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SPARC

Developing A Career in Simulation Research: Strategies for Young Investigators

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Disclosure

- Aaron W. Calhoun- Co-investigator on Health Resources and Services Administration (HRSA) targeted issues grant

Outline

- Getting Behind the Research Question- Addressing Assumptions
- Pitfalls of Research Design
- Putting it All Together- Developing a Long-term Plan for Investigation

Large Group Discussion-Past Research Question Successes and Barriers

Getting Behind the Question…

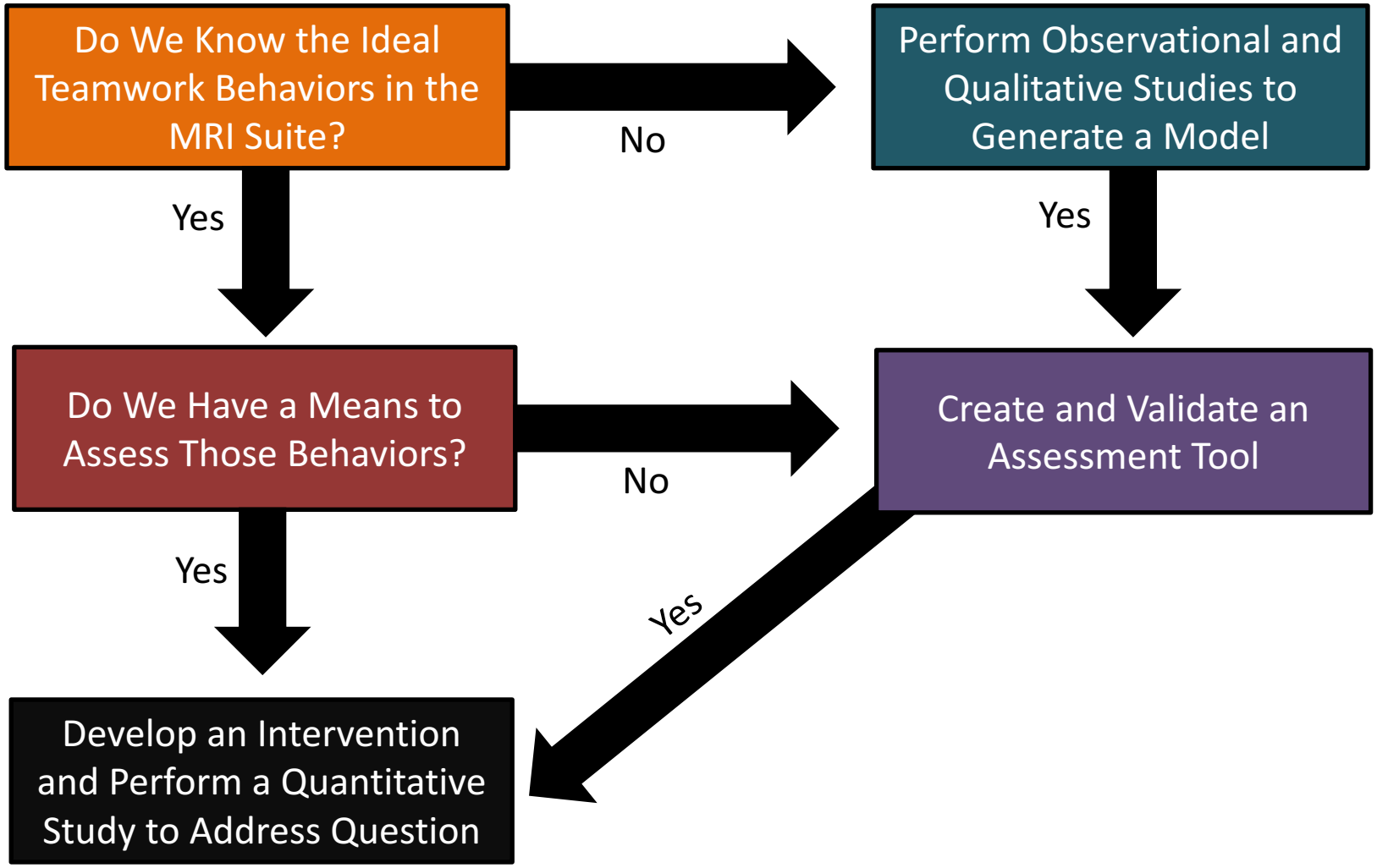
Consider the Following…

- Your Question: Does a course in sedation-related adverse events improve teamwork behavior in an MRI suite?
- Sounds like a reasonable place to start…

Questioning Assumptions

- In reality, this seemingly simple question rests on an unseen base of assumptions…
- Do we know the specific teamwork behaviors that lead to better outcomes in an MRI suite?
- Do we possess a means to reliably assess them?
- What types/level of evidence are we able to realistically gather?

A Schematic Approach



Questions vs Hypotheses

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General "Research Question"

- Informed by experience
- May or may not be specific or testable
- No assessment may yet exist
- Example: "What does unplanned mannequin death do to the learner?"

Hypothesis

- Focused, definite and predictive
- Capable of being quantitatively assessed
- Example: "Can the negative impact of simulated death on learner emotion be mitigated by specifically addressing it during debriefing using an Advocacy-Inquiry approach?"

Converting Questions to Hypothesis

In the biomedical domain, this is relatively easy

- Relies on basic physiology or pathophysiology

In social sciences/education research it is not as straightforward

- No hard-and-fast "physiology" on which to rely
- In medicine, these types of studies often lack a cohesive approach
- Conceptual models can serve as helpful organizing frameworks

Patton MQ. Qualitative Research and Evaluation Methods. Sage Publications;2002.

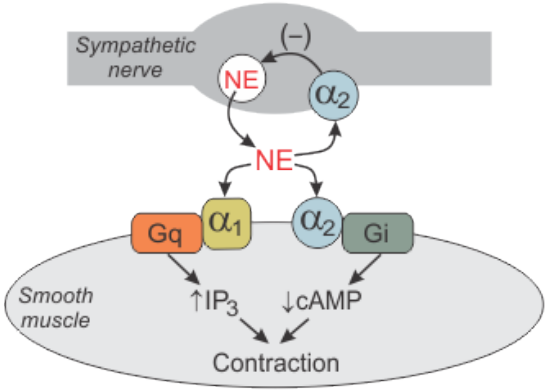
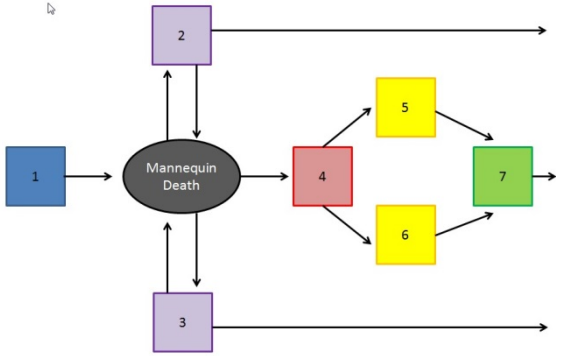
The Value of Cognitive Frameworks

"The theoretical framework is the **structure that can hold or support** a theory of a research study."

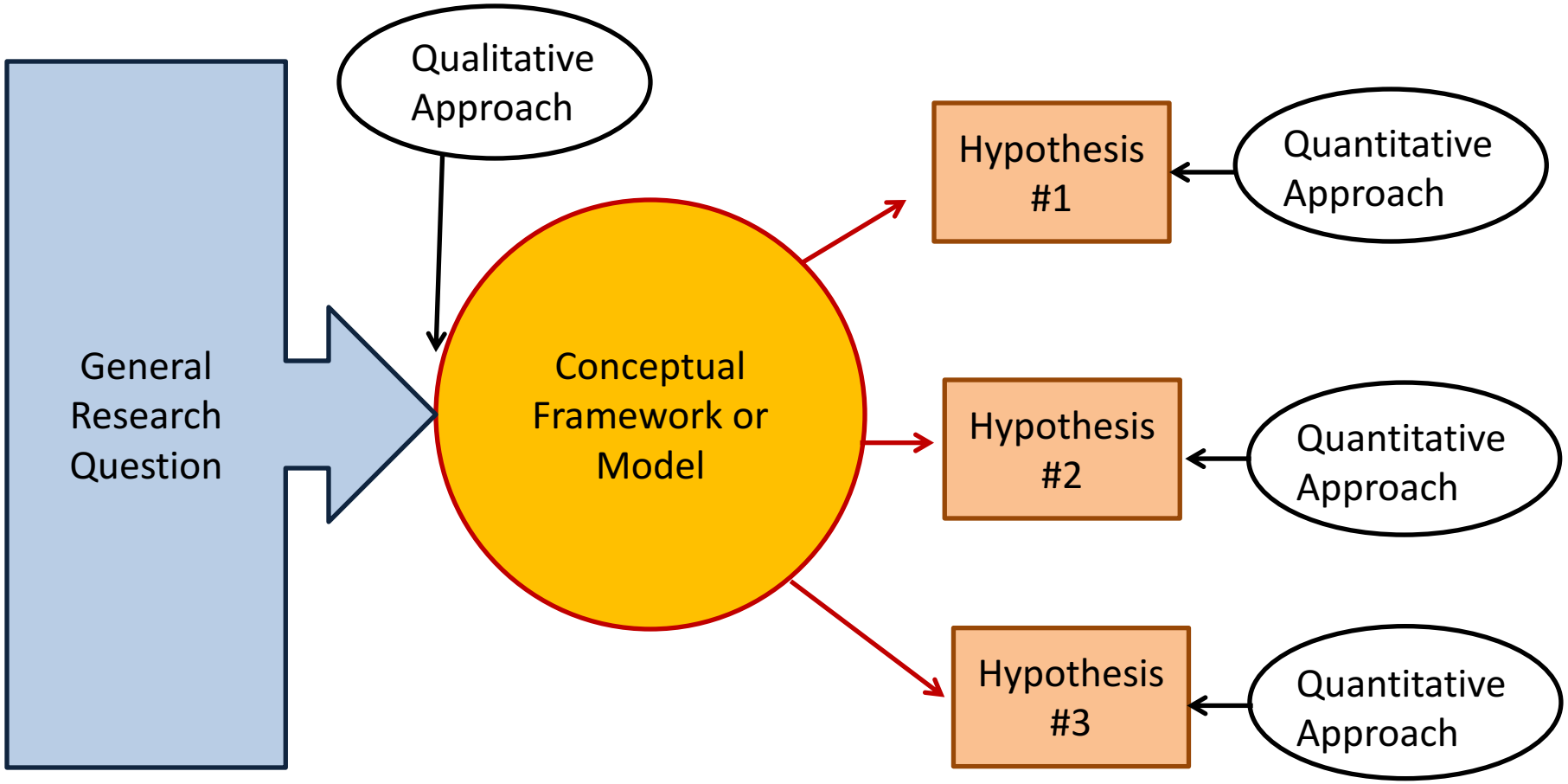
"The theoretical framework **introduces and describes** the theory that explains **why the research problem under study exists**."

Swanson R, Chernack T. Theory Building in Applied Disciplines. Berrett-Koehler Publishers;2002.

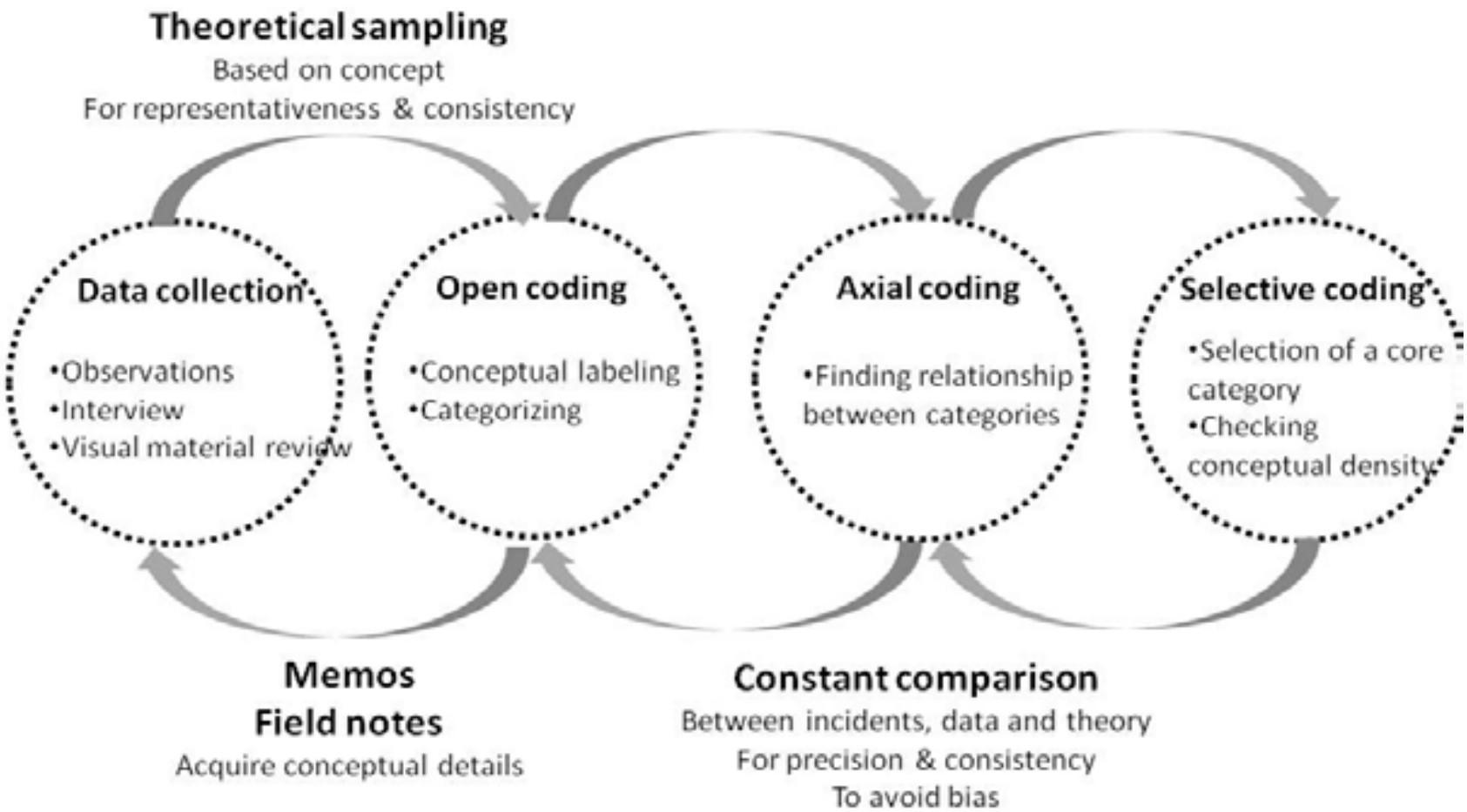
An Example…

	Framework:	Hypothesis:
Biomedical	α Receptor Physiology 	"Administration of Doxazosin (alpha 1 blocker) will lower systolic BP by 30 points."
Social Science/ Educational	Psychological Model 	"Debriefing using the Advocacy/Inquiry method can reduce negative emotions associated with mannequin death."

Conceptual Models



Elements of a Qualitative Approach



Cho JY, Lee EH. Reducing Confusion about Grounded Theory and Qualitative Content Analysis: Similarities and Differences. The Qualitative Report 2014 19(64): 1-20

Validity and Assessment-An Introduction

- Validation is hypothesis driven
- Starting point - the decision
- Framework guide the collection of data to support a cohesive validity argument
- For a tool to be used in research such an argument is crucial
- Conceptual frameworks are crucial in building these arguments

Cook DA, Brydges R, Ginsburg S, Hatala R. A Contemporary Approach to Validity Arguments: A Practical Guide to Kane's Framework. Medical Education 2015, 49: 560-575

Validity and Assessment-An Introduction

- Two validity frameworks are currently in wide use
- Each framework weaves together threads of data to generate a validity argument
- **Messick's Framework**:
  - Downing SM. Validity: On Meaningful Interpretation of Assessment Data. Med Educ. 2003 Sept;37(9):830-7.
- **Kane's Framework**:
  - Cook DA et al. A Contemporary Approach to Validity Arguments: A Practical Guide to Kane's Framework Med Educ. 2015 Jun;49(6):560-75.

Moving from Qualitative to Quantitative Research

1. Examination of the themes/relationships within a specific model
2. Formulation of a specific hypothesis based on that theme or relationship
3. Decide on study design and outcome measures
    1. Kirkpatrick Hierarchy
4. Create protocol and conduct study

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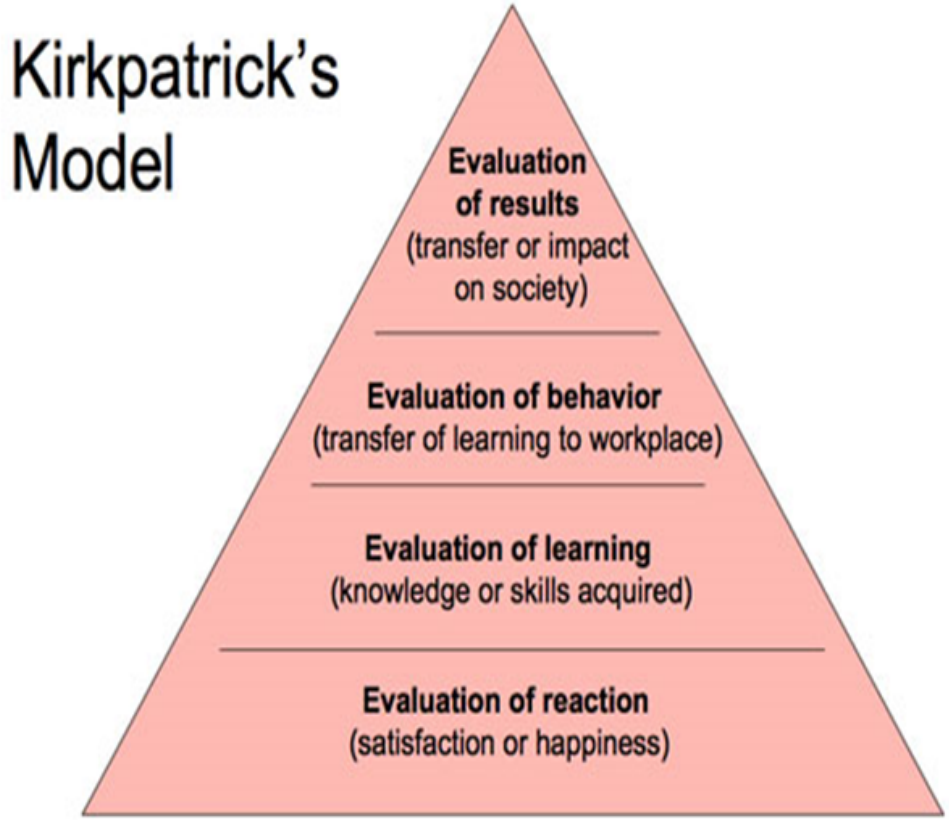
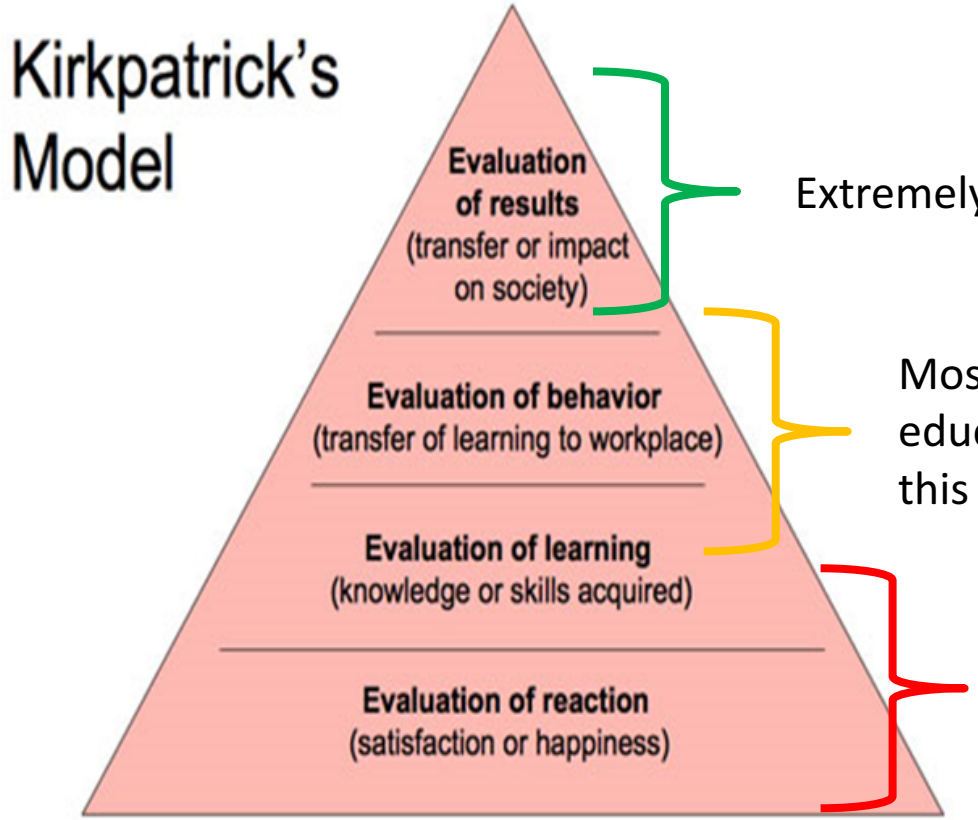
Kirkpatrick's Model



Kirkpatrick's (2006) hierarchy of evaluation.

Kirkpatrick's Model



Extremely difficult data to obtain

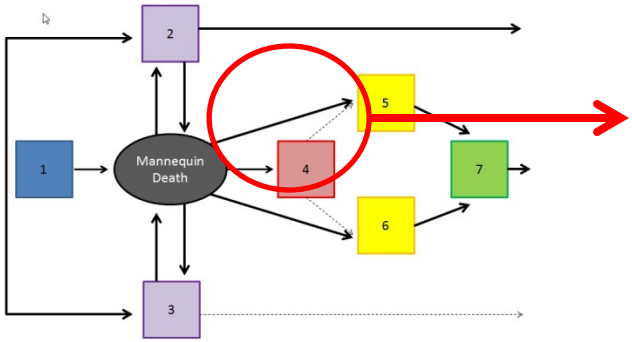
Most successful quantitative educational studies focus on this evidence level

Extremely difficult data to publish

Kirkpatrick's (2006) hierarchy of evaluation.

Translating a Framework to a Study- An Example

1. Select a Theme/Relationship



2. Form a Hypothesis
- "Advocacy-Inquiry based debriefing will significantly improve learner emotional state after exposure to simulated death."

3. Decide on Outcome Measures
- Measure of emotional state on validated scale
- External assessment of emotional state by supervising attending

4. Design of Study
- Interventional trial in which learners exposed to simulator death are split into a group that is debriefed using Advocacy-Inquiry (intervention) and a group that is debriefed using another model (control)
- Assessments are conducted on learners before the case, after the case, and after the debriefing
- Supervising attending provides an independent assessment of learner emotional state before and after the session

Small Group Work-Shaping Our Questions

Pitfalls of Study Design

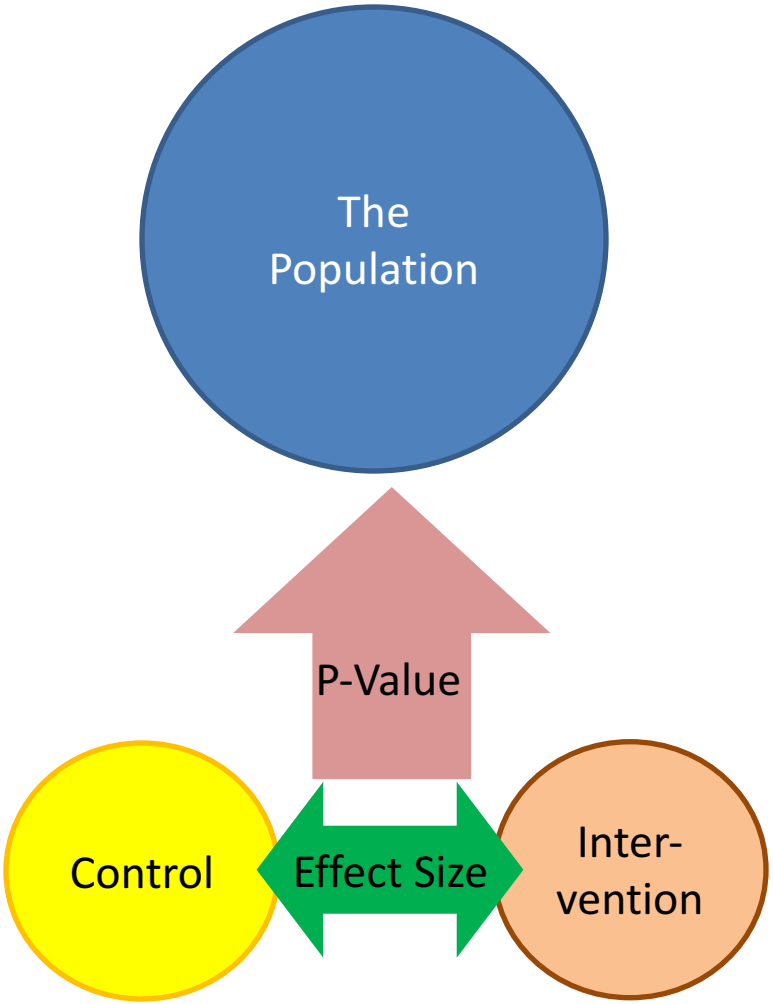
#1-Fishing

- Trawling through a large database testing for every possible association
- The Problem: If you search hard enough you will find something, but it may be meaningless
- Example: If you perform 20 statistical tests, and each is significant with a p-value of 0.05 then, by definition, at least one of those p-values is wrong, but you don't know which
- Solution: Preselect a small number of planned associations for testing

Sullivan, GM : Is There a Role for Spin Doctors in Med Ed Research. JGME. Sept 2014, 405-407

#2-The Naked P-value

- Looking at p-values without effect size
- The Problem: P-values do not comment on how meaningful a difference is, only the likelihood that you will see it in the population
- Example: A drug that is shown to significantly ($p<0.0001$) alter life expectancy, but only by 5 days
- Solution: Report an effect size (r-value, odds ratio, etc) if possible



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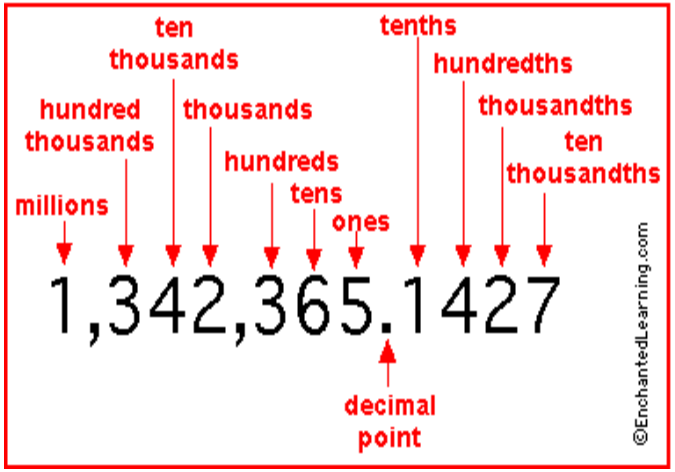
#3-Hyperprecise Likert Scales

- Means for Likert Scale (1-5) items reported to 100-1000th decimal
- The Problem: Likert Scale data is ordinal and thus averaging can be problematic (especially to this extent)
- Example: "Assessments of learners showed a change from 3.51 to 3.73 after the intervention
- Solution: If you decide to average surveys, do it to the first decimal place at most
- Medians are better for ordinal data



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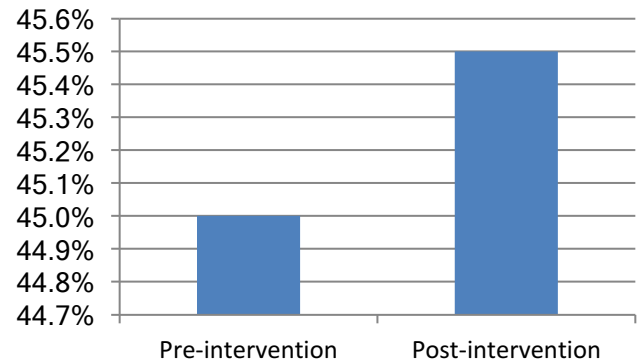
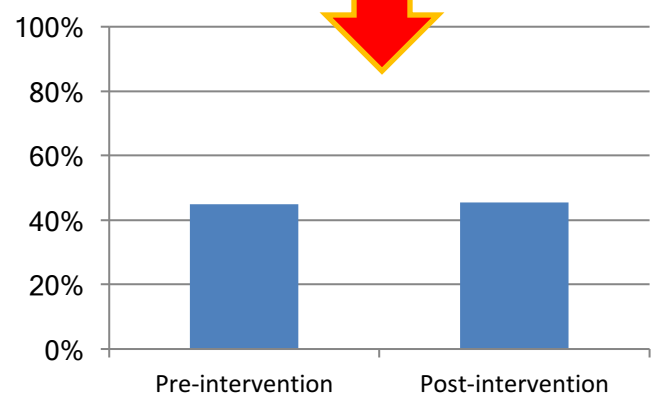
#4-Dramatic Graphs

- Doctoring the Y-axis to make a difference between groups look more impressive than it really is
- The Problem: You can make a difference on a graph look as significant as you want it to with enough work
- Example:
- Solution: Use a realistic scale



Same Graph!



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#5-Power Calculations, Not Trends

- Claiming that a lack of significance is due to lack of power or reporting “trends” that do not achieve significance
- The Problem: This may well be true, but you cannot know this for sure without an accurate power calculation
- Solution:
  1. Perform a power calculation before the study to assess optimal sample size (they are not as complicated as you may think)
  2. Play by your own rules! Do not claim that a result you want to be significant, but does not meet criteria, has a “trend” toward significance. It either meets predefined significance criteria or it does not

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#6-Disconnect Between Findings and Conclusions

- Conclusions dramatically overstate results
- Problem: Too much is being read into the data
- Example:
  - **Results**: In a sample of 50 residents, perceptions of personal musculoskeletal exam skills have declined over time
  - **Conclusion**: A national requirement to add a musculoskeletal rotation should be adopted by the ACGME
- Solution: Carefully consider whether a conclusion is justified by the evidence before stating it

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#7- The Intervention Always Works

- The Discussion or Limitations sections are used to explain why an intervention that is "obviously" effective showed no actual benefit
- Problem: The biases of the researchers are overriding the strength of the evidence
- Solution: Be honest. If your data does not support your hypothesis then state this clearly
- Recognize that negative studies can lead to interesting new areas of investigation

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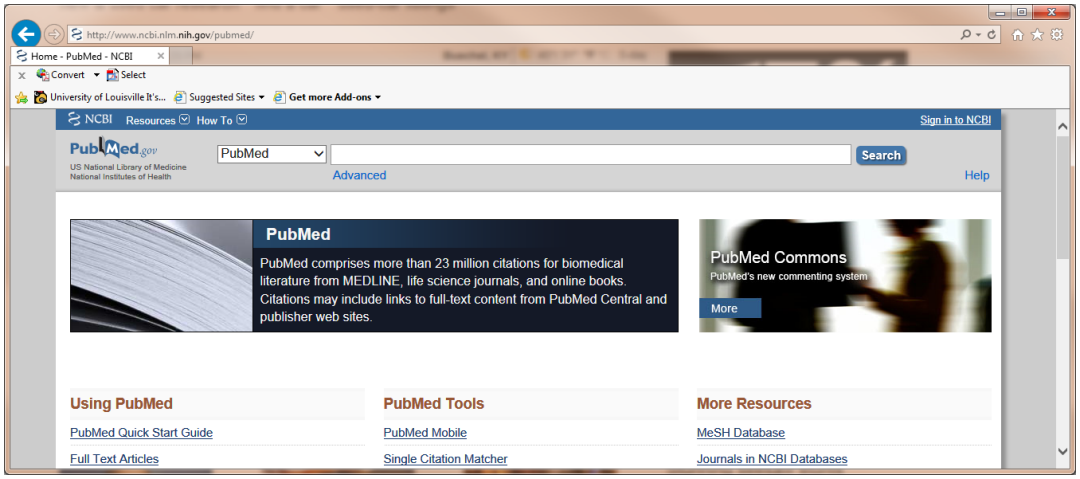
Publishing Your Work

- Completing the data gathering phase is only half of the process
- It is essential to submit and have your work accepted in a peer-reviewed journal
- Where do you start?



In Which Journal Should you Publish?

- This is extremely important because it directly affects format of the final article
- Simulation specific journal vs education journal vs specialty journal vs nursing journal
- Examples of journals accepting simulation and educational studies
  - Simulation in Healthcare-**simulation specific**
  - Advances in Simulation-**simulation specific**
  - BMJ Simulation and Technology Enhanced Learning-**simulation specific**
  - Clinical Simulation in Nursing-**simulation specific**
  - Journal of Graduate Medical Education-**resident/fellow specific**
  - Teaching and Learning in Medicine
  - Medical Teacher

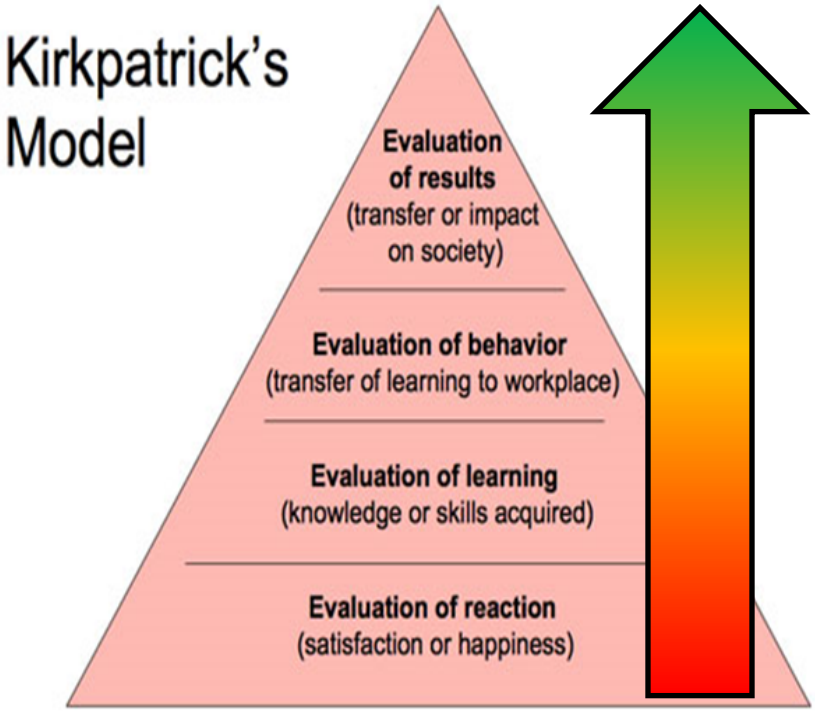
How Do You Choose…

How to maximize chances of acceptance

1. Look at example articles from a number of possible journals **prior to** writing
   - In which journal does your study seem most "at home?"
2. Once you find a possible journal, go to the website and find the "author instructions" page
3. Consider the article types available-which one fits your study best?
   - Empirical Research
   - Review
   - Curriculum Development
   - Conceptual

Types of Articles…

- Choosing the correct article type impacts acceptance
- Questions to consider
  1. How novel is my curriculum/intervention?
  2. How strong is my data?
     - Kirkpatrick level 1 data better suited to conference abstract format
  3. How well does what I have done fit in with more theoretical considerations (educational models, etc)?



Kirkpatrick's (2006) hierarchy of evaluation.

Small Group Work- Refining the Plan

Putting It All Together-Developing a Long-Term Plan

Charting a Course

- The value of careful planning
- The value of serendipity

The Value of Planning

- Often your next research question is directly dependent on the answer to the last
- A “program of research” starts with a series of linked questions

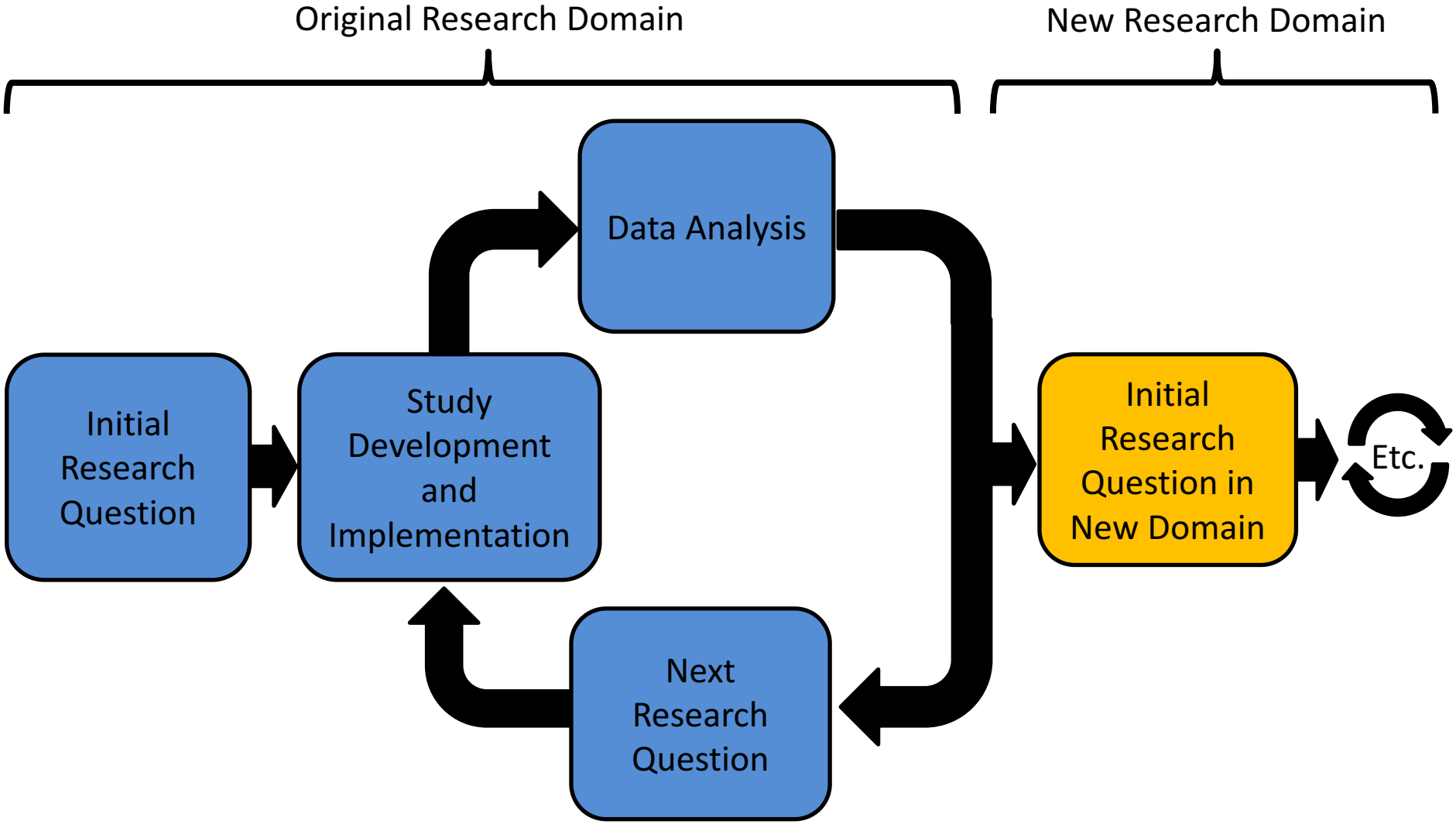
Developing New Research

- Were my results **expected** or **unexpected**?
- How do these results **impact the overall field** of research I am engaged in?
- What **new questions within that field** arise naturally from these results?
- Do these results point to a **different field of interest**?
- What question should I **investigate next**?

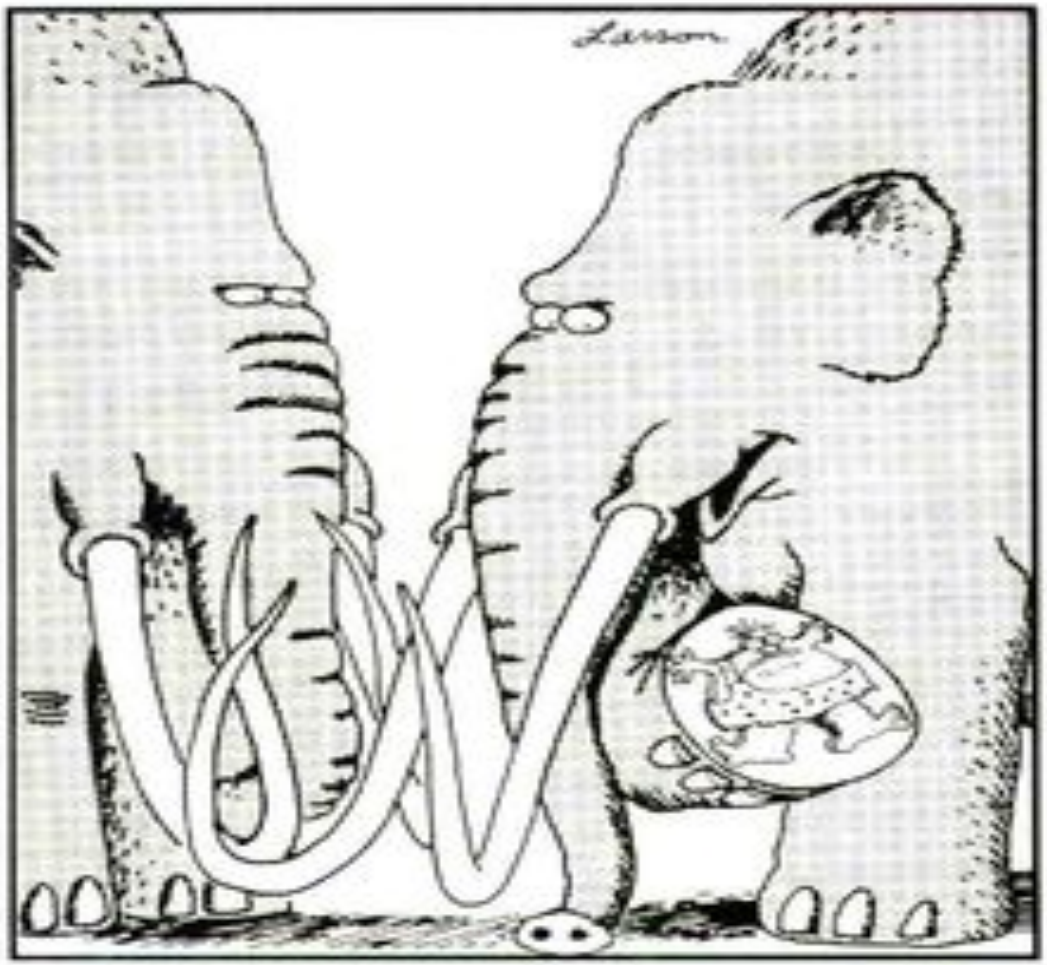
Developing The Overall Program

- What **financial resources** (if any) will I need to continue to investigate in this area?
- What **mentoring** (if any) will I need to continue to investigate this area?
- What **opportunities for research dissemination** exist in this area?
- How can this area of research **contribute to advancement** in my career?

Developing The Overall Program



Taking Advantage of Serendipity



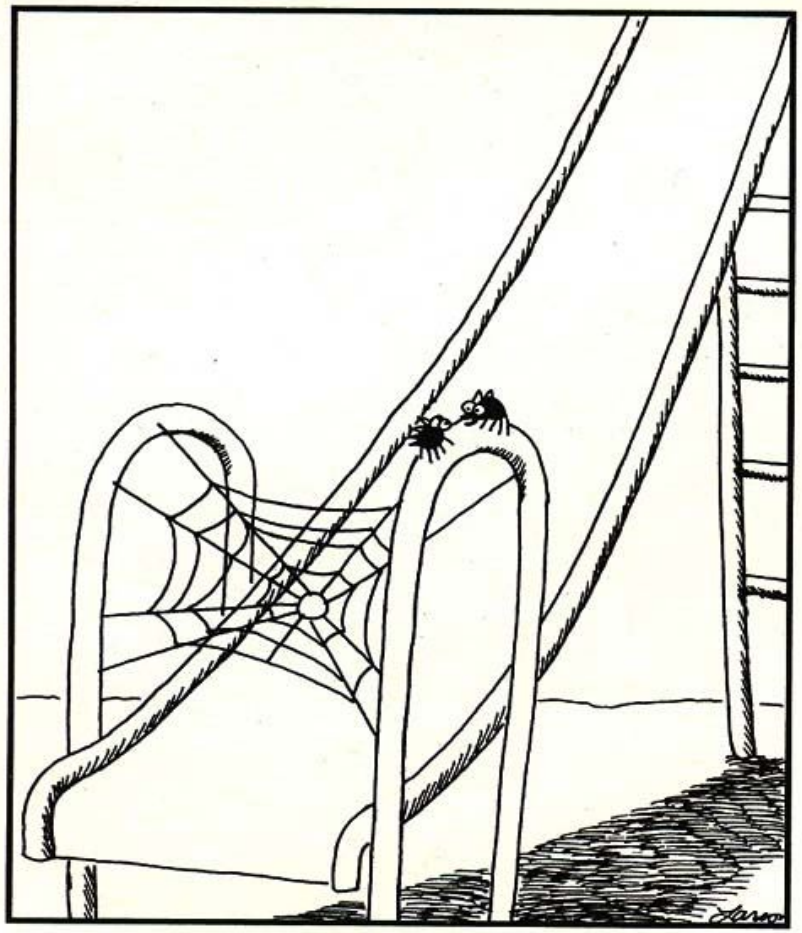
"Well, what the? ... I *thought* I smelled something."

An Example: Research in Simulation Ethics

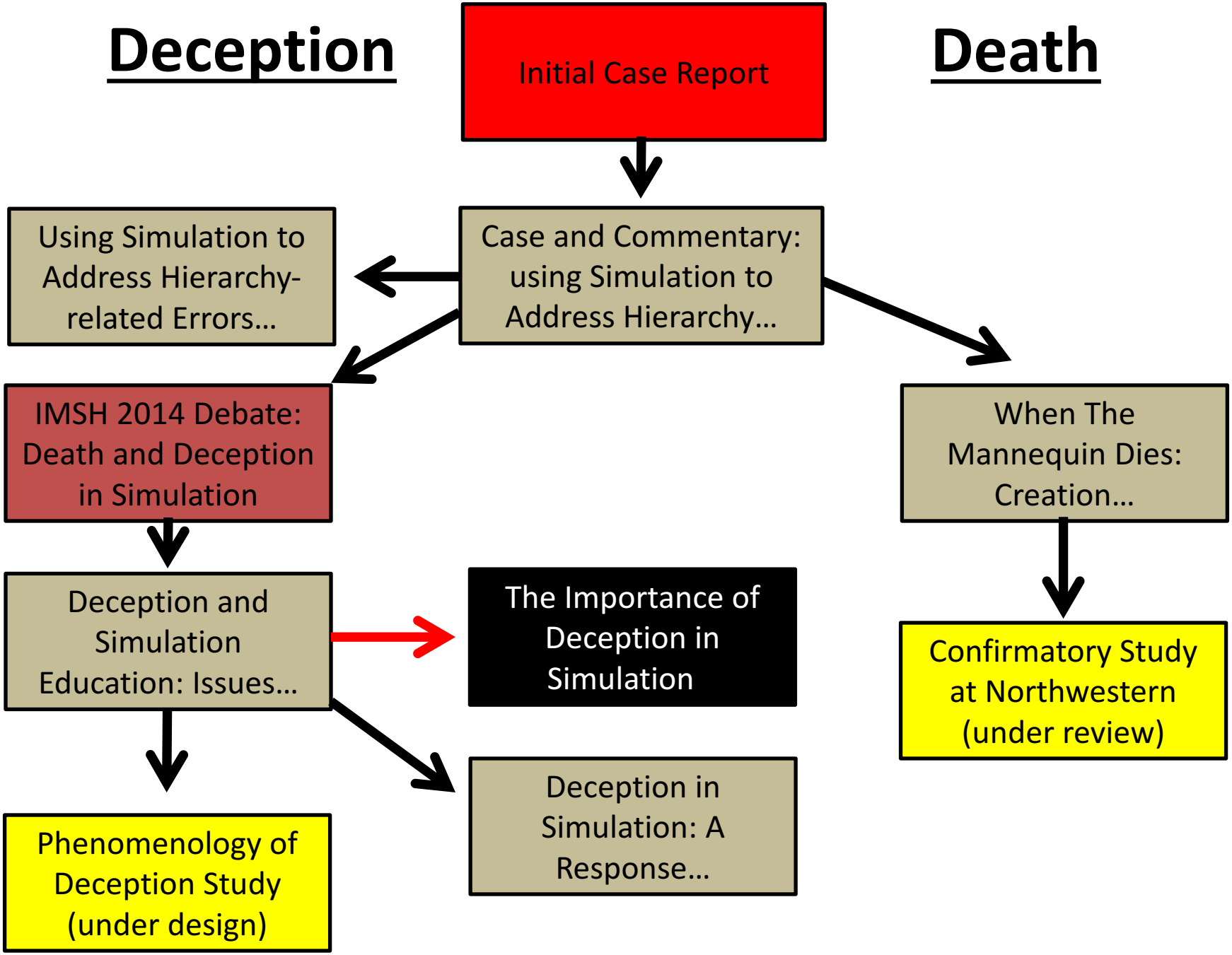
- Began with a brief case report of a simulation involving deception and death
- Received concerning reviewer comments regarding the ethics of our approach
- Called a mentor/medical ethicist from my training program for advice
- Indirect source of the review-concerned about many aspects of the work

An Example: Research in Simulation Ethics

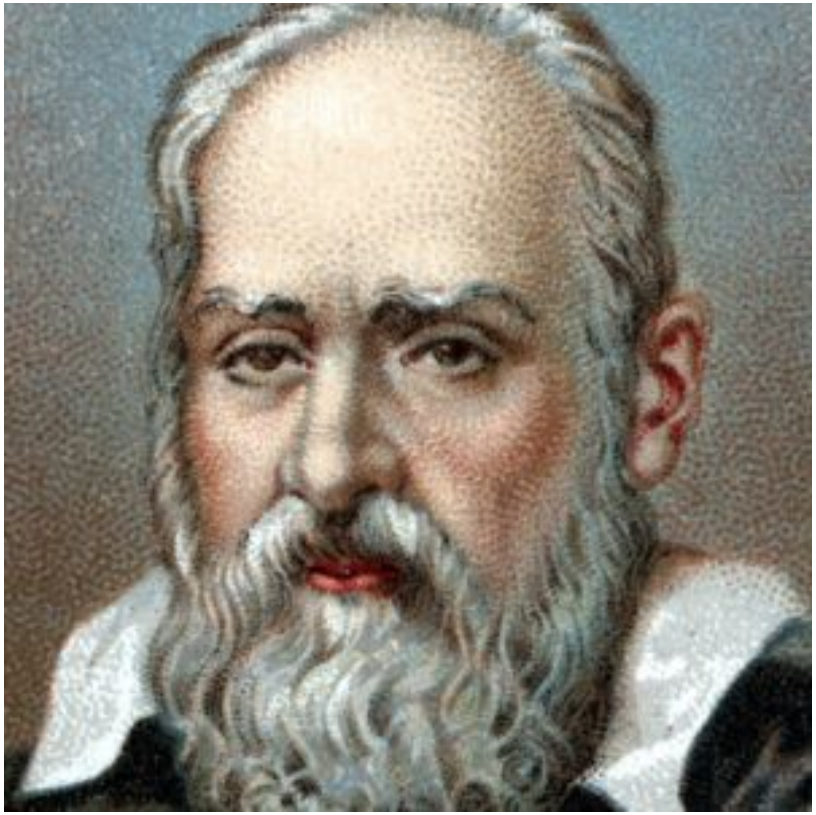
- Given the controversial nature of the case, Editor-in-Chief suggested expanding the piece into an ethical discussion of death and deception in simulation
- Left us with a choice as to how to respond
- We took up the challenge…



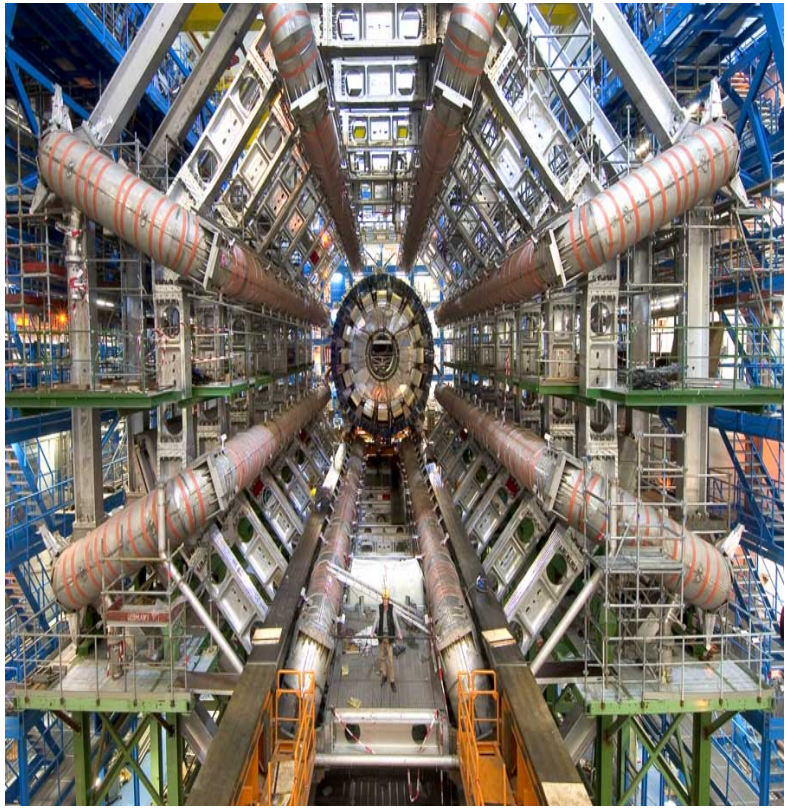
"If we pull this off, we'll eat like kings."


Deception
Initial Case Report
Death
Using Simulation to Address Hierarchy-related Errors…
Case and Commentary: using Simulation to Address Hierarchy…
IMSH 2014 Debate: Death and Deception in Simulation
When The Mannequin Dies: Creation…
Deception and Simulation Education: Issues…
The Importance of Deception in Simulation
Confirmatory Study at Northwestern (under review)
Deception in Simulation: A Response…
Phenomenology of Deception Study (under design)

The Cost of Innovation



VS

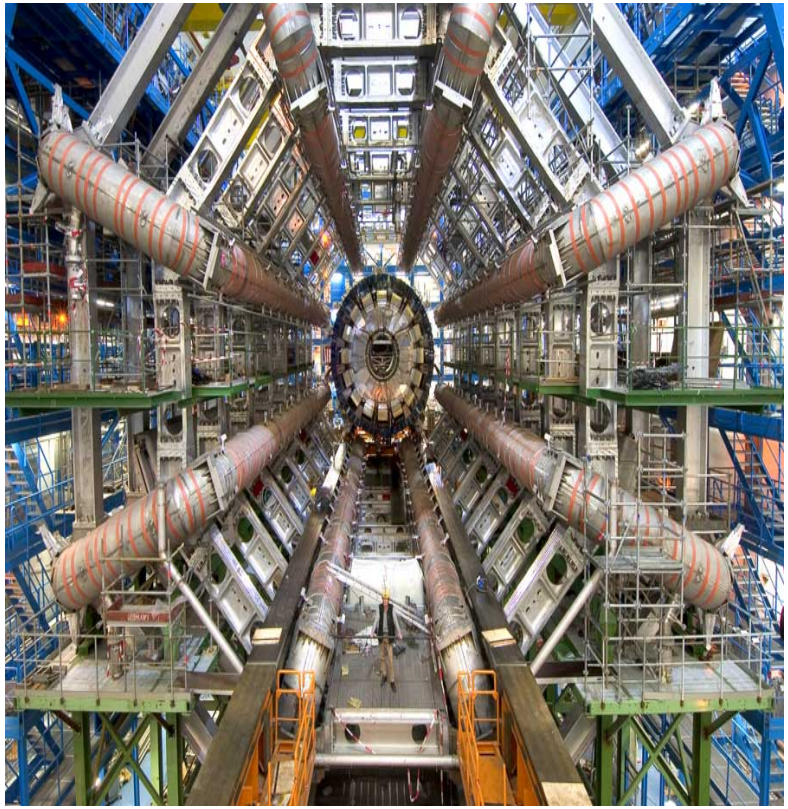


Galileo Galilei

Large Hadron Collider

Bowling Balls vs Large Hadrons

VS



$160 (for a good one)

$9,000,000,000 (for the only one)

The Value of Serendipity

- Sometimes a negative review can be a positive thing
- Often, controversy simply means that no-one has actually studied it yet
- It may not only be a promising field, but there could be a lot of low-hanging, low-cost fruit
- Planning is good, but some of the best things that happen are completely unexpected
- Take advantage of those opportunities

Question and Answer

Messick's Framework

Content Evidence	Does the content of the tool match the construct being measured?
Response Process	What are the specific connections between the questions and the resulting scores? How does this affect the quality of the data?
Internal Structure	How reproducible are the scores (also known as Reliability)? Are all the items assessing the same construct?
Relationship to Other Variables	How well do scores derived from the tool match other accepted measures of the same construct (if they exist)?
Consequences	What will the scores be used for in the "real world" and can that use be supported?

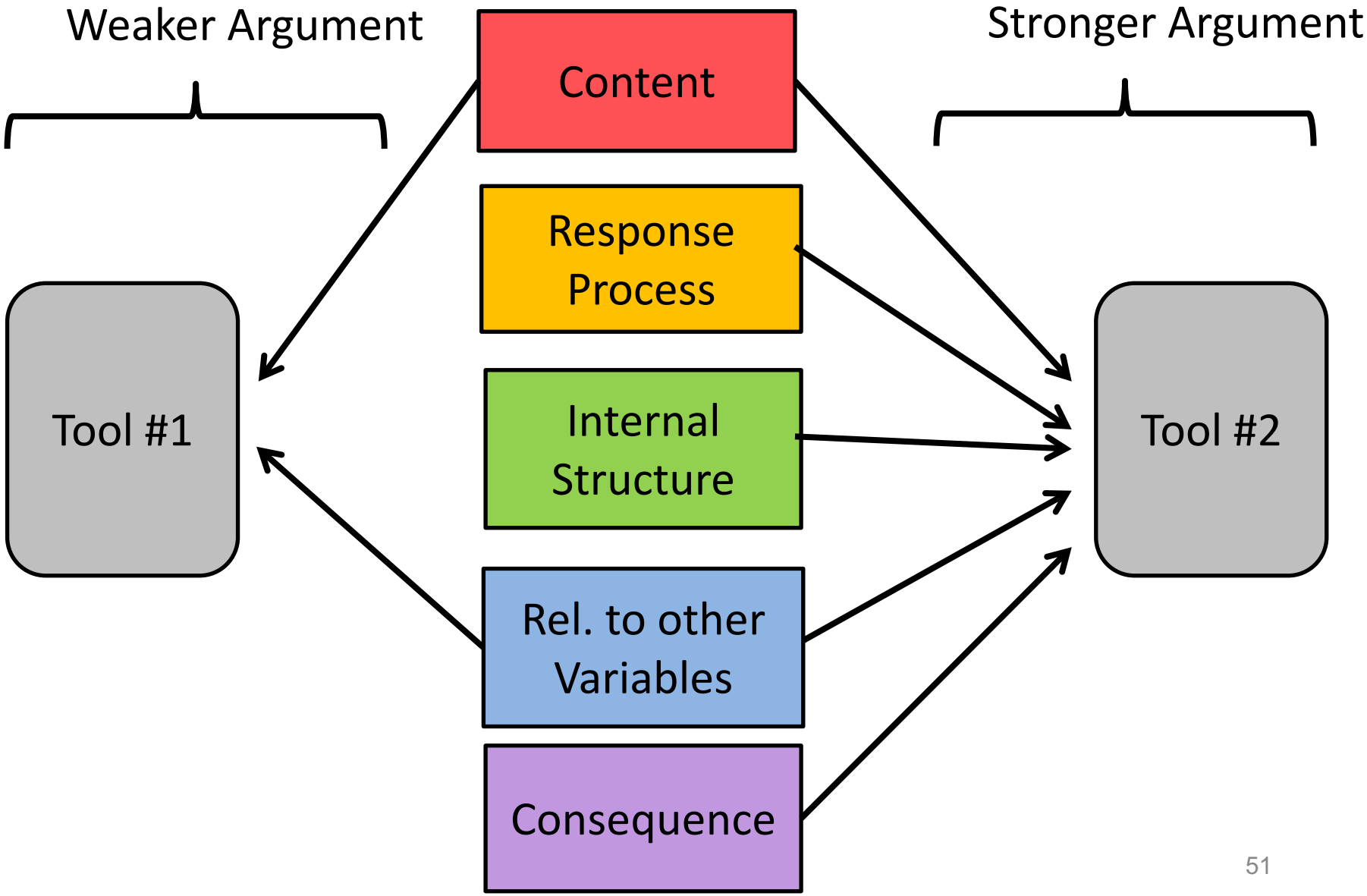
Downing S. M. Validity: On the Meaningful Interpretation of Assessment Data. Medical Education 2003;37:830-837.
American Educational Research Association, American Psychological Association, & National Council on Measurement in Education. Standards for Educational and Psychological Testing (2014) Washington, DC: American Educational Research Association.

An Alternative Approach- Kane's Framework

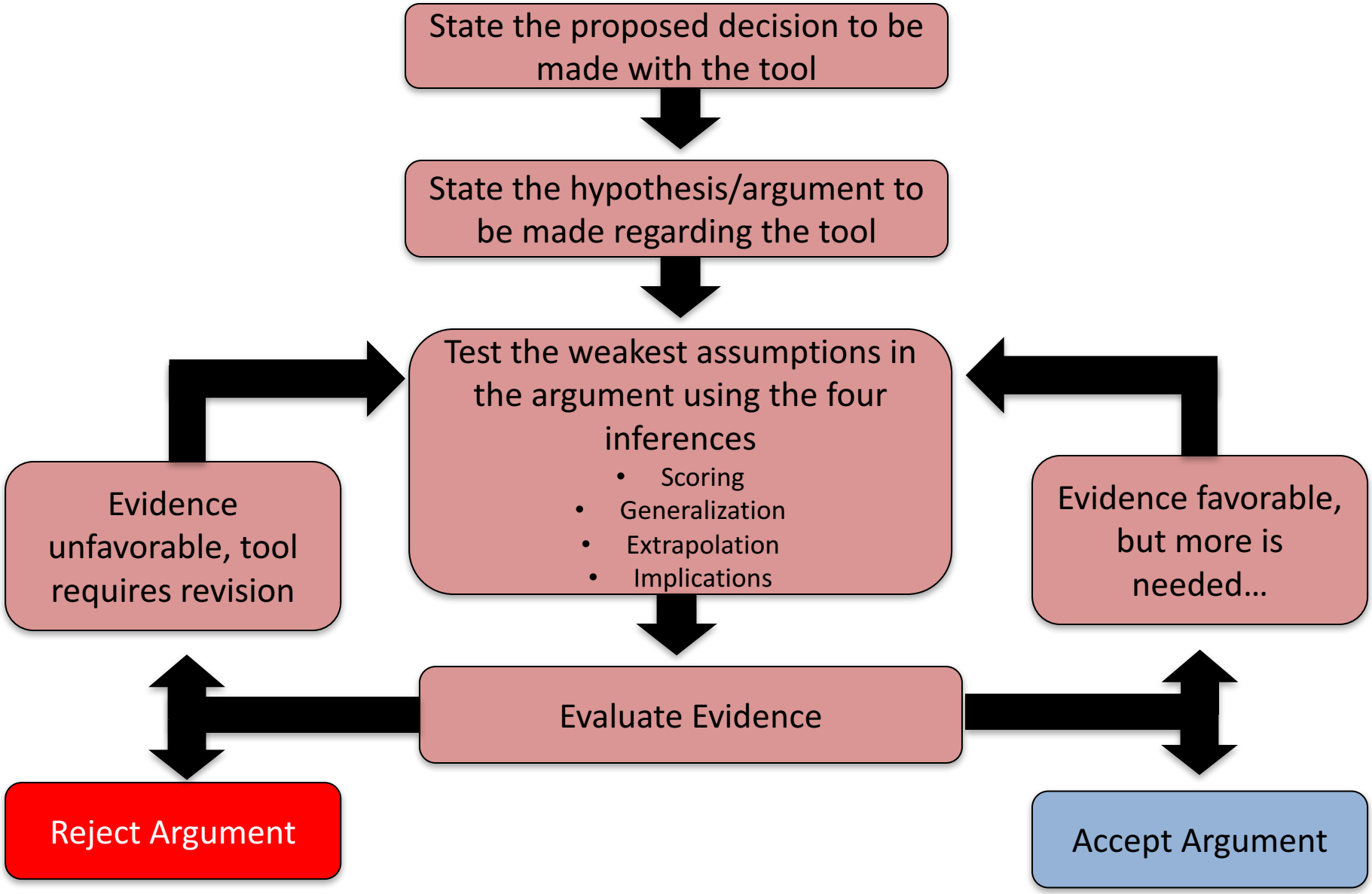
Decision	What is the specific decision that the tool is intended to facilitate?
Scoring Inference	What is the strength of the connection between rater observations and assessment tool scores?
Generalization Inference	What do those scores imply about learner performance in the specific setting of the test?
Extrapolation Inference	How easily does performance in the test setting translate to the environment of actual practice (i.e. the "real world")?
Implication Inference	Given the prior three inferences, what do the scores then imply about the learner's ability with regard to the decision in question?

Cook DA, Brydges R, Ginsburg S, Hatala R. A Contemporary Approach to Validity Arguments: A Practical Guide to Kane's Framework Medical Education 2015, 49: 560-575

Making the Validity Argument Using Messick's Framework



Making the Validity Argument Using Kane's Framework



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