Analysis/Power Lab (Moderators)

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Outline

- Software Options
- Examples
- Exercises
- Writing up the power analysis

Software Options

- www.causalevaluation.org
  - *PowerUp!-Moderator*
  - *PowerUp R Shiny App*
  - *PowerUpR*

- More limited design options

Example 1

Program: A new math curriculum for 3rd graders. The curriculum is implemented at the school level. The researchers plan to randomly assign schools to the treatment or control condition. Students are nested within schools.

Research questions:

Research suggests that the curriculum is more effective in small schools compared to large schools. Is there a differential effect based on school size?

Suppose 40 schools were recruited for the study, 20 per condition. Further, within each condition, 10 are small schools and 10 are large schools. The ICC = 0.18 and 40 percent of the variance at level-1 and 60 percent of the variance at level-2 are explained by pre-test. There are 150 kids per school. What is the minimum detectable effect size difference (MDESD)?

Example 1

- How many levels are in this study?
- What is the level of randomization?
- What is the level where outcome data is measured?
- What is the level of moderator?
- What are good estimates of the intraclass correlation? Percent variance explained by covariate(s)?

Example 1

- J : total number of clusters
- n : number of individuals per cluster
- ρ : Intraclass correlation coefficient
- δ: differential effect size, $\delta = \frac{\gamma_{03}}{\sqrt{\tau_{00} + \sigma^2}}$
- R_1^2 : proportion of variance explained at level-1
- R_2^2 : proportion of variance explained at level-2
- P: proportion of level-2 units randomized to treatment
- Q_2*: proportion of level-2 units in moderator subgroup
- Power: typically set to 0.80

*Assuming binary moderator

Example 1

- *Assume:*

- J : total number of clusters = 40
- n : number of individuals per cluster = 150
- ρ : Intraclass correlation = 0.18
- δ: differential effect size = ?
- R_{L1}^2 : proportion of variance explained at level-1 = 0.40
- R_{L2}^2 : proportion of variance explained at level-2 = 0.60
- P: proportion of level-2 units randomized to treatment = 0.50
- Q: proportion of level-2 units in moderator subgroup = 0.50
- Power: typically set to 0.80

PowerUp!-Moderator

Model CRA2-2: MDESD Calculator for Two-Level Cluster Random Assignment Design — Treatment at Level 2 and Binary Moderator at Level 2		
Assumptions		**Comments**
Alpha Level (α)	0.05	Probability of a Type I error
Two-tailed or One-tailed Test?	2	
Power (1-β)	0.80	Statistical power (1-probability of a Type II error)
Rho (ICC)	0.18	Proportion of variance in outcome that is between clusters
P	0.50	Proportion of Level 2 units randomized to treatment: $J_T / (J_T + J_C)$
Q	0.50	Proportion of Level 2 units in Moderator subgroup: $J_1 / (J_1 + J_0)$
R_1^2	0.40	Proportion of variance in Level 1 outcomes explained by Level 1 covariates
R_2^2	0.60	Proportion of variance in Level 2 outcome explained by Level 2 covariates
g*	1	Number of Level 2 covariates excluding the moderator and moderator*Treatment
n (Average Cluster Size)	150	Mean number of Level 1 units per Level 2 cluster (harmonic mean recommended)
J (Sample Size [# of Clusters])	40	Number of Level 2 units
M (Multiplier)	2.88	Computed from T_1 and T_2
T_1 (Precision)	2.03	Determined from alpha level, given two-tailed or one-tailed test
T_2 (Power)	0.85	Determined from given power level
MDESD	**0.535**	Minimum Detectable Effect Size Difference regarding Cohen's d
95% Confidence Interval	**(0.158, 0.911)**	95% Confidence Interval of MDESD

Note: The parameters in yellow cells need to be specified. The MDESD will be calculated automatically.

START OVER

Example 2

Program: A new math curriculum for 3rd graders. The curriculum is implemented at the school level. The researchers plan to randomly assign schools to the treatment or control condition. Students are nested within schools.

Research questions:

Is there a differential effect for students who start 3rd grade below grade level in math vs. above grade level in math?

Suppose 40 schools were recruited for the study, 20 per condition. Further, within each school there are 150 kids, 75 are below grade level and 75are above grade level. The ICC = 0.18 and 40 percent of the variance at level-1 is explained by pre-test. What is the MDESD? (Assume a non-randomly varying slope.)

Example 2

- How many levels are in this study?
- What is the level of randomization?
- What is the level where outcome data is measured?
- What is the level of moderator?
- What are good estimates of the intraclass correlation? Percent variance explained by covariate(s)?

Example 2

- J : total number of clusters
- n : number of individuals per cluster
- ρ : Intraclass correlation coefficient
- δ: differential effect size
- R_1^2 : proportion of variance explained at level-1
- P: proportion of level-2 units randomized to treatment
- Q_1*: proportion of level-1 units in moderator subgroup
- Power: typically set to 0.80

*Assuming binary moderator

Example 2

- *Assume*

- *J* : total number of clusters = 40
- *n* : number of individuals per cluster = 150
- ρ : Intraclass correlation = 0.18
- δ: differential effect size = ?
- R_{L1}^2 : proportion of variance explained at level-1 = 0.40
- P: proportion of level-2 units randomized to treatment = 0.50
- Q: proportion of level-1 units in moderator subgroup =0.50
- Power: typically set to 0.80

*Assuming binary, nonrandomly varying moderator

PowerUp!-Moderator

Model CRA2-1N: MDESD Calculator for Two-Level Cluster Random Assignment Design — Treatment at Level 2 and Binary Moderator at Level 1 (Nonrandomly varying moderator slope model)		
Assumptions		**Comments**
Alpha Level (α)	0.05	Probability of a Type I error
Two-tailed or One-tailed Test?	2	
Power ($1-\beta$)	0.80	Statistical power (1-probability of a Type II error)
Rho (ICC)	0.18	Proportion of variance in outcome that is between clusters
P	0.50	Proportion of Level 2 units randomized to treatment: $J_T / (J_T + J_C)$
Q	0.50	Proportion of Level 1 units in Moderator subgroup: $n_1 / (n_1 + n_0)$
R_1^2	0.40	Proportion of variance in Level 1 outcomes explained by Level 1 covariates
g*	1	Number of Level 1 covariates excluding the moderator
n (Average Cluster Size)	150	Mean number of Level 1 units per Level 2 cluster (harmonic mean recommended)
J (Sample Size [# of Clusters])	40	Number of Level 2 units
M (Multiplier)	2.80	Computed from T_1 and T_2
T_1 (Precision)	1.96	Determined from alpha level, given two-tailed or one-tailed test
T_2 (Power)	0.84	Determined from given power level
MDESD	**0.101**	Minimum Detectable Effect Size Difference regarding Cohen's d.
95% Confidence Interval	**(0.03, 0.173)**	95% Confidence Interval of MDESD

Note: The parameters in yellow cells need to be specified. The MDESD will be calculated automatically.

START OVER

Exercise

For each of the exercises, please do the following:

1. Name the specific type of CRT.

2. Identify the level of the moderator.

3. Identify the sample size at each level (if known).

4. Estimate the design parameters using the specific resource noted. Document your assumptions, e.g. state, population, covariate set.

5. Conduct the power analysis using *PowerUp Moderator*.

5. Document the results of the power analysis.
Calc MDES, MDESDCL (vary things), MDESDIND (vary things)

Exercise

Suppose a researcher is planning the evaluation of a new reading curriculum for 4th graders and is considering a cluster-randomized trial in which:

- Entire schools will be assigned at random to receive either the new reading curriculum or continue with their current practices

The researcher:

- Recruited 48 schools for the study, assumes 24 schools per condition
- Will include all 4th graders in each school, approximately 90 per school
- Does not have access to teacher-level data
- Estimates that approximately 15 percent of the variation in student test scores lies between schools
- Has access to pre-test scores and expects those scores to be explain 30 percent of the variation in the outcome at level-1 and 65 percent at level-2

Question 1: What is the MDES?

Exercise

Suppose the researcher wants to investigate whether treatment effects are different for schools below state standards vs. at or above state standards. Suppose 25 percent of schools are below state standards.

Question 2: What is the MDESD for the cluster level moderator?

Exercise

Suppose the researcher wants to investigate whether treatment effects are different for students from historically excluded groups than for others. Suppose 25 percent of students are from historically underserved groups.

Question 3: What is the MDESD for the individual level moderator? (assume non-randomly varying slope)

Exercise

Question 4: How do the following compare: MDES, MDESD for cluster level moderator, and MDESD for individual level moderator? What are the key sample sizes for each?

Writing up a Power Analysis

- Differs depending on the design
- Differs depending on software
- Critical to identify your design and software
- Be sure to identify the effect of interest