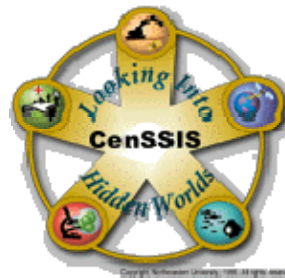


Research Methods and Validadion

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5:30pm



[Outline]

- Qualitative vs. Quantitative
- Archival Research
- Naturalistic Observation
- Survey Research
- Case Study
- Correlational Research
- Experimental Research
- Validation



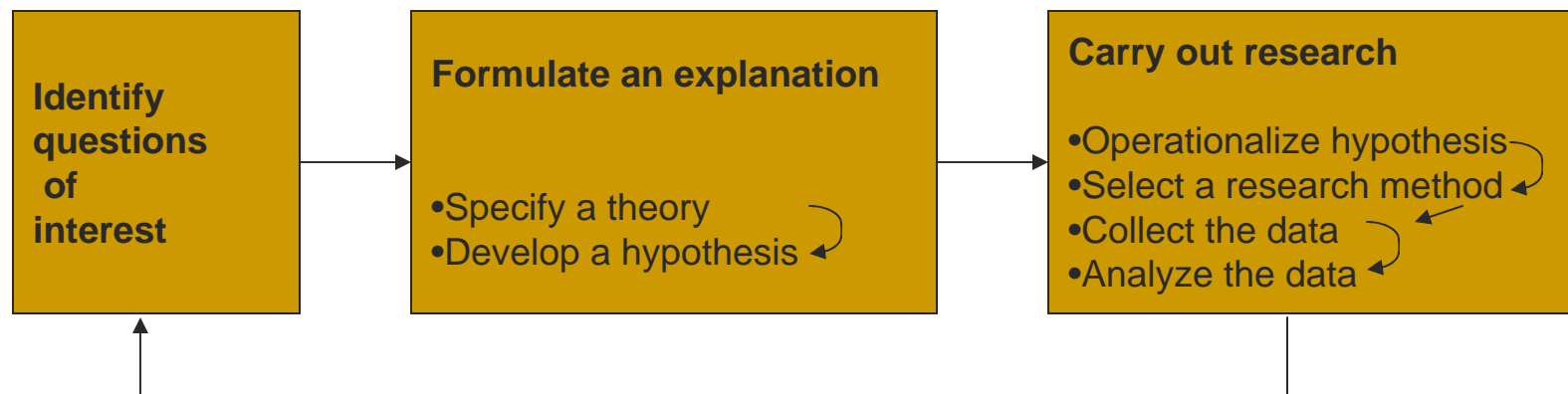
Questions

- What is the scientific method?
- How do we use theory and research to answer questions of interest?
- What are the different methods employed by engineers?
- How do we establish cause-and-effect relationships in research studies?



Scientific Method

- The approach used to systematically acquire knowledge and understanding about the phenomena of interest



[Theories]

- Broad explanations and predictions concerning phenomena of interest.
 - Framework for understanding
 - Relationships
 - Facts or principles
- Example
 - Theory: diffusion of responsibility (Latané and Darley, 1970)
 - The greater the no. of bystanders when calling for helping behavior, the more responsibility for helping is perceived to be shared by all the bystanders.
 - Kitty Genovese
 - Theory: perceived cost of helping (Piliavin and Piliavin, 1972)
 - The perceived cost of helping a victim, rather than a sense of diffused responsibility with other bystanders, primarily determines whether a bystander will help a person in need.
 - Collapsed passenger with cane (bloody vs. bloodless)



[The four canons of science]

- **Determinism**
 - The universe is orderly
 - All events have meaningful, systematic causes
- **Empiricism**
 - To make observations to figure out the order of the of the universe
- **Parsimony**
 - Adoption of the simplest assumption in the formulation of a theory or in the interpretation of data.
 - Occam's razor
 - A rule in science and philosophy stating that entities should not be multiplied needlessly. This rule is interpreted to mean that the simplest of two or more competing theories is preferable and that an explanation for unknown phenomena should first be attempted in terms of what is already known.
- **Testability**
 - Theories can be tested
 - Confirmable or disconfirmable.



[Hypotheses]

- A prediction, stemming from a theory, stated in a way that allows it to be tested.
 - Help to test the validity of theories
 - Question
 - What is the best way to study for a test?
 - Cramming the night before the exam
 - Study over several nights
 - How are questions answered?
 - Research



[Research]

- Systematic inquiry aimed at the discovery of new knowledge.
 - Operationalization
 - The process of translating a hypothesis into specific testable procedures that can be measured and observed.



Classification of Research

- Quantitative vs. Qualitative
- Based on Operationalization method
 - Archival Research
 - Naturalistic Observation
 - Survey Research
 - Case Study
 - Correlational Research
 - Experimental Research



Quantitative vs. Qualitative

Quantitative	Qualitative
Numerical values to variables	Descriptive value to variables
Predetermined categories	No predetermined categories. Promotes documentation of experiences and perspectives
Focuses on specific knowledge and control of variables	Focuses on complex knowledge and real world environments
Repetition	Diverse results, varied
Concise	Detailed
Generalized findings	Detailed findings of specific cases.



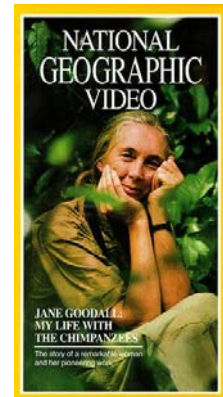
Archival Research

- Existing data examined to test the hypothesis.
- Pros
 - Data is already collected
- Cons
 - Incomplete information
 - Nonexistent data
 - Data collected by chance
- Example: Gender difference in academic performance.



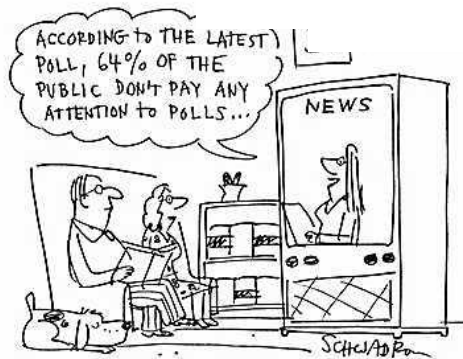
Naturalistic Observation

- Investigator observes some naturally occurring behavior and does not make any changes to the situation.
- Social/behavioral sciences
- Example
 - Jane Goodall, (Goodall, 1986)
 - Chimpanzees, East Africa, 3 decades



Survey Research

- Research in which people chosen to represent a larger population are asked a series of questions about their behavior, thoughts, or attitudes.
 - Infer how a larger group would respond



[Case Study]

- An in-depth, intensive investigation of an individual or small group of samples or population.
 - Emphasize detailed contextual analysis of a limited number of events or conditions and their relationships
 - Pros
 - Success in carefully planned and crafted studies of real-life situations, issues, and problems
 - Many reports on many disciplines
 - Cons
 - A small number of cases can offer no grounds for establishing reliability or generality of findings
 - Intense exposure to study of the case biases the findings
 - Used by Darwin, Marx, and Freud.



Case Study Steps

- Determine and define the research questions
 - The researcher establishes the focus of the study by forming questions about the situation or problem to be studied and determining a purpose for the study.
- Select the cases and determine data gathering and analysis techniques
 - Approaches to use in selecting single or multiple real-life cases to examine in depth and which instruments and data gathering approaches to use.
- Prepare to collect the data
 - Systematic organization of the data
 - Prevent the researcher from becoming overwhelmed by the amount of data
 - Prevent the researcher from losing sight of the original research purpose and questions.
- Collect data in the field
 - Collect and store multiple sources of evidence comprehensively and systematically
 - Patterns can be uncovered
- Evaluate and analyze the data
 - Interpretations in order to find linkages between the research object and the outcomes with reference to the original research questions.
- Prepare the report
 - Convey to the reader evidence that all avenues have been explored
 - Establish boundaries



Correlational Research

- Variable: A measurable factor, characteristic, or attribute of an individual or a system.
- Research that examines the relationship between two sets of variables to determine whether they are associated or “correlated”
 - Linear relationship



Correlational Research

- Pearson correlation coefficient

- Best estimate of the correlation of two variables
- Variables: x , y , N measurements

$$r_{xy} = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(N - 1)S_x S_y}$$

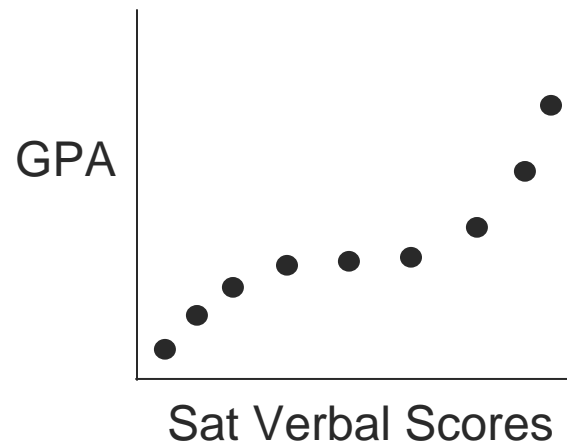
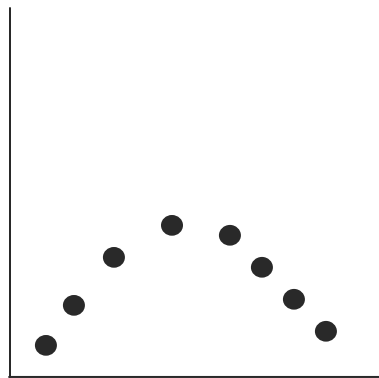
Where \bar{x} is sample mean of x
 \bar{y} is sample mean of y
and
 S_x and S_y are std deviation
of x and y

- High correlation: 1, -1, No correlation: 0
- Range: -1 ↔ 1



Correlational Research

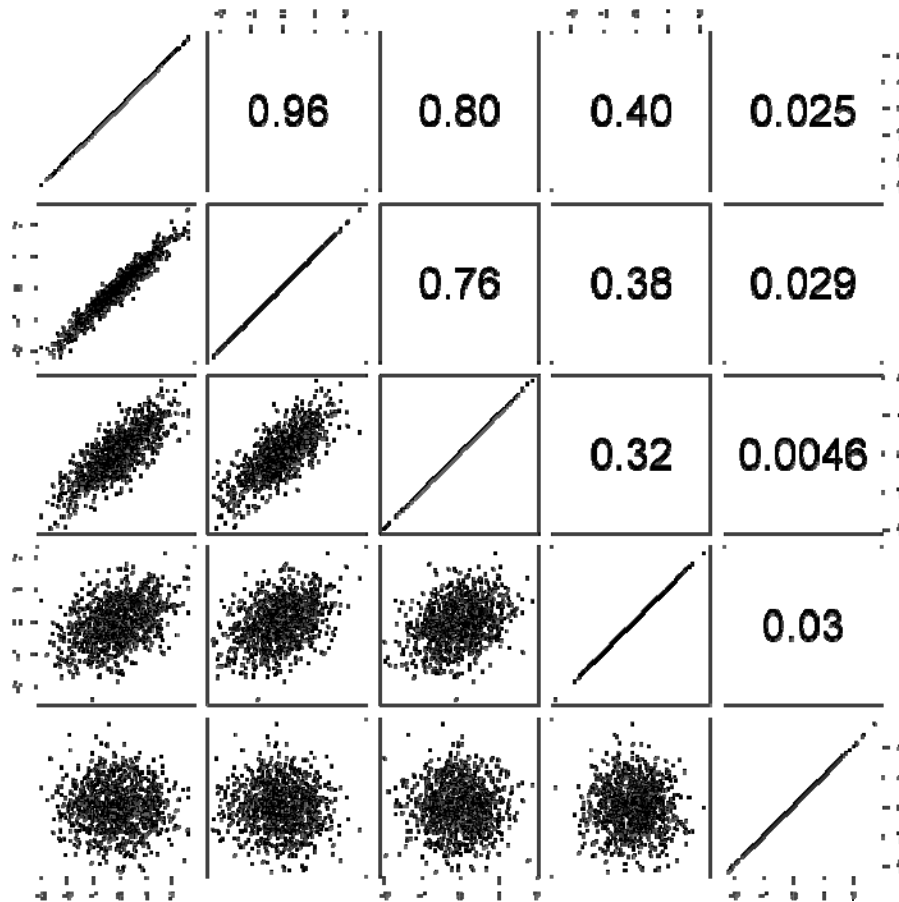
- Careful!!!



- No correlation
- Non linear relationships



Correlational Research



- Simple example of linear correlation.
- 1000 pairs of normally distributed numbers are plotted against one another in each panel (bottom left), and the corresponding correlation coefficient shown (top right).
- Along the diagonal, each set of numbers is plotted against itself, defining a line with correlation +1. Five sets of numbers were used, resulting in 15 pairwise plots.



Correlational Research

- Non causal
 - More study time → Good grades
 - Highly correlated
 - Cause?
 - Interest in the subject → More study time?
 - Correlational studies
 - Strength of relation between two variables
 - Does not demonstrate cause-and-effect



Experimental Research

- Experiment: The investigation of the relationship between two or more variables by deliberately producing a change in one variable in a situation and observing the effects of that change on other aspect of the situation.
- Cause-and-effect



Experimental Research

- Experimental manipulation: Change that an experimenter deliberately produces in a situation
- Treatment: the manipulation implemented by experimenter
- Experimental group: any group receiving a treatment in an experiment



Experimental Research

- In an *observational study*, measurements of variables of interest are observed and recorded, without controlling any factor that might influence their values.
 - Political Poll
- An *experiment*, on the other hand, deliberately imposes some treatment on individuals in order to observe their responses.
 - In principle, only experiments can give good evidence for causation.



[Experiment example]

- *New* “instant breakfast” product.
- To assess its nutritional quality, researchers in the lab feed 30 newly weaned male white rats and measure their weight gains over a 28-day period.
- They randomly select 15 rats and feed them using the new product.
- The other 15 rats receive a standard diet.



Design of Experiments

- **Experimental units:** individuals on which the experiment is done, also called subjects when the units are human beings.
 - The rats
- **Treatment:** the specific experimental condition applied to the units.
 - “instant breakfast” diet
- **Factors:** the explanatory variables, which often have levels.
 - the diet



Principles of Experimental Design

- Control
 - Researcher decides which subjects are assigned to the treatment group
- Randomization
 - Impartial and objective
- Replication
 - Reduces chance variation in the results and can help achieve statistical significance



[Validity]

- The relative accuracy or correctness of the statements.
- Internal validity
 - Information about causality
 - Confident about independence
- External validity
 - Description of what typically happens in the real world
 - Generalizability
- Conceptual validity
 - How well a specific research hypothesis maps onto the broader theory that it was designed to test.



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