A little bit about me...

- B.A. Psychology with a minor in Mathematics from San Jose State University, 2011.
- M.S. Human Factors and Ergonomics Engineering from San Jose State University, Expected 2014.

My Experience:
- San Jose State Research Foundation, worked with Dr. Van Selst in his Cognitive Psychology Lab on two joint projects with NASA Ames
- NASA Ames, Human Factors Department, worked with Dr. Liston in his Oculomotor Lab.
- UC San Diego, Summer Internship, worked with Dr. Aron in his Cognitive Neuroscience lab in Cognitive Control
Todays Agenda

- Early exploration into intelligence
- What is Science?
- The Scientific Method
- Basic research terminology
- Types of Research
- Types of Measures
  - Common measures in Cognitive Psychology
- Examples/showcase of cognitive measures
Paul Broca performed autopsies and compared brain size between males and females.

- 292 male brains had a mean weight of 1,325 grams, and 140 female brains had a mean weight of 1,144 grams.

- “We might ask if the small size of the female brain depends exclusively upon the small size of her body...But we must not forget that women are, on the average, a little less intelligent than men, a difference which we should not exaggerate but which is, nonetheless, real. We are therefore permitted to suppose that the relatively small size of the female brain depends in part upon her physical inferiority and in part upon her intellectual inferiority (1861, p. 153)” – Broca, Cited from The Mismeasure of Man by Stephen Jay Gould p. 136
Alfred Binet: Theory of IQ

- Alfred Binet first to study the measurement of intelligence via craniometry.
- “The relationship between the intelligence of subjects and the volume of their head...is very real and has been confirmed by all methodical investigators, without exception...We conclude that the preceding proposition [of correlation between head size and intelligence] must be considered as incontestable (Binet, 1989, p. 294-295).” (Gould, 176)

Is this scientific research?
What is Science?

- Cumulative
- A process
- Objective
- Open Skepticism
- Intellectual Honestly

Pseudoscience (What Science Is Not?)

- Lack cumulative progress
- Uses loose and distorted logic
- Lack internal skepticism
- Disregards real-world observations and established facts/results and contradicts what is already known
The Scientific Method

- Theory (an organized set of principles that describes, predicts, and explains some phenomenon).
- Hypothesis (a specific testable prediction, often derived from a theory)
  - Predicted relationship of variables
- Collect data → Methodological sound plan
  - Control
  - Confounds
    - Double-blind experiments, etc.
    - Reliability, validity, and replicability
- Analyze data with inferential statistics
- Interpret [generalizability?]  
  - Sample/limitation
Two Types of Research: Basic and Applied

- **Basic Research:** Research conducted to seek new knowledge rather for its practical applications. Fundamental questions about psychological processes.
  - **Goal:** to explore and understand the fundamental mechanisms that underlie behavior; establish theories, explanations, concepts and principles.

- **Applied Research:** Research conducted to solve specific problems.
  - **Goal:** to bring about direct benefits to society by addressing specific problems (e.g. depression) and develop solution.
  - **Alfred Binet:** developed the world's first modern intelligence test to help schools identify children needing special attention.
Research Methodology Basics

- **Constructs**: hypothetical attributes or mechanisms that help explain and predict behavior in a theory. E.g. Intelligence, motivation, aggression...

- **Operational Definition**: a procedure for measuring and defining construct.

- **Variables**: Characteristics or conditions that change or have different values for different individuals.

- **Independent Variable**: Variables manipulated by the researcher.

- **Dependent Variable**: the variable that is observed for changes to assess the effects of manipulating the IV.

- **Validity**: the degree to which the measurement process measures the variable that it claims to measure.

- **Reliability**: the consistency of the measurement. E.g. IQ test

- **External Validity/Generalizability**: The extent to which we can generalize the results of a research study to people, settings, times, measures, and characteristics other than those used in that study.
Types of Research

- Descriptive
- Correlational
- Experimental
Descriptive Research

- Research designs in which the research defines a problem and variable of interest but makes no predictions and does not control or manipulate anything.

Types:

- **Case Study**
  - E.g. Broca and Mr. Tan
  - Disadvantage: Individual Differences

- **Naturalistic Observation**
  - E.g. Jane Goodall observed chimpanzee’s in Tazmania
  - Advantage: Real world behavior
  - Disadvantage: time-consuming, potential for observer influence, potential for subjective interpretation.
Descriptive Research

- **Systematic Observation**
  - E.g. Usability Testing
  - Advantage: Don’t have to wait for behavior to occur.
  - Disadvantage: less natural

- **Survey**
  - Collects information about attitudes, opinions, preferences, and behaviors.
  - Advantage: flexible, obtain a wide variety of information/variables, easy and efficient.
  - Disadvantage: Low response rate, nonresponse bias, difficult to analyze, self-report (trustworthy?).

- **Interview**
Correlational Research

- Examines relationship between 2 or more variables, no manipulations or treatments.
  - E.g. GPA and Wake-up time
  - May be used for prediction

- Strengths:
  - good starting point that can lead to experimental research
  - allows researchers to investigate variables that would be impossible or unethical to manipulate (e.g. exposure to pollution)
  - high external validity.

- Limitations:
  - **Correlation does not mean causation!**
  - The third-variable problem
Experimental Research

- Experimental Research attempts to answer cause-and-effect questions about the relationship between variables by controlling and manipulating variables.

Logic:

1. Manipulate IV
2. Measure DV
3. Control Nuisance variables (e.g., randomization)
4. Compare values of the DV across the IV
Experimental Study Basics

- Random Assignment
- Experimental Group
- Control Group
- Placebo
- Single-blind Studies
- Double-Blind Studies
- Experimenter expectancy effects

Example:
Quasi-Experimental Research

- Similar to experimental, however, it makes use of naturally occurring groups rather than randomly assigning subjects to group.
  - Males and Females
  - Ethnicity
Types of Measures

- **Self-Report Measures**: written or oral accounts of a person’s thoughts, feelings, or actions.
  - Survey/Questionnaires
  - Interview
  - Limitations:
    - Social desirability bias
    - Lack of clear insight into one’s own behavior

- **Behavioral Measures**: *Objective* observations of action in either natural or lab settings.
  - Limitations:
    - Requires times to train coders and conduct coding
    - Participants may modify their behavior
Types of Measures

- Physiological Measures:
  - Blood Pressure
  - Heart rate
  - Sweating
  - Respirations
  - Pupil Dilation/Eye tracking
  - Electroencephalograms (EEG)
  - Position Emission Tomography (PET)
    - Images of brain activity via metabolic activity
  - Magnetic Resonance Imaging (fMRI)
    - Measures oxygen concentration in the blood flow in the brain.
Types of Measures

- **Multiple Measurements**: Several measures combined to acquire data on one aspect of behavior to offset any limitations of any single measurement.
  - Limitation:
    - Expensive and time consuming


The Sleep Log

Fill this part of the form out **first thing in the morning**.

- Went to bed last night at ____________
- Woke up this morning at ____________
- Are you feeling sick today? [ ] yes [ ] no
- Are you feeling pain today? [ ] yes [ ] no
Common Dependent Variables in Cognitive Research

- **Reaction Time (RT):** Time to perform a task. Measures speed.

- **Accuracy:** Number of correct items.
  - **Speed/Accuracy Tradeoff:** Relationship in which speed on a task is almost always inversely related to accuracy on the task.

- **Verbal Protocol:** People think aloud while carrying out a task, revealing conscious processing.
  - Involves introspection and creates subjective data.
  - Good for reasoning, problem solving, and writing tasks.
  - **Limitation:**
    - With certain tests/tasks people tend to perform better because they are more consciously aware, thus prone to less mistakes.
    - Lose RT data
Examples of Dependent Variables: Reaction Time & Accuracy

- DELTA Cognitive Battery Test has been used to study the effects of environmental and chemical stressors on human performance.
  - (Surrogate Measures) NASA Ames and Army Research laboratory

- Tests include
  - Box Selection/3-choice reaction time
  - Code Substitution
  - Math
  - Mental Rotation
  - Pattern Comparison
  - Alternating Finger Tapping
    - dominant and non-dominant hand
DELTA: Box Selection/3-Choice Reaction Time

“Press the numeric key that corresponds to the box that has changed”

- Presentation of a visual stimulus and measured response latency to the stimulus.
DELTA: Code Substitution

Subjects task was to associate the number with the character above it.

- This type of task was a mix of associative memory, perception, and visual search encoding-decoding, which involved memory recall and perceptual speed.
DELTA: Pattern Comparison

- The task was to determine whether the patterns were the same or different.

- This test measures integrative spatial function and has been compared to the ability to recognize changes in the radar screen or map display.
DELTA: Rapid Tapping

- Task asked participants to alternate between two fingers as fast as possible.
- Test measures manual motor skills and coordination.
DELTA: Spatial Transformation

- Task asked participants to identify which hand matches the object that appears in the box upon which the sailor is standing.
- This test measures ability to spatially transform mental images (mental rotation) and determine the orientation of a given stimulus.
Take Away

- Science is a process and ongoing.

- It is important to understand research methodology so you are able to make your own decisions about what the conclusions are.
  - Remember, science is open to skepticism

- The scientific method involves observation, prediction, testing, integration, and communication.

- Correlational research does not demonstrate casualty, only demonstrates a relationship, whereas, experimental research demonstrates cause-and-effect (if well planned and controlled).

- Many techniques exist to measure cognitive functions.
  - Verbal protocol, RT, and Accuracy
  - Physiological Measures such as ERP, PET, and fMRI reveals brain activity.
References