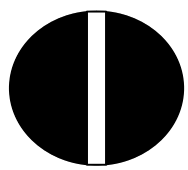
Animal Learning

James Dickson

Introduction

Any psychological theory that aspires to comprehensiveness must be able to account for stimulus control. It is nearly impossible to think of an example of behavior that is reinforced all the time, under all circumstances. The law of effect may tell us how organisms learn *what* to do, what behavior is effective. However, it is equally important that we know *when* to engage in a particular behavior. As described in lecture, a discriminative stimulus is used as a cue in operant conditioning. The cue is present when a particular behavior will be reinforced, and is absent when it will not be reinforced.

In the present experiment, we will examine the behavioral effects of reinforcing a pigeon to peck a response key illuminated by a particular discriminative stimulus (in this study, a 90^0 line angle). We would expect the pigeon would respond vigorously to stimuli that are similar to the 90^0 training stimulus (S^D), and less and less to stimuli as they become less and less similar to the 90^0.



A “90^0 line angle”

Objectives

? to explore how animals differentiate between different visual cues
? to introduce the concepts of stimulus generalization and discrimination (the “two faces” of stimulus control)
? to introduce the use of animals as research subjects
? to investigate a procedure that has been used for measuring animal behavior
? to examine the extent to which findings obtained in the laboratory with infrahuman subjects can be generalized to humans and other species

Terms

absolute generalization slope

ad-libitum weight

continuous reinforcement (CRF)

extinction

generalization gradient

law of effect

operant conditioning

orthogonal dimension

randomized blocks

relative generalization slope

replicate

response strength

response-reinforcer association

S^D

serial position

stimulus control

stimulus-response association

VI (variable interval) schedule of reinforcement

VR (variable ratio) schedule of reinforcement

Methods

Subject

The subject for this experiment will be a laboratory pigeon from the St. Olaf pigeon colony. The subject will be maintained at 80% of its “ad libitum” weight.

Apparatus

We will use a standard pigeon chamber with associated automatic programming and recording equipment. The chamber is equipped with a display cell that presents the stimuli on a translucent pecking key. The stimulus is a white line 3.2 mm wide by 22.2 mm high that can be projected with a dark background in orientations ranging from 0^0 (horizontal) to 90^0 (vertical) in 15^0 increments. The response key will provide the only source of light in the chamber, with the exception of illumination of the food magazine during reinforcement periods.

Procedure

The procedure will be replicated seven (7) times, reestablishing pecking to the 90^0 line angle and then presenting each line angle in a different specified order for a 30 second extinction period. Over the seven replications, each stimulus will be presented once in each serial position (e.g., the 75^0 angle will be first in one extinction period, second once, third once, etc.). Each row in the data sheet identifies one "replication".

SPECIFIC PROCEDURE

Weigh your bird, check all apparatus, and set the 90^0 line angle on the response key.

First Conditioning Trial: To recondition the pecking, give 5 continuous reinforcements (CRFs) and then give six (6) reinforcements on the following variable ratio (VR) schedule: 1, 5, 10, 20, 9, 15. (This means that the following responses will be reinforced: 1, 6, 16, 36, 45, 60.)

First Extinction Trial: Present each of the line angles in turn for 30 seconds, reading across the table for the order of presentation. Count the number of responses emitted to each line angle, and record the number in the appropriate box in the table. Specifically, at the end of each 30-second trial, the total number of responses through that trial will be called out. You are to enter this number in the appropriate cell in your data sheet.

After each line angle has been presented for 30 seconds, return the 90^0 line angle to the key for the next reconditioning trial.

Subsequent Reconditioning Trials: Again, extinguish pecking in the presence of each intensity for 30 seconds, presenting the line angles in the order given in the next row of the table.

Repeat this procedure 7 times, once for each row of the table. If you started in the middle of the table proceed to the end of the table, then go to the beginning and continue until you reach the row where you started. You will then have presented each line angle 8 times in extinction, once in each serial position.

After completing all 7 extinction trials, remove your bird from the experimental box, weigh it, and feed it up to 80 percent ad libitum weight if it is below that weight.

Analysis of the Data: Compute the following for the experimental subject:

1. Absolute generalization gradient
   a. First two test blocks
   b. Last two test blocks
   c. Entire test

      To calculate the <u>absolute generalization gradient,</u> you will need to determine the number of responses made to each stimulus during the generalization test. Do this by subtracting the total number of responses made to each stimulus through the previous trial from the total number of responses made to each stimulus through the trial in question. The "first two test blocks" calculation is made from the row in the data sheet where you started the test and the row that follows. The rows that enter into the "last two test blocks" calculation will be the last two rows of your test. The "entire test" calculation involves the entire data sheet. For this test, add together all of the responses for a particular stimulus.

For the "entire test" gradient you will plot number of responses on the y-axis (ordinate) against line angle on the x-axis (abscissa).

2. Relative generalization gradient
   a. First two test blocks
   b. Last two test blocks
   c. Entire test

   To calculate the <u>relative generalization gradient</u>, you will need to determine the total number of responses made in the data set in question (i.e., first two test blocks, last two test blocks, entire test), and then figure the percent of that total made to each of the test stimuli. For example, if 245 responses were made during the entire test and 44 of these were made to 45^0, the percent figure to 45^0 would be 18%.

   Enter the results of your "entire test" absolute and relative generalization gradient calculations on the graph sheets at the end of this exercise. Be sure to label and scale the axes as needed. You should also put a title on your figures.

<u>CT</u>	**How can we determine if a particular stimulus is controlling behavior?**

<u>CT</u>	**What conclusions can we reach about stimulus control if the generalization gradient is "flat"? if it is "peaked" around the S^D?**

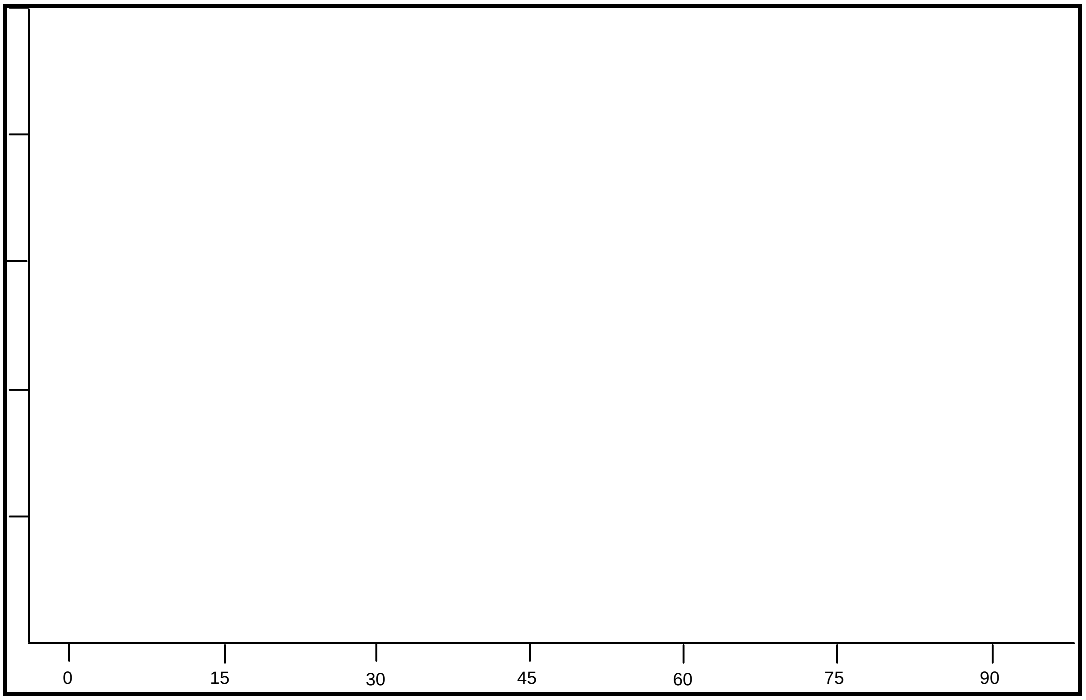
<u>CT</u>	**Why did you calculate both absolute and relative generalization gradients? As you think about the answer to this question consider which analysis might be appropriate if we were to work with a group of subjects, not just one pigeon.**

DATA SHEET, GENERALIZATION GRADIENT

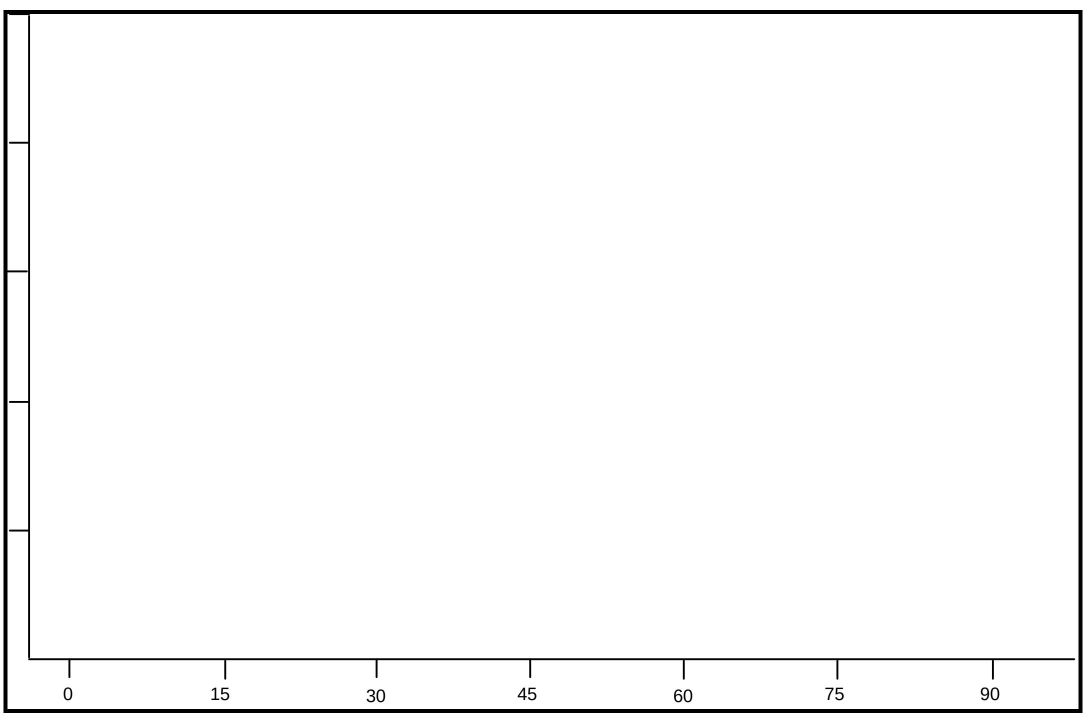
Order of Presentation of line angles during extinction trials.

LEARNING ($S^D=90^0$)	GENERALIZATION TEST (EXTINCTION)						
Block 1 VR 1, 5, 10, 20, 9, 15	0^0	30^0	90^0	45^0	75^0	15^0	60^0
Block 2 VR 1, 5, 10, 20, 9, 15	30^0	0^0	60^0	90^0	45^0	75^0	15^0
Block 3 VR 1, 5, 10, 20, 9, 15	90^0	45^0	0^0	15^0	60^0	30^0	75^0
Block 4 VR 1, 5, 10, 20, 9, 15	45^0	60^0	75^0	0^0	15^0	90^0	30^0
Block 5 VR 1, 5, 10, 20, 9, 15	75^0	15^0	30^0	60^0	90^0	0^0	45^0
Block 6 VR 1, 5, 10, 20, 9, 15	15^0	75^0	45^0	30^0	0^0	60^0	90^0
Block 7 VR 1, 5, 10, 20, 9, 15	60^0	90^0	15^0	75^0	30^0	45^0	0^0

Absolute Generalization Gradient



Relative Generalization Gradient



Discussion Questions

1. What explanations can you develop for the failure of a stimulus to control operant responding?
2. Can you design an experiment to study stimulus control in humans? What differences in procedure would you employ? Why?
3. What would happen to the generalization gradient if a subject were trained to associate extinction (non-reinforcement) with a particular line angle?
4. How would you go about demonstrating that stimulus control is an important property of behavior, not simply an idiosyncratic aspect of behavior in the pigeon?
5. Consider the ethical implications of this research.

References

Required Lab Reading

Guttman, N. & Kalish, H.I. (1966). Experiments in discrimination. In T. Verhave (Ed.), *The Experimental Analysis of Behavior* (pp. 209-216). New York, Appleton-Century-Crofts.

Suggested Readings

Honig, W. K., & K. Urcuioli, P. J. (1981). The legacy of Guttman and Kalish (1956): 25 years of research on stimulus generalization. *Journal of the Experimental Analysis of Behavior, 36*, 405-445.

Schadler, M. & Thomas, D.R. (1972). On the acquisition of dimensional stimulus control by the pigeon. *Journal of Comparative and Physiological Psychology, 79*, 82-89.

Thomas, D. R. (1993). A model for adaptation-level effects on stimulus generalization. *Psychological Review, 100*, 658-673.

Web links

Division for Behavior Analysis, American Psychological Association
http://www.apa.org/divisions/div25/

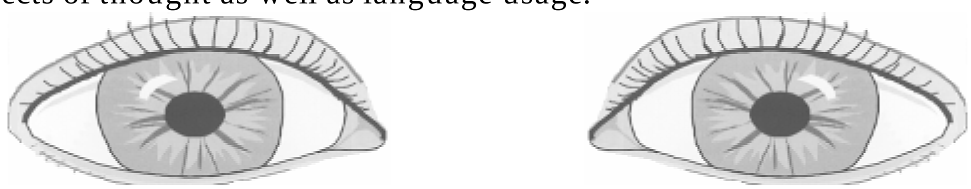
Eyeblinks and Eye Movements in Cognition

Investigations in Thinking and Language

Howard Thorsheim, Mike Mensink, and Sarah Strand

Introduction

Eyeblinks and eye movements provide "windows" through which we can understand many aspects of thought as well as language usage.



Eyeblinks

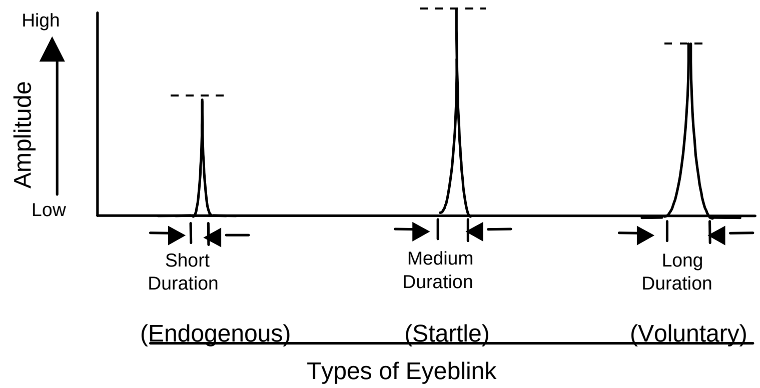
Eyeblinking is achieved through the contraction of sets of muscles called the orbicularis oculi and levator palpebrae superioris (See any anatomy resource). The electrical signal from those muscles, known as the ***electromyogram***, produces a "pulse envelope" that may last for a fraction of a second. Orchard & Stern (1991) identify three types of eyeblinks: (a) ***reflex blinks*** (in response to something invading in the eye), (b) ***voluntary blinks*** (as a result of a decision to blink), and (c) ***endogenous blinks*** (due to perception and information processing). These eyeblinks **{**xe "eyeblinks "**}**are the focus of interesting psychological research.

Reflex blinks are instinctive responses that guard the eyes against airpuffs and dust; they are also part of the startle response to loud noises. The blink reflex can be classically conditioned to a neutral stimulus such as a tone. After several pairings of a tone and airpuff, the tone itself will generate the blink. This has been shown in class demonstrations.

Voluntary blinks include squinting and winking; they are under conscious control. Applications of voluntary blinking include their use as signals for communicating when diseases (such as AIDS, Multiple Sclerosis, Muscular Dystrophy, or Alzheimer's) have made other forms of communication impossible.

Endogenous (meaning "originating from or due to internal causes") blinks occur during reading or speaking and reflect changes of attention and changes in thought processes. The more attention required by a task, the fewer endogenous blinks occur.

The typical duration of eye closure during blinks is 40 to 200 milliseconds (msec.). Useful and important information for distinguishing among the various forms of eyeblinks is provided by the fact that their “pulse envelopes” reliably differ in both duration and amplitude. The pulse envelope is the outer border of the pulse.



Summary

Amplitude	**Type of Blink**
Highest:	Startle blinks
Next highest:	Voluntary blinks
Lowest:	Endogenous blinks

Duration	**Type of Blink**
Short:	Endogenous blinks
Medium:	Startle blinks
Long:	Voluntary blinks

Figure 1. Eyeblink amplitudes and durations

An interesting issue to investigate is the specific instant at which blinks occur during thought and language processing. Research is quite clear that blinks do not occur randomly during reading. Thus, an important and useful question of interest relates to <u>when</u> eyeblinks occur during reading and conversation.

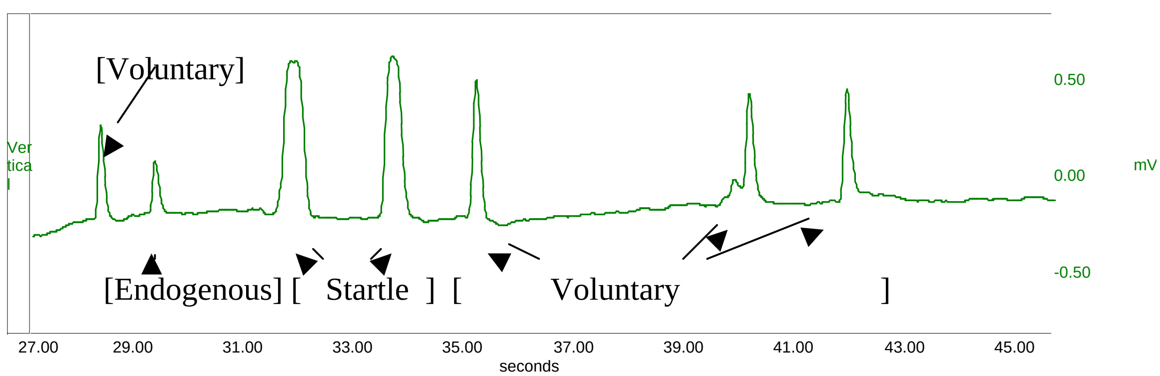


Figure 2. Actual Electrooculogram (EOG) for eyeblinks. . 2. Actual analog EOG for eyeblinks ;. 2. Actual analog EOG for eyeblinks ;{tc "Fig. 2. Actual analog EOG for eyeblinks " \l 1}Sample contains voluntary, endogenous and startle eyeblinks.

CT How could you investigate whether, through their eyeblinks, listeners might reveal something to speakers about their level of attention to what the speaker is saying? For example, how might the blink rate (blinks / minute) serve as a way to monitor the amount of attention someone is paying to a product or to a salesperson? Conversely, how could you use what you know to investigate whether a speaker may signal listeners something about his / her attention level by his / her blink rate? How could this be useful in analyzing the information "tipped off" by TV personalities you see talking or listening? What would you look for? How could you make use of listeners' blink rates?

Eye Movements
The fact that both eyes move and work together is a remarkable achievement, particularly since the two eyes are <u>not connected mechanically</u> in any way! This is in great contrast to the eyes of a toy doll. The doll's eyes are wired together and, thus, move up and down together.

Eye movements are controlled by the brain in conjunction with cranial nerves and eye muscles attached to the exterior of the eyeball called extra-ocular muscles. (Extra in extra-ocular it means “outside of the eye”)**{**xe "extra-ocular muscles"**}**. There are three pairs of extra-ocular muscles that control each eyeball, and the two eyeballs together operate in tandem. More than artifacts of the human neuro-muscular system, current theory and empirical research suggest a key role in cognition for both eye movement and eye blinking. They are implicated in significant ways in the processing of information by the brain. At issue is <u>how</u> they play a role in providing coding information for the brain itself.

Eye movements are produced by extra-ocular muscles that contract, pulling the eye first one way and then another way.

The superior rectus (above the eye) and inferior rectus (below the eye) are extra-ocular muscles that control the up-and-down movement of the eye. The lateral rectus and medial rectus control side-to-side movement. The superior and inferior oblique muscles control the rolling of the eyes.

Efficient readers move their eyes in a rather complex way; they do not simply move their eyes at a constant speed across the page. **Saccades** (see Figure 3) are horizontal (back and forth) or vertical (up and down) movements of the eye that occur when looking out at the world--or when reading; for example, when readers move their eyes from one point of fixation to the next, these movements are called saccades. Movement back to reread a selection on the same line is known as a ***regressive saccade.*** A variation of the regressive saccade is when a person sweeps his or her eyes back to begin reading the next line. When readers stop because they wish to pay attention to a certain portion of the text, this is called a ***fixation pause.*** These saccadic (pronounced sah-cad'-ick) movements and eye pauses can be used to measure many kinds of interesting cognitive processing.

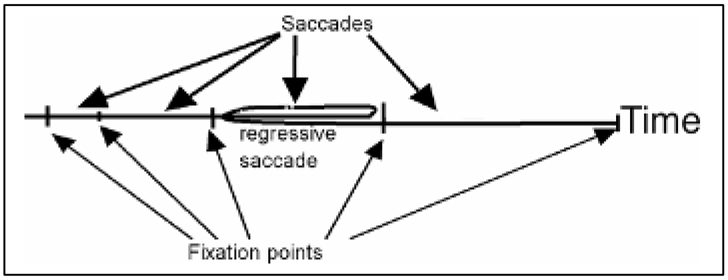


Figure 3. Terms for eye movement during reading

The measurement of eyeball movement during reading and the visual tracking of a target is called *electro-oculography* (EOG)**{**xe "electro-oculography (EOG)"**}**. These EOG signals are created by the fact that the front (anterior) of the eyeball is positive relative to the rear (posterior) of the eyeball, setting up a dipole**{**xe "dipole"**}**, as shown in Figure 4.

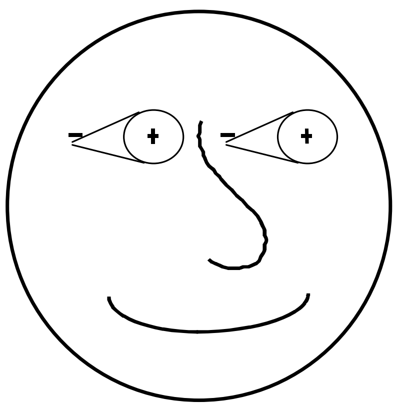


Figure 5. Stylized sketch of typical eye movements during reading three lines of text, as they would be depicted on the electrooculogram (EOG). See if you can identify the other unlabeled parts of the EOG.

Figure 6 shows how to place electrodes above and below the eye to provide information about up and down movement of the eyeball, in addition to eyeblink information.

Figure 6. Electrode Placement

Figure 6 also shows how electrodes placed on the right and left external canthi of the eyes{xe "external canthi of the eyes"} (i.e., the outside or *lateral* location, just next to each eye) will pick up the change in orientation of the +/- dipole of each eye. These electrodes will provide information about saccades, line changes, and fixation points.

In combination, the electrodes provide information about where the eyeball is oriented (direction of gaze) in an X-Y Cartesian coordinate system, as well as about eyeblinks. Electrodes on the sides of the eyes provide information about lateral movement (X-axis) and electrodes placed above and below the eyes provide information about up and down movement (Y-axis) and eyeblinks.

For investigating a number of interesting psychological questions, the EOG may be used as a general research tool to measure direction of gaze, as well as the length of fixation. The typical kind of response one finds is illustrated in Figure 7.

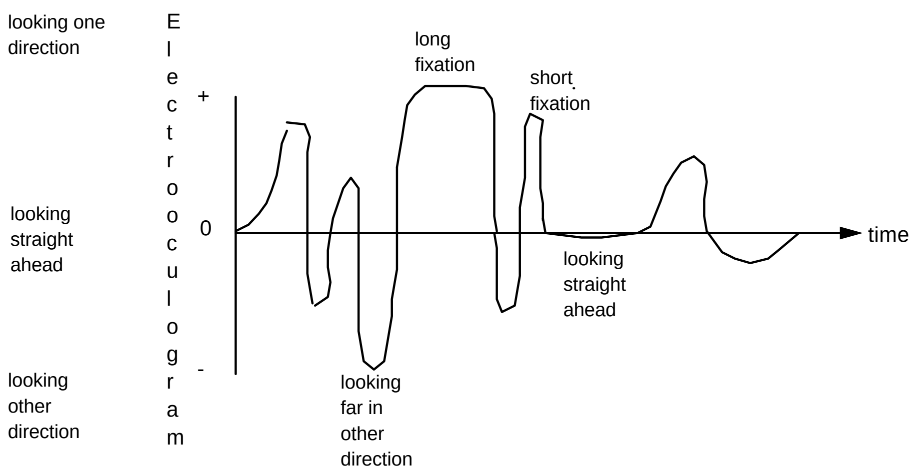


Figure 7. Typical EOG recordings during casual eye movements

CT Initial observations in our laboratory suggest that just prior to sleep onset, the extra-ocular muscles of the eyes relax. We hypothesize that eyes under closed eyelids diverge to an infinite focus when a person is asleep. A next step to test whether eye divergence is a reliable indicator of sleep onset would be special EOG measurement accompanying sleep onset. Given what you now know, where would you place electrodes to measure eye divergence?

Eyeblinks and Eye Movements--Working Together

Certain kinds of eyeblinks may occur at times when a reader does not need to be taking in information, for example, when moving from one point of fixation to the next (***saccades***), at ***line changes***, or when moving back to reread a selection on the same line (***regressive saccades***). These movements may inhibit certain kinds of blinking when the reader needs to pay attention, such as during ***fixation pauses***. On the other hand, other kinds of eyeblinks may occur because they are associated with various kinds of cognitive processing.

Objectives

- To investigate the relationship among eye behavior (specifically, eyeblinks and eye movement), thought, and language
- To investigate eyeblinks and eye movements, using ordinary visual observation as well as sophisticated instrumentation
- To investigate the relationship between types of eyeblinks and eye movements, and the time at which they occur during the reading various kinds of material
- To stimulate your ideas for future independent investigative research

Terms

Canthus (plural = canthi)
Dipole
Electrode
Electro-oculogram
Empirical
Endogenous
(EOG)
Extra-ocular
Fixation pause
Fixation point
Frequency
Impedance
Inferior (below)
Lateral vs. Medial
Line change
Operational definition
Rectus Inferior
Rectus Lateral
Rectus Medial
Rectus Superior
Reflex
Saccades
Sample
Saccadic
Superior

Method

Participants

Lab participants will work in two-person teams. One person will be the source of data, while the other person will be engaged in conducting the investigations and recording observations. Then roles will be switched. Both members of the team will share their observations, notes, and data with each other. Bring your lab notebook, handout for the lab, and citation skeleton (which will be collected at the beginning of the period) to the lab. All other belongings (coats, backpacks, heavy sweaters, etc.) should be stored in another room. (To be specified)

Logging your Work:

Good research practice includes keeping track of every time you use your equipment. Find the lab log in the top drawer of your workstation. Find the next blank log sheet and write down today's date, your names as researchers, and what you will be doing. For example, "we will be doing the 'attention and brain behavior' labs." Then, during your labs make notes about how the labs went for you, difficulties you figured out how to overcome, tips you might have for others, any problems with the equipment, etc.

PART 1

Visual Observation of Eye Movement

(Saccadic Movements, Fixation Points, and Regressive Saccades)

Materials

Paper and pencil
Reading selections
Table and chairs

Procedure

Seat yourselves as illustrated in Figure 8 so you can collect your data while keeping eye contact with your partner's eyes over the paper he/she is reading and is holding up.

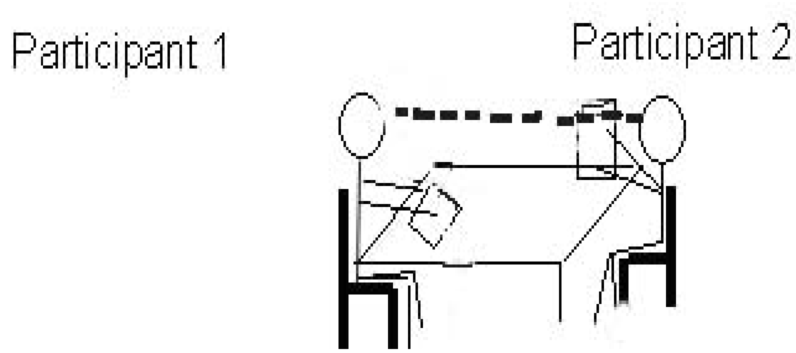


Figure 8. Positions for visual observation of eye movements during reading.

Participant 1 views Participant 2's eye movements as Participant 2 reads three samples of text material provided: (a) silently and then (b) orally as summarized in Table 1.

Table 1: Procedure Summary

Participant 2 reads	Participant 1 counts
1. A sample of text a. silently b. orally	1. The number of blinks During the silent and oral readings, make tally marks / / / / with your pencil each time you see a blink.
2. A second sample of text a. silently b. orally	2. The number of fixation points Make a tally mark for each fixation point you observe (which is only somewhat related to the number of saccades because regressive saccades will influence your count).
3. A third sample of text a. silently b. orally	3. The number of regressive saccades *Count the number of regressive saccades that occur.*

Note: For writing up your results later, it will be important to measure and record the length of the line read and to count the number of characters per line (including spaces) so you can calculate the number of eye movements per character.

PART 2

Electronic Observation of Eye Movement

(Saccadic Movements, Fixation Points, and Regressive Saccades)

Lab participants will work in two-person teams. Participant 2 will be the source of data, while Participant 1 will be engaged in conducting the investigations and recording observations. Then roles will be switched. Both members of the team will share their observations, notes, and data with each other.

Apparatus and Materials

BioPac Workstation
Psychophysiological measure called the electro-oculogram
Alcohol-acetone Prep Pads
Rubber gloves (Latex- free gloves are an option)
Printed copies of text material to be read from previous section.
BioPac Lesson 10 EOG 1
BioPac Electrode Lead Set (SS2L), Quantity-2
Disposable Vinyl Electrodes, Quantity- 6
Adhesive tape if necessary

Objective

You will explore eye movements and eye blinks while reading the same paper copy you read in Part 1. In addition, you will use the information from the physiograph to calculate your results. Before you start making recordings, discuss with your team what you are going to be looking for. Bring your lab notebook, handout for the lab, and citation skeleton (which will be collected at the beginning of the period) to the lab. All other belongings (coats, backpacks, heavy sweaters, etc.) should be stored in another room (To be specified). Remember to put on a lab coat.

Procedure

1. Make sure BioPac MP30 unit is OFF, that is no green lights are on, in the front of the MP30 box.
2. Plug in the electrode leads (SS2L) into the MP30. Horizontal is in channel 1 and vertical is in channel 2.
3. Turn on MP30 using the switch at the rear of the box.

4. Wear Gloves if you are Participant 1.
5. Clean the skin with alcohol pads where the electrodes will be placed.

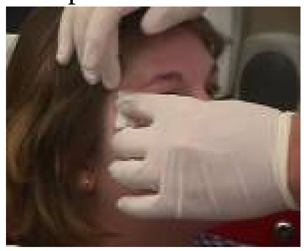


Figure 9. Shows Participant 2 cleaning one of the electrode locations. **Important:** make sure you squeeze out 3 drops of alcohol from the prep pads before using them to prevent alcohol running into participant's eyes!!

6. Place 6 electrodes on the subject as shown in figure 10. For accurate recordings, attach the electrodes so they are horizontally and vertically aligned.

Figure 10. The typical placement of Electro-oculogram (EOG) electrodes for BioPac Lab 10.

7. Attach the vertical electrode lead set (SS2L) channel 2 to electrodes.
8. Attach the horizontal electrode lead set (SS2l) from channel 1 to electrodes

Table 2: Important Instructions for where to connect each color electrode lead. (The electrodes attach with the metal facing down.)

Lead color	Channel 1 (Horizontal)	Channel 2 (Vertical)
Black	Connect the electrode above Left eye	Connect the electrode to the middle of forehead
Red	Connect the electrode lateral to Right eye	Connect the electrode above Right eye
White	Connect the electrode lateral to Left eye	Connect the electrode Below Right eye

Electrode Lead

Figure 11. The typical hook up of Electro-oculogram (EOG) electrodes for BioPac Lab 10.

9. Have subject adjust the seating position such that his/her eyes are in line with the center of the computer screen. Be sure to note the distance from the eyes to the screen.

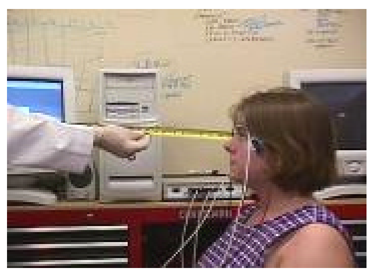


Figure 12. Participant 2 measuring the distance subject is away from the screen.

10. Start BioPac Student Lab Program. Choose Lesson L10-EOG-1. Type in a file name that both team members will be able to remember. Click on OK.
11. Click on Calibrate. You will be instructed to follow the dot on the screen with eyes only. The subject should try not to move his/her head.
12. Person 1 should be facing Person 2. Person 2 should hold a pen about 10" from person 1. Important: Person 1 should pick a focal point on the pen so that the eyes remain horizontal.
13. Click on Record
14. Participant 2 holds the pen still and in the center of the subject's visual field. Then person 2 moves the pen laterally 10 inches and back to center in about 3 seconds. Person 2 should also insert a marker (F9 Key) and type "L" for moving the pen left and "R" for moving the pen right. Participant 1 fixates on the pen, tracks it, and tries not to blink.

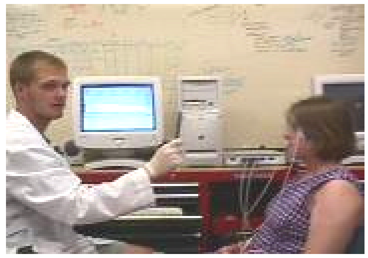


Figure 13. Participant 2 holds the pen about 10 inches away from participant 1.

15. Click on suspend. Review the Data
16. Now participant 2 should hold the pen stationary and in the center of participant 1's visual field. But this time participant 2 should move the object up for about 1 sec., down for about 1 sec., and return to the center.
17. Click on Suspend. Review data.
18. Click on Resume when the subject is ready
19. Participant 1 should read the materials from the preceding section .
20. Place the reading material on the table. Place the subject about 10" from the table. The material should still be in the center of the subject's visual field.
21. Participant 2 should insert marker (F9 Key) and label it "reading." Be sure to mark (with F9) anything you think would be important to note about the reading.
22. Click on Suspend.
23. Review data. If correct, click on Stop. If not click on Redo.
24. Partners will rotate, testing one participant at a time, and collect their data.
25. Finally, when each participant's data have been recorded, print out part of the data from steps 15, 17, and 20. To print the graphs follow these steps:
    a. File menu
    b. Print and then print graph
    c. Click ok.
26. Print out part of the EOG recordings and paste them into your lab Notebook using rubber cement.

Reminder about Lab Logs

Take out the lab log once again and add any comments you can. Be sure to note any problems with the equipment. (Review the earlier part of this lab write-up to see what kinds of things to enter in the log)

Discussion Questions

Topic 1: Cognitive Processing

What might you have learned from this "Eyeblink and Eye Movement" lab that could be used for study of various kinds of cognitive processing tasks? Think together with your lab partner about possible ideas (e.g., learning, problem solving, reading, visual search to find a certain word in the text transparency, or imagery). For example, how could you study whether the eyeblink is some kind of marker or index of cognitive activity; e.g., when a person is **{**xe "parsing"**}** *parsing* (i.e., "chunking") information into meaningful units? How might other variables--such as text difficulty, distractions, and presence of an audience, noise, divided attention language--influence your observations?

Topic 2: Videotaping Eyeblinks and Eye Movements

How could you use videotape to study some interesting psychophysiological research questions relating to eyelid movement (i.e., blinking) during reading and conversation? For example, how could you design a procedure in which you select a sample of text for a participant to read aloud, videotape his/her eyes during reading, and count the participant's eye movements while the participant follows your instructions? (What procedural steps might you follow, including replaying and stopping a videotape, so each eyeblink may be marked on a transcribed copy of the material to be read aloud <u>and</u> silently by the participant? How might you repeat the process with each participant? One issue to explore could be the extent of correspondence in the positioning of eyeblinks relative to the text, within-participant and between-participants, of material read orally and read silently. What other issues might be explored?

Topic 3: Eye Focal Length during View of "Magic Eye" Figures

A popular visual experience is known as viewing "magic eye figures." The magic eye figures popular in print require eye divergence in order to control focal length.

When one's eyes are allowed to diverge (effectively increasing their focal length to about twice the distance between them and the page, as though "looking through" the page), a three-dimensional image appears.

Learning to allow the image to emerge requires more or less practice. For some the task is easy; for others, it is very difficult unless tips are provided. How could you use what you know to provide a viewer with tips on what it feels like when the image is coming into focus. Remember, any such "feeling" would be coming from the relaxation of the extra-ocular muscles; this normally results in divergence and focus. How could you empirically observe what is going on when a person all of a sudden "feels" the image coming? Where would you place EOG electrodes to learn more about this conscious control of focus in vision?

Topic 4: Conversation Analysis

How might you apply what you know to provide new insights into conversation analysis?

Topic 5: Visually-Controlled Mouse
In our lab we have been working on a visually controlled computer mouse. The signals from the electro-oculogram have been used to provide information for sideways and vertical cursor movement, and eyeblinks have been used to serve as the mouse "click." How might this be achieved, given what you know? See http://www.cs.sunysb.edu/~vislab/projects/eye/Reports/report/index.html

Topic 6: Uses in Advertising
"Show the subject an advertising poster and determine how the subject's eyes move to the most important features of the image. Advertisers use EOG devises in poster design. Show the subject a map and ask them to find a particular city, or group of cities with certain characteristics (e.g. population size). How effective is the legend of the map in helping the subject? How often is the legend consulted? Does the subject scan the map in a specific pattern or more irregularly?"
(from http://www.qubitsystems.com/electro.html)

References

Required Lab Reading to Learn More About Eye Movements and Cognition

Orchard, L. N. & Stern, J. A. (1991). Blinks as an index of cognitive activity during reading. *Integrative Physiological and Behavioral Science, 26 (2),* 108-116.

Suggested Readings

Blanchard, H. E., & Iran-Nejad, A. (1987). Comprehension processes and eye movement patterns in the reading of surprise ending stories. *Discourse Processes, 10,* 127-138. [This article is a good example of an interesting cross-disciplinary connections. Here the impact of stories that have surprise endings, like O'Henry stories, is related to what happens to the eyes at the end of such stories.]

Glenn, F.A., Iavecchia, H. P., Ross, L. V., Stokes, J. M., Weiland, W. J., Weiss, D., & Zaklad, A. L. (1986). Eye-controlled interface. *Proceedings of the 30th Annual Meeting of the Human Factors Society*. [What practical use might eye movements have? Here is an article that describes how eye movements might someday be used to replace the mouse in controlling your computer.]

Goldstein, R., Bauer, L. O., & Stern, J. A. (1992). Effect of task difficulty and interstimulus interval on blink parameters. *International Journal of Psychophysiology*, *13*, 111-117. [Do people blink more or less when reading hard materials? Read this article to find out.]

Just, M. A., & Carpenter, P. A. (1980). A theory of reading: From eye fixations to comprehension. *Psychological Review, 87(*4), 329-354. [If you look at something for a long time, will you understand it better? How does your guess compare to what these folks found?]

Thorsheim, H. I., Rice, C. D., Harner, A., & Sjulstad, M. (1997*). Psychophysiology: Study of mental or emotional processes illuminated by involuntary physiological reactions.* Unpublished manuscript, St. Olaf College, Northfield, MN. [Also look at the website on physiological responses.]

Williams, P. L., Warwick, R., Dyson , M., & Bannister, L. H. (Eds.). (1989*). Gray's anatomy* (p. 1208). Edinburgh: Churchill Livingstone. [This reference is cited to give credit for the illustration borrowed from the book. By the way, it is a terrific resource for answering all kinds of questions about physiology.]

Web links

Electro-oculography research

http://www.cs.sunysb.edu/~vislab/projects/eye/index.html

[A moving eye appears on this page, which describes using eye movements for an EyeMouse to control a computer, instead of hand-held mouse]

Eye Movement mailing list

http://listserv.spc.edu/archives/eyemov-l.html

[A wide range of current issues in eye movement research]

Eyelink Gaze Tracking

http://www.smi.de/el/elintro.htm

[Good example of EyeMouse equipment]

St. Olaf Research Projects

http://www.stolaf.edu/depts/psych/psychophysiology/

[For St. Olaf student projects in psychophysiology underway here]

Required Lab Readings

Observing Children's Play Behavior

Brownlee, S. (1997, February 3). The case for frivolity: Play isn't just fun. Young animals can't do without it. *U. S. News & World Report, 122*(4), 45-49.

Information Literacy and Psychological Science

Brownlee, S. (1997, February 3). The case for frivolity: Play isn't just fun. Young animals can't do without it. *U. S. News & World Report, 122*(4), 45-49.

Neuropsychology: Handedness

White, L. E., Lucas, G., Richards, A. & Purves, D. (1994). Cerebral asymmetry and handedness. *Nature, 368,* 197–198.

Additional reference article to read and *__bring to lab__* (in Rolvaag Library on three-day reserve):

Swerdlow, J. L. (1995, June). Quiet miracles of the brain. *National Geographic, 187,* 2–41.

Psychopharmacology

Buresova, O., Bolhuis, J. J., & Bures, J. (1986). Differential effects of cholinergic blockade on performance of rats in the water tank navigation task and in a radial water maze. *Behavioral Neuroscience, 100,* 467-482.

Frick, K. M., Baxter, M. G., Markoweska, A. L., Olton, D. S., & Price, D. L. (1995). Age-related spatial reference and working memory deficits assessed in the water maze. *Neurobiology of Aging, 16,* 149-160.

Attention and Brain Activity

Andreassi, J. L. (1995). The EEG and behavior: Sensation, attention, perception, conditioning, and sleep. In J. L. Andreassi (Ed.*), Psychophysiology: Human behavior and physiological response* (pp. 50-54). Hillsdale, NJ: Erlbaum.

Statistics Follow-up on Play Lab

Paulos, J. A. (1990). Pseudoscience. In *Innumeracy: Mathematical illiteracy and its consequences* (pp. 49-71). New York: Vintage

Sensation and Perception: Illusions

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1977). Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology: Human Perception and Performance, 3*(4), 552-564.

Animal Learning

Guttman, N. & Kalish, H.I. (1966). Experiments in discrimination. In T. Verhave (Ed.), *The Experimental Analysis of Behavior* (pp. 209-216). New York, Appleton-Century-Crofts.

Eyeblinks and Eye Movements in Cognition

Orchard, L. N. & Stern, J. A. (1991). Blinks as an index of cognitive activity during reading. *Integrative Physiological and Behavioral Science, 26*(2), 108-116.

Psychology Citation Skeleton for Psych 122 Laboratory
Observing Children's Play Behavior

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

For Review articles: Skip to back side of Citation Skeleton, and fill that out.
For Research Studies: Fill out the following, plus backside of Citation Skeleton. [If research article describes several studies, pick one to use in filling out the rest of the material of this Citation Skeleton]

Sample and size: (If an empirical study, this information usually found in Methods section)

List terms defined conceptually; (Usually found in Introduction or Discussion sections)

Operational definition of one key term: (Usually found in methods section; vital to collecting data)**:**

Design: (Usually found in Methods section)

Procedure: (Usually found in Methods section)

Findings/Results: (Usually found in Results section; state in narrative form)

Steps or conclusions suggested by the article: (Usually found in Discussion section; what do the data mean?)

<u>Criticisms of the article</u>: (What might have been done better? What limitations exist in the study?)

<u>So what next?</u> (Give some ideas for further research that could be done. What would you like to investigate further?)

What research design, setting, and data collection method does our play project utilize?

List three play behaviors that would work well for a research study of this design. Would it be easier to study gender or age differences? Why?

1.

2.

3.

Psychology Citation Skeleton for Psych 122 Laboratory
Information Literacy and Psychological Science

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

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Steps or conclusions suggested by the article: (Usually found in Discussion section; what do the data mean?)

<u>Criticisms of the article</u>: (What might have been done better? What limitations exist in the study?)

<u>So what next?</u> (Give some ideas for further research that could be done. What would you like to investigate further?)

What is Boolean Logic? Draw a diagram illustration the concept using the words “play” and “pretend.”

List a web site of your choice in APA format

Psychology Citation Skeleton for Psych 122 Laboratory
Neuropsychology: Handedness

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

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Sample and size: (If an empirical study, this information usually found in Methods section)

List terms defined conceptually: (Usually found in Introduction or Discussion sections)

Operational definition of one key: (Usually found in methods section;vital to collecting data)**:**

Design: (Usually found in Methods section)

Procedure: (Usually found in Methods section)

Findings/Results: (Usually found in Results section; state in narrative form)

Steps or conclusions suggested by the article: (Usually found at end of Discussion section; what do the data mean?)

Criticisms of the article: (What might have been done better? What limitations exist in the study?)

So what next? (Give some ideas for further research that could be done. What would you like to investigate further?)

Describe how to find the Sylvian fissure.

Describe how graph paper may be used to measure the area of the isthmus of the corpus callosum.

Psychology Citation Skeleton for Psych 122 Laboratory
Psychopharmacology of Spatial Learning

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

For Review articles: Skip to back side of Citation Skeleton, and fill that out.
For Research Studies: Fill out the following, plus backside of Citation Skeleton. [If research article describes several studies, pick one to use in filling out the rest of the material of this Citation Skeleton]

Sample and size: (If an empirical study, this information usually found in Methods section)

List terms defined conceptually: (Usually found in Introduction or Discussion sections)

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Design: (Usually found in Methods section)

Procedure: (Usually found in Methods section)

Findings/Results: (Usually found in Results section; state in narrative form)

Steps or conclusions suggested by the article: (Usually found in Discussion section; what do the data mean?)

Criticisms of the article: (What might have been done better? What limitations exist in the study?)

So what next? (Give some ideas for further research that could be done. What would you like to investigate further?)

How do the Morris (1984) water maze and the "radial water maze differ"?

Discuss why half of the animals in this study were injected with saline solution.

Psychology Citation Skeleton for Psych 122 Laboratory
Attention and Brain Activity

<u>Reference</u>: (As illustrated in the references section of each lab)

<u>Institutional Affiliation of first author</u>: (Often listed on first page of article itself)

<u>Type of article or chapter:</u> (e.g., research study; literature review; popular press article)

<u>Goal of article:</u> (What are they trying to do?)**:**

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<u>Sample and size</u>: (If an empirical study, this information usually found in Methods section)

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<u>Operational definition of one key term</u>: (Usually found in methods section; vital to collecting data)**:**

<u>Design</u>: (Usually found in Methods section)

<u>Procedure:</u> (Usually found in Methods section)

<u>Findings/Results:</u> (Usually found in Results section; state in <u>narrative</u> form)

<u>Steps or conclusions suggested by the article:</u> (Usually found in Discussion section; what do the data mean?)

<u>Criticisms of the article</u>: (What might have been done better? What limitations exist in the study?)

<u>So what next?</u> (Give some ideas for further research that could be done. What would you like to investigate further?)

Compare alpha and beta waves.

A scientist removes the cerebellum of a turtle and then tests how it responds to poetry. Is this scientist a physiological psychologist <u>or</u> a psychophysiologist? How did you reach your conclusion?

Psychology Citation Skeleton for Psych 122 Laboratory
Statistics Follow-up on Play Lab

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

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Steps or conclusions suggested by the article: (Usually found in Discussion section; what do the data mean?)

<u>Criticisms of the article</u>: (What might have been done better? What limitations exist in the study?)

<u>So what next?</u> (Give some ideas for further research that could be done. What would you like to investigate further?)

Compare descriptive and inferential statistics.

I have 18 males and 13 females in my study. How many degrees of freedom (df) do I have?

Psychology Citation Skeleton for Psych 122 Laboratory
Sensations and Perceptions: Illusions

Reference: (As illustrated in the references section of each lab)

Institutional affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

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List terms defined conceptually: (Usually found in Introduction or Discussion sections)

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Design: (Usually found in Methods section)

Procedure: (Usually found in Methods section)

Findings/Results: (Usually found in Results section; state in narrative form)

Steps or conclusions suggested by the article: (Usually found in Discussion section; what do the data mean?)

Criticisms of the article: (What might have been done better? What limitations exist in the study?)

So what next? (Give some ideas for further research that could be done. What would you like to investigate further?)

In part 2 of the lab, why is it important for you to decide if you will compensate for the illusions, or if you will perform the exercise without trying to compensate?

List and describe (or sketch out) three commonly occurring illusions?

1.

2.

3.

Psychology Citation Skeleton for Psych 122 Laboratory
Animal Learning

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

Type of article or chapter: (e.g., research study; literature review; popular press article)

Goal of article: (What are they trying to do?)**:**

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Criticisms of the article: (What might have been done better? What limitations exist in the study?)

So what next? (Give some ideas for further research that could be done. What would you like to investigate further?)

A rat receives 3 jellybeans every time it jumps through a hoop. The hoop is always present, and the rat is on a continuous reinforcement schedule. Is there a discriminative stimulus in this scenario, and if so what is it?

Describe how to calculate the "entire test" absolute generalization gradient. Which line stimulus should have the greatest number of responses?

Psychology Citation Skeleton for Psych 122 Laboratory
Eyeblinks and Eye Movement in Cognition

Reference: (As illustrated in the references section of each lab)

Institutional Affiliation of first author: (Often listed on first page of article itself)

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Sample and size: (If an empirical study, this information usually found in Methods section)

List terms defined conceptually; (Usually found in Introduction or Discussion sections)

Operational definition of one key term: (Usually found in methods section; vital to collecting data)**:**

Design: (Usually found in Methods section)

Procedure: (Usually found in Methods section)

Findings/Results: (Usually found in Results section; state in narrative form)

<u>Steps or conclusions suggested by the article:</u> (Usually found in Discussion section; what do the data mean?)

<u>Criticisms of the article</u>: (What might have been done better? What limitations exist in the study?)

<u>So what next?</u> (Give some ideas for further research that could be done. What would you like to investigate further?)

Compare the amplitude and duration of the three types of eyeblinks.

How are the EOG signals created?