Introduction to Mediation and Moderation

**Solutions Exercises #2**

The instructions asked you to:

Use the dataset **Data\_interaction.csv**

to complete a series of tasks.

**The .R script to run these exercises is also available with the course material.**

The solutions are illustrated in what follows.

1. Run a model where the difference scores in problem behaviour, “diff”, are predicted independently by the treatment and the parenting variables. Successively, run a model where the effect of the treatment is moderated by parenting. Inspect the results.

I have called the dataset “d” for convenience:

d <- read.csv ("D:/Teaching/Mod\_Med/data\_interaction.csv")

You will have to locate the dataset and open it from your folders or directory.

Before running the analyses you will also have to load the “interactions” and the “lmtest” packages.

The first model with independent effects of “treatment” and “parenting” is specified by this command:

summary(lm(diff~treatment+parenting, data=d))

The “data” option is used to specify the dataset to be used.

The model with an interaction can be specified by creating an interaction term (i.e., multiplying treatment by parenting) and adding the interaction term in equation specified after “lm”. Alternatively, one can use the multiplication symbol \* to request a test of the interaction and the first order terms.

summary(lm(diff**\***treatment+parenting, data=d))

This command provides this output:

A screenshot of a computer code

Description automatically generated

The results show that the interaction term is significant at *p* = .029. The results suggest that the effect of the treatment is moderated by (i.e. is conditional on) parenting.

1. Run a Likelihood Ratio test comparing the two models in exercise 1 and interpret the outcome.

Before running this test we must create objects that summarise the results of the two models.

I did this through these two commands:

m1<-lm(diff~treatment+parenting, data=d)

m2<-lm(diff~treatment\*parenting, data=d)

Now the two objects “m1” and “m2” contains the results of the two models.

Since the two models are nested, I can compare them using a Likelihood Ratio test, using command “lrtest” and specifying the two models above as the objects in the test:

lrtest(m1,m2)

A screenshot of a computer code

Description automatically generated

The output indicates that we can reject the null hypothesis that the model with the additional parameter (the coefficient of the interaction) is providing the same fit to the data as the model without the interaction term, and thus retain the model with the interaction.

1. Plot the results of the moderated effect of treatment conditional on parenting using the “interactions” package. Make sure the lines representing the slopes also include confidence intervals.

To this purpose, use the “interact\_plot” command from the “interactions” package:

interact\_plot(m2, pred=treatment, modx=parenting, interval=TRUE, int.width=0.89, plot.points=TRUE, line.thickness = 3,

x.label = "Treatment", y.label = "Difference in SDQ scores",

int.type = c("confidence"), legend.main = "Parenting",

)

The first argument in the “interact\_plot” command is the model we have saved as object “m2” in the previous exercise. The option “pred” allows you to select the *predictor* you want to plot in the horizontal axis (in this case, it was the treatment variable). The option “modx” allows to select the *moderator* variable that will be represented by different lines corresponding to key values of the moderator. When the moderator is continuous, as in this case, the command selects by default the values that correspond to +1SD, the mean, and -1SD in the distribution of the moderating variable.

Other options used here:

interval=TRUE: instructs the command to plot confidence intervals of the estimated lines.

int.width=0.89: instructs the command to plot the 89% confidence interval rather than the default 95% confidence interval.

int.type=c(“confidence”): instruct the command to represent confidence intervals.

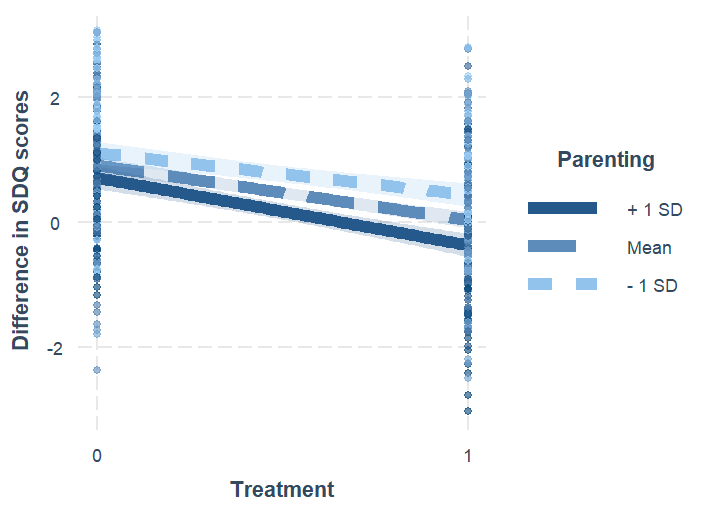
line.thickness= Changes the thickness of the lines plotted.

x.label = allows to specify the text that describes the horizontal axis.

y.label = allows to specify the text that describes the vertical axis.

legend.main= allows to specify the main legend describing the moderating variable.

The final plot will look something like this:



This suggest that the treatment is associated with a steeper decrease in problem behaviour score when parenting scores are higher.

1. Probe the moderated effect of treatment depending on parenting to test if the slope between treatment and outcome (difference scores) is significantly different from zero at different values of parenting: test first if the slopes are significantly different from zero at values corresponding to 1SD, Mean, and -1SD of parenting, and then test these considering the most extreme observed parenting scores. What are the results?

Using the “interact” packages you have options to inspect the “simple slopes” of the predictor-outcome association corresponding to different values of the moderator, testing if these slopes are significantly different from zero.

The command used is “sim\_slopes”:

sim\_slopes(m2, pred=treatment, modx=parenting, johnson\_neyman = FALSE)

This command is requesting tests of significance of the slopes where the outcome predictor is treatment, and the moderating variable is parenting. The model is still the “m2” object, i.e. the model with the interaction term, which was specified in exercise 2. For the time being we are not requesting a Johnson-Neyman test.

The output of this command will look like this:

A screenshot of a computer

Description automatically generated

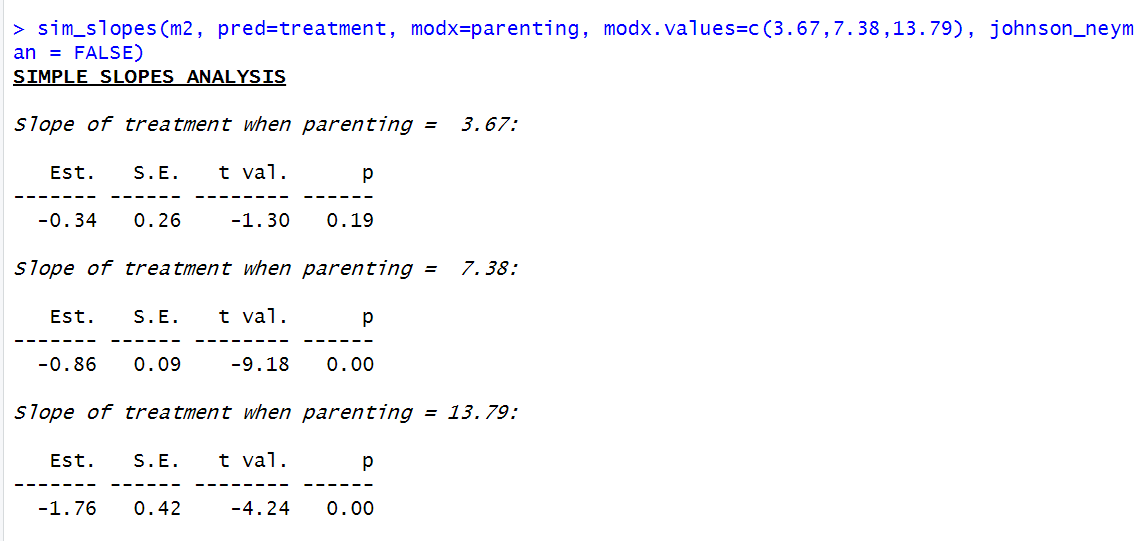
Which shows that the treatment-difference scores (predictor-outcome) slopes are negative and significantly different from 0 in correspondence of parenting values equal to -1 SD, the parenting mean, and +1 SD.

We might be interested in testing the slopes corresponding to different values of the moderator, e.g. +2 SD. Considering that the variable parenting has a range from 3.67 to 13.79 (and a median equal to 7.38), I would like to test the slopes corresponding to these values.

I can do this by running this command:

sim\_slopes(m2, pred=treatment, modx=parenting, modx.values=c(3.67,7.38,13.79), johnson\_neyman = FALSE)

The “modx.values” option allows to specify the values of the moderator where you want to estimate the slopes. The output will look like this:



While the slopes are negative across all three points, the slope estimated at the lowest value of parenting is not significantly different from zero. This would suggest that the treatment is effective in reducing problem behaviour conditionally on higher values of parenting.

1. Probe the moderated effect of treatment conditional on parenting scores using the Johnson-Neyman procedure.

Using the same command “sim\_slopes” illustrated in exercise 4, we can add the option “johnson\_neyman=TRUE” to obtain an output that indicates the range of the parenting variable values where the slopes predictor-outcome are significantly different from zero. The output will look like this:

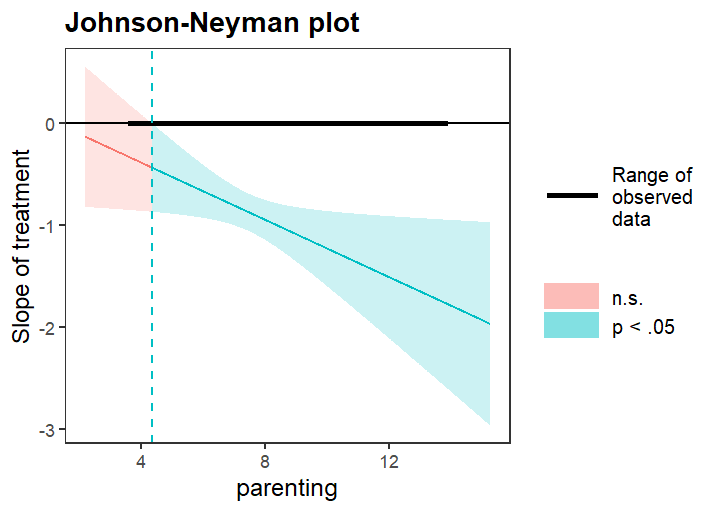
A white background with blue text

Description automatically generated

Furthermore, it is also possible to plot these areas:

johnson\_neyman(m2, pred = treatment, modx = parenting, alpha = .05)

which produces a similar plot:



The two outputs illustrate that the treatment is associated with reduced problem behaviour scores when parenting is above 4.35.