# Hypothesis and Rationale Building

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# Outline

- Introduction
- The background work
- The Research Question
- Formulating a hypothesis
- Operationalizing

# Hypothesis: Formal definition


A **hypothesis** is a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.


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# Hypothesis…..

"…hypothesis is perhaps the most powerful tool man has invented to achieve dependable knowledge"

–Fred Kerlinger

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# Hypothesis….

"The only relevant test of the validity of a hypothesis is comparison of prediction with experience."

-Milton Friedman

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# Hypothesis….

"A fact is a simple statement that everyone believes. It is innocent, unless found guilty. A hypothesis is a novel suggestion that no one wants to believe. It is guilty, until found effective."

- Edward Teller


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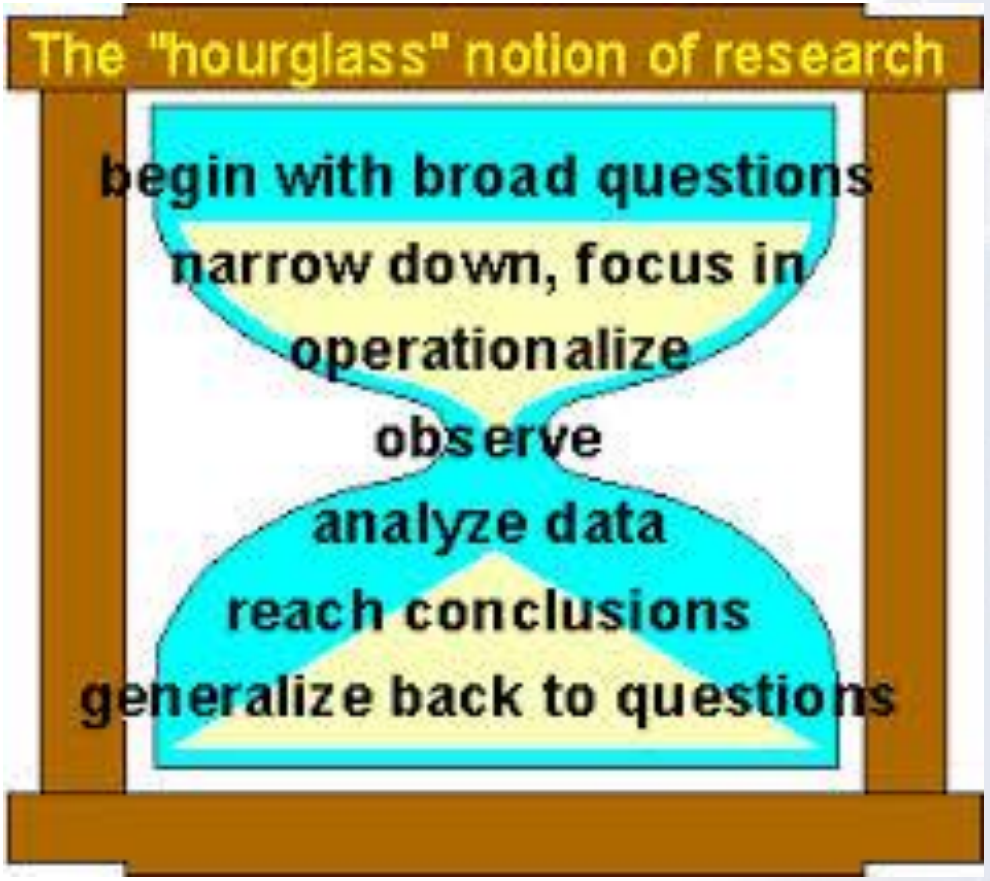
# But let's take a step back…


- How do we get to the point where we can actually formulate a hypothesis?
- What questions should you ask yourself?

# The Research Method: An hourglass




www.socialresearchmethods.net

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# The Structure for Research

The research structure helps us create research that is :

**Quantifiable Verifiable Replicable Defensible**

Corollaries among the model, common sense & paper format

| Model | Common Sense | Paper Format |
|---|---|---|
| Research Question | Why | Intro |
| Develop a Theory | Your Answer | Intro |
| Identify ~~Variables~~ (if applicable) | How | Method |
| Identify hypotheses | Expectations | Method |
| Test the hypotheses | Collect/Analyze data | Results |
| Evaluate the Results | What it Means | Conclusion |
| Critical Review | What it doesn't Mean | Conclusion |

Credit: Prasad, Rehani, Rao:www.public.asu.edu/~kroel/.../**hypothesis**.pdf

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# Answer these broad questions…

- What topics/fields am I really excited about?
- Do I know this area well?
- Am I willing to keep up to date with the literature in this field?

# Broad questions….


- What are the currently important research areas in this field?
- Which areas need further exploration?
- Where are the gaps in knowledge?

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# And once you've honed in….

- Is this good timing for this research? "hot topic"? outdated?
- Has someone already done a similar study? How can it be modified or improved?
- Can I create a niche with this research?

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# And the final, most important question…

**WHO CARES?**

**What are the future implications for answering the question you are asking?**

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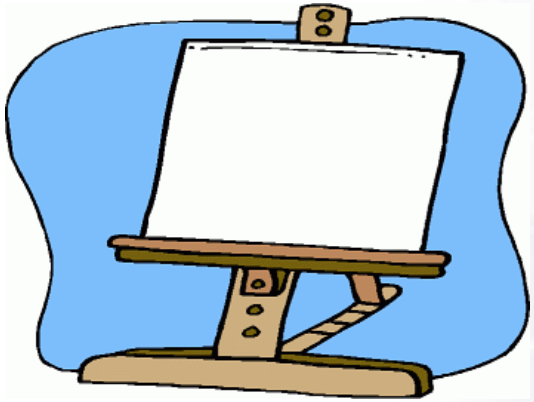
If you can’t answer the final question to your own satisfaction…

Start over from the beginning!



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# The Research Question

- The methodologic point of departure for scholarly research
- Precedes the formulation of the conceptual framework for the research
- Example: “Do children experience restorative sleep in the Pediatric ICU?”

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# Good Research Questions

- Focused and narrow: can translate directly into formulation of a hypothesis
  - Too broad: How do children sleep in the Pediatric ICU?
  - More focused: Do children experience slow-wave sleep and REM sleep in the Pediatric ICU?

# Now back to hypothesis…


A **hypothesis** is a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.


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# Basic building blocks of a hypothesis

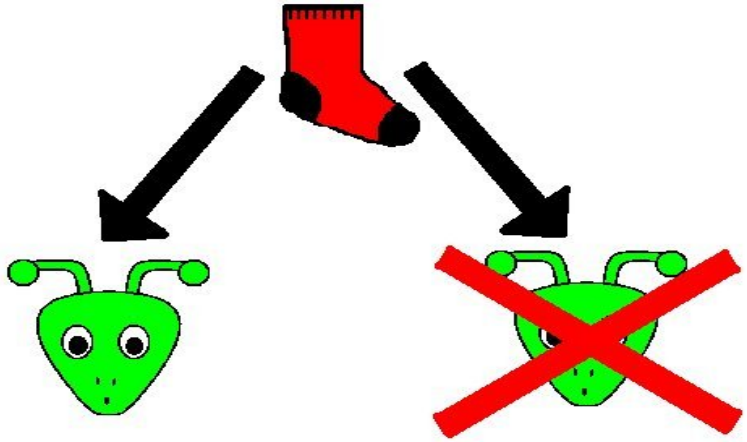
- A statement, NOT a question
- Succinct
- Proposes an expected relationship between variables
- Testable
- Reflects the literature on which it is based: the educated guess

# Writing your hypothesis

- Explicitly state the populations you wish to compare
- State the dependent variable and scale on which you expect to find differences
- State the direction of the treatment effect
- Should be able to write both research and null hypothesis

# Research/Alternative Hypothesis vs. Null Hypothesis

**Q. Where have all my socks gone?**



| Alternate Hypothesis | Null Hypothesis |
| --- | --- |
| = | = |
| Extra-terrestrial beings have transported themselves into my house in order to steal my socks. | Aliens are not to blame. There is some other explanation for the disappearing socks. |

Credit: dsm1lp.wordpress.com

# Hypothesis: Research vs. Null

- Research/alternative hypothesis ($H_1$): What you predict will happen– the proposed relationship between two variables

- Null Hypothesis ($H_0$): No difference or different outcome than the one predicted by the research hypothesis

# Example: Directional Research hypothesis

- We hypothesize that children who read for 15 minutes or more per day with a parent will score significantly higher on kindergarten reading assessment than children who do not read at least 15 minutes per day with a parent

# Example: The null hypothesis

- Children who read with a parent for at least fifteen minutes a day will not score significantly higher on kindergarten assessment testing than children who do not read at least fifteen minutes a day with a parent.

# Once you have a hypothesis: Testing it!

Four Steps:

1. State the null and alternative hypothesis
2. **Set criteria for decision**
3. Collect data
4. Analyze data and decide if null hypothesis can be rejected

# Setting criteria for decision: operationalizing

- Determine the primary endpoint or outcome that you will be quantifying: i.e.

  % change in systolic blood pressure
- Visualize the final analysis and the statistical methods you'll be using

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# SAMPLE SIZE: Building blocks

Alpha-α (significance level)

Beta-β/Power (1-β)

Effect Size

Estimates of variability

Prevalence of event in population

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# Why is sample size so important?

It is how we make inferences about a population for the research question of interest

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# Why is sample size so important?

- Too few cases: May not detect a clinically important difference that actually exists

- Too many cases
  - More expense
  - More risk to more subjects if intervention has potential adverse effects

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# Effect size

- Refers to the magnitude of the effect of one variable on another
- For every hypothesis, one must determine what effect size is
  - Clinically relevant
  - Feasible in the context of sample size

# Effect size

- As a rule:
  - The smaller the effect size you want to detect, the larger the sample size that will be needed
  - Important to balance clinical relevance and feasibility

# A word about errors: Type I and II

**Type I error**: Rejecting the null hypothesis when it is actually true

α= probability of a Type I error

**Type II error**: Failing to reject the null hypothesis when it is actually false

β= probability of a Type II error

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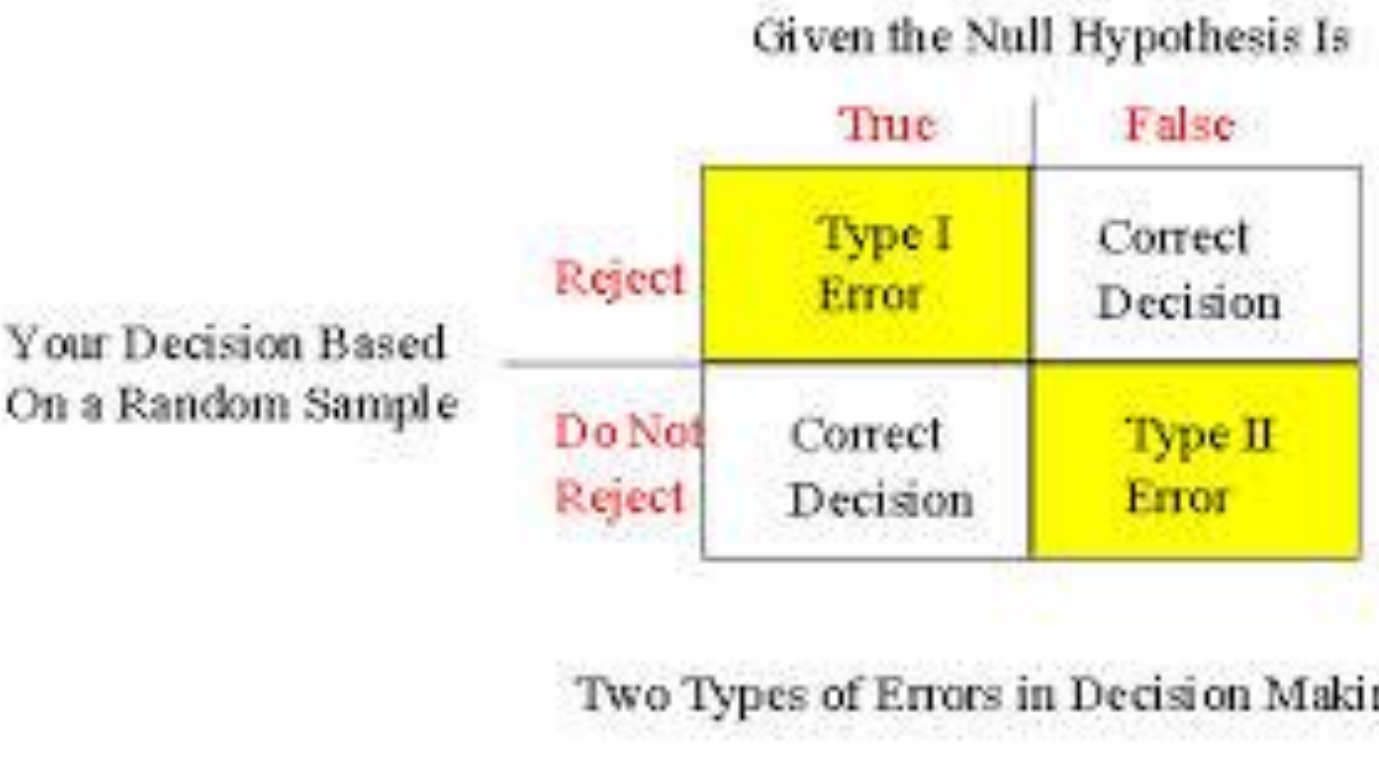
# We want to minimize Type I and Type II errors!



# Power= 1-β

- The probability of rejecting the null hypothesis when the alternative hypothesis is true
- The ability of a test to detect an effect, if that effect actually exists
- β= Probability of Type II error, or false negative rate

# Power calculations

- Can be used to determine the minimal sample size needed to have a strong likelihood (i.e. 80%) of detecting a given effect size

- Can be used to determine the minimum effect size that is likely to be detected with a given sample size

# Alpha (α), Type I error, and the famous p-value

- α= probability of rejecting null hypothesis when it is true: THE MOST IMPORTANT THING TO AVOID!

- If the p-value is at or below the set α-level, then the null hypothesis is rejected and the result is “statistically significant”

# An example