PSY 653 Module 2: Interaction Effects (aka Moderation)

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Part 1: In-class Demo

Use the "moderation_demo.csv" datafile

Load libraries

```
library(psych)
library(tidyverse)
```

```
## -- Attaching packages ---------------------------------------------------------------------------
## v ggplot2 3.3.0     v purrr   0.3.3
## v tibble  3.0.0     v dplyr   0.8.5
## v tidyr   1.0.2     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.5.0
## Warning: package 'ggplot2' was built under R version 3.6.3
## Warning: package 'tibble' was built under R version 3.6.3
## Warning: package 'tidyr' was built under R version 3.6.3
## Warning: package 'dplyr' was built under R version 3.6.3
## Warning: package 'forcats' was built under R version 3.6.3
## -- Conflicts ------------------------------------------------------------------------------------
## x ggplot2::%+%()   masks psych::%+%()
## x ggplot2::alpha() masks psych::alpha()
## x dplyr::filter()  masks stats::filter()
## x dplyr::lag()     masks stats::lag()
```

```
library(olsrr)
```

```
## Warning: package 'olsrr' was built under R version 3.6.3
##
## Attaching package: 'olsrr'
## The following object is masked from 'package:datasets':
##
##     rivers
```

Read in data

```
dat <- read_csv("moderation_demo.csv")
```

```
## Parsed with column specification:
## cols(
##   att1 = col_double(),
##   att2 = col_double(),
##   att3 = col_double(),
##   att4 = col_double(),
##   att5 = col_double(),
##   group1 = col_double(),
##   group2 = col_double(),
##   out1 = col_double(),
##   out2 = col_double(),
##   out3 = col_double(),
##   out4 = col_double()
## )
```

Get descriptives

```
describe(dat)
```

```
##        vars   n mean   sd median trimmed  mad min max range  skew kurtosis   se
## att1      1 692 1.14 1.52      0    0.88 0.00   0   9     9  1.88     5.14 0.06
## att2      2 692 1.94 0.88      2    1.88 1.48   1   9     8  2.14    13.31 0.03
## att3      3 692 1.48 1.44      1    1.30 1.48   0   9     9  2.73    11.57 0.05
## att4      4 692 1.17 1.39      1    0.98 1.48   0   9     9  2.88    13.43 0.05
## att5      5 692 1.26 1.51      1    1.06 1.48   0   9     9  1.09     1.19 0.06
## group1    6 692 2.58 1.17      2    2.50 1.48   1   9     8  1.56     6.06 0.04
## group2    7 692 1.59 0.49      2    1.62 0.00   1   2     1 -0.38    -1.86 0.02
## out1      8 692 1.39 1.41      2    1.32 0.00   0   9     9  2.57    12.68 0.05
## out2      9 692 1.21 1.55      1    0.97 1.48   0   9     9  2.96    12.17 0.06
## out3     10 692 1.38 1.43      2    1.30 0.00   0   9     9  2.62    12.54 0.05
## out4     11 692 1.39 1.48      2    1.29 0.00   0   9     9  2.64    11.91 0.06
```

Examine correlation between att1 & att3

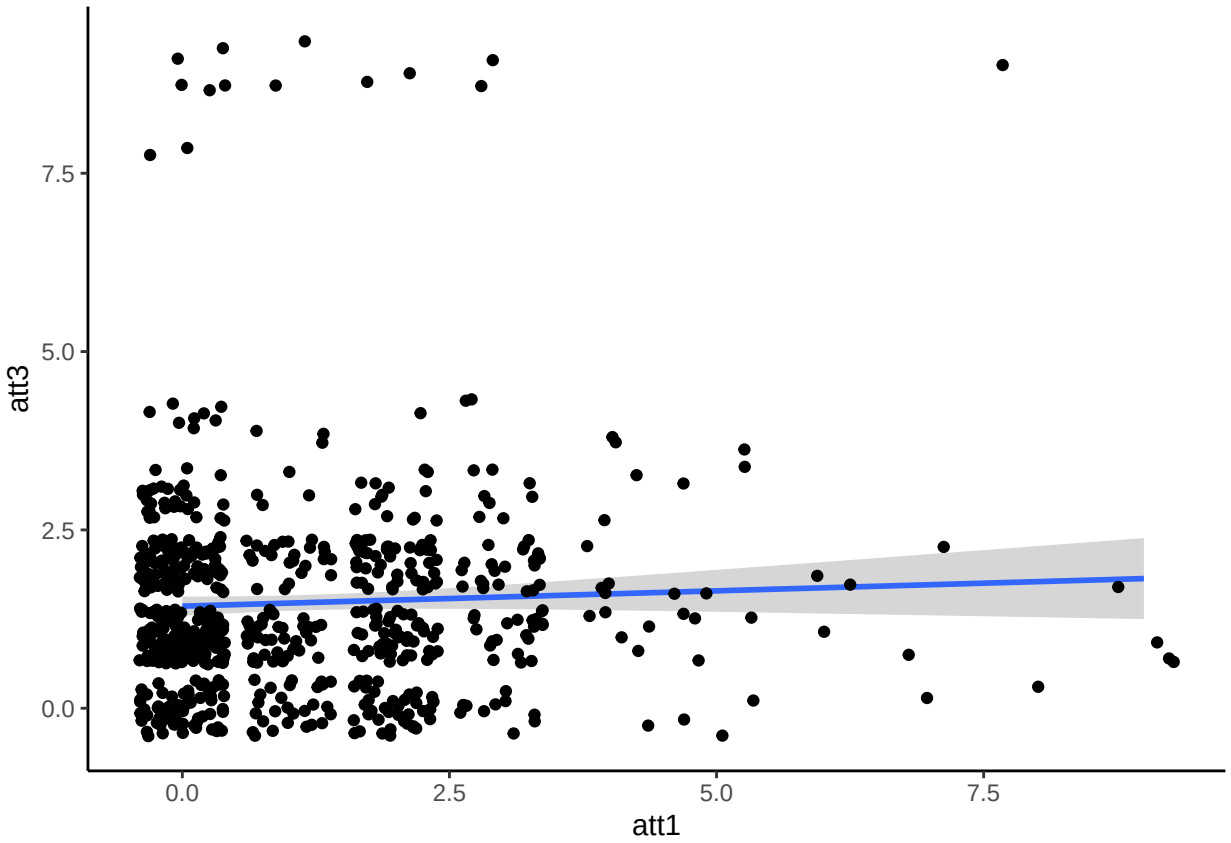
```
cor(dat$att1, dat$att3)
```

```
## [1] 0.04521701
```

Since the correlation between att1 and att3 is small, there is room for a moderation effect.

```
ggplot(dat, aes(x = att1, y = att3)) +
  geom_smooth(method = "lm")+
  geom_jitter()+
  theme_classic()
```

```
## `geom_smooth()` using formula 'y ~ x'
```



Create the cross product of att1 & att3

```
dat <- mutate(dat, att1att3 = att1*att3)
```

Run moderated regression in which att1, att3, and att1*att3 predict out4 ### Main Effects model

```
modME <- lm(out4  ~ att1 + att3, data = dat)
ols_regress(modME)
```

```
##                         Model Summary
## ----------------------------------------------------------------
## R                       0.453       RMSE                 1.317
## R-Squared               0.206       Coef. Var           94.839
## Adj. R-Squared          0.203       MSE                  1.735
## Pred R-Squared          0.179       MAE                  0.905
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                 ANOVA
## --------------------------------------------------------------------
##                 Sum of
##                Squares         DF    Mean Square      F         Sig.
```

```
## ----------------------------------------------------------------------
## Regression     309.277          2        154.638    89.148    0.0000
## Residual      1195.156        689          1.735
## Total         1504.432        691
## ----------------------------------------------------------------------
##
##                                 Parameter Estimates
## ------------------------------------------------------------------------------------------
##       model     Beta    Std. Error    Std. Beta      t        Sig      lower    upper
## ------------------------------------------------------------------------------------------
## (Intercept)    0.655         0.080                  8.185    0.000     0.498    0.812
##        att1    0.049         0.033        0.050     1.480    0.139    -0.016    0.114
##        att3    0.458         0.035        0.448    13.190    0.000     0.390    0.527
## ------------------------------------------------------------------------------------------
```

Interaction model

```
modINT <- lm(out4 ~ att1 + att3 + att1*att3 , data = dat)
ols_regress(modINT)
```

```
##                         Model Summary
## ----------------------------------------------------------------
## R                       0.462       RMSE                 1.311
## R-Squared               0.213       Coef. Var           94.435
## Adj. R-Squared          0.210       MSE                  1.720
## Pred R-Squared          0.176       MAE                  0.907
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                 ANOVA
## ----------------------------------------------------------------------
##                 Sum of
##                Squares         DF    Mean Square      F         Sig.
## ----------------------------------------------------------------------
## Regression     321.154          3        107.051    62.243    0.0000
## Residual      1183.278        688          1.720
## Total         1504.432        691
## ----------------------------------------------------------------------
##
##                                   Parameter Estimates
## ------------------------------------------------------------------------------------------
##       model      Beta    Std. Error    Std. Beta      t        Sig      lower    upper
## ------------------------------------------------------------------------------------------
## (Intercept)     0.757         0.089                  8.539    0.000     0.583    0.931
##        att1    -0.032         0.045        0.041    -0.716    0.474    -0.121    0.056
##        att3     0.393         0.043        0.439     9.210    0.000     0.309    0.477
##   att1:att3     0.049         0.019        0.090     2.628    0.009     0.012    0.085
## ------------------------------------------------------------------------------------------
```

```
library(sjPlot)
```

```
## Warning: package 'sjPlot' was built under R version 3.6.3
```

```
## Registered S3 methods overwritten by 'lme4':
##   method                          from
##   cooks.distance.influence.merMod car
##   influence.merMod                car
##   dfbeta.influence.merMod         car
##   dfbetas.influence.merMod        car
```

```
## Learn more about sjPlot with 'browseVignettes("sjPlot")'.
```

```
library(sjmisc)
```

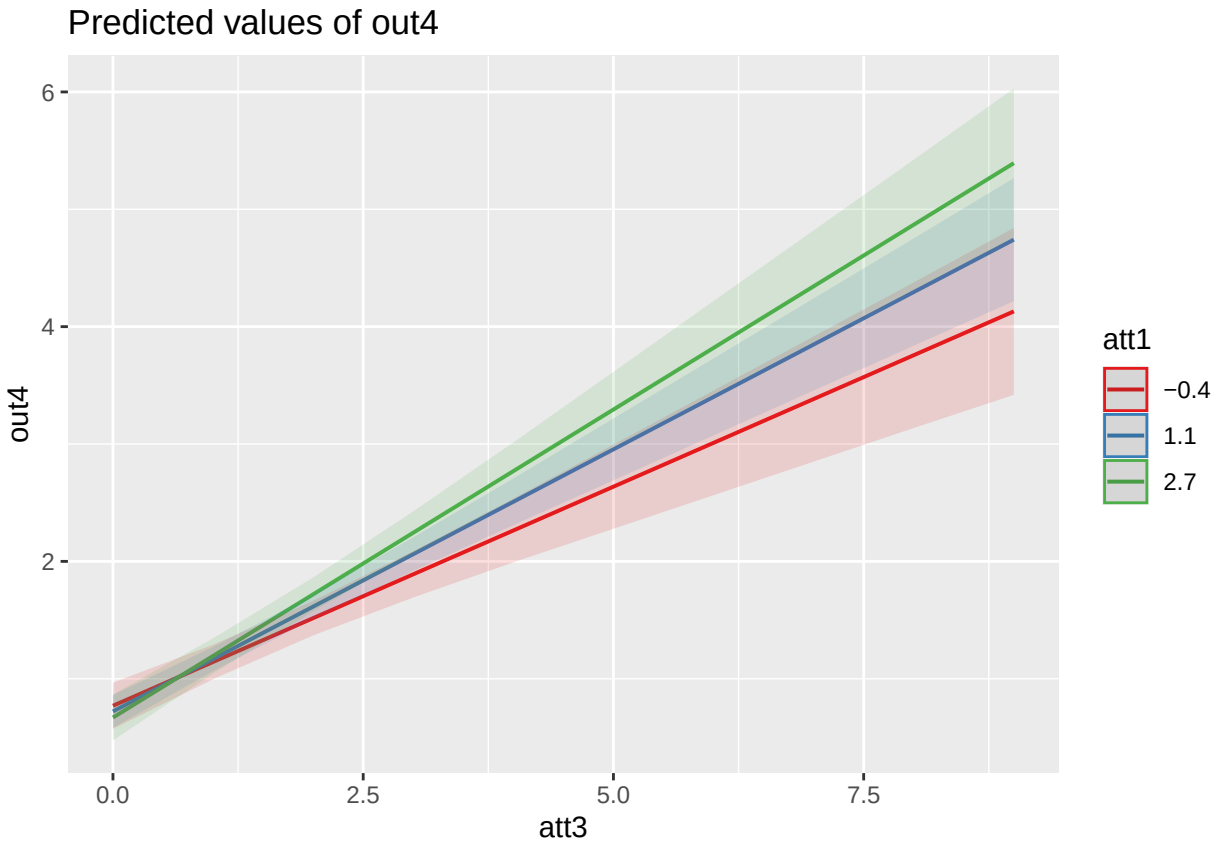
```
##
## Attaching package: 'sjmisc'
```

```
## The following object is masked from 'package:purrr':
##
##     is_empty
```

```
## The following object is masked from 'package:tidyr':
##
##     replace_na
```

```
## The following object is masked from 'package:tibble':
##
##     add_case
```

```
plot_model(modINT, type = "pred", terms = c("att3", "att1"),
           show.intercept = TRUE, se = FALSE)
```



Compare the two models

```
anova(modME,modINT)
```

```
## Analysis of Variance Table
##
## Model 1: out4 ~ att1 + att3
## Model 2: out4 ~ att1 + att3 + att1 * att3
##   Res.Df    RSS Df Sum of Sq      F   Pr(>F)
## 1    689 1195.2
## 2    688 1183.3  1    11.877 6.9058 0.008783 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The model that includes the interaction effect accounts (modINT) for a significantly larger amount of variance in out4 compared to the model that only includes the main effects (modME) of the two predictors.

Part 2: Try it yourself

Use the "moderation_sleepdata.csv" datafile In this exmaple, you will examine how sleep hygiene, anxiety, and the interaction between sleep hygiene and anxiety influence how well participants slept.

Read in data

```
sleep_data <- read_csv("moderation_sleepdata.csv")
```

```
## Parsed with column specification:
## cols(
##   age = col_double(),
##   anxiety = col_double(),
##   hygiene = col_double(),
##   sleep = col_double(),
##   lifesat = col_double()
## )
```

Get descriptives

```
describe(sleep_data)
```

```
##         vars   n  mean    sd median trimmed   mad   min   max range  skew
## age        1 600 44.94 12.87  45.20   45.12 16.46 20.00 67.80 47.80 -0.10
## anxiety    2 600  3.88  0.90   3.86    3.89  0.93  1.05  6.84  5.79 -0.07
## hygiene    3 600  5.99  1.57   6.05    6.04  1.57  1.68  9.74  8.06 -0.23
## sleep      4 600 68.88 12.14  69.00   69.09 11.86 34.00 99.00 65.00 -0.16
## lifesat    5 600  4.06  0.92   4.05    4.04  0.96  1.68  6.61  4.93  0.13
##         kurtosis   se
## age        -1.14 0.53
## anxiety    -0.06 0.04
## hygiene    -0.29 0.06
## sleep      -0.17 0.50
## lifesat    -0.23 0.04
```

Examine correlation between anxiety and hygiene

```
cor(sleep_data$anxiety, sleep_data$hygiene)
```

```
## [1] 0.0888915
```

Since the correlation between the two variables is relatively small, there is room for a moderation effect

Create the cross-product of hygiene and anxiety

```
sleep_data <- mutate(sleep_data, anxiety_hygiene = hygiene*anxiety)
```

Run moderated regression in which hygiene, anxiety, and hygiene*anxiety predict sleep ### Main effects model

```
slp_mod1 <- lm(sleep  ~ hygiene + anxiety, data = sleep_data )
ols_regress(slp_mod1)
```

```
##                         Model Summary
## ----------------------------------------------------------------
## R                       0.759       RMSE                7.915
## R-Squared               0.576       Coef. Var          11.491
## Adj. R-Squared          0.575       MSE                62.644
## Pred R-Squared          0.572       MAE                 6.245
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                 ANOVA
## --------------------------------------------------------------------------
##                  Sum of
##                 Squares         DF    Mean Square       F          Sig.
## --------------------------------------------------------------------------
## Regression    50878.425          2      25439.213    406.092    0.0000
## Residual      37398.448        597         62.644
## Total         88276.873        599
## --------------------------------------------------------------------------
##
##                                 Parameter Estimates
## ----------------------------------------------------------------------------------------
##       model      Beta    Std. Error    Std. Beta      t        Sig      lower     upper
## ----------------------------------------------------------------------------------------
## (Intercept)    44.465         1.808                24.596    0.000    40.915    48.016
##     hygiene     5.791         0.206        0.751   28.071    0.000     5.386     6.196
##     anxiety    -2.653         0.359       -0.198   -7.394    0.000    -3.358    -1.948
## ----------------------------------------------------------------------------------------
```

Interaction model

```
slp_mod2 <- lm(sleep  ~ hygiene + anxiety + anxiety_hygiene, data = sleep_data )
ols_regress(slp_mod2)
```

```
##                         Model Summary
```

```
## ----------------------------------------------------------------
## R                       0.761       RMSE                 7.893
## R-Squared               0.579       Coef. Var           11.459
## Adj. R-Squared          0.577       MSE                 62.297
## Pred R-Squared          0.574       MAE                  6.225
## ----------------------------------------------------------------
##  RMSE: Root Mean Square Error
##  MSE: Mean Square Error
##  MAE: Mean Absolute Error
##
##                                ANOVA
## -------------------------------------------------------------------------
##                  Sum of
##                 Squares         DF    Mean Square       F         Sig.
## -------------------------------------------------------------------------
## Regression    51148.102          3      17049.367    273.681    0.0000
## Residual      37128.771        596         62.297
## Total         88276.873        599
## -------------------------------------------------------------------------
##
##                                  Parameter Estimates
## ----------------------------------------------------------------------------------------------------
##           model      Beta    Std. Error    Std. Beta      t        Sig      lower     upper
## ----------------------------------------------------------------------------------------------------
##     (Intercept)    33.424         5.604                 5.964    0.000    22.418    44.431
##         hygiene     7.587         0.887        0.984    8.550    0.000     5.844     9.329
##         anxiety     0.237         1.435        0.018    0.165    0.869    -2.580     3.055
## anxiety_hygiene    -0.468         0.225       -0.336   -2.081    0.038    -0.909    -0.026
## ----------------------------------------------------------------------------------------------------
```

Compare the two models

```
anova(slp_mod1,slp_mod2)
```

```
## Analysis of Variance Table
##
## Model 1: sleep ~ hygiene + anxiety
## Model 2: sleep ~ hygiene + anxiety + anxiety_hygiene
##   Res.Df   RSS Df Sum of Sq      F Pr(>F)
## 1    597 37398
## 2    596 37129  1    269.68 4.3289 0.0379 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

At a significance threshold of $p<0.05$, the model that included the interaction effect (slp_mod2) explained a significantly larger amount of variance in sleep than the model that only tested the main effects of anxiety and sleep hygiene (slp_mod1).