Week of February 23

1. Power analysis: What is it, and what is it good for?
2. Relations among effect size, sample size, α, and power
3. Conducting a power analysis
4. Exercises with the Power and Precision software

Power Analysis: What Is It?

- For a given formal test (e.g., a test of the difference between two group means), when three of the following four quantities are known or can be estimated, a power analysis can solve for the fourth quantity
  1. The significance level (α) used to test the effect
  2. The true size of the effect being tested (i.e., the population effect size)
  3. The sample size
  4. The power of the test (i.e., the probability that the planned test will obtain a significant result)

Power Analysis (Huh!): What Is It Good For?

- Three common questions that can be answered by a power analysis:
  1. I'm planning to run a study to test a particular effect. What sample size should I use so that I have a reasonable chance (usually 80%) of getting a significant result?
  2. I'm planning to run a study with a particular sample size to test a particular effect. What are the chances that I will obtain a significant result? (Important for grant applications.)
  3. My study (or a study I read about) obtained a null result. Is this probably because the effect isn't there (or is very small), or because the study didn't have sufficient power to detect it?

Relations Among Sample Size, Effect Size, α, and Power

- As sample size **increases**, power **increases**
  - Because we can be more confident that our sample statistics are close to the population values
- As the population effect size **increases**, power **increases**
  - Because our observed effects will tend to be further from the null hypothesis
- As α becomes **smaller** (i.e., more conservative), power **decreases**
  - Because we are requiring a larger observed effect before rejecting the null hypothesis

Steps for Most Power Analyses

1. Determine the kind of test and the significance level (usually α = .05)
2. Estimate the population effect size (Note: This is the most difficult step for many researchers)
   a. The effect-size estimate can come from theory or from similar previous studies
   b. When in doubt, assume a conservative (i.e., small or medium) effect size
3. Set either the available sample size or the desired power (usually 80%), then solve for the other using computer software—such as Power and Precision—or power tables—such as those in Cohen (1988) or online at http://fsweb.berry.edu/academic/education/vbissonnette/tables/tables.html

Effect Size Guidelines: Informal

- In general…
  - A **large** effect is one that is obvious to casual observation
  - A **medium** effect is one that can be detected with the naked eye
  - A **small** effect is one that is difficult to detect without careful observation and analysis

Some Measures of Effect Size

See also J. Cohen (1988 book, 1992 Psych Bull)

- Difference between two group means: Cohen's *d* (the difference between the group means divided by the standard deviation within the groups)
- Differences among multiple group means: Cohen's *f* (the standard deviation among the group means divided by the standard deviation within the groups)
- The correlation between two variables: Pearson's *r* (the expected standard-deviation change in the criterion associated with an increase of one standard deviation in the predictor)
- The correlation of one criterion variable with multiple predictors: Multiple R^2 (the proportion of variance in the criterion explained by the set of predictors)

Effect Size Guidelines: Formal

See also J. Cohen (1988 book, 1992 Psych Bull)

ES Measure	Small ES	Medium ES	Large ES
Cohen's *d*	.20	.50	.80
Cohen's *f*	.10	.25	.40
Pearson's *r*	.10	.30	.50
Multiple R^2	.02	.13	.26

Exercises: Solve Using *Power and Precision* or Online Power Tables

1. For a test of the difference between two means, what sample size is needed for power = .60 when the population difference is small and $\alpha = .05$? With this sample size, what would be the power for a test at $\alpha = .01$?
2. For a test of a single correlation coefficient, what sample size is needed for power = .80 when the population correlation is large and $\alpha = .05$?
3. For a one-way between-groups design with four levels, what is the power when the population effect is medium, there are $s = 30$ participants in each group, and $\alpha = .05$?
4. For a test of a multiple correlation coefficient with 8 predictors, what sample size is needed for power = .80 when the population effect is medium and $\alpha = .01$? With this sample size, what would be the power for a test at $\alpha = .05$?