HOW TO APPLY THE MULTIPHASE OPTIMIZATION STRATEGY (MOST) IN YOUR INTERVENTION DEVELOPMENT RESEARCH

Module 4
Some conceptual and technical aspects of the factorial experiment

Lesson 4: Two distinct perspectives on research: Conclusion-priority and decision-priority

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Intervention Optimization Initiative

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In the previous lesson you learned how to:

- Understand the basics of powering a factorial experiment

In this lesson you will learn how to:

- Distinguish between the conclusion-priority and decision-priority perspectives
- Discern whether the conclusion-priority or decision-priority perspective is appropriate in a given situation

Quick review

- Type I error = rejecting the null hypothesis, given that it is true = mistakenly concluding an effect exists when it does not
- α = Type I error rate = probability of rejecting the null hypothesis, given that it is true

Quick review

- Type II error = failing to reject the null hypothesis, given that it is false = mistakenly overlooking an effect
- β = Type II error rate = probability of failing to reject the null hypothesis, given that it is false

In your prior scientific training you probably learned:

- Purpose of conducting a study: To enable you to conclude whether or not a particular effect exists
- So you assess likely effect size, and determine *N* needed to achieve sufficient power (say, power=.8), α=.05
- If you have the resources to obtain that *N* you conduct the study; if you don't have the resources you do not undertake the study

In your prior scientific training you probably learned:

- If you obtain significant results at $p<.05$, you conclude that you can reject H_0 and the effect exists
- If you obtain non-significant results, you conclude that you don't know whether or not the effect exists
- We will call this the conclusion-priority perspective

Now consider an alternative perspective

- You need to make a decision about which components make up the optimized intervention
- You have certain levels and kinds of resources, and you are going to use these resources to obtain the kind of information you need

Now consider an alternative perspective

- According to the resource management principle of MOST, you are going to make the best use of these resources to get the largest amount of, and highest-quality, information you can to enable you to make that decision

Now consider an alternative perspective

- Saying “We cannot decide, the information is not good enough” is not an option. Every component examined in the optimization trial will either be included in the optimized intervention or not

- We will call this the decision-priority perspective

Type I and Type II error rates and the two perspectives

- In the conclusion-priority perspective, the investigator is planning for results to be judged in peer review. Think of this as "science court" where:
  - Maximum acceptable α=.05
  - Minimum acceptable power in .7 to .8 range, so β in .2 to .3 range acceptable
  - Notice Type II error rate routinely 4 to 6 times the Type I error rate

Type I and Type II error rates and the two perspectives

- Thus, an investigator working from the conclusion-priority perspective is saying:
- *I would MUCH RATHER overlook an effect that exists, than mistakenly conclude an effect exists when it doesn't.*
- *To me, making a Type I error is 4 to 6 times more painful/costly than a Type II error.*

Type I and Type II error rates and the two perspectives

- Investigators plan experiments based on selected desired Type I and Type II error rates
- So, to an extent this is under the investigator's control
- Let's revisit all this from the decision-priority perspective

Type I and Type II error rates and the two perspectives

- In the decision-priority perspective, the investigator is planning to use the results in making a decision about which components and component levels will make up the optimized intervention
- Overlooking an effective component may be at least as painful/costly as mistakenly concluding that a component is effective

Type I and Type II error rates and the two perspectives

- This suggests that a different balance of Type I and Type II error rates could be considered

Type I and Type II error rates and the two perspectives

- Suppose you start with a maximum acceptable β, say .2 (minimum acceptable power=.8)
- Suppose you cannot afford the *N* to give you both power=.8 AND α=.05
- The resource management principle suggests: consider raising α to enable more power with the *N* you can afford

Type I and Type II error rates and the two perspectives

- The resource management principle suggests: consider raising α to enable more power with the *N* you can afford
- NOTE that this is a TRADE-OFF
- You are **strategically** accepting a higher Type I error rate to reduce the Type II error rate

Example

- Suppose you are planning an optimization trial.
  - You want to maintain power of at least .8.
  - Your available resources enable you to obtain a maximum of 100 participants.
  - You conduct a power analysis using your anticipated effect size and α=.05, and find you will need *N*=126

Example

- The resource management principle suggests that you consider raising α. You are comfortable with α=.10
- You find that with α=.10, the required *N* drops to 98
- With α=.10 the optimization trial can be accomplished within your resource limitations
- BUT you have a higher probability of a Type I error

Type I and Type II error rates and the two perspectives

- The decision-priority approach and the resource management principle are closely related
- The idea: You need to use resources strategically
- You need to manage resources to enable you to make the best decisions
- This means managing the Type I and Type II error rates

Which perspective is appropriate in intervention optimization?

- BOTH perspectives are appropriate, but at different times and for different purposes
- In the optimization phase, typically the decision-priority perspective
  - In particular, in planning the optimization trial
- In the evaluation phase, typically the conclusion-priority perspective

Summary of conclusion-priority vs. decision-priority perspectives

Conclusion-priority	Decision-priority
OK to conclude “we don’t know”	Necessary to make a decision

Summary of conclusion-priority vs. decision-priority perspectives

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Hypothesis-testing “master”	Hypothesis-testing one tool for decision-making

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$\alpha \leq .05$ dictated by “science court”	α selected based on resource management principle

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Appropriate for evaluation phase	Appropriate for optimization phase

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In the next lesson you will learn how to

- Recognize when a cluster structure is present
- Understand how a cluster structure can affect statistical power