Research Experience- Part 1

Jigsaw of Research Papers

One of the goals of this course is to have you experience science. **Next week's laboratory work is the beginning of a six-week adventure** into ***doing science the way scientists would***. As you learned in lecture and through your reading, scientists first make an observation, then ask questions about it, develop a testable hypothesis, do the experiment, analyze results, and then talk to each other about it. You will do the same process.

The 6-week limitation that you will have in this laboratory for this course means that you don't have time to write a grant, purchase equipment, hire staff... instead, you will need to focus your research questions and use our existing tools to do the experiment. For our purposes, we will be using lab equipment and associated software called "iWorx", which can be used to assess a number of different physiological activities. We have chosen to have you focus on some physiological processes such as heart rate, heart rhythm, pulse, and tidal volume, which are measured as described briefly at the end of this handout.

To help you start thinking about the process of science, we have chosen four papers on research about human biology. ***Today's take-home assignment*** is for you to read one of the papers below in depth, answering the questions located further into this assignment. ***In next week's lab,*** you will explain the content of your paper to others in your lab. They, in turn, will explain the contents of their research papers to you. At the end of the next lab period (Part 1- Jigsaw), based on what you read in your papers, you should have a better understanding of the content and format of science research papers, how to write a good hypothesis and design an experiment. In your main working group, you should begin to think about the experimental question you want to ask and how you are going to test your hypothesis (use the handout "Part 3- Experimental Design" as a guide). In the following lab period, you will learn the iWorx equipment and program (Part 2- the iWorx tutorial) that you will be using to conduct your experiment.

<u>Instructions for Research Experience Part 1: Reading Scientific Literature, the Jigsaw Lab</u>

For this lab, you should have read your assigned scientific research paper **at home** (see assigned readings below). You will not have had the same reading assignment as your group members.

To help you understand your paper, **read Section A** of this handout that provides guidelines *for how to read a scientific paper.* You should also use the definitions at the end of Section A to help you understand the research experiments described in the paper.

Answer the questions in **Section B** below to help you learn and think about the scientific process – *Why are the scientists researching this topic? Why are they doing what they're doing to answer their questions? What steps do they go through to learn more about human biological processes?*

Bring a copy of your assigned research paper and your written answers to the questions in Section B to lab. You must show your lab TA your written answers <u>at the beginning of class</u> to participate in the required jigsaw activity and to earn half of the weekly lab points for this activity.

Group Reading Assignments: (papers available on Lab Moodle site.)

Group Bernardi: Bernardi, L., C. Porta, and P. Sleight. 2006. "Cardiovascular, Cerebrovascular, and Respiratory Changes Induced by Different Types of Music in Musicians and Non-musicians: The Importance of Silence." *Heart* 92 (4) (April 1): 445–452. doi:10.1136/hrt.2005.064600.

Group Field: Field, T., M. Diego, and M. Hernandez-Reif. 2010. "Tai Chi/yoga Effects on Anxiety, Heartrate, EEG and Math Computations." *Complementary Therapies in Clinical Practice* 16 (4): 235–238.

Group Inoue: Inoue, N., K. Kuroda, A. Sugimoto, T. Kakuda, and T. Fushiki. 2003. "Autonomic Nervous Responses According to Preference for the Odor of Jasmine Tea." *Bioscience, Biotechnology, and Biochemistry* 67 (6): 1206–1214.

Group Parsons: Parsons, J.P., D. Cosmar, G. Phillips, C. Kaeding, T. M. Best, and J.G. Mastronarde. 2012. "Screening for Exercise-Induced Bronchoconstriction in College Athletes." *Journal of Asthma* 49 (2) (March): 153–157. doi:10.3109/02770903.2011.652329.

During the Jigsaw lab, you will first find the other students in your lab that read the same paper as you did. Each group of students reading the same paper will be the "expert" group on that specific research paper. You will have a short time (10 minutes) to sit together and share the answers and insights you each got from reading your paper. Use this time to clarify any questions you have about the paper, as your next task will be to briefly present the key points of this paper to your main lab group (the group you will be performing the research experiment with).

After this short time in your "expert" group, you will return to your regular lab group of 4 and each person will have a chance to share the main points and experimental design of the paper that they read (5 minutes each person).

At the end of the jigsaw activity, you will take a short quiz on general science research processes to earn up to an additional five points. This short quiz will cover the general science research processes discussed throughout this handout, including information from the questions that you answered below about your assigned research article **and** information from the sections on "How to read a scientific paper" and "Definitions and Concepts."

Section A **How to read a scientific paper** - Read this section to help you understand content and format of science papers. Information from this section will be part of the lab quiz.

As part of this course, you will be reading peer-reviewed scientific papers. Even in your chosen career, you will likely need to read research papers or informational articles about a given topic. Here are some pointers for what you can expect to read in a scientific paper, and what to look for and think about as you are reading.

Scientific papers usually contain the following **sections of information**:

- **Abstract** (background, what this research is testing, how they tested it, what they found, what they concluded, and how this is important to the field.)
- **Introduction** (important background information and what their hypothesis/prediction is)
- **Materials and Methods** (how they tested their hypothesis)
- **Results** (what data they obtained)
- **Discussion** (what the results show compared to their hypothesis/prediction)
- **Conclusion** (what this study contributes to the field, what further study is needed)
- **References** (any references cited in the paper)

If you read the abstract, you know what the research is all about. Read the rest of the paper:

- To be convinced of what their abstract says – can start by looking at their figures.
- Information on their materials and methods so you can repeat the experiment or modify it for your question.
- For more background (the Introduction), or
- Just more information.

But be aware that

- Format varies among different journals. For example, for some journals, the materials and methods are now only available as online supplements.
- Not all good scientists are good writers. Imagine that!
- Even good writers are constrained by journal space allowances, so each sentence is often very dense with information.
- The authors assume the reader has some specialized knowledge so they may use vocabulary unfamiliar to you. Thus, you may need some additional help in understanding the paper. The web is pretty good for this.
- **Research is built on other research**, so often times the materials and methods simply refer you to other papers instead of telling you what they exactly did.
- It is sometimes hard to distinguish speculation from solidly based conclusions.
- One single paper on a subject is rarely the last word. Watch for additional research.

A couple more notes about papers that are very useful:

- In an area you are familiar with and just want more depth, instead of original research that is narrow in focus, you might try reading reviews on the topic first.
- If a topic is unfamiliar to you, you might try reading the popular scientific press (e.g., ScienceNews, Discover, Scientific American). You could also use online encyclopedias, but be aware that these are not always as current as the research papers.
- Some original research is actually meta-analysis of many other research papers, thus they cover more ground than a single paper. That doesn't mean their conclusions are correct, but at least you will see more data.

Definitions and Concepts

Blinding This describes the process in an experiment where the assignment of treatments is not shown to any researcher or subject involved with the experiment. Thus, the researchers and subjects are "blind" to the assignment of treatments. A person not personally involved with the experiment makes the treatment assignments and keeps those assignments secret in the entirety of the experiment. This removes unintentional bias by the researcher or subjects.

Confounding Confounding is external influence, often unknown, on a research experiment that results in the distortion of the results of the experiment. This usually causes a negative effect on the relationship between the variables in the study. This may cause the researcher to analyze the results incorrectly. An example might be having research subjects with unknown underlying disease.

Control A "control" treatment is a treatment that is used as a standard to which the results of the other treatment can be compared. For example, in a study of fertilizer effects on plants, a control would be a plant grown with regular soil that did not have any fertilizer added to it.

Experimental Error This is not really an "error" in the experiment! This just describes how the experimental "units" (e.g., different animals, different humans, different plants) vary in their responses to the same treatment.

Experimental Units An experimental unit is a person, animal, plant, plot of land, or other thing that is being studied by the researcher. This is the basic object upon which the study is carried out.

Inference After reviewing the results from an experiment, this is a conclusion drawn by a researcher using scientific reasoning.

***P*-value** A *p*-value is a statistical measure of how likely you would see a relationship between your independent variable and dependent variable by chance alone. So the smaller the *p*-value, the less likely any relationship you are seeing would have occurred by chance alone. Thus the smaller *p*-values give us more confidence that the relationship we see is real. (Remember that the independent variable is the one you control, like amount of caffeine a test subject will drink. The dependent variable is what you measure, like your heart rate, respiratory rate, and number of times they have to urinate.)

Placebo A placebo is a blank treatment used to examine the results of an experiment that is run in the absence of the real treatments. For example, if examining the effect of a drug, various dosages of the drug could be considered treatments, while the dosage of a sugar pill could be a placebo treatment.

Randomization This is the randomized assignment of treatments to experimental units. Randomization helps to reduce unintentional human bias that might occur if humans made their own assignment of treatments to the experimental units.

Replication To improve the accuracy of results, individual treatments are applied to more than one experimental unit. For example, to test the usefulness of a drug, the drug would be given to more than one person. In this type of experiment, a person is the experimental unit, and each person that gets the same drug (one specific treatment) is called a **replicate**.

T-test The t-test is a specific type of statistical analysis that assesses whether or not two groups are statistically different from each other.

Treatment Treatments are the different processes or applications to be tested. For example, a new drug might be tested at three dosages; each of these dosages would be called a treatment. Three different fertilize levels might be three treatments tested on a plot of agricultural land.

Section B Questions to guide your reading and sharing - Print these pages out and bring your written answers to lab to show your TA *at the beginning of class* in order to participate in the jigsaw activity.

Your Name: _____ **Jigsaw Group Name: _____**

1) List the section headings of your assigned research paper. During the jigsaw lab, compare this to articles read by others in your group.

2) What is the main question the authors are trying to answer in this paper? Why is this an important question for the researchers to be asking (i.e. why should/do we care)?

3) State the authors' hypothesis. Note how specific the hypothesis statement is in regard to the main question. **Hypothesis statements** must be stated in such a way that the statement can be supported or rejected by the results of the experiment - (***you can only accept or reject a hypothesis*, you cannot prove a hypothesis to be *true or false***).

4) Briefly describe the experiment(s) the authors performed to answer their question. In your description include the following information:

- What methods did they use? Did they use replicates in this study? You may use additional space.

- Was this an **experimental** or **observational** study?

  In an *experimental* study, researchers apply treatments to experimental units (animals, people, plots, etc.) and then they observe the effect of the treatments on the experimental units. For example, researchers studying the effects of cigarette smoke on the lung tissue integrity of laboratory mice might introduce different amounts of cigarette smoke to groups of mice. Each level (amount) of cigarette smoke is the independent variable (treatment), and the effect that each treatment has on the mice is the dependent variable (result). The dependent variable is what experimental research measures.

  In an *observational* study, researchers observe subjects and measure variables of interest. The researcher does not determine the treatment that each subject receives. For example, studying the effect of smoking on the lung capacity of men. Researchers cannot assign levels of cigarette smoke to humans, but can determine what already exists and can conduct observational studies to examine how the smoking appears to affect who is already smoking.

- Was there a control, and if so, what was the control?

- What information was collected?

4) Summarize the take-home message of each table or figure in your article. You may use additional space/paper for this answer.

5) What do the authors conclude from their results? Do you agree that the data support their conclusion? Explain.

Ending Assignment

At the end of today's jigsaw work, you and your group should start thinking of questions YOU might want answers to. To help you know what is possible in our lab, here is a list of what parts of the iWorx program are available to use and what they measure:

(ECG: Electrocardiogram, also known as EKG. Measures heart rhythm.)

Human Heart
HH-3: ECG-Circulation-LS2: Measures pulse, ECG, and heart rate and then correlates this to resting, leg exercises, and hand exercises.
HH-6: Human Heart Rate Variability: Measure ECG and heart rate, to determine the variation in the time interval between heartbeats. This can be used to assess the effects of different types of stress on the body.

Spirometry
HS-1: Breathing-Rest-Exercise-LS2: Measures breathing parameters (various lung volumes) on a subject at rest and after exercise.