Introduction to Empirical Research

Science is a process, not an accumulation of knowledge and/or skill.

"*The scientist is a pervasive skeptic who is willing to tolerate uncertainty and who finds intellectual excitement in creating questions and seeking answers*"

Science has a history that pre-dates recorded fact!!!

Who have been some great scientists?

Hippocrates Gregor Mendel Freud Watson and Crick

Darwin Galileo Oppenheimer Curie

Pasteur Franklin Newton Einstein Bernouilli

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Empirical Research, cont'd.

Some important definitions:

facts: events that can be directly, empirically, and repeatedly observed.

observation: using our senses to recognize and record facts.

inference: conclusions derived from facts or other ideas.

constructs: Non-observable inferred events, that are rationale ideas constructed by the researcher. The constructs are then used as though they are facts.

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Acquiring Knowledge

Unfortunately, **science** is not the only process one can use to view and interpret the world.

G.C. Helmstadter (1970) identified 6 common methods of acquiring knowledge. *(3 are bad, 3 are acceptable)*

Tenacity

Accepted because the idea has been accepted for so long

Intuition

Acceptance based on no process of interpretation of assessment. A "gut feeling"; intuition.

Authority

Accepted due to the high standing of the source.

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Acquiring Knowledge, cont'd.

Tenacity, intuition and authority place few demands on information processing. They assert that something is true because;

1. it has always been so (*tenacity*)
2. we feel it is so (*intuition*)
3. an authority says it is so (*authority*)

My thoughts on exercise physiology?

anaerobic threshold lactic acidosis VO_2max limited by central capacities and function

anaerobic glycolysis Time averaging VO_2 data

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Acquiring Knowledge, cont'd.

Rationalism

Reaching a conclusion through **logic**. This is acceptable, only if the resulting question/interpretation is treated as a hypothesis and tested.

Examples with your field????

Empiricism

Knowledge gained by observation.

Naïve empiricism - , "I will not believe it until I see it".

Sophisticated empiricism - , When indirect measures are used as evidence for the intended observation.

Examples within your field????

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The Empirical Approach

The "*WHY*", "*WHOM*", "*HOW*", and "*WHEN*" of research!

WHY: establishes the need for the study, and generates a series of expected results, or *hypotheses*.

WHOM: what population, and whether the population or a sample

HOW: selection of variables to observe, and how to statistically analyze them

WHEN: establishes the need for the study

Acquired data may be numbers or narrative, depending on the type of research

Quantitative Qualitative

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Empirical Approach, cont'd.

Problem with Rationalism and Empiricism

"If scientists did nothing but collect facts, all we would have is a long list of facts….. Facts are most useful when we can think about them, apply our rationale intelligence to organize them, draw meanings from them, and ***use them to make predictions***."

Science

" Science is a way of thinking that involves continuous and systematic interplay of rationale thought and empirical observation."

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Role of Theory In Research

Theories explain relationships between discrete observations.

- Not all research tests or develops theories
- Most research relies on theories to develop hypotheses.
- Theories can be Deductive or Inductive.

Theory leads to the development of hypotheses

My work on quantifying the acidosis or alkalosis from specific metabolic reactions

Theory formulated from discrete observations

My work on the biochemistry of metabolic acidosis

Typically, inductive theories lead to the possibility to deduce hypotheses and then test these through research.

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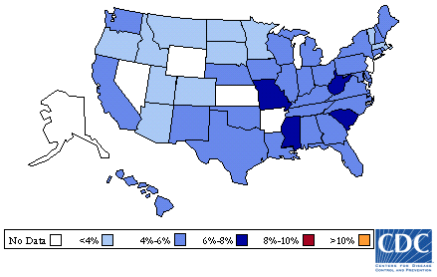
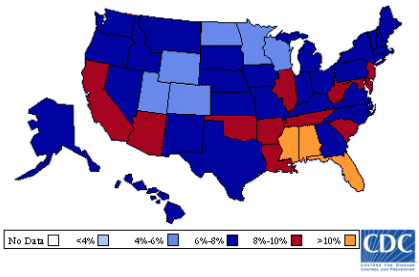
Two Main Types of Empirical Research

Experimental vs. Non-experimental Research

- A treatment or intervention is used to cause a hypothesized change to a series of variables of interest
- Subjects are observed without experimental intervention





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Experimental Research Methods

Best suited for establishing cause-and-effect relationships.

Two Types of Experimental Research

"True" Experimental – when subjects are divided at random into "experimental and "control" groups

Other – when there is no random assignment of subjects into groups

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Experimental with Non-Random Subject Assignment

- ***Matching*** *- subjects are assigned to groups in pairs that are similar as possible on everything other than the variable of interest.*
- ***Cross-sectional*** *- subjects are assigned to groups based on how they differ on the independent (classification) variable. The intervention(s) is/are then applied and the dependent variable(s) are then measured.*
- ***Longitudinal & Time Series*** *- same subjects studied multiple times over time.*

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Types of Non-Experimental Research

Causal-Comparative Research

A type of non-experimental research that can provide the researcher with "*close to*" cause-effect interpretation.

1. True experimental approach prevented for reasons of ethics, cost, legality, etc.
2. Identify your dependent variable (eg. Lung cancer).
3. Study *(from past research and basic physiology)* the cause-effect potentials of this disease.
4. Identify a group of subjects with lung cancer.
5. Identify another group of subjects who do not have lung cancer.

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Causal-Comparative Research

6. Study how the two groups differ on other variables.

7. If there are differences between the groups in other variables, then these *might be* causing, or *related to the cause*, of the lung cancer.

8. Recognize the non-experimental limitations of the method. For example, other variables that are not controlled (*confounding variables*) could be the actual cause of the relationship between lung cancer and your seemingly related variable(s).

The essence of good causal-comparative research is to recognize all potential confounding variables **or events**, *and control them (group selection or statistics)*

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Non-Experimental Research, cont'd.

- Survey or poll – where a sample of a population is studied by either written survey, phone interview, etc.
- Census – as above but the entire population is studied (eg. US census)
- Case Study – typically involves only one subject. Accepted if the subjects possesses unique characteristics that allow for an unusual thorough investigation of potential causes for the condition. Most common in medical research, such as when a new for of disease or infection is noted (eg. SARS).

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Types of Non-Experimental Research

- Field Research – Thorough investigation of a group of subjects in their naturalistic setting (on location).
- Longitudinal Research – Repeatedly measure traits of a group of subjects repeatedly over time.
- Correlational Research – Provides the extent of a relationship between two or more variables. Regression is then used to predict outcomes.
- Historical Research – Attempt to understand the dynamics of human history through historical documents.
- Combinations of some of the above methods also exist – eg. epidemiology

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Confounding Events

Maturation	Changes in the dependent variable that occur during the course of a study that are due to the normal maturation of the participant
History	Changes in the dependent variable that are due to historical events that occur during the study but are unrelated to the study
Testing	Any change in a participant's score on the dependent variable that is a function of having been tested previously
Instrumentation	Any change in the calibration of the measuring instrument or procedure over the course of the study that affects the scores on the dependent variable
Regression to the mean	The tendency for participants who are selected because they have extreme scores on a variable to be less extreme in a follow-up testing
Selection	Any factor that creates groups that are not equivalent at the beginning of the study
Attrition	The loss of participants during a study; differential loss is problematic because the participants who drop out are likely to be different from those who continue
Diffusion of treatment	Change in the response of participants in a particular condition because of information the participants gained about other research conditions from participants in those other conditions
Sequence effects	Effects on a participant's performance in later conditions that result from the experience the participant had in the previous conditions of the study

Maturation as a Confounding Event

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Variables

Independent Variable (IV) – What is causing a change in another variable of interest

Dependent Variable (DV) – the variable of interest (what is measured)

In experimental research, the IV is the manipulated variable

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Tabulating Research Designs and Variables

Does the size of the school influence the knowledge of NCAA rules by student advisors?

IV or Factor

3 Levels or categories

	IV=School Size		
	Small	Medium	Large
DV =	knowledge	knowledge	knowledge

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Tabulating Research Designs and Variables

Is there a gender difference in learning different subjects?

2 Factors

4 Levels

	IV_1=School Subject			
IV_2=Gender	Math	Science	English	Music
Male	Grade	Grade	Grade	Grade
Female	Grade	Grade	Grade	Grade

2 Levels

DV = Grade

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