Power calculation examples

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This document includes some examples of calculations with the `pwr` package, which you must have installed.

```
library(pwr)
```

Example discussed in 2.4.1 in the text:

- To calculate power for a two-sample t test, when sample size in each sample is $n = 16$, effect size (Cohen's d) is 0.5, at significance level $\alpha = 0.05$:

```
pwr.t.test(n=16, d=0.5, sig.level = 0.05)
```

```
##
##      Two-sample t test power calculation
##
##              n = 16
##              d = 0.5
##      sig.level = 0.05
##          power = 0.2777445
##    alternative = two.sided
##
## NOTE: n is number in *each* group
```

- Calculate what sample size would be needed to achieve power of $\beta = 0.8$ for this effect size and α:

```
pwr.t.test(d=0.5, sig.level = 0.05, power=0.8)
```

```
##
##      Two-sample t test power calculation
##
##              n = 63.76561
##              d = 0.5
##      sig.level = 0.05
##          power = 0.8
##    alternative = two.sided
##
## NOTE: n is number in *each* group
```

Another example: back-of-the-envelope power calculation for an effect in a more complicated model

- First, load German incomplete neutralization data, do some data processing, and fit mixed model from Roettger et al. (2014):

```
library(arm)
library(lmerTest)
## load data
E1 = read.csv("roettgerEtAlData.csv",comment.char="")

## REMOVE THIS ROW, there are NAs for variables
E1 <- E1[-481,]

## turn items, subjects into factors
```

```r
E1$item_pair = as.factor(E1$item_pair)
E1$subject = as.factor(E1$subject)

## MS: centered voicing var
E1$voiceless <- rescale(E1$voicing)

## fit original model
E1.mdl = lmer(vowel_dur ~ voiceless  +                    # critical fixed effect
                accent_type + prosodic_boundary +         # prosodic control variables
                place + vowel +                           # phonological control variables
                norming_voiceless_count +                 # norming
                (1+voiceless|subject) + (1+voiceless|item_pair),
              data=E1)

summary(E1.mdl)
```

```
## Linear mixed model fit by REML t-tests use Satterthwaite approximations
##   to degrees of freedom [lmerMod]
## Formula:
## vowel_dur ~ voiceless + accent_type + prosodic_boundary + place +
##     vowel + norming_voiceless_count + (1 + voiceless | subject) +
##     (1 + voiceless | item_pair)
##    Data: E1
##
## REML criterion at convergence: 6648.9
##
## Scaled residuals:
##     Min      1Q  Median      3Q     Max
## -4.4852 -0.5826 -0.0078  0.6154  2.8534
##
## Random effects:
##  Groups    Name        Variance Std.Dev. Corr
##  item_pair (Intercept)  79.772   8.932
##            voiceless     5.817   2.412   1.00
##  subject   (Intercept) 686.218  26.196
##            voiceless    20.902   4.572   -0.94
##  Residual              392.104  19.802
## Number of obs: 749, groups:  item_pair, 24; subject, 16
##
## Fixed effects:
##                        Estimate Std. Error      df t value Pr(>|t|)
## (Intercept)             194.440     10.444  72.200  18.617  < 2e-16 ***
## voiceless                -8.673      2.026  19.600  -4.281 0.000380 ***
## accent_typenuclear      -12.573      7.738 706.300  -1.625 0.104648
## accent_typeprenuclear    -1.544      6.293 706.800  -0.245 0.806225
## prosodic_boundaryyes     22.057      5.377 710.100   4.102 4.56e-05 ***
## placelabial             -21.110      4.846  17.000  -4.356 0.000432 ***
## placevelar               -4.870      4.738  17.100  -1.028 0.318299
## vowelau                  -3.281      6.432  19.400  -0.510 0.615698
## voweli                  -55.432      6.001  17.700  -9.238 3.50e-08 ***
## vowelo                  -31.433      5.617  20.900  -5.596 1.52e-05 ***
## vowelu                  -54.381      5.870  19.700  -9.264 1.27e-08 ***
## norming_voiceless_count  -2.648      1.784 146.800  -1.484 0.139977
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Correlation of Fixed Effects:
##            (Intr) voclss accnt_typn accnt_typp prsdc_ plclbl plcvlr
## voiceless   -0.206
## accnt_typnc -0.451 -0.002
## accnt_typpr -0.584 -0.030  0.759
## prsdc_bndry -0.075 -0.048 -0.511      0.077
## placelabial -0.246 -0.020 -0.018     -0.002      0.021
## placevelar  -0.211 -0.030 -0.011     -0.005      0.006  0.552
## vowelau     -0.271 -0.076 -0.010     -0.017     -0.004  0.008 -0.129
## voweli      -0.314 -0.070 -0.002     -0.010      0.000  0.089 -0.041
## vowelo      -0.240  0.006 -0.008     -0.023      0.003 -0.082 -0.147
## vowelu      -0.259 -0.060 -0.007     -0.034     -0.016 -0.073 -0.137
## nrmng_vcls_ -0.212 -0.331 -0.022      0.015      0.043  0.060  0.095
##            vowela voweli vowelo vowelu
## voiceless
## accnt_typnc
## accnt_typpr
## prsdc_bndry
## placelabial
## placevelar
## vowelau
## voweli      0.506
## vowelo      0.477  0.495
## vowelu      0.507  0.520  0.548
## nrmng_vcls_ 0.245  0.221  0.026  0.176
```

- The effect of interest is `voicless`, for which the degrees of freedom estimated by `lmerTest`, using the Satterthwaite approximation, is 19.6.

- Suppose we wanted to calculate power for this effect, *if true effect size is $d = 0.5$*. Since two groups (voiced and voiceless) that are roughly balanced are being compared, we can get a ballpark power estimate by using the fact that $df = n_1 + n_2 - 2$ for a two-sample t test, and assuming $n_1 \approx n_2$, so $n = 10.3$ for each group.

- So approximate power (with $\alpha = 0.05$) would be 0.19:

```
pwr.t.test(n=10.3, d=0.5, sig.level = 0.05)
```

```
##
##      Two-sample t test power calculation
##
##              n = 10.3
##              d = 0.5
##      sig.level = 0.05
##          power = 0.1897558
##     alternative = two.sided
##
## NOTE: n is number in *each* group
```