Annotated Output

```
EXAMINE VARIABLES=Group cov dv
  /PLOT BOXPLOT STEMLEAF
  /COMPARE GROUPS
  /STATISTICS DESCRIPTIVES
  /CINTERVAL 95
  /MISSING LISTWISE
  /NOTOTAL.
```

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Group	75	100.0%	0	0.0%	75	100.0%
meta cognitive	75	100.0%	0	0.0%	75	100.0%
Achievement	75	100.0%	0	0.0%	75	100.0%

James Madison University
PSYCH-608 Course Work
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Research Questions

Proposed Research Questions:

1. Is there a relationship between meta-cognition skills and achievement? Can meta-cognition predict achievement? Meta-cognition skills involve being able to accurately assess what you know and what you don't know.

2. Do the 3 types of students differ in terms of achievement from the average achievement for the whole sample when controlling for meta-cognition skills? For example, is one group performing significantly worse than average while the other two are performing better than average, after controlling for differences on meta-cognition skills. The three types of students are nontraditional female students, traditional male students, and traditional female students.

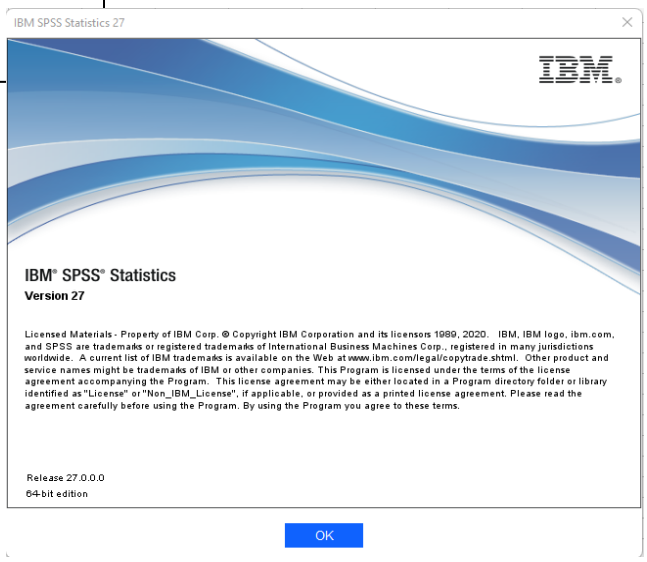
3. Does the prediction of achievement from meta-cognition change depending on what type of student you are? If so, how?

Are there differences between non-traditional female students, traditional female students and traditional male students in achievement when controlling for meta cognition?

Approach

Statistical Software used: SPSS

Version: 27



The research questions posed above call for a mix of analytic methods in order to determine what models best fit the data.

The first question asks simply, is there a correlation between two continuous variables. The independent variable is described as Meta-cognition, and the dependent variable is described as achievement. In order to conduct this analysis a simple correlation and simple regression is performed.

The second questions requires the use of multiple regression, although the techniques applied resemble traditional ANOVA and ANCOVA designs. For the second questions we have one categorical predictor (type of student), one continuous predictor (metacognitive ability), and one continuous criterion or dependent variable (achievement). The strength of utilizing a model based approach with a multiple regression framework is the ability to identify specific sources of variance with our model, compare different models, and explore interactions at once. This is particularly useful as this question specifically asks how each one of our levels of the categorical variable (student type) performs relative to achievement, while controlling for our continuous variable (meta cognitive ability).To answer the second question, we will need to first obtain descriptive to foreshadow relationships, then check for an interaction, followed by our follow up analysis based on whether or not an interaction is found. In this case, there is no interaction, so our follow up analysis consider the main effects while controlling for our continuous IV.

The third question is addressed in the process of answering number two, using a model based multiple regression framework. Here, the test of the interaction indicates whether or not the prediction of achievement from metacognitive ability depends on the type of student.

The following output and associated syntax follows the approach described above, with key elements identified with → an arrow, and annotations included in ▭ text boxes.

Question #1: Simple Regression
SPSS Syntax:

```
REGRESSION
  /DESCRIPTIVES MEAN STDDEV CORR SIG
N
  /MISSING LISTWISE
  /STATISTICS COEFF OUTS CI(95) R
ANOVA CHANGE ZPP
  /CRITERIA=PIN(.05) POUT(.10)
  /NOORIGIN
  /DEPENDENT dv
  /METHOD=ENTER cov
  /PARTIALPLOT ALL
  /RESIDUALS HISTOGRAM(ZRESID).
```

Descriptive Statistics

	Mean	Std. Deviation	N
Achievement	49.8133	3.63055	75
meta cognitive	101.8133	6.30249	75

A positive correlation between continuous IV and DV indicates that as meta cognitive ability increases, so does achievement. This does not account for student type.

Correlations

		Achievement	meta cognitive
Pearson Correlation	Achievement	1.000	.749
	meta cognitive	.749	1.000
Sig. (1-tailed)	Achievement	.	.000
	meta cognitive	.000	.

Meta Cog predicts 56% of the variance in Achievement

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.749[a]	.560	.554	2.42397	.560	93.005	1	73	.000

a. Predictors: (Constant), meta cognitive

b. Dependent Variable: Achievement

This proportion of variance is significant

Meta Cog predicts a sig. amount of variance in achievement. For every one unit increase in met cog there is a .431 increase in achievement.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B		Correlations		
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound	Zero-order	Partial	Part
1	(Constant)	5.914	4.561		1.297	.199	-3.175	15.003			
	meta cognitive	.431	.045	.749	9.644	.000	.342	.520	.749	.749	.749

a. Dependent Variable: Achievement

Question #2: Analysis of Covariance
Part 1: Descriptive Statistics
SPSS Syntax:

```
MEANS TABLES=dv cov BY Group
  /CELLS=MEAN COUNT STDDEV.
```

Report

Group		Achievement	meta cognitive
non traditional females	Mean	50.9600	100.9200
	N	25	25
	Std. Deviation	3.69098	6.24446
traditional male	Mean	48.8800	101.7200
	N	25	25
	Std. Deviation	3.34564	6.38697
traditional female	Mean	49.6000	102.8000
	N	25	25
	Std. Deviation	3.67423	6.39010
Total	Mean	49.8133	101.8133
	N	75	75
	Std. Deviation	3.63055	6.30249

These descriptive stats provide the means for each one of the levels of the categorical variable on achievement and meta cognitive ability. Notice, these values differ.

Non traditional females have the highest mean on achievement, and the lowest mean on meta cog. Traditional females have a mean between the other two on achievement, and the highest meta cog mean. Also notice here, the differences between the meta cognitive means.

Of note regarding these descriptive is the relationship between the categorical IV (student type) and the continuous IV (meta cognitive). We can see that a change in student type, does not appear to have a very large impact on the level of meta cognitive ability. This indicates that the correlation between student type and meta cognitive ability is low. This is a good property of this model

Question #2: Analysis of Covariance

Part 2: Simple regression between achievment (DV) and meta

Metacognitive ability (continuous IV) for each student type (catagorical IV).

SPSS Syntax:

```
SORT CASES BY group .
Temporary.
SPLIT FILE
  SEPARATE BY group .
REGRESSION
  /DEPENDENT dv
  /METHOD=ENTER cov.
```

Non Traditional Females

Coefficients[a,b]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.519	7.554		.466	.646
	meta cognitive	.470	.075	.795	6.291	.000

a. Group = non traditional females

b. Dependent Variable: Achievement

Traditional Males

Coefficients[a,b]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5.850	6.565		.891	.382
	meta cognitive	.423	.064	.808	6.567	.000

a. Group = traditional male

b. Dependent Variable: Achievement

Traditional Females

Coefficients[a,b]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	3.235	7.659		.422	.677
	meta cognitive	.451	.074	.784	6.065	.000

a. Group = traditional female

b. Dependent Variable: Achievement

Here we see that the assumption of homogeneity of regression is met, with each of the levels of student type (Cat IV), displaying very similar slopes.

This foreshadows that there is not an interaction between the two IV's on the DV.

Here we can see that there was a slight difference between the prediction of achievement in males, when compared to females, while controlling for meta cognition. There was not a noticeable difference between non-traditional and traditional females in predicting achievement while controlling for meta cognition. Multiple regression analysis will be performed to formally test the significance of the interaction between males and females.

Question #2: Analysis of Covariance
Part 3: Coding of Categorical Variable & And creation of interaction variables.
SPSS Syntax:

```
if (group=1) e1 =-1.
if (group=2) e1=1.
If (group=3) e1=0.

if (group=1) e2=-1.
if (group=2) e2=0.
if (group=3) e2=1.
execute.

compute int1=e1*cov.
compute int2=e2*cov.
execute.
```

Code Key: Effect Coding
Non-traditional Females = Group 1, coded -1 in e1
Traditional Males = Group 2, coded 1 in e1
Traditional Females = Group 3, coded 1 in e2

Part 4: Multiple regression analysis of three nested models. Test of interaction.
SPSS Syntax:

```
REGRESSION
  /STATISTICS COEFF R ANOVA CHANGE
  /DEPENDENT dv
  /METHOD=ENTER cov/METHOD=ENTER e1
e2/METHOD=ENTER int1 int2
```

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	meta cognitive[b]	.	Enter
2	e1, e2[b]	.	Enter
3	int1, int2[b]	.	Enter

a. Dependent Variable: Achievement

b. All requested variables entered.

The first thing to examine is the interaction term's impact on the R^2Change in Model 3. Adding the interactions did not explain a significant amount of remaining variance.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change
1	.749[a]	.560	.554	2.42397	.560	93.005	1	73	.000
2	.808[b]	.652	.637	2.18615	.092	9.374	2	71	.000
3	.808[c]	.653	.628	2.21409	.001	.110	2	69	.896

a. Predictors: (Constant), meta cognitive

b. Predictors: (Constant), meta cognitive, e1, e2

c. Predictors: (Constant), meta cognitive, e1, e2, int1, int2

Because the interaction is not significant, model 2 is examined to determine whether the intercepts (main effects) are different for each of the three student types.

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5.914	4.561		1.297	.199
	meta cognitive	.431	.045	.749	9.644	.000
2	(Constant)	4.230	4.145		1.021	.311
	meta cognitive	.448	.041	.777	11.019	.000
	e1	-.892	.357	-.202	-2.497	.015
	e2	-.655	.359	-.148	-1.824	.072
3	(Constant)	4.201	4.198		1.001	.320
	meta cognitive	.448	.041	.778	10.885	.000
	e1	1.648	5.913	.373	.279	.781
	e2	-.966	5.942	-.219	-.163	.871
	int1	-.025	.058	-.575	-.431	.666
	int2	.003	.058	.069	.051	.959

a. Dependent Variable: Achievement

the interactions in model three. There is **no significant interaction.**

Because the interaction is not significant, we examine the data in model 2.

b value	Name	Interpretation
Constant = 4.230	Average intercept	This is the predicted value of achievement (DV), when metacognition is zero, collapsing across groups.
Meta Cognitive = .448	Common Slope	There is a positive relationship between achievement and metacognition after controlling for student type.
e1= -.892	Slope for traditional Males	The mean for the males is less than the grand mean, after controlling for metacognition. This was a significant difference.
e2= -.655	Slope for traditional Females	The mean for the females is less than the grand mean, while controlling for metacognition but it is not significantly different.

Question #2: Analysis of Covariance
Part 4: Regression equations and Adjusted Means

$$y' = a + b_{e_1} + b_{e_2} + b_{metacog}$$
$$y' = 4.230 - .892 - .655 + .448_{metacog}$$

Males

$$y' = 4.230 - .892(1) - .655(0) + .448_{metacog}$$
$$y' = 3.338 + .448_{metacog}$$

Females

$$y' = 4.230 - .892(0) - .655(1) + .448_{metacog}$$
$$y' = 3.575 + .448_{metacog}$$

Nontradi Females

$$y' = 4.230 - .892(-1) - .655(-1) + .448_{metacog}$$
$$y' = 5.77 + .448_{metacog}$$

Computing Adjusted Means:

$$\overline{Y_{adJ.}} = b_c(\bar{X}_G) + a_j$$

$$\overline{Y_{adJ(gM).}} = .448(101.8133) + 3.338$$
$$\overline{Y_{adJ(gF).}} = .448(101.8133) + 3.575$$
$$\overline{Y_{adJ(gNTF).}} = .448(101.8133) + 5.77$$

Adjusted Means

$$\overline{Y_{adJ(gM).}} = 48.950$$
$$\overline{Y_{adJ(gF).}} = 49.187$$
$$\overline{Y_{adJ(gNTF).}} = 51.38$$

Here we have calculated the adjusted means for each group. We can see that these adjusted means differ from the observed means. The table below details this relationship.

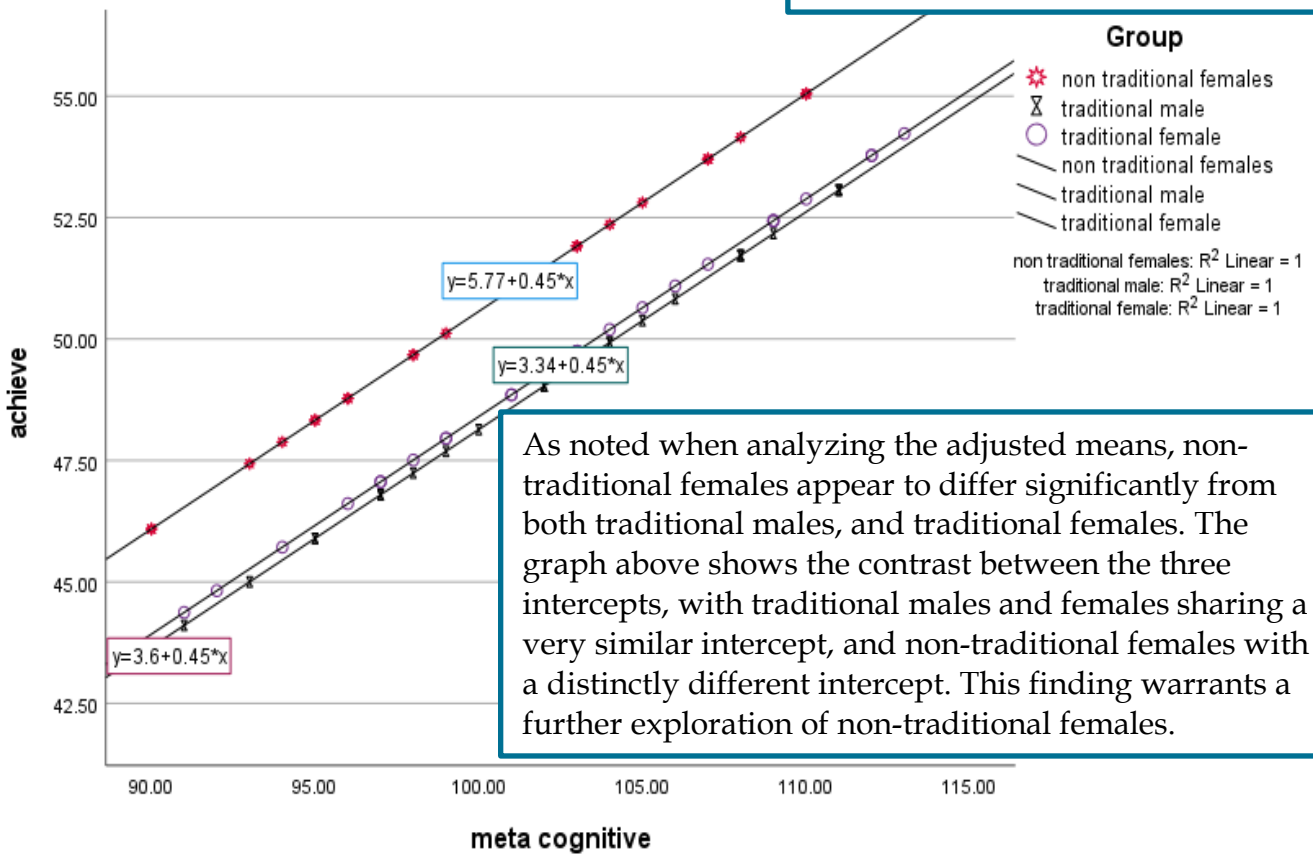
Report

Group		Achievement	meta cognitive
non traditional females	Mean	50.9600	100.9200
	N	25	25
	Std. Deviation	3.69098	6.24446
traditional male	Mean	48.8800	101.7200
	N	25	25
	Std. Deviation	3.34564	6.38697
traditional female	Mean	49.6000	102.8000
	N	25	25
	Std. Deviation	3.67423	6.39010
Total	Mean	49.8133	101.8133
	N	75	75
	Std. Deviation	3.63055	6.30249

Student Type	Achievement		Meta Cognitive		Adjusted Achievement	Difference from grand mean 49.81
	M	*SD*	*M*	*SD*	*M*	
Traditional Male	48.88	3.35	101.72	6.39	48.95	.86
Traditional Female	49.60	3.67	102.80	6.39	49.187	.62
Non-Traditional Feamle	50.96	3.69	100.92	6.24	51.38	-1.57

This table displays the adjusted means for each of the student types, in addition to the difference between the adjusted mean and the grand mean. Here we can see that Non-traditional females and males represent the largest differences from the grand mean. We know that traditional male average achievement was statistically significantly different from the grand mean, after controlling for meta cognitive ability. We also know that traditional females average achievement was not significantly different from the grand mean, after controlling for metacognitive ability. Because the difference is greater for non-traditional females that for males, who were significantly different from the grand mean, it is recommended that an additional analysis be conducted with non traditional females as one of the coded variables.

if (group=1) achieve = 5.77 + .448*(cov).
If (group=2) achieve = 3.338 + .448*(cov).
If (group=3) achieve = 3.605 +.448*(cov).
execute.



As noted when analyzing the adjusted means, non-traditional females appear to differ significantly from both traditional males, and traditional females. The graph above shows the contrast between the three intercepts, with traditional males and females sharing a very similar intercept, and non-traditional females with a distinctly different intercept. This finding warrants a further exploration of non-traditional females.

Follow up Analysis of Non Traditional Females

```
if (group=1) e1 =1.
if (group=2) e1=0.
If (group=3) e1=-1.

if (group=1) e2=0.
if (group=2) e2=1.
if (group=3) e2=-1.
execute.

compute int1=e1*cov.
compute int2=e2*cov.
execute.
```

Code Key: Effect Coding
Non-traditional Females = Group 1, coded 1 in e1
Traditional Males = Group 2, coded 1 in e1
Traditional Females = Group 3, coded -1 in e2

```
REGRESSION
  /STATISTICS
COEFF R ANOVA
CHANGE
  /DEPENDENT dv
  /METHOD=ENTER
cov/METHOD=ENTER
e1 e2/METHOD=ENTER
int1 int2
```

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5.914	4.561		1.297	.199
	meta cognitive	.431	.045	.749	9.644	.000
2	(Constant)	4.230	4.145		1.021	.311
	meta cognitive	.448	.041	.777	11.019	.000
	e1	1.547	.359	.350	4.310	.000
	e2	-.892	.357	-.202	-2.497	.015
3	(Constant)	4.201	4.198		1.001	.320
	meta cognitive	.448	.041	.778	10.885	.000
	e1	-.682	5.956	-.154	-.115	.909
	e2	1.648	5.913	.373	.279	.781
	int1	.022	.059	.509	.376	.708
	int2	-.025	.058	-.580	-.431	.668

a. Dependent Variable: Achievement

After recoding the variables for non traditional females, we can see that the average achievement of non traditional females was significantly different that the grand mean when controlling for meta cognition. This aligns with the foreshadowing earlier in the analysis, and helps to answer research question 2. Additionally, because non traditional females were originally considered to be of little interest to the research question, reconsideration of this variable for inclusion in analysis and future studies is justified.

Question 3: Test of the interaction

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.749[a]	.560	.554	2.42397	.560	93.005	1	73	.000
2	.808[b]	.652	.637	2.18615	.092	9.374	2	71	.000
3	.808[c]	.653	.628	2.21409	.001	.110	2	69	.896

a. Predictors: (Constant), meta cognitive

b. Predictors: (Constant), meta cognitive, e1, e2

c. Predictors: (Constant), meta cognitive, e1, e2, int1, int2

As we can see from the model summary which was presented originally on page 6, the increment of variance explained when the interaction is added is extremely small, And not statistically significantly different than zero.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	5.914	4.561		1.297	.199
	meta cognitive	.431	.045	.749	9.644	.000
2	(Constant)	4.230	4.145		1.021	.311
	meta cognitive	.448	.041	.777	11.019	.000
	e1	-.892	.357	-.202	-2.497	.015
	e2	-.655	.359	-.148	-1.824	.072
3	(Constant)	4.201	4.198		1.001	.320
	meta cognitive	.448	.041	.778	10.885	.000
	e1	1.648	5.913	.373	.279	.781
	e2	-.966	5.942	-.219	-.163	.871
	int1	-.025	.058	-.575	-.431	.668
	int2	.003	.058	.069	.051	.959

a. Dependent Variable: Achievement

We can also see that the interactions coefficients are not statistically significant. (page 7)

We can see that the prediction of achievement from meta-cognition does not change depending on what type of student you are. Instead, there are differences between the level of achievement for particular groups. (page 9 and 10)

Summary

In summary, the above output indicates that prediction of achievement from metacognition is a plausible model based on this data analysis (page 3). There are differences between the three types of students on achievement when controlling for metacognition (pages 4-7). Specifically, traditional males had lower average achievement than the grand mean, after controlling for meta cognitive ability. Non traditional females had a higher average achievement than the grand mean, after controlling for meta cognitive ability. Traditional females did not have a statistically significant difference in average achievement from the grand mean, after controlling for meta cognitive ability (pages 8-9). Finally, the prediction of achievement from meta-cognition does not appear to change depending on the type of student. (page 11).