

HKBM7000

Approaches to Research and Academic Communications Day 1 (31 July 2021)

Logics and Philosophies of Science and Research

[1]

Topics

- Introduction
- Scientific Method
- Developing a Methodology
 - Meditation Example
- Connection to Empirical Papers
- The Research Plan
- Logics of the Scientific Method
- Reproducibility and Other Issues Related to Doing "Good Science"

[2]

INTRODUCTION

[3]

Course Objectives

- Evaluate Research
 - Understand research process
 - Read journal articles effectively
 - Critically evaluate media reports
- Conduct research
 - Develop research ideas/questions
 - Develop appropriate methods/measures
 - Analyze data (introduction to R)/draw conclusions
- Communicate effectively
 - Written reports
 - Oral presentations
 - Importance of visual representations

[4]

Readings

- Malhotra, Naresh K. (2010), Marketing Research: An Applied Orientation, 6rd edition, Pearson.
- Additional readings will be listed
- Recommended: Khan Academy Stats videos

[5]

Course Requirements

- Written Assignment
- Oral Presentation

[6]

Goals of Research

- Why do we conduct research?
 - To provide scientific understanding
 - Curiosity guided by theories and data
 - To solve practical problems

[7]

Evaluating Research

- Why do we evaluate research?
 - How do academicians and business practitioners use research findings?
 - What get published in journal articles?
 - Become an educated consumer of research studies
 - Become a critical thinker

[8]

Components of a Theoretical Model

- **Independent variable (IV)**
 - The cause
 - predictor, antecedent, factor
- **Dependent variable (DV)**
 - The outcome
 - effect
- **Control variable**
 - Should be held constant in experiments
 - Should be measured and statistically controlled in survey data

[9]

Confounding Variables

- **Confounding variable**
 - Varies with or contaminate the IV
 - Threat to internal validity
- Critical thinking about research involves
 - Looking for design flaws, such as confounding
 - Making informed judgments

[10]

TASK 1

- Can music enhance work performance or not?
- How to answer this question?

[11]

SCIENTIFIC METHOD

[12]

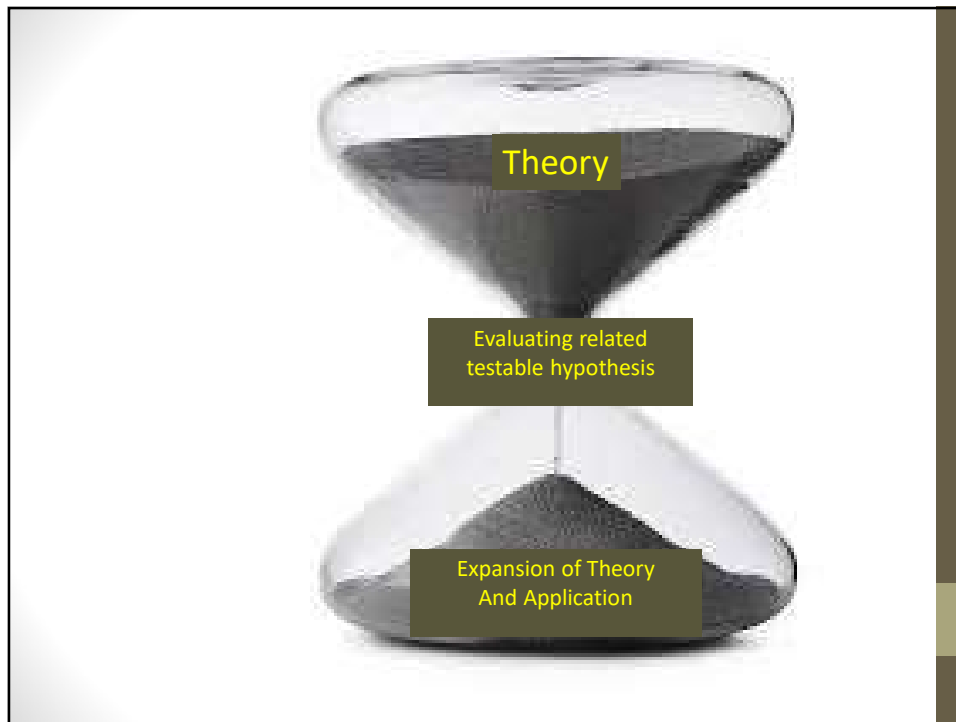
What is the Scientific Method?

[13]

What is the Scientific Method?

- Empirical approach
 - Data- or evidence-based
 - Operationalization of variables
- Logical inferences
 - Induction
 - Deduction
- Replicability (Reproducibility)

[14]



Scientific Method vs. Confirmation Bias

- Problem of confirmation bias
 - Noticing supportive evidence
 - Ignoring disconfirming evidence
- Everyday examples?
- Science examples?

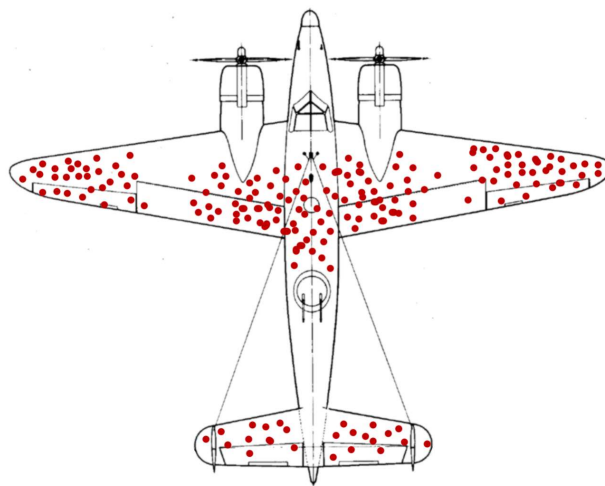
In Water, Water Everywhere

- Evidence of Confirmation Bias
- <https://www.nature.com/articles/d41586-020-01284-x>
- <https://theconversation.com/donald-trump-is-taking-hydroxychloroquine-to-ward-off-covid-19-is-that-wise-139031>
- The File Drawer Problem



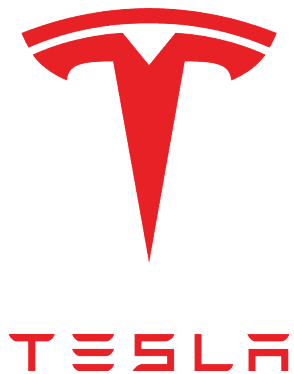
[17]

Survivor Bias



[18]

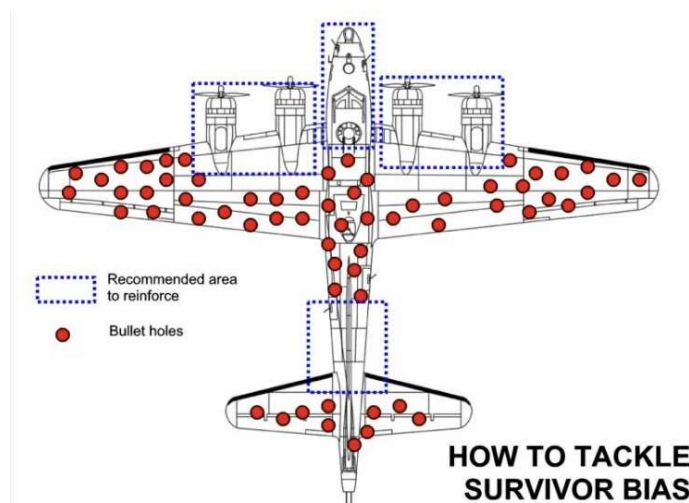
What management theories can we develop from this company?



- Tesla overtakes Toyota as the world's most valuable car maker.
- <https://hk.asiatatler.com/life/tesla-worlds-most-valuable-automaker>
- What can we learn from this story?

[19]

How to Tackle Survivor Bias



[20]

DEVELOPING A METHODOLOGY

[21]

Introduction to Developing an Empirical Study

Observation: Meditation helps people

Theory: Meditation improves ability to focus



Hypothesis: Meditation will improve worker performance

Step 1: Literature review

Identify benefits of meditation that relate to worker performance

[22]

Introduction to Developing an Empirical Study

Hypothesis:

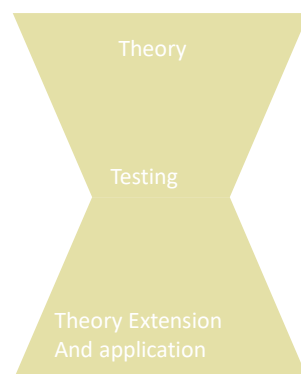
Meditation will improve worker performance

Step 2: Develop a method

- Who are your participants? (age, gender, etc.)
- What are they works? (office workers, salespeople, etc.)
- Operationalize IV and DV
 - What type of meditation?
 - What is/are your control(s)?
 - What are you measuring? When? How? etc.

[23]

Introduction to Developing an Empirical Study



[24]

Theory Extension

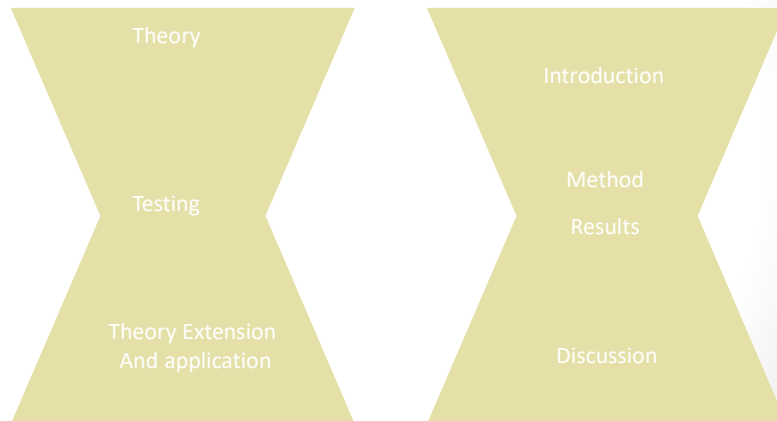
- What are the underlying mechanisms?
 - Mediators
 - E.g., *Chi* (氣)
- Are there conditions in which the effects are more or less significant?
 - Moderations
 - E.g., music

[25]

CONNECTION TO EMPIRICAL PAPERS

[26]

Reading/Writing an empirical paper



[27]

Empirical Papers – How to read them: Knowing the Structure

- Title
- Abstract
- Introduction
- Method
- Results
- Discussion
- References

- Plus Tables and Figures

[28]

Goal:

Deep understanding for class

- Identify strategies
 - Do you start at the beginning and read all the way through?
 - If not, what do you do?
 - What do you look for in each section?
 - What is most challenging? Why?
 - What gets most focus? Why?

[29]

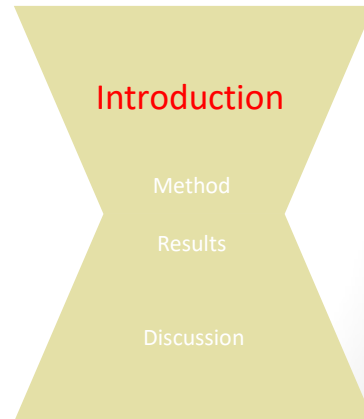
Title and Abstract

- What is paper about?
- Can you understand the abstract?
- What can you guess about the article?
- Is it relevant to your needs?
- Abstract - the structure (often)
 - Intro
 - Method
 - Results
 - Discussion

[30]

Introduction

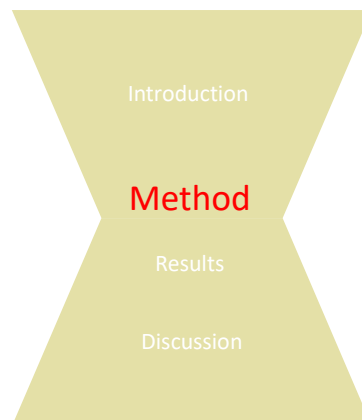
- Skim first
- Motivation/Rationale
- Literature review
- Hypotheses



[31]

Method

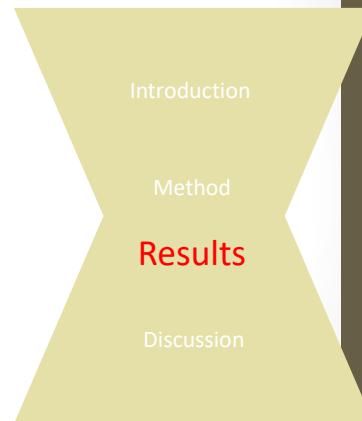
- Participants
- Materials
- Procedure
- Measures



[32]

Results

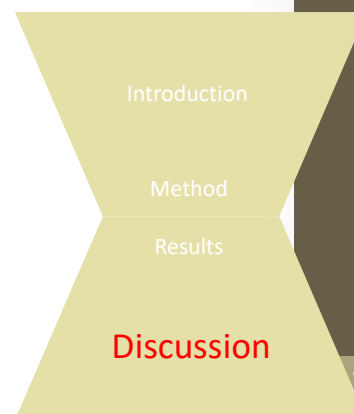
- Descriptive Statistics
- Means comparisons
- Correlations/Regressions
- Assorted other tests ☺
- Statistically significant
 - Surprising
 - Unlikely to occur by chance
- ★ • Tables and Figures
 - Important results



[33]

Discussion

- Central results in theoretical context
 - Consistent with predictions?
 - Results explained?
- ★ • Implications?
- Suggestions?
- Do you agree?



An example

- Luk, C.L., Yau, O.H.M., Sin, L.Y.M., Tse, A.C.B., Chow, R.P.M., & Lee, J.S.Y. (2008). The effects of social capital and organizational innovativeness in different institutional contexts. *Journal of International Business Studies*, 39 (4), 589-612.

[35]

THE RESEARCH PLAN

[36]

Typical Steps of a Research

- Get an idea
- Formulate a **testable hypothesis**
- Review the literature
- Conduct **pilot research**
- Conduct the research
- Analyze the results
- Interpret the results
- Prepare an article or presentation

[37]

Sources of Research Ideas

- Observation
 - Look around with a critical eye
 - Phrase your question for additional observations
 - Motivated by
 - Innate curiosity
 - Need to solve a particular problem
- Experts
 - Professors, instructors, authors of journal articles, textbooks
- Literature Search
 - Journal articles, edited books, book chapters
 - Tips: Keep record of your research ideas
 - Authors' names, journal and article titles, information about the methods and results
- Search engines
 - PsycINFO
 - Google scholar



<http://petrook.org/wp-content/uploads/2012/04/google-scholar1.gif>

[38]

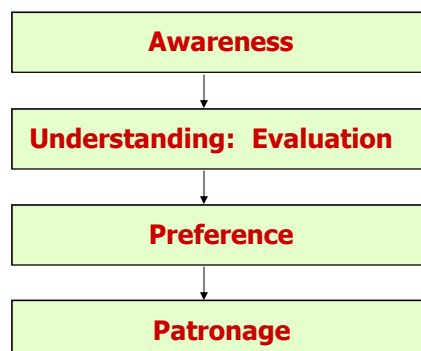
Models

An **analytical model** is a set of variables and their interrelationships designed to represent, in whole or in part, some real system or process.

In **verbal models**, the variables and their relationships are stated in prose form. Such models may be mere restatements of the main tenets of a theory.

Graphical Models

Graphical models are visual. They are used to isolate variables and to suggest directions of relationships but are not designed to provide numerical results.



Mathematical Models

Mathematical models explicitly specify the relationships among variables, usually in equation form.

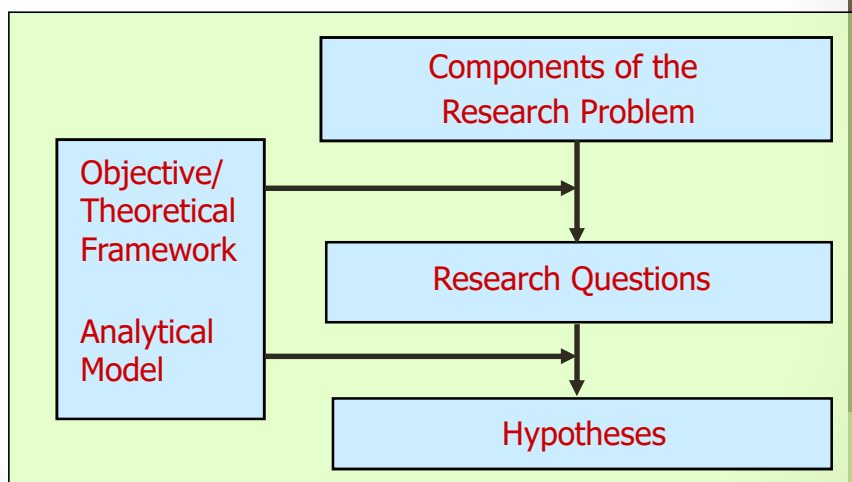
$$y = a_0 + \sum_{i=1}^n a_i x_i$$

Where

y = degree of preference

a_0, a_i = model parameters to be estimated statistically

Development of Research Questions and Hypotheses



Research Questions and Hypotheses

- **Research questions** (RQs) are refined statements of the specific components of the problem.
- A **hypothesis** (H) is an unproven statement or proposition about a factor or phenomenon that is of interest to the researcher. Often, a hypothesis is a possible answer to the research question.

Developing Testable Hypotheses

- A presumed or theoretical relation between two or more variables
 - Implies that variables are **measurable**
 - Specifies the relation among the variables

TASK 2:

Identify Testable Hypotheses

- Are these statements testable?
 - The U.S. would not have become involved in World War II if the Japanese had not bombed Pearl Harbor.
 - College students consume more beer per capita than any other age group.
 - Our actions sometimes reflect conscious intentions, but they are usually governed by unconscious urges.
 - Diamonds are a good investment.
 - You learn more information when studying for an essay test than when studying for a multiple-choice test.

[45]

TASK 3:

Develop Testable Hypotheses

- Write down 3 testable hypotheses on a piece of paper
- Evaluate whether the hypotheses of your classmates are testable? And how?

[46]

[http://www.willcomminc.com/images/pi_s
ect_2_photo.gif](http://www.willcomminc.com/images/pi_s
ect_2_photo.gif)

Reviewing the Literature

- Determine what is known about your hypothesis
 - Do not “reinvent the wheel”
 - Whether your hypothesis has been tested
 - Important things for you to consider in developing your research project
- Journal articles
- Reference lists
 - Why is there a reference list at the end of a journal article?
- Subject index of textbooks

[47]

Example: Department Store Project

- RQ: Do the customers of Sears exhibit store loyalty?
- H1: Customers who are store-loyal are less knowledgeable about the shopping environment.
- H2: Store-loyal customers are more risk-averse than are non-loyal customers.

Department Store Project

Specification of Information Needed

Component 1

- The researcher identified the following factors as part of the choice criteria: quality of merchandise, variety and assortment of merchandise, returns and adjustment policy, service of store personnel, prices, convenience of location, layout of store, credit and billing policies. The respondents should be asked to rate the importance of each factor as it influences their store selection.

Component 2

- The researcher identified nine department stores as competitors to Sears based on discussions with management. The respondents should be asked to evaluate Sears and its nine competitors on the eight choice criteria factors.

Department Store Project

Component 3

- 16 different product categories were selected, including women's dresses, women's sportswear, lingerie and body fashion, junior merchandise, men's apparel, cosmetics, jewelry, shoes, sheets and towels, furniture and bedding, and draperies. The respondents should be asked whether they shop at each of the 10 stores for each of the 16 product categories.

Component 4

- No additional information needs to be obtained from the respondents.

Department Store Project

Component 5

- Information should be obtained on the standard demographic characteristics and the psychographic characteristics of store loyalty, credit use, appearance consciousness, and combining shopping with eating.

TASK 4: Collect Research Ideas

- Duration: 30 minutes
- Group Size: 5
- Instructions
 - Select a hypothesis from those generated in Task 3
 - Report on a paper, 2 relevant journal articles, and 2 books on the selected hypothesis
 - On the same paper, answer the following questions
 - Which one of those articles interested you the most?
 - Which one of those got the most citations? Why?

[52]

Conducting Pilot Research

- Test a small number of participants
 - To debug your research procedure
 - To test the levels of your independent variable
- What you may find in a pilot study?

[53]

Some Pitfalls to Avoid Breaches of Ethical Practice

- Overarching issue
 - The well-being of the participants
 - Physical and mental harm are avoided or minimized
 - Confidentiality is not breached
 - Deception are not used
- Give an example of how the principles mentioned above may be breached

[54]

Some Pitfalls to Avoid

Biased Research

- Biased questions and methods
 - E.g., white people are more intelligent than black people
 - E.g., using biased samples to support one's hypothesis
 - Solutions: be more self-aware, invite peer reviews
- Biased treatment given to the participants based on their assigned experimental conditions
 - Solutions: Strictly adhering to protocol, using a double-blind design
- Biased responses from the participants
 - Solution: Using placebo and a double-blind design in medical research
- Personal attributes of the researcher
 - E.g., gender of the experimenter
- Data-recording bias
- Anthropomorphizing
 - Attributes human characteristics to animals

[55]

TASK 5:

Identify Biases

- Administered intelligence tests in English to incoming immigrants in the U.S.
- What is the researcher bias?

[56]

Some Pitfalls to Avoid

Reliability of Communication

- Use of terminologies and their definitions
 - E.g., what does a pleasant personality mean to you?
 - Avoid subjective descriptions
- Solution
 - Use an **operational definition**
 - A formula for building a construct in a way that other scientists can duplicate
 - The procedures or operations used to produce and measure a construct are clearly specified
 - Criteria: clear and reproducible

[57]

LOGICS OF THE SCIENTIFIC METHOD

[58]

Belief Fixation (Peirce, 1877)

- Method of authority
 - E.g., mom and dad, news commentator, professor
 - What are the strengths and weaknesses of this source?
- Method of tenacity
 - Steadfastly refusing to alter acquired knowledge, regardless of evidence to the contrary
- *A priori* method
 - Propositions that seem reasonable are believed
 - E.g., the world is flat, the sun and the moon revolve around the earth
- Scientific method
 - Fixes belief on the basis of experience
 - Repeatable and self-correcting based on empirical observation

[59]

Strengths of Scientific Method

- Empirical
 - “experience” in Greek
 - Relies on data
- Self-correcting
 - Offers procedures to compare old and new beliefs

[60]

Nature of Scientific Explanation

- **Data**
 - Empirical observations
- **Theory**
 - Organization of concepts that permit prediction of data
- Which is more important?
Which comes first?
- **Induction**
 - From data to theory
- **Deduction**
 - From theory to data

http://1.bp.blogspot.com/_GqUgVxtrMqs/50DC1717VII/AAAAAAAAAY/-CYQADyQloA/s400/Inductive_Deductive_Reasoning.png

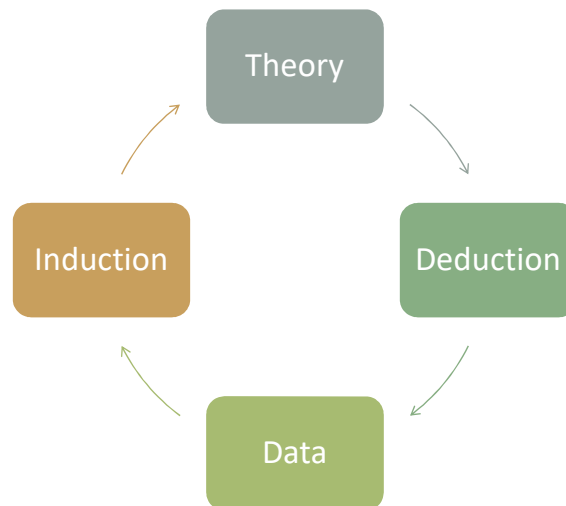
[61]

Task 6: Case Analysis

- **Objective:** A scientist theorizes that people who have blue eyes are more intelligent than people with brown eyes.
- **Methods:** In order to test the theory the scientist obtains a variety of intelligence measures for 30 blue- and 30 brown-eyed people. These measures include college grade point average, IQ scores, and SAT scores.
- **Results:** A comparison of measures between groups shows that the blue-eyed people score higher on all tests than the brown-eyed ones.
- **Conclusion:** The scientist states that, "The data prove that people with blue eyes are more intelligent than those with brown eyes."
- Do you agree or disagree with this statement? Why?
- Importance of falsification
 - How can you prove "all swans are black"?

[62]

Circular Relationship of Data and Theory



[63]

Strong Inference (Platt, 1964)

- 1) Devising alternative hypotheses;
- 2) Devising a crucial experiment (or several of them), with alternative possible outcomes, each of which will, as nearly as possible, exclude one or more of the hypotheses;
- 3) Carrying out the experiment so as to get a clean result;
- 1') Recycling the procedure, making subhypotheses or sequential hypotheses to refine the possibilities that remain; and so on. (p.347)"

[64]

Abduction

- Provides the basis for novelty
- Needs to be evaluated using inductive and deductive methods

[65]

<http://henleydlmba.files.wordpress.com/2012/06/induction-deduction-abduction-syllogism-in-grass.jpg>

From Theory to Hypothesis

- **Hypothesis**
 - A very specific, testable statement that can be evaluated from observable data
 - E.g., drivers older than 65 years would have a higher frequency of accidents involving left turns across oncoming traffic when driving at night than do younger drivers
- **Generalization**
 - A broader statement that cannot be tested directly
 - E.g., generalized to different kinds of accidents and driving behaviors
- **Theory**
 - “a set of related statements that explains a variety of occurrences”
 - Parsimonious theory → better theory
 - E.g., theories of attention, perception, and decision making

[66]

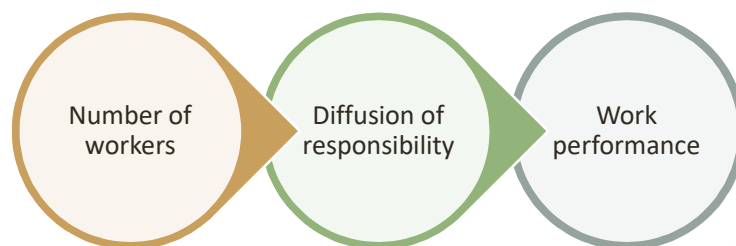
Functions of Theory

- Organization
 - A framework for the systemic and orderly display of data
 - Like a “filing system” of research results
- Prediction
 - To generate predictions for situations in which no data have been obtained
 - Unfortunately, researchers may derive different hypotheses from the same theory

[67]

Intervening Variables

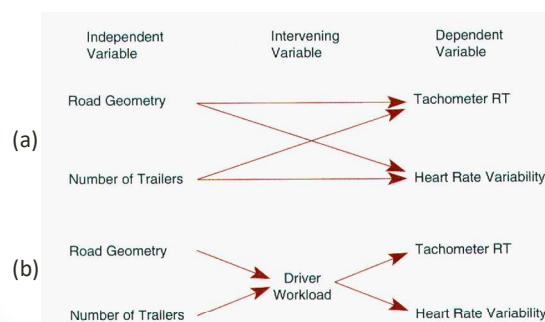
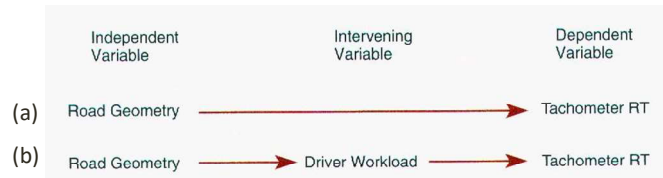
- Abstract concepts that link IVs to DVs



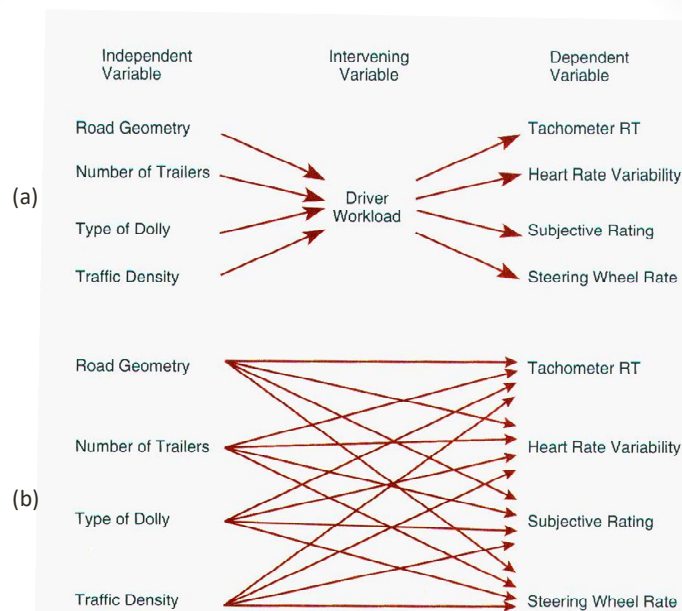
- Intervening variable

[68]

Which is more parsimonious?



[69]



[70]

Parsimony

- If one IV can satisfactorily explain the DV, don't use two
- No redundant variables or paths
- E.g., How people make decisions?

[71]

Evaluating and Comparing Theories

- Scientists try not to determine whether a theory is true or false in an absolute sense.
 - A theory can be false in some part but continue to be used.
- Evaluation criteria
 - Parsimony
 - Precision (e.g., mathematical equations and computer programs)
 - Testability
- Comparison criteria
 - All of the above
 - Satisfactory
 - Theoretically correct
 - Usable

[72]

Task 7:

Case Analysis

- **Background:** A researcher seeking a grant from a federal funding agency proposes a series of experiments in which the effects of temperature stress on task performance will be studied.
- **Methods:** Specifically, the researcher plans to test people in an environmental chamber that either will be cold (40 degrees F), normal (72 degrees), or hot (95 degrees). Participants will monitor a TV screen filled with letters and will press a button whenever a particular predetermined target is displayed. Performance is expected to change depending upon the temperature of the chamber.
- **Results:** A reviewer at the funding agency recommends that funding for the grant be denied, because the letter detection task bears no outright similarity to any task performed in a real job situation.
- Do you agree with the reviewer's judgment? Why or why not?

[73]

Are experiments too far from real life?

- Both involve similar processes
- Experiments allow to study the process in a carefully-controlled environment
- 2 important reasons for doing basic research (in contrast to applied research)
 - Demonstrates what can happen
 - Findings from a controlled lab setting may have more force than similar findings obtained in a real-life setting

[74]

REPRODUCIBILITY AND ISSUES RELATED TO “GOOD SCIENCE”

[75]

Issues Relate to “Good Science”

- Why Trust/Mistrust Science?
 - Science in society
 - Examining the field
 - Recognizing the empirical challenge
- Examining Problems and Issues
 - Where can problems arise?
 - Blatant cheating vs Questionable practices/ Bad Decisions
- Suggestions for Improved Science
 - Converging evidence and replicated results
 - More transparent data analysis
 - Open Science Movement

[76]

Science & Culture

- Why are people skeptical?
 - During the pandemic?
 - In general?
- Is the scientific method racist?

[77]

Challenges for Social Policy

- High public expectations
- Poor public knowledge of science/statistics
 - Evolving/limited knowledge/models
- Consequences of making drastic changes
 - Getting it right destroys the evidence
 - What if you are wrong?
- Funding/Politics determines progress

[78]

What is Science?

- **“Science”** – Systematically gathering and evaluating empirical evidence to answer questions and test hypotheses
- Empirical Process
- Data Driven
- Self-Correcting
- **MUST BE TESTABLE and REPLICABLE**

[79]

Critiquing individual studies

- Construct Validity
 - Operationalizing
- Internal Validity
 - Method
- External validity
 - Representativeness of sample
 - Generalizability of method
- Statistical Analysis and interpretation
 - Planned vs posthoc tests
 - Type 1 errors
 - Third variables

[80]

Evaluating a field as a whole

What additional
Challenges
Arise?

Experiment Experiment Experiment
Experiment Experiment Experiment
Experiment Experiment
Experiment Experiment

[81]

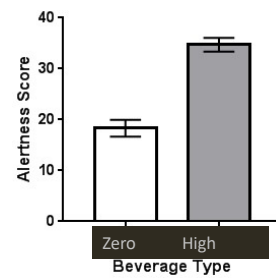
An example experiment

- Interested in studying the effects of caffeine on alertness
- IV caffeine (12 oz. no caffeine soft drink vs 12 oz. high caffeine soft drink)
- DV alertness scale
- Method: drink, wait 30 minutes, test

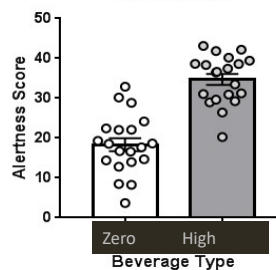


[82]

Caffeine and Alertness



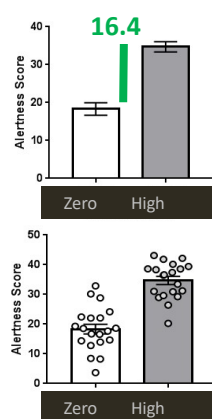
Effect size = 16.4
Statistically significant



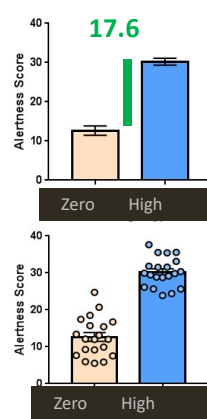
{ 83 }

Single Study vs Multiple Studies

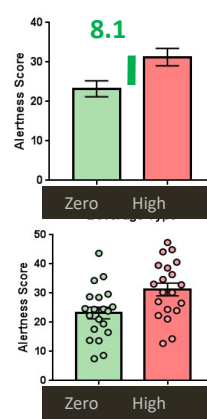
Experiment # 1



Experiment # 2



Experiment # 3



{ 84 }

What is replication?

- Exact replication
- Replication of statistics
- Conceptual replication

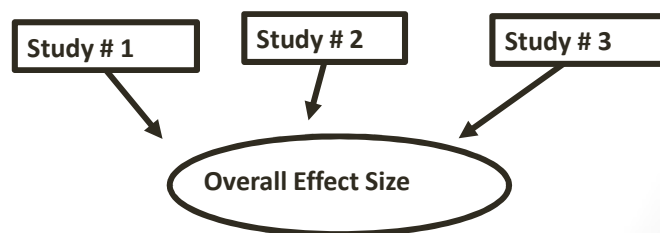
[85]

Types of Replication

- Direct replication
 - Repeating an earlier experiment's method as closely as possible
- Systematic replication
 - Repeating an earlier experiment while manipulating several potentially irrelevant variables
 - If these variables indeed do not contribute to observed effects, then consistent results should be obtained
- Conceptual replication
 - Attempting to demonstrate an existing finding or phenomenon using a very different method

Meta-Analysis

- Statistically combine data from multiple studies
- Identify boundary conditions
- Empirically determine effect size



[87]

Lesson # 1...

Do it.....



AGAIN!!!!

**Replication is ESSENTIAL
to quality science**

**Science needs to be
REPRODUCIBLE**

[88]

How replicable is the field of psychology?

RESEARCH

RESEARCH ARTICLE

PSYCHOLOGY

Estimating the reproducibility of psychological science

Open Science Collaboration[†]

Methods

- Conducted replications of 100 experimental and correlational studies
- Included 270 contributing authors

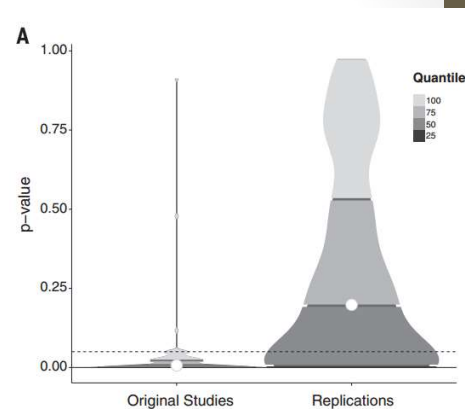
Estimating the reproducibility of psychological science, Science, 2015

	Replications $P < 0.05$ in original direction	Percent
Overall	35/97	36
JPSP, social	7/31	23
JEP:LMC, cognitive	13/27	48
PSCI, social	7/24	29
PSCI, cognitive	8/15	53

[89]

$P < .05$ gets published

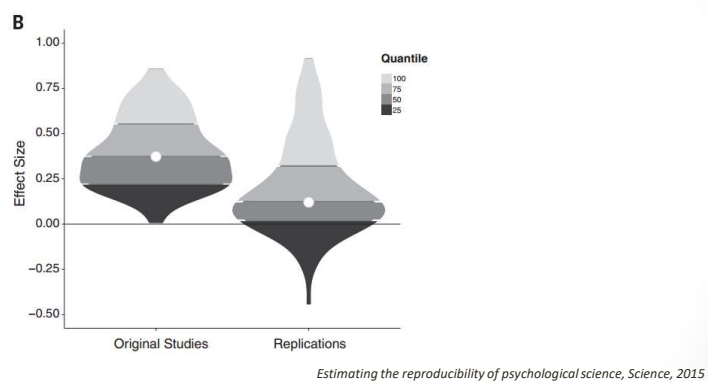
- File drawer problem
- Regression to the mean
- P-hacking



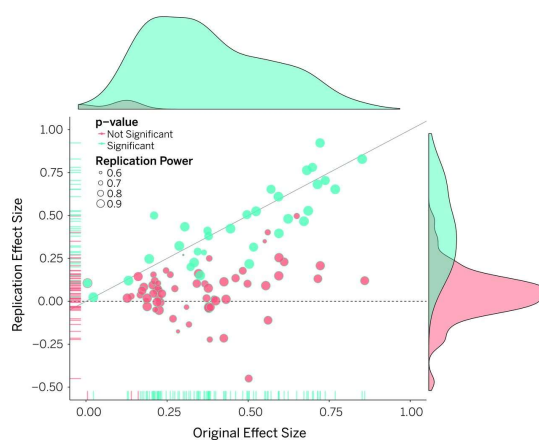
Estimating the reproducibility of psychological science, Science, 2015

[90]

Effect sizes – same problem



[91]



[92]

Different reasons for "bad" and unreproducible science

**Blatant Cheating
and Lying**

**Questionable
Practices and
Decisions**

[93]

Covid-19 studies based on flawed Surgisphere data force medical journals to review processes

- New England Journal of Medicine and Lancet peer reviewers did not see raw data behind findings before publication
- The Lancet study found the anti-malarial drug **hydroxychloroquine** was associated with a higher risk of death and heart complications in Covid-19 patients, a finding which prompted the World Health Organisation and research institutions worldwide to place studies of the drug on hold. That study was revealed to be problematic and was retracted by the Lancet earlier in June.
- Was the “flawed” data politically motivated?
- <https://www.theguardian.com/world/2020/jun/12/covid-19-studies-based-on-flawed-surgisphere-data-force-medical-journals-to-review-processes>

[94]

Blatant Lying and Cheating

- Some people have been caught making data up from scratch never having even run an experiment

Diederik Stapel



- 3 students suspected something was unusual
- A committee examined his work
- Found he made up data for at least 30 publications
- Ran studies at schools where “Only he had access to be”
- He controlled all access to data in his lab
- Students asking to see the data were released from the lab

[95]

Here is what Diederik Stapel had to say:

“I failed as a scientist. I adapted research data and fabricated research. Not once, but several times, not for a short period, but over a longer period of time.

... I think it is important to emphasize that I never informed my colleagues of my inappropriate behavior. I offer my colleagues, my PhD students, and the complete academic community my sincere apologies. I am aware of the suffering and sorrow that I caused to them. ... **I did not withstand the pressure to score, to publish, the pressure to get better in time. I wanted too much, too fast.** In a system where there are few checks and balances, where people work alone, I took the wrong turn. I want to emphasize that the mistakes that I made were not born out of selfish ends”.

[96]

The Scientific Method

```

graph TD
    A[Ask a Question] --> B[Research Existing Sources]
    B --> C[Formulate a Hypothesis]
    C --> D[Design and Conduct a Study]
    D --> E[Draw Conclusions]
    E --> F[Report Results]
        
```

Questionable practices and bad decisions

At what stages can these happen?

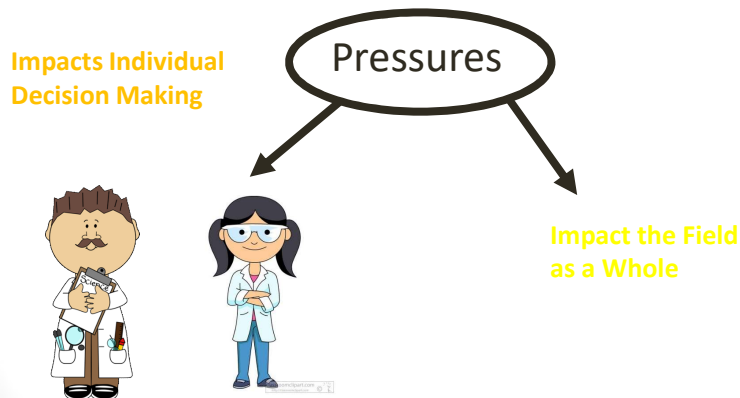
97

What does it mean to communicate results?

- 1) Write a paper describing the results
- 2) Write a scientific grant
- 3) Give a talk about your findings
- 4) Speak at a conference
- 5) Present a poster at a conference
- 6) Speak with general media and social media to share the results

98

Pressures of current publication practices



[99]

Communicating Results... Pressures impacting individual scientists

- Incentive Structure in Science and Academia
- For jobs, promotion, tenure
 - 1) Publish or Perish
 - 2) Flashy discoveries - publicity
 - 3) New grants = money \$\$
 - *** Pressure to:
 - Publish a lot
 - Publish exciting and flashy new work

[100]

Communicating Results... Pressures impacting the field as a whole

- Publication Bias
- File Drawer Effect
- Winners Curse (regression to the mean)

Young, N. S., Ioannidis, J. P. A., & Al-Ubaydli, O. (2008). Why Current Publication Practices May Distort Science. *PLOS Medicine*, 5(10), e201. doi: 10.1371/journal.pmed.0050201

[101]

Publication bias

- We have a distorted perception because it's very hard to publish negative results

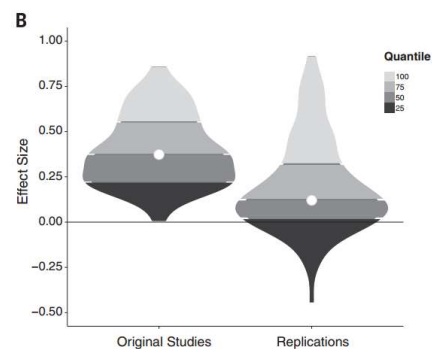
The File Drawer Effect



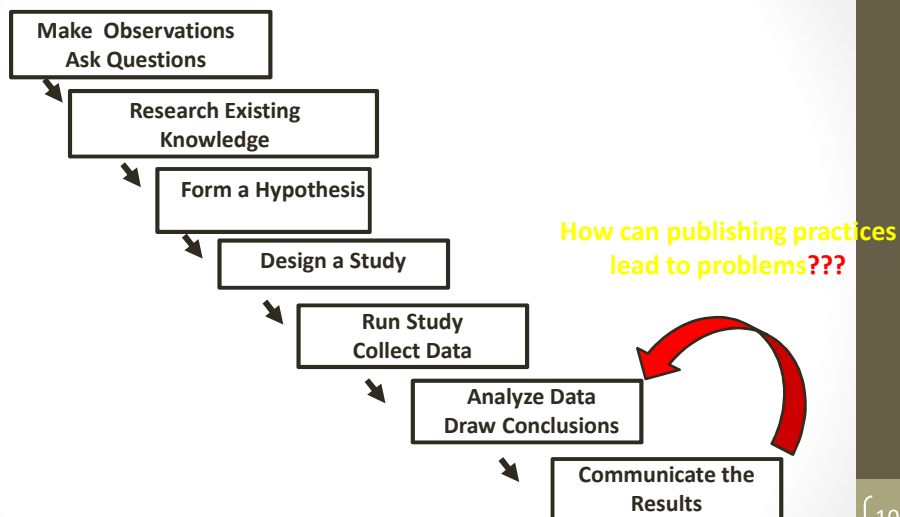
[102]

Winners Curse: Regression to the mean

- On average, the first published result will OVER-ESTIMATE the effect size of a true result



[103]



[104]

Issues Related to Analyzing Data and Drawing Conclusions

- Pressure to publish new, exciting findings
 - Not exciting or “attention grabbing” to publish a replication
 - Really hard to publish “negative results”
 - Career issues

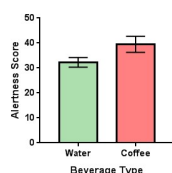
[105]

Pressure to find positive effects in our data

- Bias to find effects that fit the hypothesis
- Culture of “p-hacking”
 - Making small changes to get significant p-values
 - Removing outliers from our data
 - Dropping subjects all together
 - Running the wrong statistical tests
- Data mining without acknowledgement

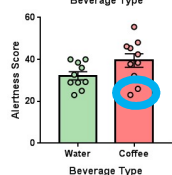
[106]

p-hacking

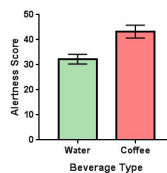


Not a "significant result"

Wont be published

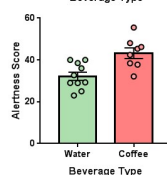


Unpaired t test	
P value	0.0698
P value summary	ns



Found a "significant result"!!!

Can be published



Unpaired t test	
P value	0.0031
P value summary	**

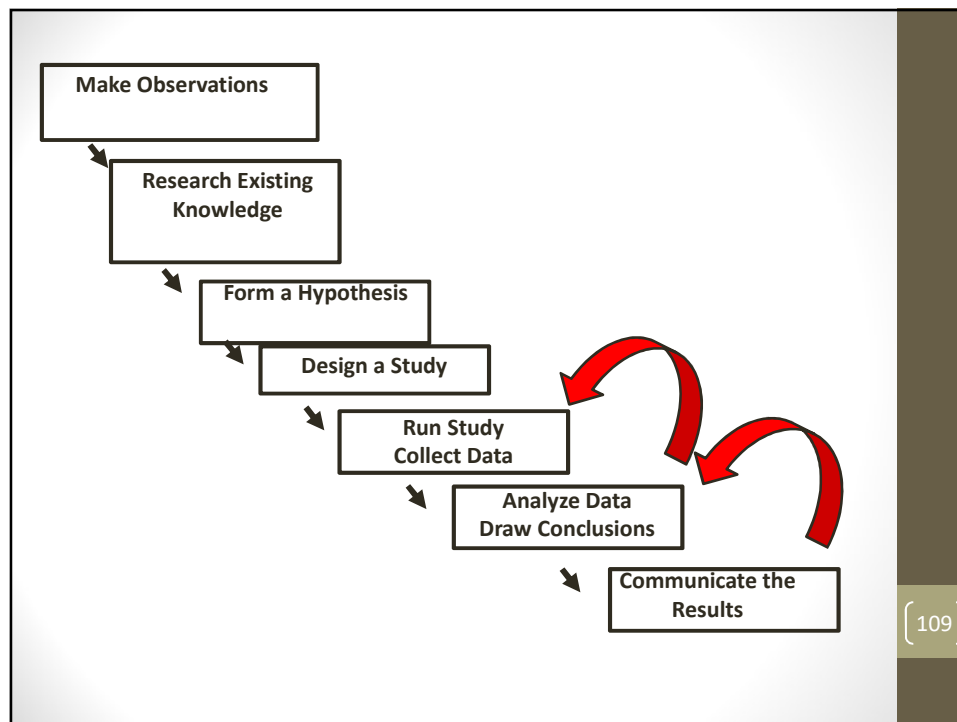
(107)

Lesson # 2...



Empiricism is based on seeing DATA
not reading papers

(108)



collecting data

- Sample size too small
- Cherry picking data

ANALYSIS

Power failure: why small sample size undermines the reliability of neuroscience

Katherine S. Button^{1,2}, John P. A. Ioannidis³, Claire Mokrysz², Brian A. Nosek⁴, Jonathan Flint⁵, Emma S. J. Robinson⁶ and Marcus R. Munafo¹

Alertness Score

Beverage Type

Water Coffee

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafo, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nat Rev Neurosci*, 14(5), 365-376. doi: 10.1038/nrn3475

(110)

Suggestions for improving how we do science

[111]

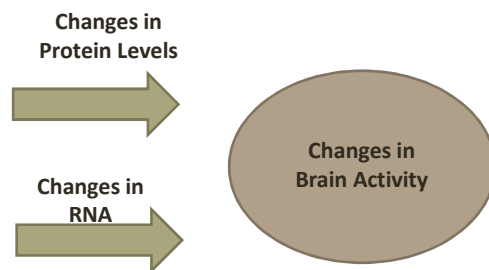
What are the signs of good science?

- Lines of converging evidence
- Replicated by many labs many times
- Robust methods – works under many conditions and in many people's hands

[112]

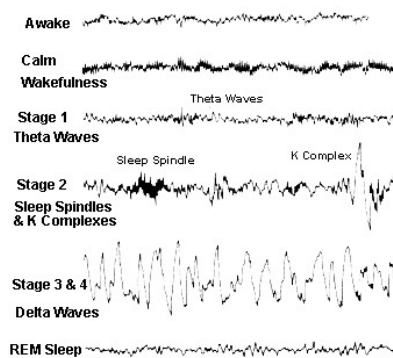
Lines of Converging Evidence

- Multiple different measures or methods pointing to the same answer



[113]

Replicated by many labs many times



[114]

Converging Operations

- A term that refers to two or more methods that point toward a unified interpretation of results by ruling out alternative hypotheses

Improving how we use statistics

- Statistically significant is not the same thing as significant in the real world
- Mean and Average fetishes... What about variability?
- Violations of assumptions

[116]

Reproducible Data Analysis and Code

- Should be able to repeat Data Analysis
- Should be able to create Figures

[117]

Important reasons data analysis process should be reproducible....

- Research Transparency
- Enables others to use and extend our methods and data
- Transfer of methodological knowledge to others

[118]

Lesson # 3

- A rising tide lifts all boats



[119]

THE END

[120]