ADHD Study 2 Power Analysis

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library(pacman)  
p\_load(tidyverse, stats, rstatix, MASS,effects,Superpower)  
set.seed(1234)  
filter <- dplyr::filter  
select <- dplyr::select

## Setting Parameters

To estimate the correlation between work-specific and general frame of reference (FOR) Conscientiousness scores within-subjects, I used *r* = .49 as reported by Lievens et al. (2008). I used the same within-subjects correlation for ADHD and non-ADHD participants.

For the general FOR items, I used the results from Study 1 to estimate the mean and standard deviation (SD) for the ADHD (M = 3.27, SD = 0.53) and non-ADHD (M = 3.74, SD = 0.55) groups, Cohen’s *d* = 0.87.

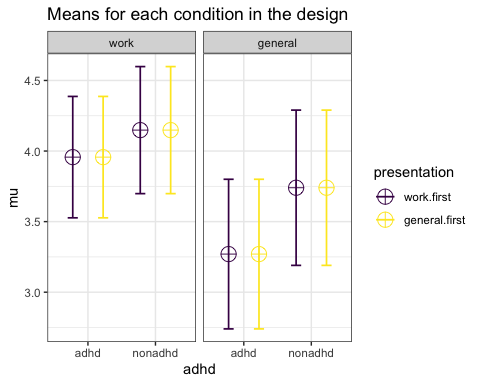
I used Cohen’s *d* = 0.797 for the difference between general and work-specific items among non-ADHD participants (Lievens et al., 2008). This value was calculated from the statistics reported in the paper.

I tested a range of effect sizes for group mean differences by ADHD status in the work-specific FOR. I estimated that the effect of ADHD on group mean differences on the work-specific items would be half the difference that was found on general items in Study 1 (i.e. estimated *d* = 0.87/2 = 0.435). Here, we’re assuming no effect of presentation order.

nadhd.mean.general <- 3.74  
nadhd.sd.general <- .55  
nadhd.sd.work <- .45  
r.val <- .49  
nadhd.mean.work.denom <- sqrt(((nadhd.sd.general^2)+(nadhd.sd.work^2))-(2\*r.val\*(nadhd.sd.general)\*(nadhd.sd.work)))  
cod.nadhd.work.general <- .797  
nadhd.mean.work.ls <- cod.nadhd.work.general\*nadhd.mean.work.denom  
nadhd.mean.work <- nadhd.mean.work.ls + nadhd.mean.general  
  
adhd.sd.work <- .43  
nadhd.n <- 140 #conservative n of 140  
adhd.n <- 140  
comp.denom <- sqrt((((nadhd.n-1)\*nadhd.sd.work^2) + ((adhd.n-1)\*adhd.sd.work^2))/(nadhd.n+adhd.n-2))  
cod.adhd.nadhd.work <- .435  
comp.ls <- cod.adhd.nadhd.work\*comp.denom  
adhd.mean.work <- nadhd.mean.work-comp.ls  
  
adhd.mean.general <- 3.27  
adhd.sd.general <- .53

Below, the power analysis suggests that 280 participants (140 with ADHD and 140 without ADHD) will result in over 80% power for the effects of ADHD, FOR, and their interaction with an alpha level of .05.

m <- c(adhd.mean.work, adhd.mean.general,  
 adhd.mean.work, adhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general) # means  
  
sd <- c(adhd.sd.work, adhd.sd.general,  
 adhd.sd.work, adhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general)  
  
design\_result <- ANOVA\_design(design = "2b\*2b\*2w",  
 n = 70, #conservative n, 140 in both ADHD and non-ADHD groups for 280 total participants  
 mu = m,  
 sd = sd,  
 r <- r.val,  
 label\_list = list(adhd = c("adhd", "nonadhd"),  
 presentation = c("work.first", "general.first"),  
 frame = c("work", "general")  
 ))



ANOVA\_exact(design\_result,verbose=F,alpha\_level = .05)

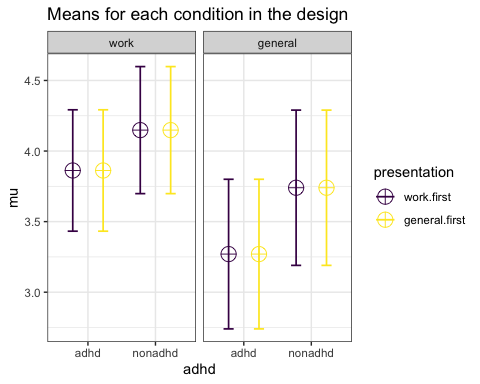
## Power and Effect sizes for ANOVA tests  
## power partial\_eta\_squared cohen\_f non\_centrality  
## adhd 99.9997 0.1338 0.3930 42.6342  
## presentation 5.0000 0.0000 0.0000 0.0000  
## adhd:presentation 5.0000 0.0000 0.0000 0.0000  
## frame 100.0000 0.5465 1.0977 332.5575  
## adhd:frame 99.6118 0.0723 0.2792 21.5141  
## presentation:frame 5.0000 0.0000 0.0000 0.0000  
## adhd:presentation:frame 5.0000 0.0000 0.0000 0.0000

If the difference in the effect of ADHD on scores in the work-specific vs. general items is smaller (i.e., a Cohen’s *d* closer to that observed in the general FOR items, or *d* > 0.435 when comparing ADHD vs. non-ADHD in the work-specific items), how many participants are needed?

For this sensitivity analysis, I’ll use Cohen’s *d* = 0.87\*0.75 = 0.65.

As shown below, this still results in over 80% power with 140 subjects and alpha = .05.

nadhd.mean.general <- 3.74  
nadhd.sd.general <- .55  
nadhd.sd.work <- .45  
r.val <- .49  
nadhd.mean.work.denom <- sqrt(((nadhd.sd.general^2)+(nadhd.sd.work^2))-(2\*r.val\*(nadhd.sd.general)\*(nadhd.sd.work)))  
cod.nadhd.work.general <- .797  
nadhd.mean.work.ls <- cod.nadhd.work.general\*nadhd.mean.work.denom  
nadhd.mean.work <- nadhd.mean.work.ls + nadhd.mean.general  
  
adhd.sd.work <- .43  
nadhd.n <- 140 #conservative n of 140  
adhd.n <- 140  
comp.denom <- sqrt((((nadhd.n-1)\*nadhd.sd.work^2) + ((adhd.n-1)\*adhd.sd.work^2))/(nadhd.n+adhd.n-2))  
cod.adhd.nadhd.work <- 0.65  
comp.ls <- cod.adhd.nadhd.work\*comp.denom  
adhd.mean.work <- nadhd.mean.work-comp.ls  
  
adhd.mean.general <- 3.27  
adhd.sd.general <- .53  
  
m <- c(adhd.mean.work, adhd.mean.general,  
 adhd.mean.work, adhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general) # means  
  
sd <- c(adhd.sd.work, adhd.sd.general,  
 adhd.sd.work, adhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general)  
  
design\_result <- ANOVA\_design(design = "2b\*2b\*2w",  
 n = 70, #conservative n, 140 in both ADHD and non-ADHD groups for 280 total participants  
 mu = m,  
 sd = sd,  
 r <- r.val,  
 label\_list = list(adhd = c("adhd", "nonadhd"),  
 presentation = c("work.first", "general.first"),  
 frame = c("work", "general")  
 ))



ANOVA\_exact(design\_result,verbose=F,alpha\_level = .05)

## Power and Effect sizes for ANOVA tests  
## power partial\_eta\_squared cohen\_f non\_centrality  
## adhd 100.0000 0.1679 0.4493 55.7048  
## presentation 5.0000 0.0000 0.0000 0.0000  
## adhd:presentation 5.0000 0.0000 0.0000 0.0000  
## frame 100.0000 0.5014 1.0028 277.5724  
## adhd:frame 86.2593 0.0329 0.1844 9.3800  
## presentation:frame 5.0000 0.0000 0.0000 0.0000  
## adhd:presentation:frame 5.0000 0.0000 0.0000 0.0000  
##

# Simulate Data for Test Analysis

First, we’ll make sure that the effect sizes produced by the simulation are roughly the same as the parameters set in the second more conservative power analysis.

n <- rep(70, 8)  
  
m <- c(adhd.mean.work, adhd.mean.general,  
 adhd.mean.work, adhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general,  
 nadhd.mean.work, nadhd.mean.general) # means  
  
sd <- c(adhd.sd.work, adhd.sd.general,  
 adhd.sd.work, adhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general,  
 nadhd.sd.work, nadhd.sd.general)  
  
dp <- cbind(n,m,sd) # create rows of n/m/SD  
df <- apply(dp, 1, function(x) rnorm(x[1],x[2],x[3])) # generate data based on each row of dp  
df <- data.frame(df)  
colnames(df) <- c("adhd.work.wf", "adhd.general.wf",   
 "adhd.work.gf", "adhd.general.gf",  
 "nadhd.work.wf", "nadhd.general.wf",   
 "nadhd.work.gf", "nadhd.general.gf")  
consc.df <- stack(df) %>%  
 mutate(adhd = factor(if\_else(str\_starts(ind, "nadhd"), "NO ADHD", "ADHD"),  
 levels = c("NO ADHD", "ADHD")),  
 presentation = factor(if\_else(str\_detect(ind,"gf"), "general.first", "work.first"),  
 levels = c("general.first", "work.first")),  
 frame = factor(if\_else(str\_detect(ind, "work"), "work.scores", "general.scores"),  
 levels = c("general.scores", "work.scores"))) %>%   
 group\_by(frame) %>%   
 mutate(pnum = 1:(sum(n)/2))%>%   
 arrange(pnum) %>%   
 ungroup()  
  
cod.tmp <- consc.df %>%   
 filter(frame=="general.scores") %>%   
 cohens\_d(values~adhd)  
cat(paste0("Effect of ADHD on general scores: ", scales::number(cod.tmp$effsize[1], accuracy = .01)))

Effect of ADHD on general scores: 0.87

cod.tmp<- consc.df %>%   
 filter(frame=="work.scores") %>%   
 cohens\_d(values~adhd)  
cat(paste0("Effect of ADHD on work scores: ", scales::number(cod.tmp$effsize[1], accuracy = .01)))

Effect of ADHD on work scores: 0.60

cod.tmp <- consc.df %>%   
 dplyr::filter(adhd=="ADHD") %>%  
 cohens\_d(values ~ frame, paired = T)  
cat(paste0("Effect FOR on ADHD participants' scores: ", scales::number(cod.tmp$effsize[1], accuracy = .01)))

Effect FOR on ADHD participants’ scores: -0.84

cod.tmp <- consc.df %>%   
 dplyr::filter(adhd=="NO ADHD") %>%  
 cohens\_d(values ~ frame, paired = T)  
cat(paste0("Effect FOR on non-ADHD participants' scores: ", scales::number(cod.tmp$effsize[1], accuracy = .01)))

Effect of FOR on non-ADHD participants’ scores: -0.56

Run the ANOVA:

p\_load(afex,lsmeans)  
  
  
model <- aov\_ez(consc.df,   
 id="pnum",   
 dv="values",   
 within="frame",  
 between = c("adhd","presentation"))

## Contrasts set to contr.sum for the following variables: adhd, presentation

summary(model)

##   
## Univariate Type III Repeated-Measures ANOVA Assuming Sphericity  
##   
## Sum Sq num Df Error SS den Df F value Pr(>F)   
## (Intercept) 7952.9 1 69.195 276 31721.9328 < 2.2e-16 \*\*\*  
## adhd 19.2 1 69.195 276 76.4567 2.251e-16 \*\*\*  
## presentation 0.4 1 69.195 276 1.6996 0.193427   
## adhd:presentation 0.2 1 69.195 276 0.9688 0.325844   
## frame 33.6 1 66.860 276 138.7819 < 2.2e-16 \*\*\*  
## adhd:frame 1.7 1 66.860 276 6.8916 0.009143 \*\*   
## presentation:frame 0.1 1 66.860 276 0.2618 0.609325   
## adhd:presentation:frame 0.0 1 66.860 276 0.0144 0.904637   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

#no effect of presentation order--drop the factor  
model <- aov\_ez(consc.df,   
 id="pnum",   
 dv="values",   
 within="frame",  
 between = c("adhd"))

## Contrasts set to contr.sum for the following variables: adhd

summary(model)

##   
## Univariate Type III Repeated-Measures ANOVA Assuming Sphericity  
##   
## Sum Sq num Df Error SS den Df F value Pr(>F)   
## (Intercept) 7952.9 1 69.864 278 31645.8474 < 2.2e-16 \*\*\*  
## adhd 19.2 1 69.864 278 76.2733 2.353e-16 \*\*\*  
## frame 33.6 1 66.926 278 139.6479 < 2.2e-16 \*\*\*  
## adhd:frame 1.7 1 66.926 278 6.9346 0.008928 \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

**References**

Lievens, F., De Corte, W., & Schollaert, E. (2008). A closer look at the frame-of-reference effect in personality scale scores and validity. *Journal of Applied Psychology*, *93*(2), 268–279. https://doi.org/10.1037/0021-9010.93.2.268