The Scientific Method

Kin 304W

Week 1: May 7, 2013

Imagine the following scenario…

- Your Mom is 55. She has bad arthritis in her left knee which causes her a lot of pain and makes it difficult to walk. Her doctor recommended she undergo joint replacement surgery, but she is scared; she wants you to tell her what she should do.
- How would you tackle this problem?

The Scientific Method

1. Define the problem
2. Develop the hypothesis (research question)
3. Test the hypothesis
4. Compile the results
5. Communicate the results

Kin 304W focuses on these last 3 steps

1. Define the Problem

- Observe the phenomenon and gain a deep knowledge of it
- Conduct a literature review by thoroughly searching and reviewing the relevant research literature
- SFU Library provides a list of databases specifically relevant to Biomedical Physiology and Kinesiology http://cufts2.lib.sfu.ca/CRDB/BVAS/browse/facets/subject/575
- We will have a library tutorial near the middle of the semester to help you learn how to more effectively do a literature search

2. Develop the Hypothesis

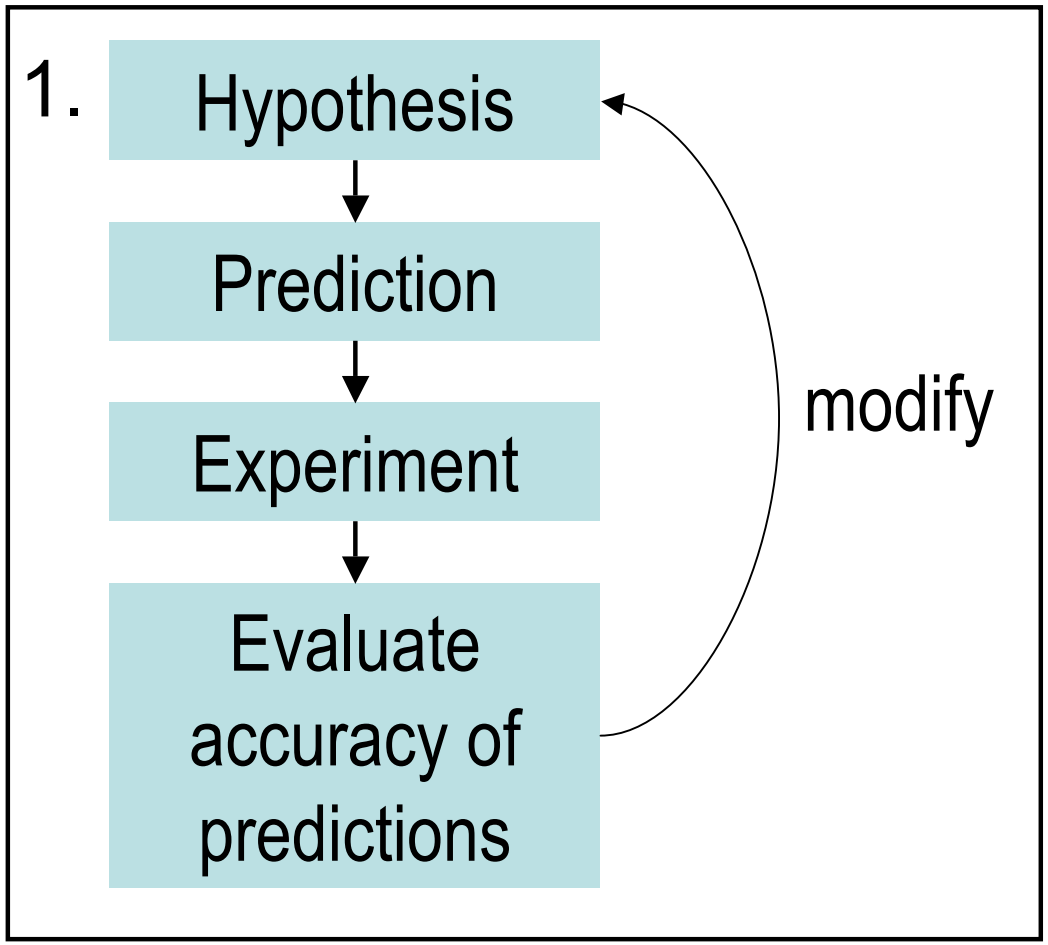
- Research question: precise question the study will address

  - Poor example: Does exercise impact fatigue levels?

- Hypothesis: statement explaining a phenomenon under consideration, based upon researcher's understanding before any experimental testing has occurred.

  - Try rewriting the above research question as a hypothesis.

3. Test the Hypothesis



2. Model

A model is a hypothesis that has been shown repeatedly to hold true under certain conditions (e.g., muscle models describe force-velocity relationship)

3. Theory/Law

When a hypothesis has been tested and shown to hold under many experimental conditions it may be called a theory or law (e.g., laws of motion). Theories and laws are difficult to dismiss as they are based on repeated & consistent experimental evidence.

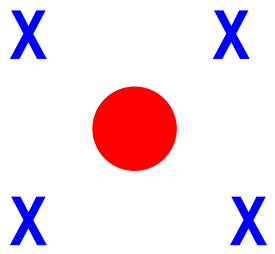
3. Test the Hypothesis: Study Design

- Informed Consent for human subjects research
  - University Research Ethics Board
- Sampling (obtaining study participants)
  - Specify your recruitment methods
  - Only random if you employ a truly random sampling method
  - Sample size determined by power calculation
- Measurement tools should be valid and reliable
  - Valid (accurate) tools minimize **systematic** measurement error. Calibration improves accuracy.
  - Reliable (reproducible) tools minimize **random** measurement error. Objective tools usually more reliable than subjective.
- Data collection instruments

Reliable but not valid

E.g., Weight is measured on a digital scale within +/-1 lb on 4 occasions but is ‘off’ by 10 lbs of the truth.

Valid but not reliable



E.g., Weight is measured on a digital scale within +/- 5 lb on 4 occasions, but on average is equal to the truth.

3. Test the Hypothesis

- For a given hypothesis, statistical tests allow researchers to determine:
  - Is there a difference? (T-tests, ANOVA, ANCOVA, and their non-parametric equivalents)
  - Is there a relationship? (Correlation, regression, and their non-parametric equivalents)

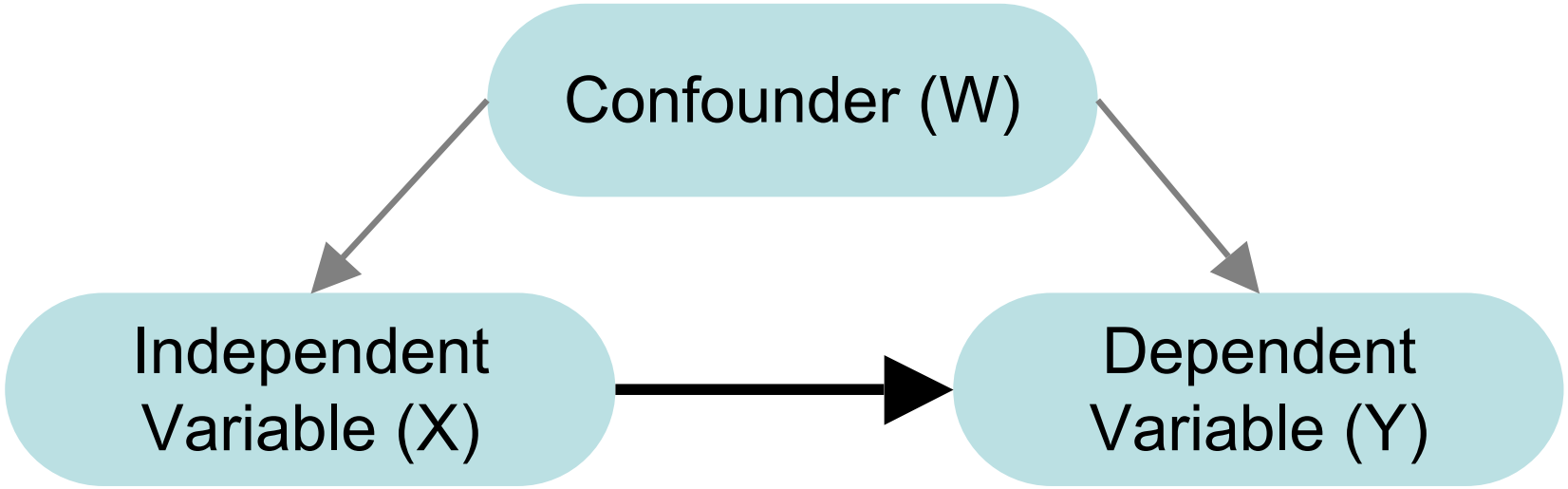
4. Compile the Results

- With EXCEL and SPSS it is easy to do data analysis
- But, make sure you do the correct analysis
- Attention to detail is important
  - E.g., in SPSS, use the correct Split File or Select Cases

4. Compile the Results: Types of Variables

- Independent variable (IV): the variable that you change or manipulate.
  - Also known as predictor variable or exposure variable
- Dependent variable (DV): the variable that is observed and changes in response to the independent variable.
  - Also known as outcome variable or response variable
- Covariates: variables that are held constant either by research design or statistical analysis.
  - Also known as confounders or controlled variables

4. Compile the Results: Types of Variables



E.g., A teacher observed that heart rate was 15 bpm higher in her students during their final exam than during their first lecture. What are the dependent and independent variables?

4. Communicate the Results

Researchers have a responsibility to communicate their findings to the rest of the scientific community and to other stakeholders who fund the research and who can apply the findings.

1. Conferences and research symposia
   - Up-to-date results that are not yet published
2. Peer-reviewed journal articles
   - Most highly regarded form of scientific communication
3. Books
   - Often not peer reviewed and therefore not as highly regarded

Peer-Reviewed Journal Article

- Abstract
  - A brief, structured summary of the study
- Introduction
  - Relevant background and study objectives/hypotheses
- Methods
  - Study population, experimental protocol, statistical analysis. Should be detailed enough for another scientist to repeat the study.
- Results (includes tables and figures)
  - Clear description of results without any interpretation
- Discussion
  - Interpret results in the context of the hypothesis and existing literature
  - Comment on future research directions
- Submission Format
  - "Information for Authors" provided by individual journals
  - Attention to detail is mandatory

http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtoc.html

MS EXCEL Basics

- Entering data
- Opening data files
- Formatting
- Adjusting column widths and row heights
- Saving data (for use with other applications)
- Entering formula
- Functions (e.g., average)
- Copying formulas
- Split windows
- Relative and absolute referencing
- Copying and moving data
- Sorting data
- Charts
- Statistical tests (data analysis tool pack)
- Solver
- http://www.utexas.edu/its/training/handouts/UTOPIA_ExcelGS/