PSY 201: Statistics in Psychology

Lecture 36
Power for Dependent ANOVA
Leverage relationships.

Greg Francis

Purdue University

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HYPOTHESES

- The null for a dependent ANOVA is an *omnibus* hypothesis. It supposes no difference between any population means

$$H_0 : \mu_i = \mu_j \; \forall \; i, j$$

- the alternative is the complement

$$H_a : \mu_i \neq \mu_j \;\; \text{for some } i, j$$

- To compute power, we have to provide the standard deviation, α, n, specific values for the means, and the correlation (ρ) between the different measures

POWER CALCULATOR

- Consider a situation with $K = 3$ dependent means (all different from each other), $n = 25$, and $\rho = 0$:

Enter the Type I error rate, $\alpha =$ 0.05

Enter the population standard deviation, $\sigma =$ 1.0

Enter the population correlation between levels, $\rho =$ 0

How many levels (groups) do you have in your ANOVA? $K =$ 3

Number of iterations (bigger values produce better estimates, but take longer) 50000

Level name	Population Mean
Level1	10.9
Level2	10.7
Level3	11.3

Add a contrast test

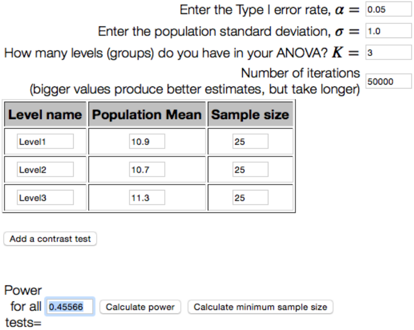
Power for all tests= 0.44972 Calculate minimum sample size

Sample size $n =$ 25 Calculate power

- We estimate the power to be 0.45

INDEPENDENT CALCULATOR

- Since we have $\rho = 0$, the means are independent. Thus, we get nearly the same result with the independent means power calculator



- We estimate the power to be 0.46
- when $\rho = 0$, the independent and dependent ANOVA are almost the same test

DEPENDENT POWER CALCULATOR

- Increasing the correlation increases the power
- Consider a situation with $K = 3$ dependent means (all different from each other), $n = 25$, and $\rho = 0.3$:

Enter the Type I error rate, $\alpha =$ 0.05

Enter the population standard deviation, $\sigma =$ 1.0

Enter the population correlation between levels, $\rho =$ 0.3

How many levels (groups) do you have in your ANOVA? $K =$ 3

Number of iterations (bigger values produce better estimates, but take longer) 50000

Level name	Population Mean
Level1	10.9
Level2	10.7
Level3	11.3

Add a contrast test

Power for all tests= 0.60466 Calculate minimum sample size

Sample size $n =$ 25 Calculate power

- We estimate the power to be 0.6

DEPENDENT POWER CALCULATOR

- Consider a situation with $K = 3$ dependent means (all different from each other), $n = 25$, and $\rho = 0.6$:

Enter the Type I error rate, $\alpha =$ 0.05

Enter the population standard deviation, $\sigma =$ 1.0

Enter the population correlation between levels, $\rho =$ 0.6

How many levels (groups) do you have in your ANOVA? $K =$ 3

Number of iterations (bigger values produce better estimates, but take longer) 50000

Level name	Population Mean
Level1	10.9
Level2	10.7
Level3	11.3

Add a contrast test

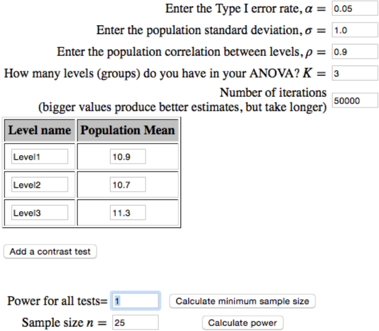
Power for all tests= 0.84974 Calculate minimum sample size

Sample size $n =$ 25 Calculate power

- We estimate the power to be 0.85

DEPENDENT POWER CALCULATOR

- Consider a situation with $K = 3$ dependent means (all different from each other), $n = 25$, and $\rho = 0.9$:



- We estimate the power to be 1.0

DEPENDENT POWER CALCULATOR

- Positive correlations are easy to imagine:
- e.g., reading scores in third, fourth, and fifth grades are positively correlated with each other
- It is plausible that the correlations are (nearly) the same for all variables
- Negative correlations for all variables would be weird
- e.g., GPA for athletes over three different sports seasons
- kind of suggests multiple factors influencing behavior
- for three measures, a negative correlation can be no stronger than $\rho = -0.5$
- the calculator will take your negative correlation and try to do something, but be skeptical about the results

NEGATIVE CORRELATIONS

- Consider a situation with $K = 3$ dependent means (all different from each other), $n = 25$, and $\rho = -0.2$:

Enter the Type I error rate, $\alpha =$ 0.05

Enter the population standard deviation, $\sigma =$ 1.0

Enter the population correlation between levels, $\rho =$ -0.2

How many levels (groups) do you have in your ANOVA? $K =$ 3

Number of iterations (bigger values produce better estimates, but take longer) 50000

Level name	Population Mean
Level1	10.9
Level2	10.7
Level3	11.3

Add a contrast test

Power for all tests= 0.3834 Calculate minimum sample size

Sample size $n =$ 25 Calculate power

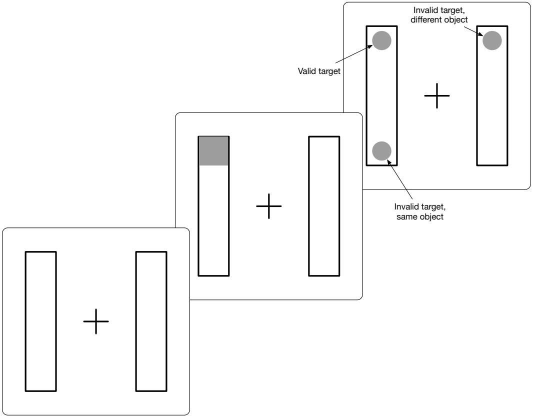
- We estimate the power to be 0.38 (worse than when $\rho = 0$)

OBJECT BASED ATTENTION

- The eye is (kind of) like a camera, with photoreceptors that are similar to pixels in a camera
- However, what people *see* corresponds to objects that are somehow "grouped" together
- We can *select* and *attend* some objects to the exclusion of other objects
- One way of measuring this property of visual perception is to study the "object based attention" effect

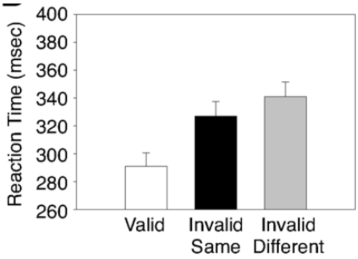
OBJECT BASED ATTENTION

- Measure reaction time (RT) to the target
- Dependent design: each subject provides data for 3 types of targets



PREVIOUS DATA

- A study by Marrara & Moore (2003) found the following results for $n = 19$:



- ANOVA finds: $F_{2,36} = 100.63$, $p \approx 0$
- Contrast for RT on valid trials vs. RT on invalid-same trials: $t_{36} = 11.76$
- Contrast for RT on invalid-same trials vs. RT on invalid-different trials: $t_{36} = 4.13$ (this is the object based attention effect)

REPLICATION

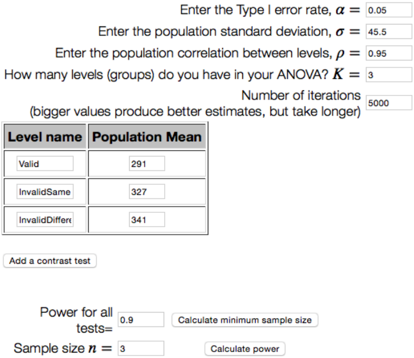
- The study was done 15 years ago (before everyone spent all day staring at a phone). You might want to repeat it with current students to make sure the object based attention effect still exists.
- To design your experiment, you can use the original data to do a power analysis. It takes a bit of effort, but you find that the data has:

$$\overline{X}_{\text{Valid}} = 291, \quad \overline{X}_{\text{InvalidSame}} = 327, \quad \overline{X}_{\text{InvalidDifferent}} = 341$$

$$s = 45.5, \quad r = 0.95$$

POWER CALCULATOR

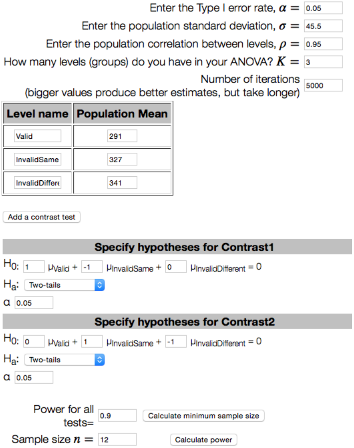
- For just the ANOVA



- To have 90% power, we need only 3 subjects (if the effects are similar to the original study)

POWER CALCULATOR

- We can add the contrasts:
- Now, we need $n = 12$ to get 90% power



CORRELATION

- The original study found $r = 0.95$, which seems rather high. Maybe we think it should be smaller, say $r = 0.75$.
- What is the impact on power if we use $n = 12$?
- Power drops to 0.28!

Enter the Type I error rate, $\alpha =$ 0.05
Enter the population standard deviation, $\sigma =$ 45.5
Enter the population correlation between levels, $\rho =$ 0.75
How many levels (groups) do you have in your ANOVA? $K =$ 3
Number of iterations (bigger values produce better estimates, but take longer) 5000

Level name	Population Mean
Valid	291
InvalidSame	327
InvalidDiffer	341

Add a contrast test

Specify hypotheses for Contrast1

H_0: 1 μ_{Valid} + -1 $\mu_{InvalidSame}$ + 0 $\mu_{InvalidDifferent}$ = 0
H_a: Two-tails
α 0.05

Specify hypotheses for Contrast2

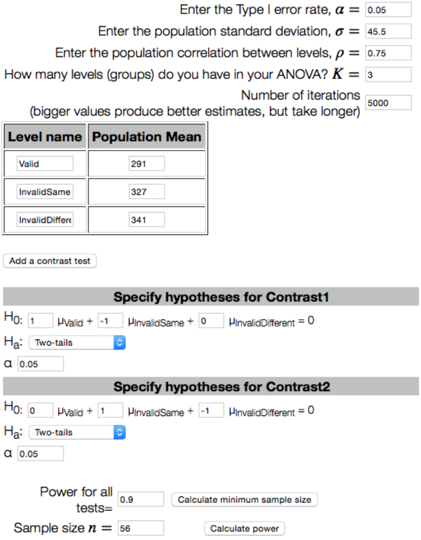
H_0: 0 μ_{Valid} + 1 $\mu_{InvalidSame}$ + -1 $\mu_{InvalidDifferent}$ = 0
H_a: Two-tails
α 0.05

Power for all tests= 0.2836 Calculate minimum sample size
Sample size $n =$ 12 Calculate power

Test	Estimated Power
ANOVA	0.9984
Contrast1	0.9602
Contrast2	0.309

CORRELATION

- The original study found $r = 0.95$, which seems rather high. Maybe we think it should be smaller, say $r = 0.75$. What sample size do we need to have 90% power?
- Need $n = 56$! The correlation makes a *big* difference in dependent means experiments



CONCLUSIONS

- power for dependent ANOVA
- power for contrasts

NEXT TIME

- Catch all
- Challenges with hypothesis testing
- Questionable Research Practices

Tell the truth!