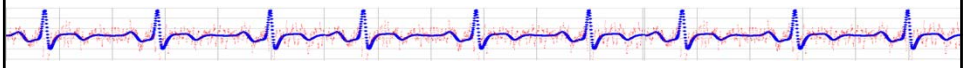
# Empirical Research Methods in Information Science

## IS U580



Lecture 2

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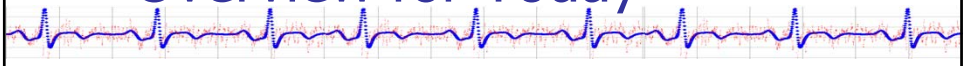
## Overview for Today



- The Scientific Method
- Sample Research Plan
- Doing Background Research

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## But first…

- Why are we using psychology texts in an IS/PHI/CS course?

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## B&A Ch 1: Scientific Explanations

Why important?

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## Why care about research methodology, even if you don't plan to become a researcher?

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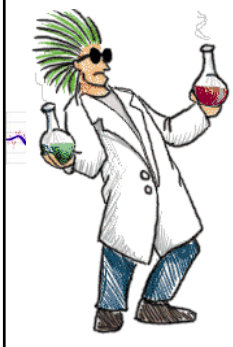
## What is science?



A set of methods used to collect information about phenomena in a particular area of interest, and build a reliable knowledge base about them

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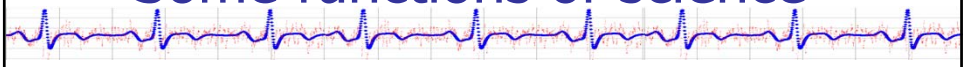
## Some functions of science



- Describe the world
- Explain phenomena
- Predict phenomena

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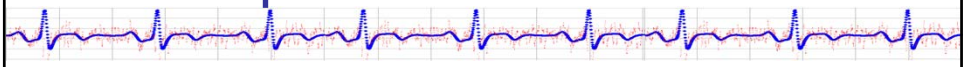
## Examples of non-science?



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## Science vs. Non-science vs. Pseudoscience

- Science – generally follows scientific method
- Nonscience – does not follow scientific method but is up front about it (e.g., philosophy)
  - Commonsense explanation
  - Belief-based explanation
  - Rationalistic explanation
- Pseudoscience – does not follow scientific method, but tries to pass off as science (e.g., phrenology)

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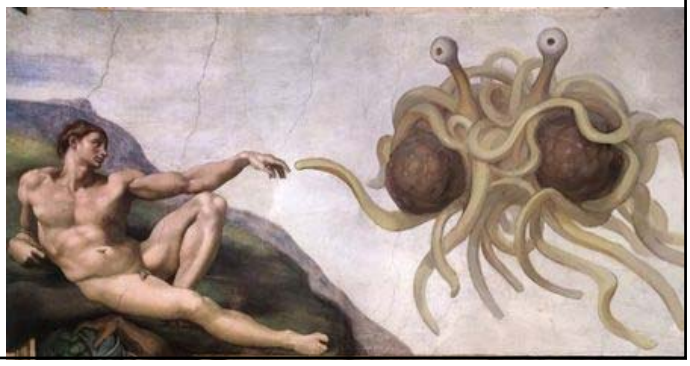
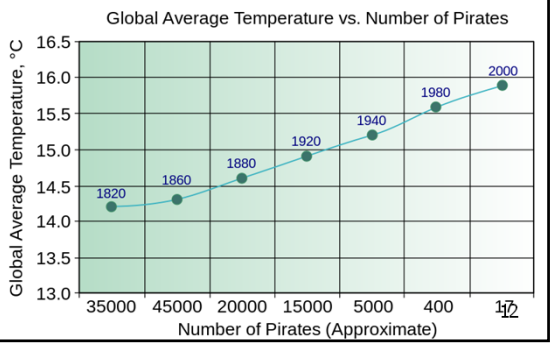
## Pseudoscience: Flying Spaghetti Monster

- **Pastafarianism**
- A parody religion to counter creationism.



# Global Warming as Proof of *His Noodly Appendage*

- Pirates are "absolute divine beings" and the original Pastafarians.
- Global warming, earthquakes, hurricanes, and other natural disasters are a direct effect of the shrinking numbers of pirates since the 1800s.
- Correlation does not imply causation.

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# What kinds of explanations do these provide?

- Astrology
- Medicine
- Personal experience
- Philosophy
- Phrenology
- Physics
- Religion
- Creationism
- Mathematics

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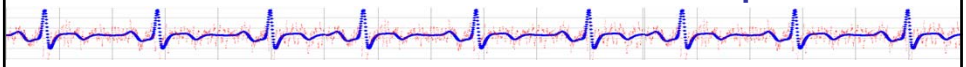
## Characteristics of Scientific Explanations



- *Scientific explanations are EMPIRICAL*
  - They are based on objective, systematic observations
- *Scientific explanations are RATIONAL*
  - They follow the rules of logic and are consistent with known facts
- *Scientific explanations are TESTABLE*
  - They are verifiable through observation and can be disproved

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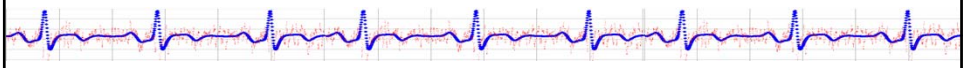

- *Scientific explanations are GENERAL*
  - They apply beyond the original observations on which they are based
- *Scientific explanations are PARSIMONIOUS*
  - They provide the simplest explanation using the fewest possible assumptions

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- *Scientific explanations are TENTATIVE*
  - They are never accepted as absolutely correct
- *Scientific explanations are RIGOROUSLY EVALUATED*
  - They are constantly evaluated for consistency with evidence, generality, and parsimony

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## Scientific vs. Nonscientific Explanations

| Explanation Type | Empirical | Rational | Testable | Parsimony | General | Tentative | Rigorously Evaluated |
|---|---|---|---|---|---|---|---|
| Scientific | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Belief Based | No | No | No | No | No | No | No |
| Common-sense | No | No | Maybe | No | No | No | Maybe |

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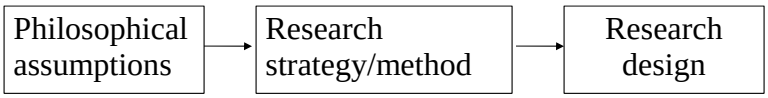
# Research method

A strategy of inquiry, which moves from underlying philosophical assumptions to a research design

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# Research Methods

- Different disciplines have different methods and techniques
  - Ethnography, Conversation Analysis study individuals in detail
    - A single sample is worthy of study
    - Generality not an issue

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## Research Methods

- Method of Authority
  - Authoritative source (e.g., book or expert) consulted
  - Useful in early stages of science
- *Critique?*

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## Research Methods

- The Rational Method
  - Self-evident truths (axioms)
  - Logical reasoning
- *Critique?*

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# Research Methods: The Scientific Method

1. Observe a phenomenon
2. Formulate testable explanations (hypotheses)
3. Further observe and experiment
4. Refine and retest explanations

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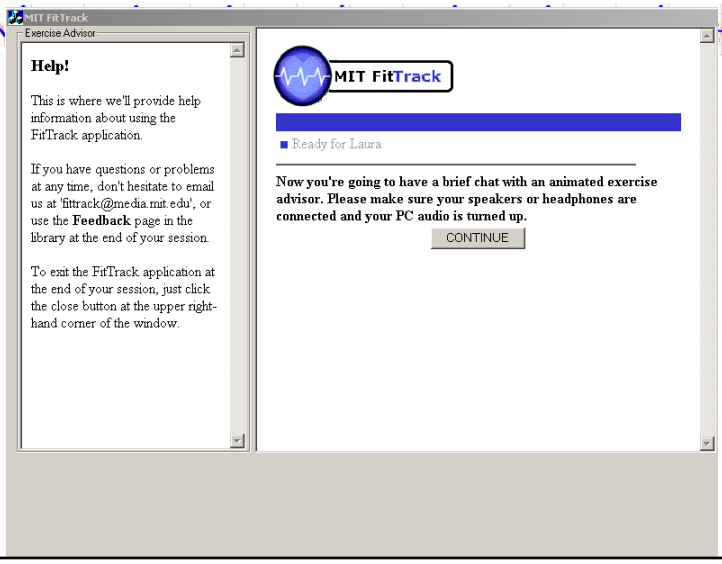
# Example: Repetitiveness in Counseling Agents – Day 2

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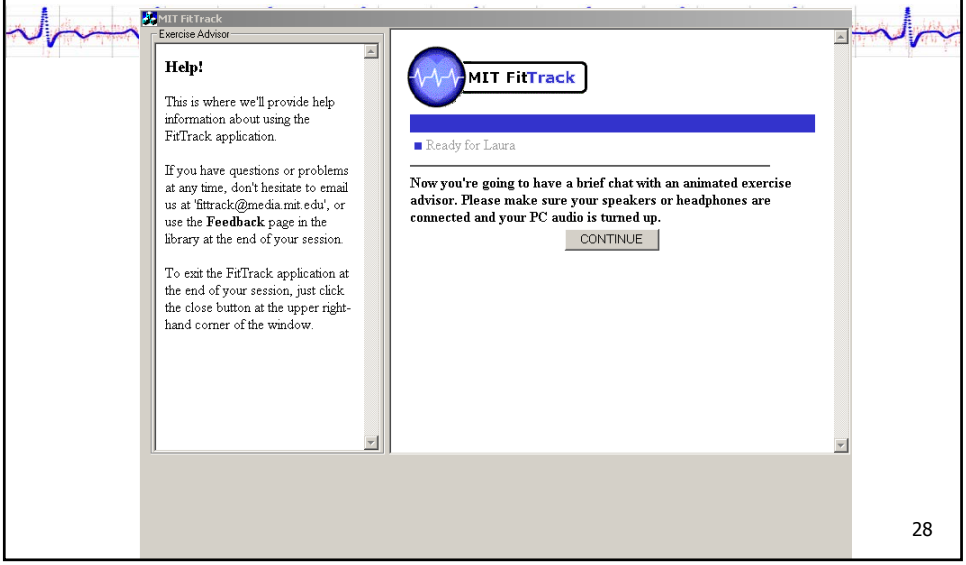
# Example: Repetitiveness in Counseling Agents – Day 3

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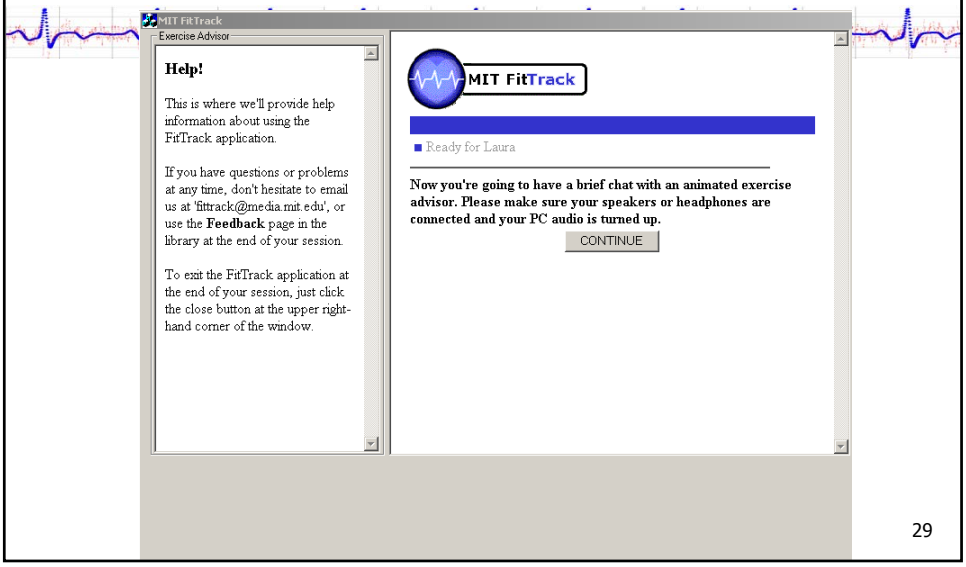
# Example: Repetitiveness in Counseling Agents – Day 4

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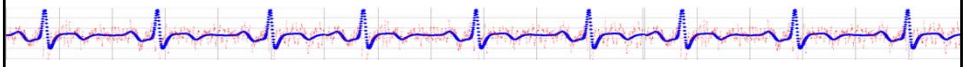
# Example: Repetitiveness in Counseling Agents



- The first couple of days I was impressed by it. But, there didn't seem to be a lot of variety going on after that, so it kind of lost my interest, it lost the engagement factor. Maybe, six or seven days into the study I could almost predict what she was going to say, and once the engagement was lost you sort of lose the power of the animated instructor. ...
- In the beginning I was extremely motivated to do whatever Laura asked of me, because I thought that every response was a new response. Whereas, towards the end I could tell what she was going to say to a couple of my responses.

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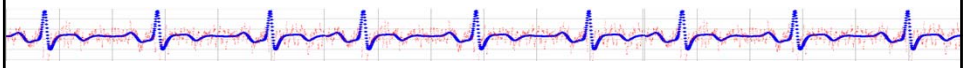
# Example: Repetitiveness in Counseling Agents



Hypotheses:

H1. Reduced superficial variability increases perceived repetitiveness.
H2. Reduced superficial variability decreases engagement.
H3. Reduced superficial variability has negative effect on outcomes.

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## Example: Repetitiveness Experiment Design

- Physical activity intervention to promote daily walking.
- Between-subjects, 2 conditions.

1. **NONVARIABLE**: agent uses exactly the same dialogue structure and language in every situation.
2. **VARIABLE**: dialogue structure, surface form, and background image are randomly varied.

## Example: Repetitiveness Variability: Surface Form

"Looks like you met your exercise goal of 5,000 steps. Great job!"

"Looks like you got your walking in and met your goal of 5,000 steps!"

# Example: Repetitiveness Variability: Dialogue Structure

1. Greeting
2. Weather talk
3. Past event talk
4. Read pedometer
5. Follow up on behavior
6. Ask enjoyment
7. Get commitment
8. Upcoming event talk
9. Farewell

1. Greeting
2. Read pedometer
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# Example: Repetitiveness Variability: Background

## Example: Repetitiveness Measures

- Steps per day (Omron HJ-720ITC pedometer).
- Desire to continue (5-item rating scale)
- Perceived repetitiveness (5-item rating scale)

Steps assessed daily

Self-report assessed at each session (up to daily)

## Example: Repetitiveness Study Participants

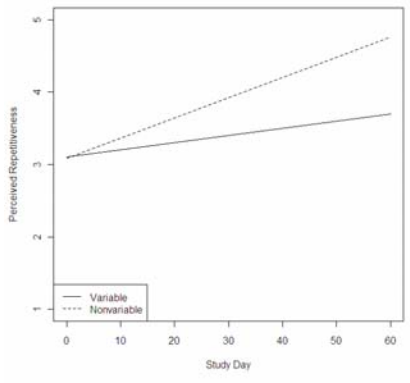
- N=24
- 17 female, 7 male
- Ages 55-75
- Not currently regularly exercising
- 40-120 days of interaction with the system (mean 82.25)

# Example: Repetitiveness Statistical Analysis

- For some outcome *y* for subject *i* at time *j:*
- Start with a linear model of change over time.
- Add random effects to account for clustered data (multiple measurements per subject):
  - $\gamma_{0i}$ and $\gamma_{1i}$ model individual differences in intercept and slope.
  - We assume that both are normally distributed.

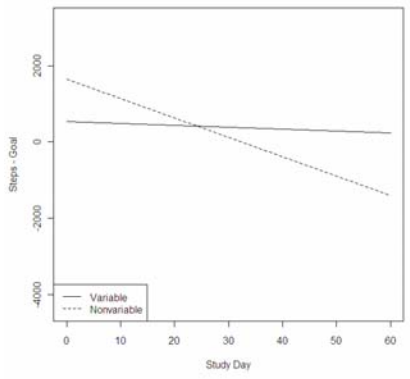
$$y_{ij} = \beta_0 + \beta_1 day_{ij} + \beta_2 cond_i + \beta_3 day_{ij} cond_i + \varepsilon_{ij} + \gamma_{0i} + \gamma_{1i} day_{ij}$$

# Results: Perceived Repetitiveness




- Near-significantly greater increase in perceived repetitiveness in NONVARIABLE
  - B=0.018, p≈0.051

# Results: Performance relative to Goals




- Significantly greater decrease in performance over time in NONVARIABLE
  - B=-45.77, p<0.01

# Example: Repetitiveness in Counseling Agents

Hypotheses:

√ H1. Reduced superficial variability increases perceived repetitiveness.

**X** H2. Reduced superficial variability decreases engagement.

√ H3. Reduced superficial variability has negative effect on outcomes.

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## Is this study basic or applied research?

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## The Scientific Method

1. Observe a phenomenon
2. Formulate testable explanations (hypotheses)
3. Further observe and experiment
4. Refine and retest explanations

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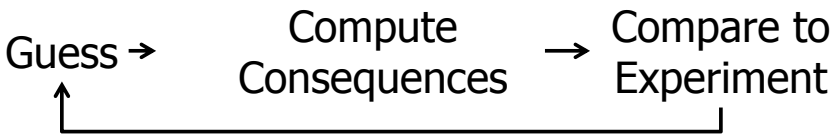
# Feynman's Model




"falsifiability criterion"

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# The Scientific Method

1. Observe a phenomenon
2. Formulate testable explanations (hypotheses)
3. Further observe and experiment
4. Refine and retest explanations

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## Example

Your boss says that someone complained to her that your company website sucks. How would you use the scientific method to investigate this?

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## Science Gone Bad

- Intentionally
- Unintentionally

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## Is this science?

## Reliability of the scientific method

- Reliability = ability to get same results under the same conditions.
- Experiments are repeatable.
- Subsequent failures to repeat earlier results invalidate "proven" hypotheses.
- The scientific method is self-correcting.

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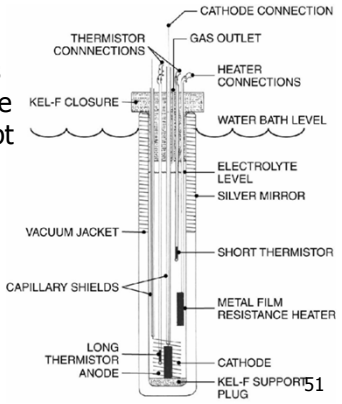
# Cold Fusion

- A nuclear reaction that occurs at room temperature.
- Gained attention after reports in 1989 by Pons and Fleischmann, that their apparatus had produced "excess heat", of a magnitude they asserted would defy explanation except in terms of nuclear processes.
- They reported measuring small amounts of nuclear reaction byproducts, including neutrons and tritium.

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# Cold Fusion

- Results received wide media attention, and raised hopes of a cheap and abundant source of energy.
- Many scientists tried to replicate the experiment.
- Evidence against
  - Large number of negative replications
  - Withdrawal of many positive replications
  - Discovery of flaws in the original experiment
  - Discovery that Fleischmann and Pons had not actually detected nuclear reaction byproducts.

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# The Research Process

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# The Steps of the Research Process

1. Developing an idea and a hypothesis
2. Doing background research
3. Choosing an appropriate research design
4. Choosing an appropriate unit of study (e.g., which human subjects, which organizations, which systems, etc.)
5. Deciding on what to measure and how
6. Writing research plan
7. Conducting a study
8. Analyzing data
9. Reporting results

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## Sample Research Plan

Embodied Conversational Agents to Promote Health Literacy for Older Adults

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## Sample Research Plan

- Health literacy
- Older adults
- Diabetes

## Sample Research Plan

- Hypotheses
  - Agents will lead to greater knowledge gains (regarding diabetes) compared to "standard of care" (brochures)
  - Ditto for glycemic control
  - Ditto for patient satisfaction

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## Sample Research Plan

- What are the units of study?
- What are the variables?
- How measured?
- What are the time points of interest?

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# Sample Research Plan

**Embodied Conversational Agents to Promote Health Literacy for Older Adults**

**A. SPECIFIC AIMS**
**B. BACKGROUND AND SIGNIFICANCE**
**C. PRELIMINARY STUDIES**
**D. RESEARCH DESIGN AND METHODS**
**E. HUMAN SUBJECTS**

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# Sample Research Plan

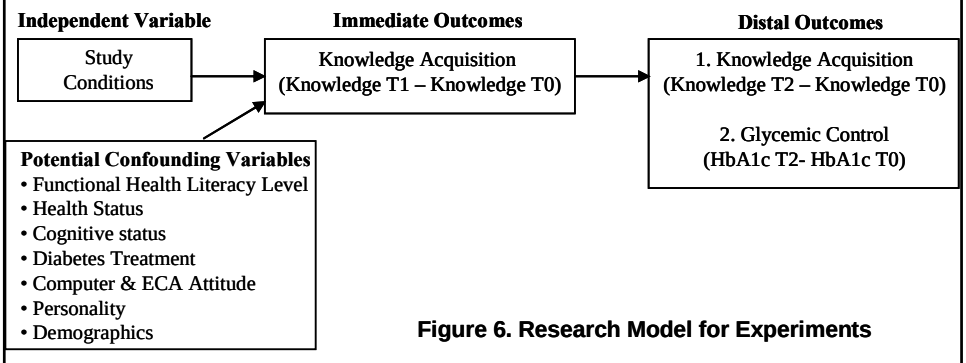


**Figure 6. Research Model for Experiments**

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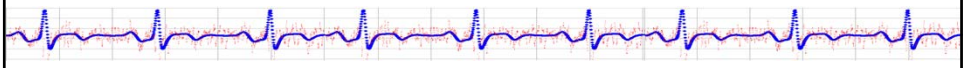
## Exercise



Design a study following the scientific method

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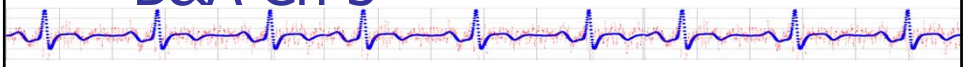
## B&A Ch 3



*Focus on*

Doing Background Research

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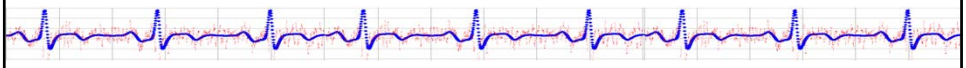
# Why do background research?



*Most important take-away from this chapter…*

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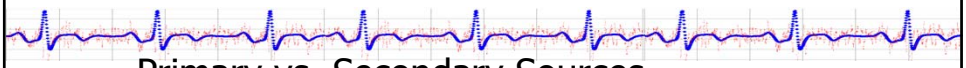
# Sources of Research Information



- Primary vs. Secondary Sources
  - A *primary source* includes a full report of a research study, including methodological details
    - Primary sources are preferred
  - A *secondary source* summarizes information from a primary source
    - These should be used sparingly, because they may be
      - incomplete
      - biased
      - inaccurate

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# Which is better? How can you tell?

- Magazine – substantive (SciAm)
- Journal – refereed (JAMA)
- Sensationalist Tabloid (Enquirer)
- Book – single author
- Newspaper (Globe)
- Magazine – popular (Wired)
- Conference paper
- Book – edited collection
- Open source / Online Journal

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# Differences Between Published Sources

| Example? | Scholarly | Substantive | Popular | Sensational |
|---|---|---|---|---|
| **Appearance** | Sober and serious | Attractive, with photographs | Attractive with many photos | Newspaper format |
| **Reference Citations** | Always provided | Sometimes cited | Rarely provided | Obscure references |
| **Author** | Scholar in the field | Scholar, editorial staff, freelance | Wide range of authors | Wide range |
| **Language** | Geared to scholars | For educated, no specialty | Simple, for less educated | Elementary for gullible audience |
| **Content** | Original research | No original research | Sources mentioned, may be obscure | Pseudoscientific sources |
| **Publisher** | Many by professional organizations | Commercial or professional organization | Commercial to entertain | Commercial to arouse curiosity |

## Genius or Bozo?

- **King, A.**, **Haskell, W.**, **Taylor, C.**, **Kraemer, H.**, and **DeBusk, R.**: Group vs. home-based exercise training in healthy older men and women. JAMA 266, 1991) 1535-1542.
  - King: Stanford Prof.

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## Genius or Bozo?

- McClusky, M. *Review: Canon Powershot A640 Digital Camera,* Wired Blog, 1/12/07.

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## Genius or Bozo?

- Nass, C. and Gong, L.: Is Maximization or Consistency the More Social? The Case of Synthesized Voices and Faces. Proceedings of CHI '00 (2000)
  - Prof. Stanford

72

## Genius or Bozo?

- Dorfman, P. *Measurement and Meaning of Recreation Satisfaction: A Case Study in Camping*, Environment and Behavior, Vol. 11, No. 4, 483-510 (1979)
  - Prof at U. NM

73

## Genius or Bozo?

- Grundel, C. Schneider-Hufschmidt, M. *A direct manipulation user interface for the control of communication processes - making call handling manageable*, Proceedings HCI International '99.

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## How do you do a literature review?

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## Tip

- To find the "seminal" articles in a field, look for number of citations
  - e.g., Web Of Science (at Boston Public Library)

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## Some Literature Searching Tools at Northeastern

- *ACM Digital Library*
  - ACM affiliated journals, conference proceedings, etc.
- *IEEE/Explore*
  - IEEE affiliated journals, conference proceedings, etc.
- *PsycINFO*
  - Indexes over 1,800 journals in 25 languages (1872 to the present)
- And don't forget *Google Scholar (scholar.google.com)*
  - Most CS conference & journal articles are on the web.
- Also *Citeseer (citeseer.ist.psu.edu*)
- And for the PHI crowd: PubMed

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## Standard format for quantitative study report

- Introduction
- Methods
- Results
- Discussion

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## How do you tell if a study report is credible?

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## Study Report Evaluation

- Author & Affiliation
- Introduction
- Methods
- Results
- Discussion

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## Factors Affecting the Quality of Research Information

- Statistical Significance
  - Journals typically do not publish findings that do not meet the minimum .05 level of statistical significance
  - *File drawer* phenomenon: Findings that don't reach significance at .05 end up in the file drawer
    - If 100 articles about a phenomena are studied…
    - How to prevent?
  - "Effect Size" also important when interpreting significance – more on this later.

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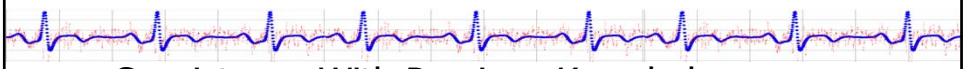

- Consistency With Previous Knowledge
  - Research results are expected to build on what came before
  - Results that don't fit within current thinking are suspect
  - Anomalous findings are treated with suspicion and may not get published in mainstream journals
  - An anomalous finding may be important, but ignored

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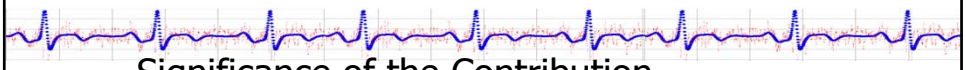

- Significance of the Contribution
  - Do findings advance knowledge in science?
  - Currently, many journals will not publish single experiments
    - Require a series of experiments
    - This requirement may delay publication of important results until all studies are completed
- Editorial Policy
  - A journal editor may set a policy that favors certain research topics and excludes others
  - An editor's choice of reviewers may be biased

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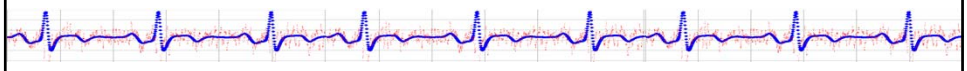

- Peer Review
  - Articles submitted for publication are reviewed by experts in the field (usually *blind reviewers*)
  - Intended to ensure quality research is published
  - The process is time-honored, but has problems
    - Personal feelings of reviewers can bias review
    - Agreement with reviewer's view enhances chances of publication
    - Low rates of inter-reviewer agreement

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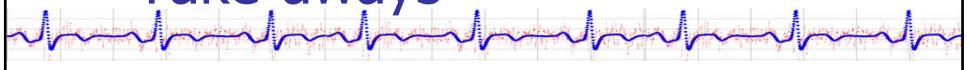
## Take-aways



- The scientific method is the best way we know to make valid and reliable claims about the physical world.
- The first step in doing any research is going to the library.

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# Homework 2-3

1. Describe how knowledge acquired from conducting the study specified in the sample research plan meets (or does not meet) the criteria for "scientific explanations".
2. Describe the roles that background research play in the sample research plan, giving an example of each.
3. Find at least three technical references that relate to the proposed study in different ways. For each, give the full citation, describe how you found it, and describe how it contributes to the research plan.

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# Homework

- Read B&A Ch 6 & 7
- Start Homework 2-3

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