PowerAnalysis.m Guide

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General Notes

- PowerAnalysis_tTests.m and PowerAnalysis_ANOVA do most the work, and are called in the example scripts
  - Note that PowerAnalysis_ANOVA currently works for within and mixed-factor designs, but not purely between-subjects designs

- Key Components:
  - prefs.data:
    - Name of a CSV file containing your data
    - Top row of CSV contains column headings (used for graphing)
    - Each additional row in CSV file is a trial
    - For t-tests (1 factor designs), you should have 3 columns: Col 1 = sub ID, Col 2 = trial score, Col 3 = condition
    - For ANOVAs (2 factor design), you should have 4 columns: Col 1 = sub ID, Col 2 = trial score, Col 3 = factor 1 names, Col 4 = factor 2 names
  - prefs.N_range
    - Range of number of participants to simulate. E.g., 10:10:50 will simulate with 10, 20, 30, 40, and 50 participants. This is TOTAL number of participants (not number of subjects for condition, although these are equivalent for within-subjects designs)
  - prefs.trial_range
    - Range of number of trials per condition to simulate. E.g., 8:4:24 will simulate with 8, 12, 16, 20, and 24 trials per condition
  - prefs.alpha
    - Significance level to use in simulations (often .05)
  - prefs.nSims
    - How many simulations to use for every participant/trial number combination. 10,000 is a decent estimate and runs pretty quickly, 100,000 is slower but a more stable estimate.
  - prefs.comps
    - Which comparisons to test for significance. Each row is a comparison, with the condition expected to be higher magnitude listed in the first column, and the condition expected to have lower magnitude in the second column. A study will be classified as "successful" only if all listed comparisons are significant (see examples).
  - prefs.condition_allocation
    - Used only for between-subjects designs (ignored otherwise). Ratio of how total number of subjects should be divided between conditions during simulations. Should be a value for each condition in data, and values should sum to 1 (100%). For example, [.5, .5] would divide subjects evenly between two conditions. [.25, .5, .25] would use a 1:2:1 ratio for dividing subjects between 3 conditions.
  - prefs.sig_ME1, prefs.sig_ME2, prefs.sig_int
    - For ANOVAs (2-factor designs), whether significant main effects for either factor or a significant interaction is necessary for a successful study design. Note that for mixed-factor design, the between-subjects factor is always considered the first factor.

Example 1: within-subjects t-test

Pilot Data

- 3 columns
- 1 header row, then a row for each trial

	A	B	C
1	Subject	Accuracy	Condition
2	S1	0	Within
3	S1	1	Across
4	S1	0	Across
5	S1	1	Across
6	S1	1	Within
7	S1	1	Across
8	S1	1	Within
9	S1	0	Across
10	S1	1	Within

Data_tTest_Within.csv

Power Analysis Settings

```
clear
%can either be your data as a sub * cond matrix,
% or name of an excel/csv file as str
prefs.csv_file = 'Data_tTest_Within.csv';

%interval of N to simulate (e.g, 10-100 by 10)
%for between-subjects designs, this is TOTAL subjects (not per condition)
prefs.N_range = 10:10:100;

%interval of trials per condition to simulate (e.g, 8-24 by 4)
prefs.trial_range = 8:4:24;

%p value to use in statisical test during simulation
prefs.alpha = .05;

%number of experiments to simulate per trial*N combination
%higher number of sims will give more stable/accurate power estimates,
%but will be slower. 10000 or 100000 is usually good
prefs.nSims = 10000;

%what comparisons do you want to make? Should be a comparison * 2 vector,
%with condition that should be larger on the left
%for example, if you expect condition 2 to be larger than condition 1, you
%should enter [2, 1];
%when you run this script, a graph will display how your conditions have
%been numbered (adjust below and run again if necessary)
prefs.comps = [2, 1];

%FOR BETWEEN-SUBJECTS DESIGNS ONLY (ignored otherwise)
%how participants should be split between conditions, must sum to 1 (100%)
%for example, if 60 participants in 2 condition between-subjects design,
%prefs.condition_allocation = [.5, .5] would have 30 subs/condition.
%[.75, .25] would result in condition 1 = 45 subs, condition 2 = 15 subs
%[1/3, 2/3] would result in condition 1 = 20 subs, condition 2 = 40 subs
prefs.condition_allocation = [];

%Run Power Analysis with these settings
power_results = PowerAnalysis_tTests(prefs);
```

CSV file name as string

I decided to simulate N from 10-100 by 10

I decided to simulate trial number per condition from 8-24 by 4

Critical p-value of .05 used in simulation

10,000 sims per N x num_trials combo (sims per cell in output graph)

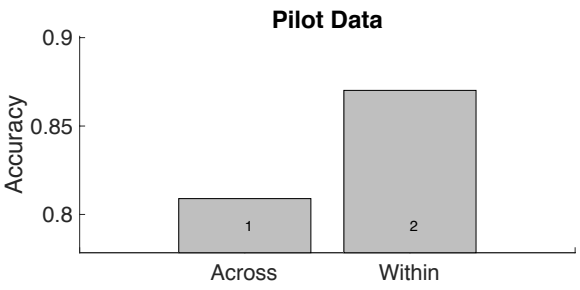
Only comparison I was interested in was condition 1 being larger than condition 2

Used only for between-subjects designs (not used here)

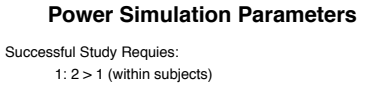
Run power analysis using these settings

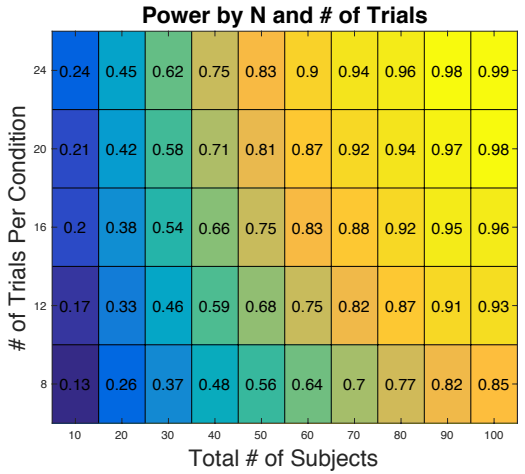
Power Analysis Output

Plot of data and pilot simulation parameters. Use this plot to make sure you have specified prefs.comps as intended.



Percentages in heatmap to right indicate percentage of simulated studies where are all parameters are true





Simulated power for each N x number or trials per condition combo we specified in settings. From this, I know I could achieve about 95% power by running 90 subjects with 16 trials per condition, for example

Example 2: within-subjects t-test with multiple comparisons

Pilot Data

- 3 columns
- 1 header row, then a row for each trial

	A	B	C
4	1	0	BB
5	1	0	WW
6	1	0	BB
7	1	1	WB
8	1	1	WW
9	1	1	WW
10	1	0	WW
11	1	1	WB
12	1	0	WB
13	1	1	WB
14	1	0	WW
15	1	1	BB
16	1	0	BW

Data_tTest_Within_Multi.csv

Power Analysis Settings

```
clear
%can either be your data as a sub * cond matrix,
% or name of an excel/csv file as str
prefs.csv_file = 'Data_tTest_Within_Multi.csv';

%interval of N to simulate (e.g, 10-100 by 10)
%for between-subjects designs, this is TOTAL subjects (not per condition)
prefs.N_range = 100:50:300;

%interval of trials per condition to simulate (e.g, 8-24 by 4)
prefs.trial_range = 8:4:24;

%p value to use in statisical test during simulation
prefs.alpha = .05;

%number of experiments to simulate per trial*N combination
%higher number of sims will give more stable/accurate power estimates,
%but will be slower. 10000 or 100000 is usually good
prefs.nSims = 10000;

%what comparisons do you want to make? Should be a comparison * 2 vector,
%with condition that should be larger on the left
%for example, if you expect condition 1 to be larger than condition 2, you
%should enter [1, 2];
%when you run this script, a graph will display how your conditions have
%been numbered (adjust below and run again if necessary)
prefs.comps = [4, 1
    4, 2
    4, 3
    2, 1
    3, 1];

%FOR BETWEEN-SUBJECTS DESIGNS ONLY (ignored otherwise)
%how participants should be split between conditions, must sum to 1 (100%)
%for example, if 60 participants in 2 condition between-subjects design,
%prefs.condition_allocation = [.5, .5] would have 30 subs/condition.
%[.75, .25] would result in condition 1 = 45 subs, condition 2 = 15 subs
%[1/3, 2/3] would result in condition 1 = 20 subs, condition 2 = 40 subs
prefs.condition_allocation = [];

%Run Power Analysis with these settings
power_results = PowerAnalysis_tTests(prefs);
```

CSV file name as string

I decided to simulate N from 100-300 by 50

I decided to simulate trial number per condition from 8-24 by 4

Critical p-value of .05 used in simulation

10,000 sims per N x num_trials combo (sims per cell in output graph)

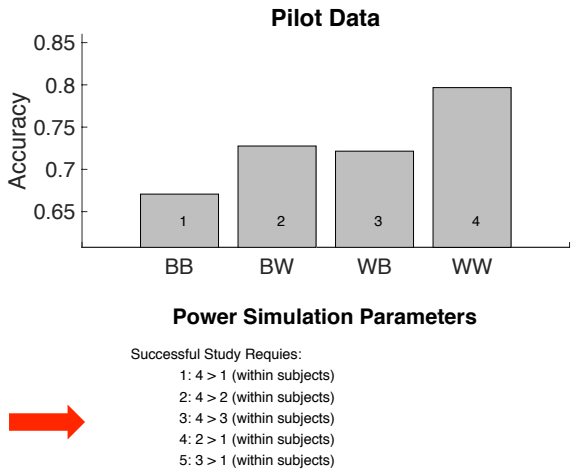
Studies are only considered a success if all 5 of these comparisons are significant

Used only for between-subjects designs (not used here)

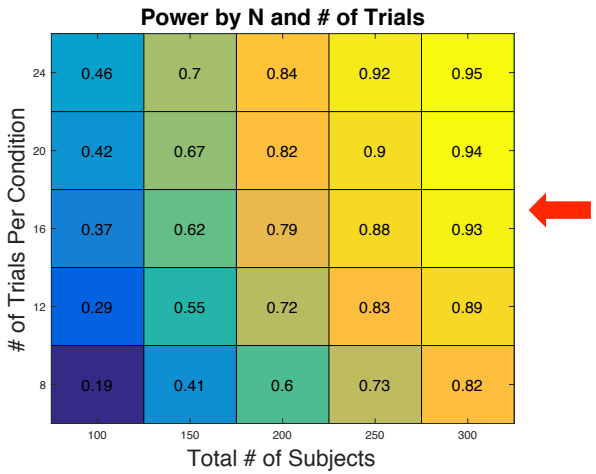
Run power analysis using these settings

Power Analysis Output

Plot of data and pilot simulation parameters. Use this plot to make sure you have specified prefs.comps as intended.



Percentages in heatmap to right indicate percentage of simulated studies where are all 5 of these comparisons are true



Simulated power for each N x number or trials per condition combo we specified in settings. From this, I know I could achieve about 90% power by running 250 subjects with 20 trials per condition, for example

Example 3: mixed-factors ANOVA
(1 within-subjects factor & 1 between-subjects factor)

Pilot Data

- 4 columns
- 1 header row, then a row for each trial

	A	B	C	D
1	Subject	Accuracy	Movement Type	Motion Direction
2	1	1	Vertical	Cross
3	1	1	Horizontal	Cross
4	1	1	Vertical	Cross
5	1	1	Horizontal	Cross
6	1	1	Horizontal	Cross
7	1	1	Horizontal	Cross
8	1	0	Vertical	Cross
9	1	0	Vertical	Cross
10	1	1	Vertical	Cross

Data_ANOVA_Mixed.csv

Power Analysis Settings

```
clear
%can either be your data as a sub * cond matrix,
% or name of an excel/csv file as str
prefs.csv_file = 'Data_ANOVA_Mixed.csv';

%interval of N to simulate (e.g, 50-300 by 25)
prefs.N_range = 50:25:200;

%interval of trials per condition to simulate (e.g, 8-20 by 4)
prefs.trial_range = 8:8:32;

%p value to use in statisical test during simulation
prefs.alpha = .05;

%number of experiments to simulate per trial*N combination
%higher number of sims will give more stable/accurate power estimates,
%but will be slower. 10000 or 100000 is usually good
prefs.nSims = 10000;

%what comparisons do you want to make? Should be a comparison * 2 vector,
%with condition that should be larger on the left
%for example, if you expect condition 1 to be larger than condition 2, you
%should enter [1, 2];
prefs.comps = [2, 1];

%does the first main effect need to be significant to be a "success"
%note that for mixed-factors designs, between-subjects factor will always
%be considered "factor 1"
prefs.sig_ME1 = false;

%does the second main effect need to be significant to be a "success"
%note that for mixed-factors designs, within-subjects factor will always
%be considered "factor 2"
prefs.sig_ME2 = false;

%does the interaction need to be significant to be a "success"
prefs.sig_int = true;

%FOR BETWEEN-SUBJECTS OR MIXED DESIGNS ONLY (ignored otherwise)
%how participants should be split between between-factor levels
%needs a value for each between-subjects factor level, and sum to 1 (100%)
%for example, if 60 participants in 2 condition between-subjects design,
%prefs.condition_allocation = [.5, .5] would have 30 subs/condition.
%[.75, .25] would result in condition 1 = 45 subs, condition 2 = 15 subs
%[1/3, 2/3] would result in condition 1 = 20 subs, condition 2 = 40 subs
prefs.condition_allocation = [.5, .5];

%Run Power Analysis with these settings
pow_results = PowerAnalysis_ANOVA(prefs);
```

CSV file name as string

I decided to simulate N from 50:-200 by 25

I decided to simulate trial number per condition from 8-24 by 4

Critical p-value of .05 used in simulation

10,000 sims per N x num_trials combo (sims per cell in output graph)

Need condition 2 > condition 1 for study to be a success

I do NOT need main effect of factor one (between-subjects factor for mixed designs) to be significant for successful study

I do NOT need main effect of factor two (within-subjects factor for mixed designs) to be significant for successful study

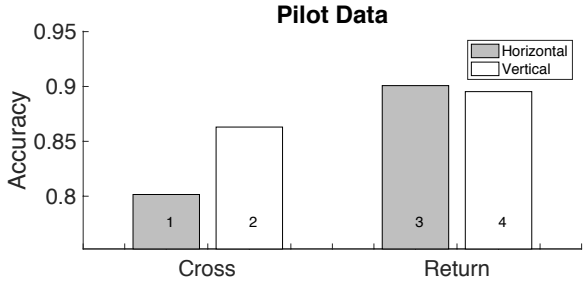
I DO need significant interaction of two factors for successful study

Evenly allocate subjects to the two between-subjects factor levels

Run power analysis using these settings

Power Analysis Output

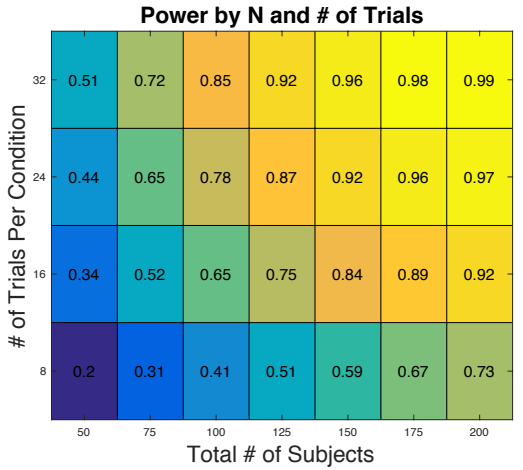
Plot of data and pilot simulation parameters. Use this plot to make sure you have specified prefs.comps as intended.



Percentages in heatmap to right indicate percentage of simulated studies where both of these are true

Power Simulation Parameters

Successful Study Requies:
1: Interaction of Movement Type x Motion Direction
2: 2 > 1 (within subjects)



Simulated power for each N x number or trials per condition combo we specified in settings. From this, I know I could achieve about 96% power by running 150 subjects with 32 trials per condition, for example