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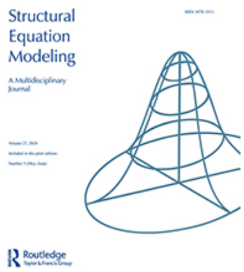

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SOFTWARE REVIEW

Probing Two-way Moderation Effects: A Review of Software to Easily Plot Johnson-Neyman Figures

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ABSTRACT
This review explores the possibility of generating Johnson-Neyman's interaction plot merely using the functions from software or packages without involving complex calculations. Three different programs were compared: Mplus version 8.3, the *Johnson-Neyman*() function in the *interaction* package for R version 3.6.2, and PROCESS Macro version 3.4 for IBM SPSS Statistics version 25. These three functions/software are capable of probing or providing sufficient information to probe the J-N interaction figure simply. Mplus and the *Johnson-Neyman()* are straightforward, including the graphing function, although the figure created in Mplus does not show the region(s) of significance. *Johnson-Neyman()* and PROCESS Macro provide more information in the output related to the J-N technique, reporting the region(s) of significance and the observed range of the moderator for identifying the actual region of significance. *Johnson-Neyman()* is superior for using the J-N technique to probe two-way moderation effects compared tootheravailable functions/software.

KEYWORDS
Johnson-Neyman Technique; moderation; Mplus; R; PROCESS Macro

When an association varies by a moderator (Aiken & West, 1991; Cohen, Cohen, West, & Aiken, 2003), graphs can help interpret the moderation effect. Social scientists prefer one of two techniques for depicting moderation effects: the pick-a-point estimation technique and the Johnson-Neyman (J-N) technique. The pick-a-point technique (Rogosa, 1980) is used to plot and test the effect of a predictor on an outcome at a few selected values of a moderator. For a binary moderator, the picked points of the moderator are the values of the two categories. For a continuous moderator, three points are usually picked: one standard deviation above the mean, the mean, and one standard deviation below the mean, representing high, medium, and low levels of a moderator. Although the pick-a-point technique is relatively simple and has been widely used, its figure only shows the effect of the predictor on the outcome at the chosen values of the moderator; the selected values are somewhat arbitrary and could be located outside the range of the moderator's observed values (Bauer & Curran, 2005).

The J-N technique shows how the main effect varies across the full range of the values of a moderator in a single regression line. It can be enhanced with confidence bands around the regression line and region(s) of significance, i.e., the range of moderation values for which the main effect between the predictor and outcome is significant. Compared to the pick-a-point technique, the J-N technique provides more comprehensive information for reporting how the effect of an independent variable's influence on a dependent variable is conditional on the entire range of a moderator. However, drawing confidence bands and identifying the region of significance rely on complicated calculations (Bauer & Curran, 2005; Rast, Rush, Piccinin, & Hofer, 2014). This can hinder some researchers who prefer simple approaches. The purpose of this review is to explore the possibility of generating Johnson-Neyman's interaction plot merely using the functions from software or packages without involving complex calculations.

The J-N technique

The J-N technique addresses how the effect of a predictor on an outcome varies from being significant or not based on the value of the moderator. The relationship between the predictor-outcome effect and the moderator can be displayed in a regression line with the effect regressed on the moderator. This regression line is based on the multiplicative interaction effect model. As described by Bauer and Curran (2005), the mathematical formula for the two-way interaction effect is:

$$Y_i = b_0 + b_1 X_i + b_2 M_i + b_3 X_i M_i + e_i$$

Where, Y_i is the outcome variable, b_0 is the intercept, X_i is the predictor with its coefficient b_1, M_i is the moderator with its coefficient b_2, $X_i M_i$ is the interaction with its coefficient b_3, and e_i is the unpredicted error. The formula could be rearranged to emphasize how the effect of the predictor varies by the moderator. That is:

$$Y_i = (b_0 + b_2 M_i) + (b_1 + b_3 M_i) X_i + e_i$$

Let:

$$b^* = b_1 + b_3 M_i \tag{1}$$

where b^* is the effect of the predictor X_i on the outcome Y_i, which varies across values of moderator M_i. The effect includes two parts: the constant main effect b_1 and the

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moderated effect b_3M. The effect is conditional on changes in the value of M_i. To probe the interpretation of a moderation effect, the J-N technique uses a regression line based on Formula (1) with the effect b^* regressed on the moderator M_i to show how the effect changes according to changes in the moderator. When the regression line crosses the X-axis, the effect is zero. When the regression line crosses the Y-axis, the moderator is zero and the effect b^* is the main effect b_1 in the first equation above. The J-N technique also uses 95% confidence bands around the simple regression line, which determines the region(s) of significance. The width of the 95% confidence bands around the regression line indicates which regions of the regression line are estimated more precisely than others (the narrow area of the confidence bands represent smaller errors of estimate). When one of the confidence bands crosses the X-axis, the corresponding value of the moderator is the dividing point between a region of significance and one of non-significance. Detailed calculations for the confidence bands and the regions of significance were worked out by Bauer and Curran (2005).

Scope of this review

The purpose of the current review is to evaluate three software programs that can be used to make a graph to probe a moderation using the Johnson-Neyman (J-N) technique. All three software programs either had an option to generate a plot of a moderation effect using the J-N technique or produced sufficient output to plot the interaction figure. The three programs were also selected for ease of use, in that none of them required extra calculations. The software programs included Mplus version 8.3, the *Johnson-Neyman*() function in the *interaction* package for R version 3.6.2, and the PROCESS Macro version 3.4 for IBM SPSS Statistics version 25.

The three software programs were compared in four aspects. First, did they generate J-N interaction figures as an available function? Second, did its J-N figure include a simple regression line that specified how the effect of a predictor on an outcome varied by moderator values, two 95% confidence bands around that simple regression line, and the region(s) of significance? Third, if it did not generate a J-N interaction figure, could it produce output with sufficient information to create a J-N figure to probe the interaction. Fourth, did it report the region(s) of significance or provide data for it in the output. The current review focuses only on two-way interactions, i.e., two independent variables (one as a predictor and the other as a moderator) and a dependent variable.

Review method

For the purpose of this review, a sample was drawn from the Fragile Families study of urban families in 20 American cities (Reichman, Teitler, Garfinkel, & McLanahan, 2001), when the child was 15 years old. The research question is related to the prediction of youth's math grade as the joint influence of aggressive behaviors and attention problems at the same time point. It was hypothesized that aggressive behaviors would negatively influence math grade, but that the relationship between aggressive behaviors and math grade is conditional on attention problems. Math grade was coded on a 4-point scale from D (1) to A (4). Aggressive behaviors were measured using the aggressive behavior subscale, and attention problems were measured using the attention problem subscale from mothers' reports on the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001). Item responses used a 3-point scale (1 = not true, 2 = sometimes true, and 3 = often true). The aggressive behavior subscale includes 11 items about bullying others, destroying things, disobeying, fighting, physically attacking people, having a temper, threatening people, arguing, being stubborn, and being unusually loud. The attention problem subscale includes three items: trouble concentrating, trouble sitting still, and acting without thinking. The means of the items (11 items for aggressive behavior and three items for attention problem) were computed to generate an aggressive behavior composite score and an attention problem composite score separately. Then the two composite scores were centered for moderation analysis. Samples missing one variable were excluded, resulting in a final sample of 3202 mothers' reports. The preliminary analysis (Table 1) indicates that the main effects and the Aggression X Attention interaction were all significant.

Table 1. Moderating effects of attention problems on the association between aggressive behaviors and math grade.

Parameter	Coefficient b	$SE\ b$	t	p
Constant	2.74	0.02	148.28	< .001
Aggression	−0.44	0.07	−5.92	< .001
Attention Problems	−0.22	0.04	−5.02	< .001
Aggression × Attention Problems	0.24	0.08	2.88	.004

The data were used to probe the moderation effect using the J-N technique in Mplus version 8.3, R version 3.6.2, and IBM SPSS Statistics version 25.

Mplus

Mplus is a widely used program for latent variable modeling (Muthén & Muthén, 1998–2017). The following syntax was used to run the moderation effect model in Mplus.

```
data:
  file = mod_data_mplus.csv;
variable:
  name = agg att math;
  usevariable are agg att math aggXatt;
define:
aggXatt = agg * att;
model:
math ON agg (a1)
       att
     aggXatt (a3);
model constraint:
  loop (att,-2, 5.5, 0.1);
  plot (effect);
  effect = a1+a3*att;
  plot: type = plot2;
output:
stdyx residual samp;
```

The *data* function is used to specify the name of the data file. The *variable* function is used to specify the variables in the data file in order and the variables used for this analysis: `agg` for aggressive behaviors, `att` for attention problems, and `math` for math grade. The *define* function defines a new variable `aggXatt`, which is the product of aggressive behaviors and attention problems to represent the interaction. The *model* function is used to specify the model that the dependent variable *math* is regressed on three variables: aggressive behaviors `agg`, attention problems `att`, and the interaction `aggXatt`, storing the estimated parameter for aggressive behaviors in `a1` and the parameter for the interaction in `a3`. The *model constraint* function is used to specify the values of the moderation to be included in the figure: *loop* specifies the range of the moderator att on the X-axis from −2 units below the mean to 5.5 unites above the mean with a incremental value 0.1, and *plot (effect)* specifying the value for the Y-axis. The syntax `effect = a1+ a3* att` calculates the effect size according to Equation (1), which specifies the outcome of the simple regression line to be probed. In actual practice, the range of the X-axis should reflect most of the observed range of values of the moderator. If the moderator is normally distributed, for example, a range from −2 to 2 standard deviations around the mean would represent about 95% of the observed values. The only reason for specifying the range from −2 units to 5.5 units is to show two regions of significance. In actual practice, a region of significance outside the range of observed values of the moderator may be of little importance.

Figure 1 shows the estimated effect of aggressive behavior on math grade as a function of attention problems using Mplus. The figure displays the simple regression line (red) representing the effect regressed on attention problems and its 95% confidence bands (two blue lines). Boundaries of the two regions of significance can be seen at the points where the 95% confidence interval crosses the line for effect = 0. This occurs when attention problems are about one unit above its mean and when attention problems are about five units above the mean. However, the exact values of the region(s) of significance are reported in neither the figure nor the output. The Mplus output does not specifically report these statistics for the J-N technique.

The *Johnson_Neyman()* function in the *interaction* package for R

R is a popular open-source set of programs for statistical analysis and graphics. It is free for users to download and for software developers to add functions and packages. The *interaction* package (Long, 2019) was specifically designed for analyzing and probing two-way and three-way interaction effects. The *Johnson_neyman()* function is available in the *interaction* package for probing two-way interaction effects.

Usage of *Johnson_neyman()* is shown below with most arguments set to the defaults:

```
johnson_neyman(model, pred, modx, vmat = NULL, alpha =
               0.05, plot = TRUE, control.fdr = FALSE,
               line.thickness = 0.5, df = "residual",
               digits = getOption("jtools-digits",
               2), critical.t = NULL, sig.color =
               "#00BFC4", insig.color = "#F8766D",
               mod.range = NULL, title = "Johnson-
               Neyman plot")
```

Most of the arguments can be left to their default settings except for the first three. The *model* argument indicates the model being analyzed. Options include *lm*(Linear models), *glm*(generalized linear model), *svyglm* (Survey-weighted generalized linear models) objects, and others. The *pred* function indicates the predictor variable involved in the interaction, which is aggressive behavior in this case. The *modx* function indicates the moderator, which is attention problems in this analysis. The *mod.range* function indicates the range of values of the moderator to be graphed on the X-axis, with (−1, 1) as the default. For showing the two regions of significance, the range of the values of the moderator was

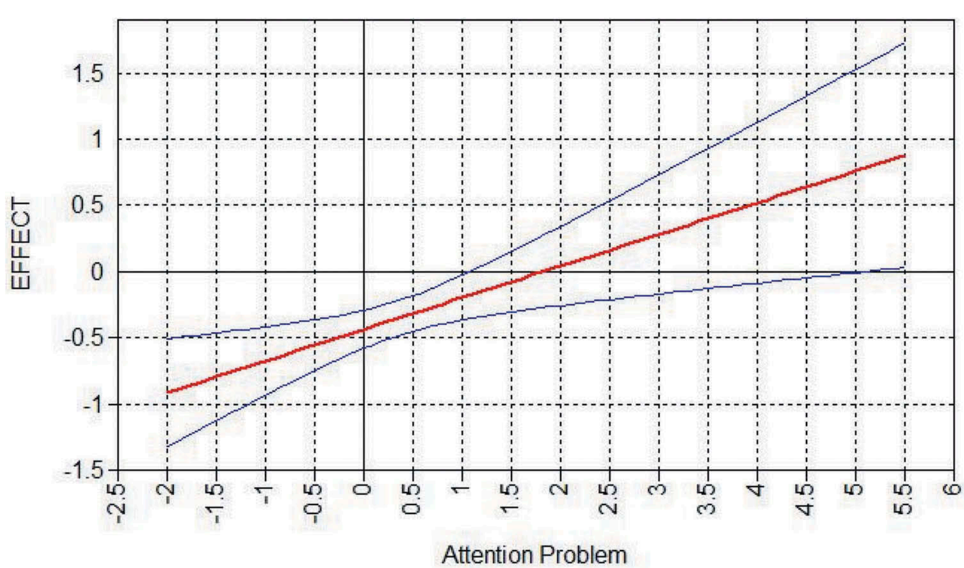

Figure 1. J-N interaction plot using Mplus for the conditional relation between aggressive behaviors and math grade as a function of attention problems.

assigned as (−1, 6). The following codes were used to run the moderation effect model in R.

```
install.packages("interactions")
library(interactions)
my_data <- read.csv(file = "mod_data_r.csv")
reg <- lm (math ~ agg * att, data = my_data)
summary(reg)
mod <- johnson_neyman(model = reg, pred = agg, modx = att,
mod.range = c(-1,6))
mod
```

Before actually running the *Johnson-neyman()* function, it is necessary to install the package, load the data into R, and specify the statistical model. The *install.packages* function is used to install the *interactions* package, and the *library* function is used to load the *interactions* package. The *read.csv* function is used to read the data table from the data file "mod_data_r.csv" and the data table is stored in a data frame called *my_data*. The *lm* function is used to fit the linear model (the interaction model in the current study) to the data, and the model is stored in a data frame named *reg*. In the *Johnson-Neyman* function, the model *reg* is called with other arguments: the independent variable *agg*, the moderator *att*, and the range of the moderator from −1 to 6 to probe the interaction figure by using the J-N technique.

Figure 2 Plot A shows the conditional relation between aggressive behaviors and math grade as a function of attention problems using the *Johnson_neyman()* function to run the data. Similar to the figure in Mplus, the simple regression line representing the effect regressed on attention problems is shown along with its 95% confidence bands. In addition, the regions of significance are shown in green, while the region of non-significance is shown in pink. The figure also shows the range of the moderator using a solid bold line, which indicates that most of the green area in the left of the figure is a meaningful region of significance because it is within the range of the data, whereas the green area in the right is not because it is outside the range of the data. The *Johnson_neyman()* function also gives the output to specify the actual region of non-significance (the interval [1.09, 5.12]) and the range of observed values (−.36, 1.64) of attention problems.

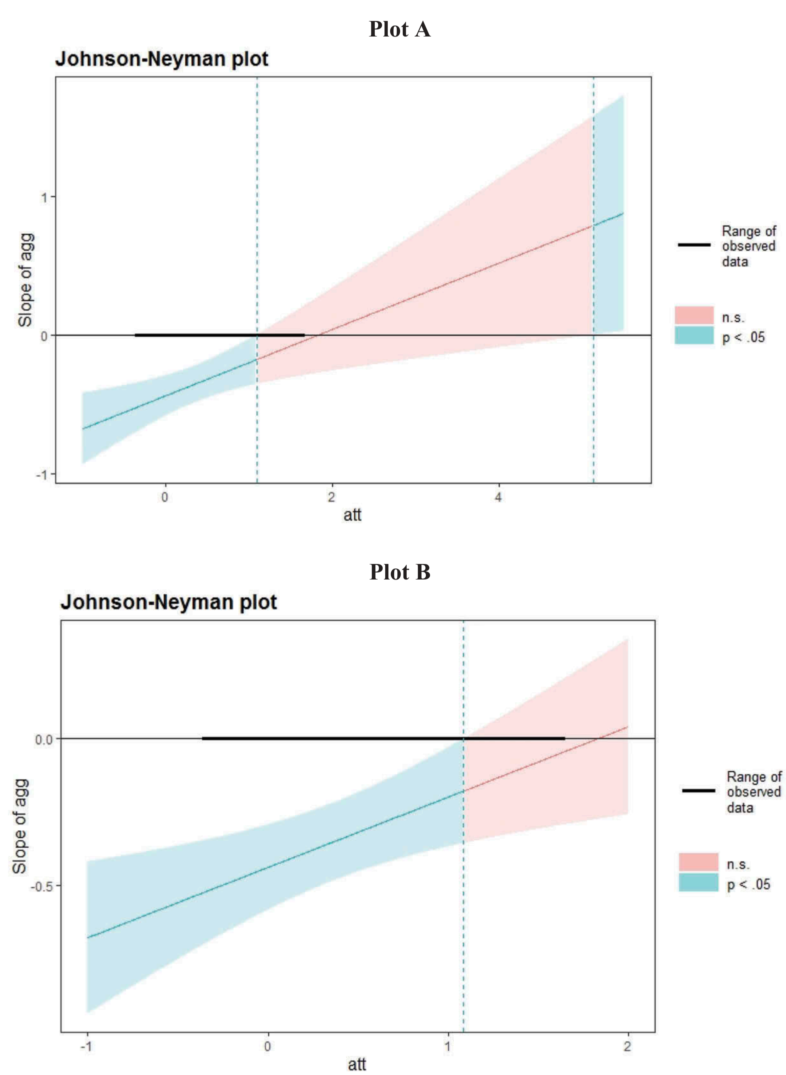

Figure 2. J-N interaction plot using the Johnson_neyman() function in the interaction package for R.

```
JOHNSON-NEYMAN INTERVAL
When att is OUTSIDE the interval [1.09, 5.12],
the slope of agg is p<.05.
Note: The range of observed values of att is
[-0.36, 1.64]
```

This gives useful information to revise the graph to constrain the range of the moderator in X-axis based on the observed values (–.36, 1.64). Figure 1 Plot B shows the revised graph that reset the range of the moderator from –1 to 2.

PROCESS Macro for SPSS

SPSS is a popular statistical software commonly used in the social sciences. SPSS does not have a specific function for using the J-N technique to analyze moderation effects. However, the PROCESS Macro could be downloaded and added on to SPSS for analyzing mediation and moderation effects (Hayes, 2016). Once the add-on PROCESS Macro is installed, the steps shown in Figure 3 can be used to conduct the analysis.

Step 1: Select the PROCESS add-on under the Regression option in the pull-down menu for Analyze.

Step 2: Specify the model: Dependent Y variable to be *math*, predictor X variable to be *agg*, and moderator variable W to be *att*. Select 1 (the two-way interaction model) as the Model number. Then click the button "Options."

Step 3: In the option window, click the check-box "Johnson-Neyman output" for getting the results for the

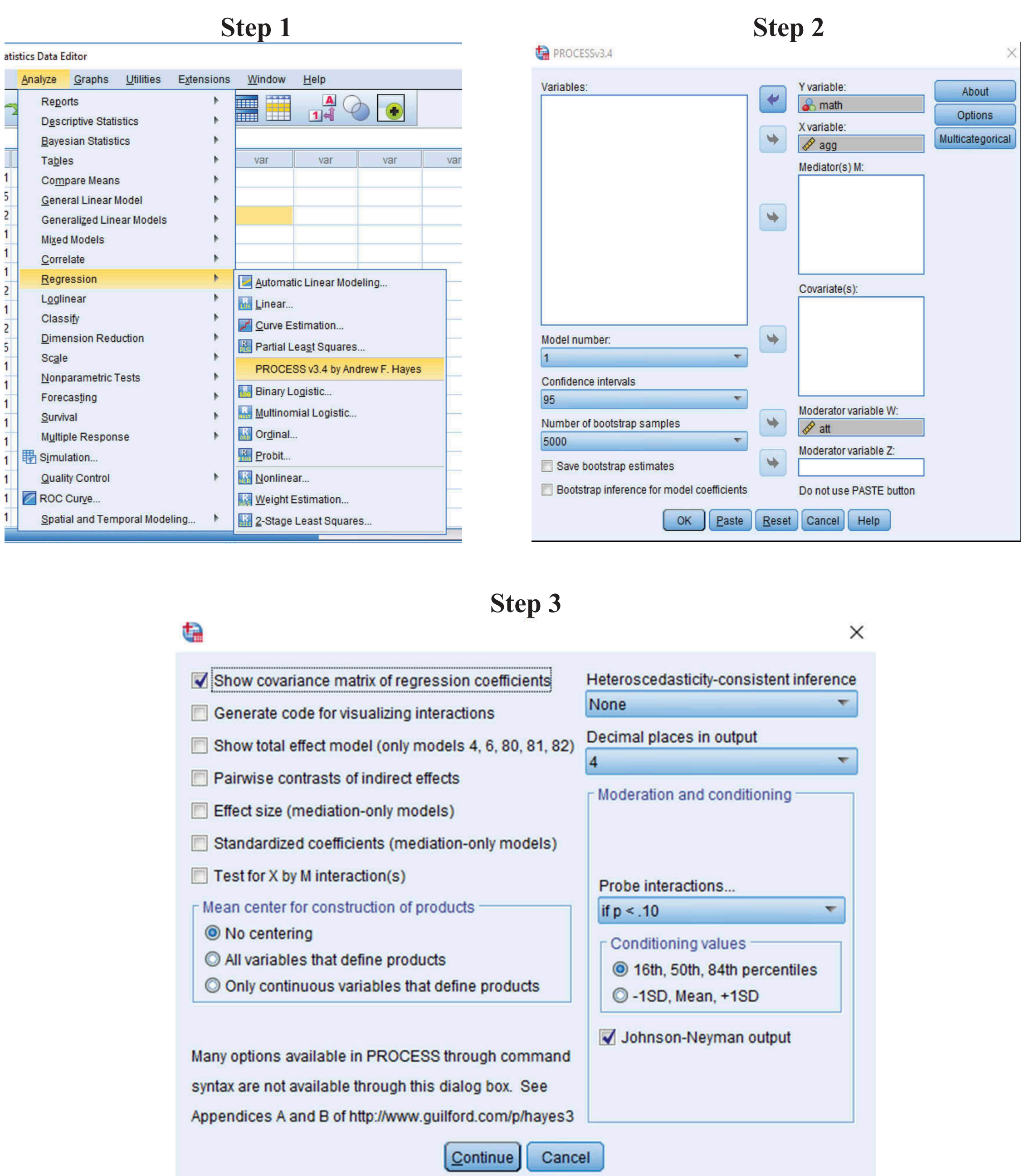

Figure 3. Step-by-step of using PROCESS Macro for SPSS to run a two-way interaction model.

J-N interaction figure and select the check-box "Show covariance matrix of regression coefficients."

When the analysis is conducted, the results will be reported in the Output window, including model summary, covariance matrix, the region(s) of significance, the conditional effect of the focal predictor at values of the moderator, and so on.

The boundary of region of significance is reported only for values within the range of the observed moderator data, which

```
Model Summary
                R          R-sq         MSE            F          df1          df2           p
            .1965         .0386       .8715      42.8558       3.0000    3201.0000       .0000
Model
                          coeff          se            t            p         LLCI        ULCI
constant                 2.7390       .0185     148.1912        .0000       2.7028      2.7753
agg                      -.4372       .0739      -5.9180        .0000       -.5820      -.2923
att                      -.2157       .0430      -5.0133        .0000       -.3001      -.1313
Int_1                     .2391       .0832       2.8749        .0041        .0760       .4022

Product terms key:
Int_1       :               agg           x          att
Covariance matrix of regression parameter estimates:
                       constant         agg          att        Int_1
constant                  .0003       .0003        .0001       -.0007
agg                       .0003       .0055       -.0013       -.0025
att                       .0001      -.0013        .0019       -.0011
Int_1                    -.0007      -.0025       -.0011        .0069
Test(s) of highest order unconditional interaction(s):
                        R2-chng           F          df1          df2            p
X*W                       .0025      8.2653       1.0000    3201.0000        .0041
---
              Focal predict: agg         (X)
                    Mod var: att         (W)
Conditional effects of the focal predictor at values of the moderator(s):
              att        Effect          se            t            p         LLCI        ULCI
           -.3595        -.5231       .0902      -5.7973        .0000       -.7001      -.3462
           -.3595        -.5231       .0902      -5.7973        .0000       -.7001      -.3462
            .6405        -.2840       .0714      -3.9764        .0001       -.4241      -.1440
Moderator value(s) defining Johnson-Neyman significance region(s):
            Value       % below     % above
           1.0859       94.6646      5.3354
Conditional effect of focal predictor at values of the moderator:
              att        Effect          se            t            p         LLCI        ULCI
           -.3595        -.5231       .0902      -5.7973        .0000       -.7001      -.3462
           -.2595        -.4992       .0850      -5.8768        .0000       -.6658      -.3327
           -.1595        -.4753       .0802      -5.9284        .0000       -.6325      -.3181
           -.0595        -.4514       .0760      -5.9384        .0000       -.6005      -.3024
            .0405        -.4275       .0726      -5.8906        .0000       -.5698      -.2852
            .1405        -.4036       .0700      -5.7693        .0000       -.5408      -.2664
            .2405        -.3797       .0683      -5.5627        .0000       -.5135      -.2459
            .3405        -.3558       .0675      -5.2672        .0000       -.4882      -.2233
            .4405        -.3319       .0679      -4.8909        .0000       -.4649      -.1988
            .5405        -.3080       .0692      -4.4523        .0000       -.4436      -.1723
            .6405        -.2840       .0714      -3.9764        .0001       -.4241      -.1440
            .7405        -.2601       .0746      -3.4888        .0005       -.4063      -.1139
            .8405        -.2362       .0785      -3.0111        .0026       -.3900      -.0824
            .9405        -.2123       .0830      -2.5582        .0106       -.3750      -.0496
           1.0405        -.1884       .0881      -2.1388        .0325       -.3611      -.0157
           1.0859        -.1776       .0906      -1.9607        .0500       -.3551       .0000
           1.1405        -.1645       .0936      -1.7565        .0791       -.3481       .0191
           1.2405        -.1406       .0996      -1.4116        .1582       -.3359       .0547
           1.3405        -.1167       .1059      -1.1022        .2705       -.3242       .0909
           1.4405        -.0928       .1124       -.8254        .4092       -.3131       .1276
           1.5405        -.0689       .1191       -.5779        .5633       -.3024       .1647
           1.6405        -.0449       .1261       -.3565        .7215       -.2921       .2023
```

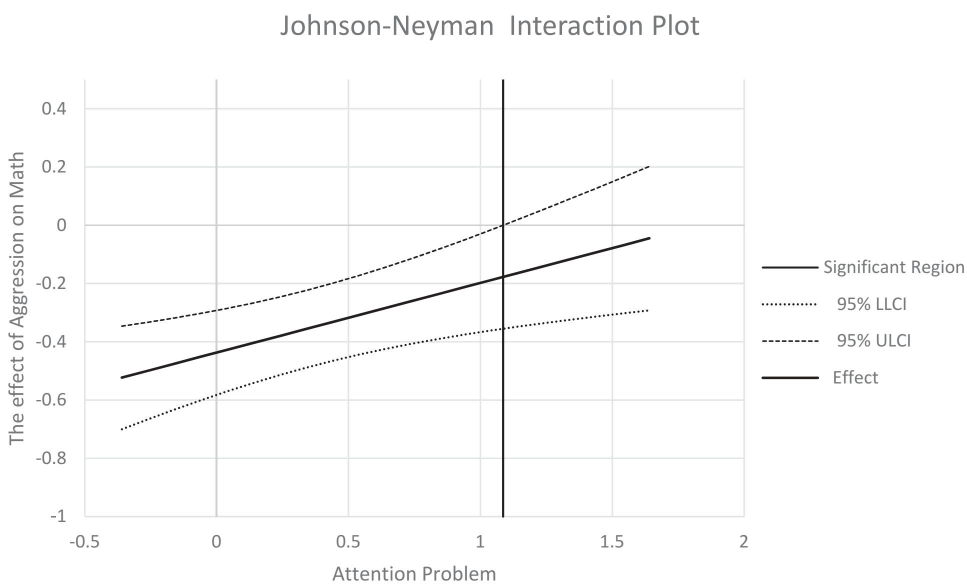

Figure 4. J-N interaction plot in Excel using results from PROCESS Macro for SPSS.

is 1.0859 in this case. The default output lists the conditional effect of the focal predictor at each value of attention problems from −0.3595 to 1.6405 with incremental steps of 0.1. Each row presents the conditional effect and its standard error, t-value, *p*-value, and 95% confidence intervals for each tabled value of attention problem.

The output could be used to probe the interaction with the J-N moderation plot in another software program. For example, the first two columns (attention problem and conditional effect) and the last two columns (lower and upper 95% confidence limits) could be copied and pasted in a spreadsheet (e.g., Excel) to plot the J-N figure. Figure 4 shows a J-N graph created in Excel file from these data. The black bold solid line is the simple regression line showing how the effect of aggression on math varies by attention problems, and the two dashed lines are the 95% confidence bands. The vertical black straight line represents the boundary of the region of significance, which could be drawn by adding a column that repeated the boundary value 1.0859 for all values of ATT in the Excel data file. The advantage is that the output only reported results within the range of observed moderator scores, so that conclusions are not made or implied outside the range of observed moderator values.

Another popular method to use the J-N technique to probe an interaction is to manually insert parameters such as coefficients, coefficient variances, coefficient covariances, and so on in Kristopher Preacher's website (http://www.quantpsy.org; Preacher, Curran, & Bauer, 2006). The output of the model summary, model, and covariance matrix from PROCESS Macro provide sufficient information (highlighted in bold) to do that. Note that the standard errors for the coefficients need to be squared to get the coefficient variances. Once the values of the parameters (Figure 5) were inserted on the website (http://www.quantpsy.org/interact/mlr2.htm), the following R codes are generated on the website, which could be copied and run in R.

Regression Coefficients		Coefficient Variances	
$\hat{b}_0$	2.7390	$\hat{b}_0$	0.00034225
$\hat{b}_1$	-.4372	$\hat{b}_1$	0.00546121
$\hat{b}_2$	-.2157	$\hat{b}_2$	0.001849
$\hat{b}_3$	.2391	$\hat{b}_3$	0.00692224
Other Information		**Coefficient Covariances**	
df	3205	$\hat{b}_2, \hat{b}_0$	.0001
α	.05	$\hat{b}_3, \hat{b}_1$	-.0025

Figure 5. Values of parameters inserted in Kristopher Preacher's website for generating R codes.

```
z1=-10   #supply lower bound for z
z2=10    #supply upper bound for z
z <- seq(z1,z2,length=1000)
fz<- c(z,z)
y1 <- (-0.4372+0.2391*z)+(1.9607*sqrt(0.00546121+
(2*z*-0.0025)+((z^2)*0.00692224)))
y2 <- (-0.4372+0.2391*z)-(1.9607*sqrt(0.00546121+
(2*z*-0.0025)+((z^2)*0.00692224)))
fy<- c(y1,y2)
fline<- (-0.4372+0.2391*z)
plot(fz,fy,type='p',pch
='.',font=2,font.lab=2,col=2,
xlab='Moderator',ylab='Simple Slope',
main='Confidence Bands')
lines(z,fline)
f0 <- array(0,c(1000))
lines(z,f0,col=8)
abline(v=1.0861,col=4,lty=2)
abline(v=5.1267,col=4,lty=2)
```

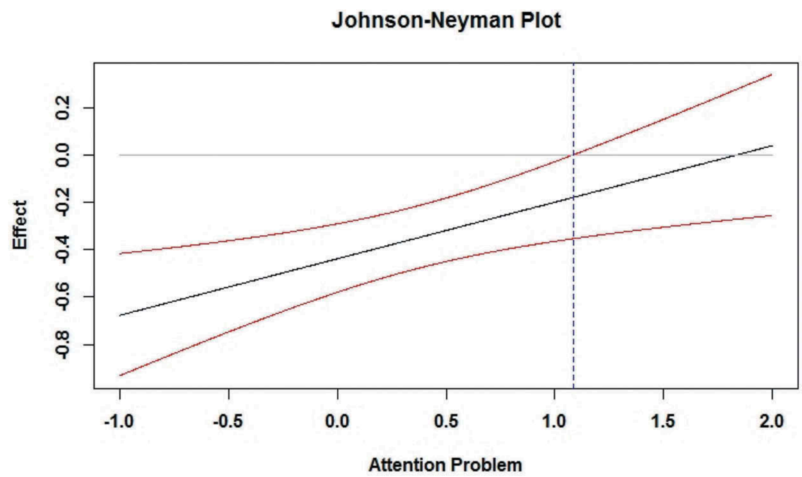

Figure 6. J-N interaction plot in R using results from PROCESS Macro to generate R codes in Preacher's website.

The codes were modified slightly to change the range of the X-axis and the labels for the figure: z1 = −1, z2 = 2, xlab = 'Moderator', ylab = 'Simple Slope,' and main = 'Confidence Bands' and then ran in R. Figure 6 was created in R.

The operation of using PROCESS is simple, and the output reported by the PROCESS Macro for SPSS provides enough information to draw the J-N interaction figure, which includes the simple regression line, the region of significance, and the 95% confidence bands.

Discussion

With increased testing of moderation effects in quantitative analyses, the J-N technique has become very useful for interpreting moderation results. The primary advantage of using the J-N technique to probe the moderation effect is that the full range of the conditional effects are displayed, including regions of moderator values where the main effect is significant, and the confidence of the entire range of conditional effects. This provides a comprehensive interpretation of moderations. However, the complex calculations for the 95% confidence bands and region(s) of significance could restrict the number of its users. To overcome that limitation, this article reviews simple procedures to get the J-N moderation figures. Three software programs were reviewed and compared: Mplus version 8.3, the *Johnson-Neyman*() function in the *interaction* package for R version 3.6.2, and the PROCESS Macro version 3.4 for IBM SPSS Statistics version 25. The performance of the functions is compared including their ability of probing the J-N moderation figure, information communicated in the plot, output information for probing in another software program, and other information in the J-N output.

In terms of the ability to graph the J-N figures, both Mplus and the *Johnson-Neyman* function are satisfactory. By specifying the regression model in the *model constraint* function, Mplus includes a figure in its output, which includes the simple regression line representing the relation between the effect regressed on the moderator and its confidence bands. Neither the figure created in Mplus nor the output reports the specific region(s) of significance and the data range of the moderator, which is a drawback of Mplus 8.3. Most interactions will have two regions of significance at some point, but figures like the one from Mplus are potentially misleading in suggesting that an opposite effect of aggression on math grades occurs for some youth, when that significant reversal occurs only for impossible scores (outside the possible range of attention problem). The figure created in R using the *Johnson-Neyman*() function in the *interaction* package provides all of the relevant information: the simple regression line, 95% confidence bands, and the region(s) of significance in a colorful format. These two software/programs have the capability to graph the J-N interaction figure; they therefore do not give detailed output for a third software to plot the J-N interaction figure. The PROCESS Macro for SPSS does not have a function for graphing the J-N figure directly. Instead, the output provides the necessary data, including the model, the covariance matrix of the regression parameter, the conditional effects, the moderator, and the upper and lower 95% confidence bands for probing the J-N figure in another software.

The output file in Mplus does not include the specific statistics used to graph the J-N technique. Therefore, the region(s) of significance and the range of the predictor are not reported. Output in *Johnson-Neyman*() and in PROCESS Macro both include the exact values of the region(s) of significance and the observed range of the moderator data.

Conclusions

Overall, the three software programs are capable of using the J-N technique to probe a moderation effect based on fairly simple procedures. Mplus and the *Johnson-Neyman()* function are more straightforward, including the graphing function, although the figure created in Mplus does not show the region(s) of significance as clearly. *Johnson-Neyman()* and the PROCESS Macro provide more information in the output related to the J-N technique. They report the region(s) of significance and the observed range of the moderator for identifying the actual regions of significance. Considering all the abovementioned, *Johnson-Neyman()* is easy to use, comprehensive, and therefore superior for using the J-N technique to probe two-way moderation effects compared to other available alternatives.

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