

The Scientific Method

Kin 304W

Week 1: Jan 8, 2013

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
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- Kin 304W focuses on these last 3 steps

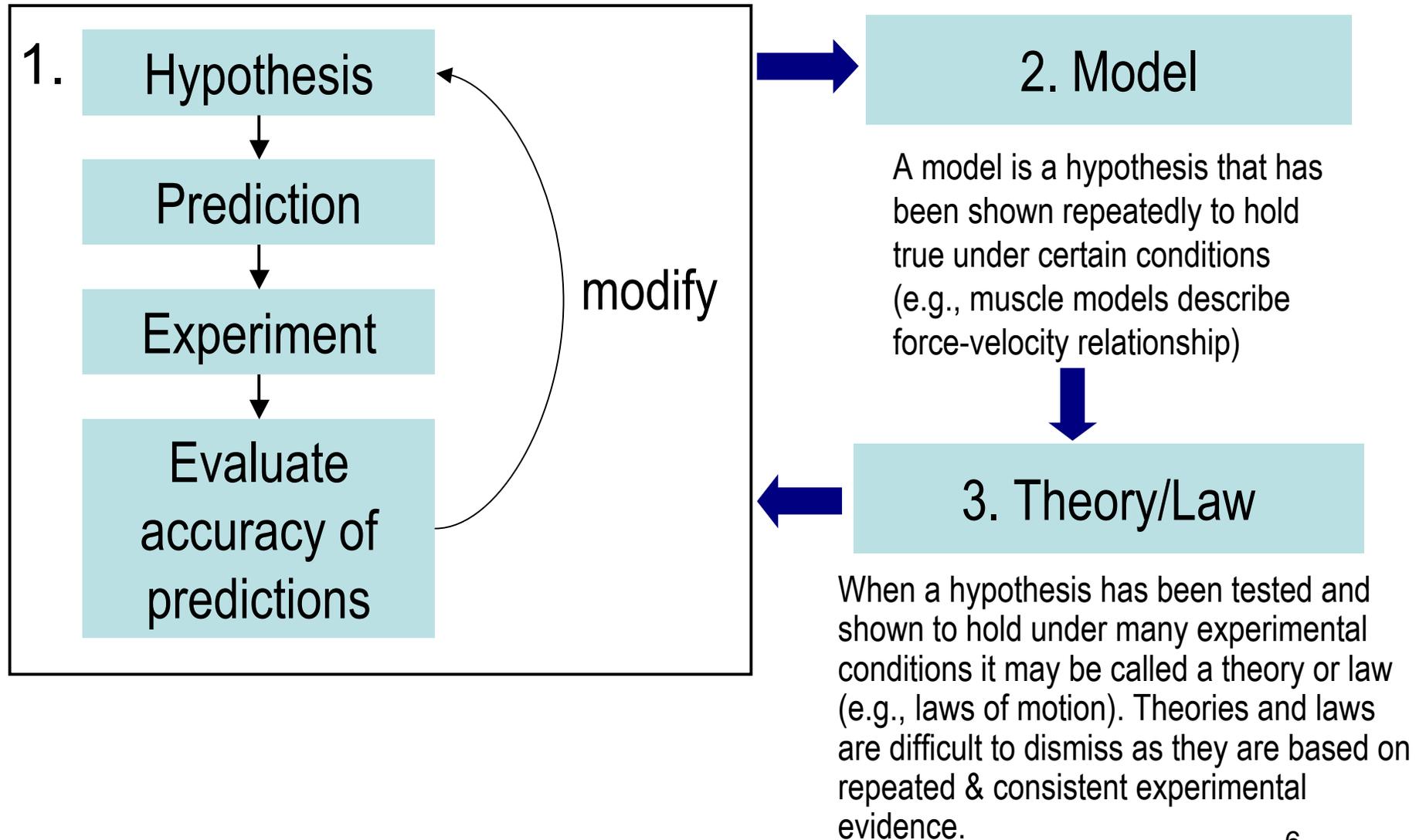
1. Define the Problem

- 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>

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



3. Test the Hypothesis: Study Design

- Informed Consent for human subjects research
 - University Research Ethics Board
- Sampling (obtaining study participants)
 - 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

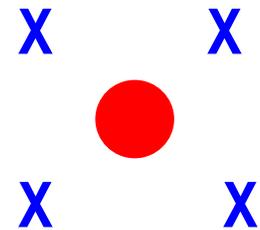
Reliable but not valid

Measurements 



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**

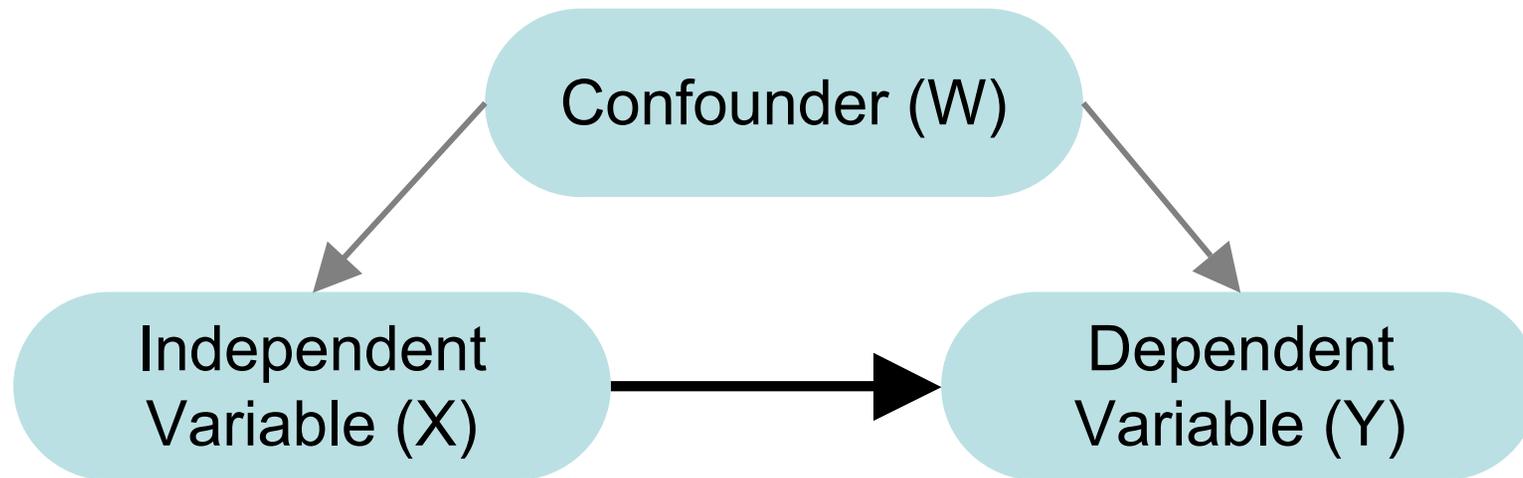


4. Compile the Results:

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>

Undergraduate Student Research Awards (USRAs)

- Who has heard about the current NSERC/VPR USRA competition?
 - NSERC - 3 awards for 2013
 - Vice President Research (VPR) - 2 guaranteed awards for 2013, possibly more
- USRA positions are fully eligible to count as co-op work terms.
- Student application deadline January 13, 2013 (this Sunday!)
- See Cheri or Darleen in the BPK Co-op Office for more details

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/