Home Exam

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PS2304: Methods IV

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Question 1

I performed a simple linear regression analysis for each of the variables as predictors for sense of coherence. The variance explained by the predictors ranges from 1.37% (age) over 5.46% (social anxiety) and 6.01% (perceived physical health) to 19.1% (perceived mental health). These values indicate which proportion of the total variation in sense of coherence can be accounted for by each variable, if we look at them independently.

Question 2

Entered into one model of multiple linear regression, the variables age, social anxiety, perceived physical health and perceived metal health explain R^2=22.3% of variance (R^2_{adj}=20.7%) in sense of coherence. This value differs from the results in question 1, as it is lower than the sum of the variances explained by each score independently. This suggests that some of the predictors have shared variance (i.e., they explain overlapping parts of the variance in sense of coherence). At the same time, this model explains a larger amount of variance than each of the predictors on their own, indicating that this model is more useful in predicting sense of coherence than each of the variables independently. The coefficients and their statistics of each predictor are presented in the appendix (table 6).

Question 3

The model from question 2 does not show any problems in terms of multicollinearity (all VIF values <1.2), also the predictors only show low correlations to each other (the highest correlation of Spearman's *rho* = -.23 can be found between social anxiety and perceived mental health). To assess the distribution of residuals I visually inspected a histogram of residuals and performed a descriptive analysis. The residuals are approximately normal distributed (skewness = -0.301, kurtosis = 0.179), with a non-significant Shapiro-Wilk test (p=.087) suggesting a normal distribution. To detect outliers with a high leverage, I calculated Cook's distance for all values. The maximum Cook's distance was 0.073, which is far below the threshold of problematic values of 1 as suggested by Field (2018). To assess autocorrelation, I performed a Durbin-Watson test (DW=2.09), which suggests that there are no problems in terms of correlation of residuals as the DW statistic is close to 2 (Field (2018) suggests values smaller than 1 and larger than 3 should be considered problematic). Finally, I plotted the predicted values of the models against the residuals to visually assess homoscedasticity. Across the values of the model, the variance of residuals seemed relatively equal, without clear indications of heteroscedasticity.

In summary, all assumptions for a linear multiple regression are met and no problematic outliers could be detected. This means that the model can be trusted, and that its conclusions are valid. However, as table 6 displays, only one of the predictors (mental health) is statistically significant. Even though the model explains more variance than only perceived mental health does, one might consider to delete predictors with a low contribution for a more parsimonious model.

Question 4

I performed a hierarchical multiple regression analysis, in which I entered the predictors in order of their importance, starting with the most interesting. Thus, I first entered social anxiety as a predictor (step 1), next I entered perceived physical health and perceived mental health (step 2), and at last I entered gender and age (step 3), being considered the least important predictors. This resulted in a hierarchical design with three blocks, and all variables were entered into the model with "forced entry". Standard errors, confidence intervals and p-values are based on 1000 bootstrap samples. The resulting steps with predictors and their coefficients are presented in table 1.

Table 1

Regression coefficients with their 95% confidence intervals, standard errors, standardized regression coefficients and p-values for all variables in each step of the model. Confidence intervals, standard errors and p-values are based on 1000 bootstrap samples.

Step	Predictors	*b*	95% CI	SE *b*	β	*p*
1	Social anxiety	-0.032	[-0.052; -0.011]	0.011	-.233	.004
2	Social anxiety	-0.015	[-0.033; 0.003]	0.010	-.113	.112
	Mental health	0.440	[0.273; 0.585]	0.080	.380	<.001
	Physical health	0.114	[-0.034; 0.254]	0.070	.117	.112
3	Social anxiety	-0.014	[-0.033; 0.004]	0.020	-.107	.133
	Mental health	0.437	[0.270; 0.585]	0.080	.376	<.001
	Physical health	0.107	[0.-034; 0.237]	0.070	.110	.124
	Gender	-0.179	[-0.355; 0.006]	0.091	-.130	.061
	Age	-0.004	[-0.023; 0.017]	0.010	-.026	.673

To summarize the most important results, we can see that social anxiety alone roughly explains R^2 = 5% of the variance within sense of coherence in the first step (as the simple linear regression model in question 1 already indicated). As soon as perceived physical health and mental health are entered into the model in the second step, the explained variance of the model increases to R^2 = 22.2% (R^2_{adj}=21.0%). In step 2, mental health is the strongest predictor of sense of Coherence (β =.380, p<.001), while physical health (p=.112) and now also social anxiety (p=.122) are not statistically significant. Looking at step 3, we can see that mental health (β =.376, p<.001) remains the only significant predictor after entering age and gender. The explained variance of the full model is R^2 = 24.0% (R^2_{adj}=22.0%).

These results suggest that social anxiety is not the most interesting predictor. Perceived mental health has a much stronger predictive value for explaining changes in sense of coherence scores. As soon as perceived mental health is added to the model, social anxiety loses its statistical significance as a predictor for sense of coherence. Mental health is positively associated with sense of coherence. With each increase by 1 of the mental health value, the predicted value for sense of coherence is increased by b=0.437 (model from Step 3). Perceived mental health remains highly significant even after adding possible confounders into the model, supporting its value for predicting sense of coherence.

Question 5

I used PROCESS in SPSS to evaluate the moderating effect of gender, age and social anxiety on the effect of sense of coherence on perceived mental health. For each model, I used the standard moderation model in PROCESS ("model 1"). For age and social anxiety, I chose the "pick a point" method with the mean, +1SD, and -1SD to assess the moderating effect. Confidence intervals, p-values and standard errors are based on 5000 bootstrap samples.

Table 2 shows the moderating effect of each variable (the effect of the interaction between each moderator and sense of coherence on perceived mental health).

Table 2

Effect of interaction between each moderator and sense of coherence on perceived mental health. The bootstrapped confidence intervals and standard errors are based on 5000 samples.

					Bootstrap	
Interaction	*b*	95 % CI	SE	*p*	95% CI	SE
Gender x SOC	-0.236	[-0.455; -0.017]	0.111	.035	[-0.485; 0.015]	0.128
Age x SOC	0.003	[-0.022; 0.028]	0.013	.841	[-0.028; 0.037]	0.017
Social Anxiety x SOC	0.027	[0.008; 0.046]	0.010	.005	[0.008; 0 .049]	0.010

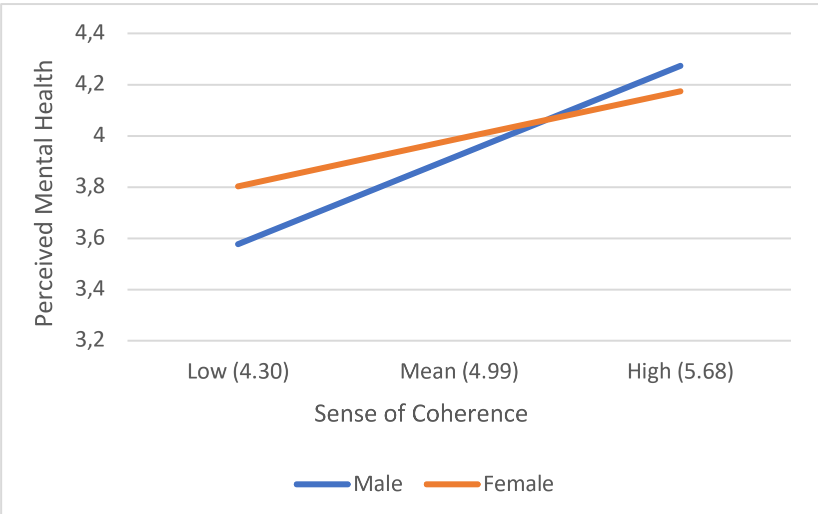
Based on the p-values, gender and social anxiety are significant moderators on the effect of sense of coherence on perceived mental health. Age is not a significant moderator. Based on 5000 bootstrap samples, only social anxiety is a significant moderator, with a 95% confidence interval that does not include 0. In the following, I will present simple slope graphs for each moderator, and an interpretation of the direction of moderation. For the exact values of the simple slopes see table 7 in the appendix.

A) Gender

The moderating effect of gender on the effect of sense of coherence on perceived mental health is significant (p = .035). However, the bootstrapped confidence interval does include 0, indicating that the interaction effect might not be significant. Therefore, the results should be interpreted with caution. As figure 1 shows, the effect of sense of coherence on perceived mental health is stronger in male participants and smaller in female participants.

Figure 1

The effect of sense of coherence (x-axis) on perceived mental health (y-axis), moderated by gender (slopes). The effect of sense of coherence on perceived mental Health is stronger in male participants (blue) than in female participants (orange).

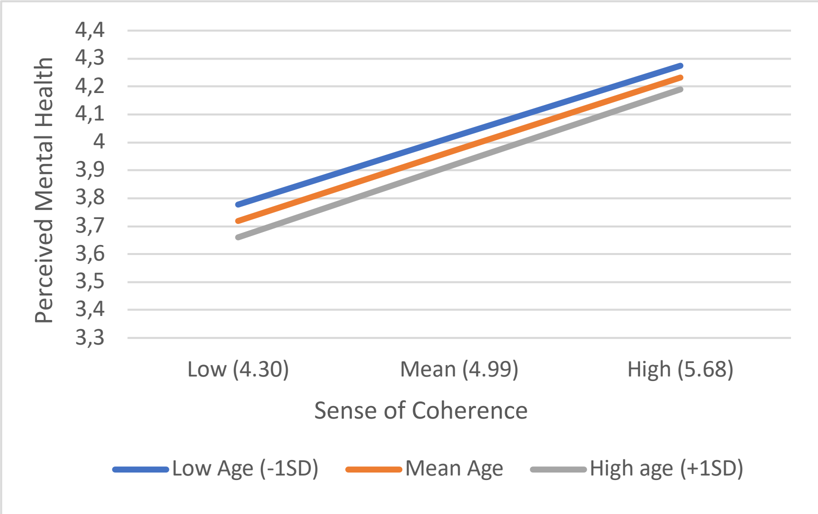


B) Age

The moderating effect of age on the effect of sense of coherence on perceived mental health is not significant (p=.841). This can easily be seen in the simple slope graph in figure 2, as the slopes are nearly parallel. This indicates that age does not moderate the effect of sense of coherence on perceived mental health.

Figure 2

The effect of sense of coherence (x-axis) on perceived mental health (y-axis), moderated by age. Different levels of age are pictured as slopes: low (blue), mean (orange) and high (grey). The moderation is not significant.

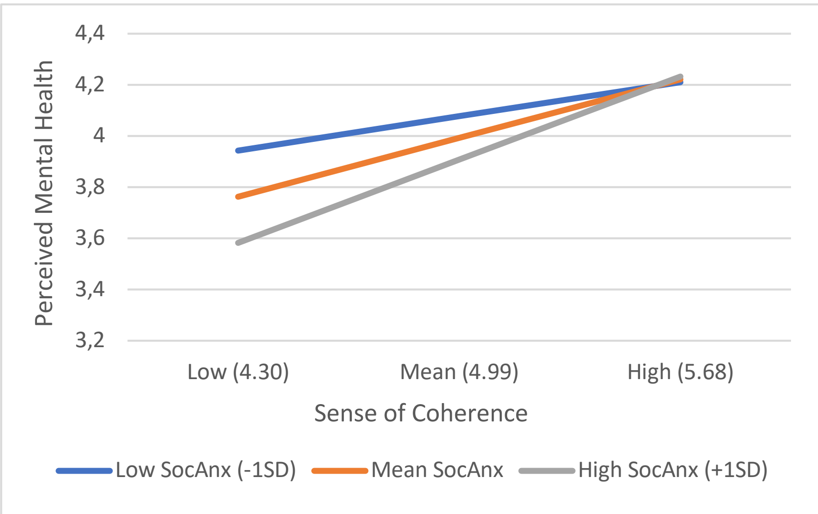


C) Social Anxiety

The moderating effect of social anxiety on the effect of sense of coherence on perceived mental health is significant (p = .005). As figure 3 shows, the effect of sense of coherence on perceived mental health is strongest in participants with high social anxiety, and weakest in participants with low social anxiety.

Figure 3

The effect of sense of coherence (x-axis) on perceived mental health (y-axis), moderated by social anxiety (slopes). The effect of sense of coherence on perceived mental health is strongest in participants with high social anxiety (grey) and weakest in participants with low social anxiety (blue).

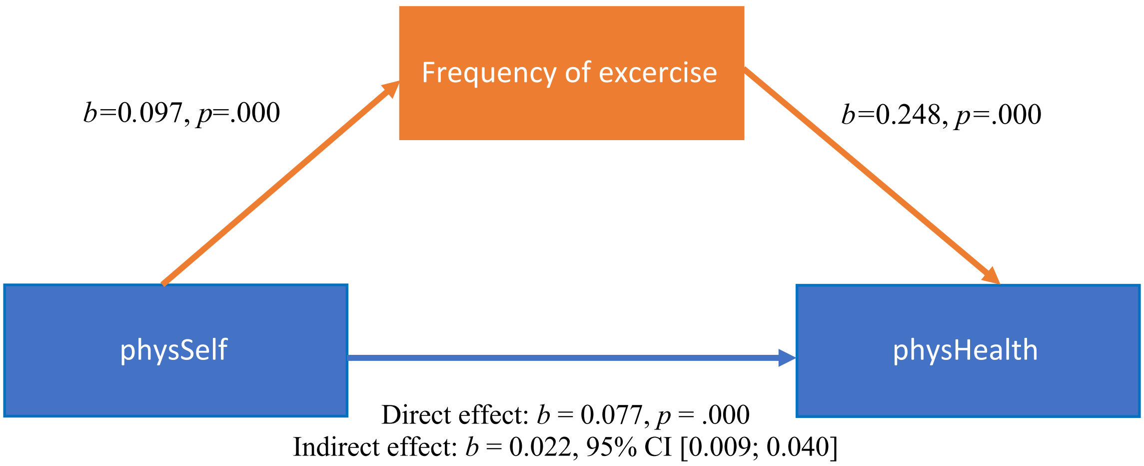


Question 6

a) I used PROCESS in SPSS to evaluate the mediating effect of frequency of exercise (exfreq) in the effect of physical self-perception (physSelf) on perceived physical health (physHealth). I used PROCESS' standard mediation model ("model 4") for the analysis. The results of the analysis are presented in figure 4 (for more details see tables 8 and 9 in the appendix). All paths in the model are statistically significant, suggesting that exfreq is a partial mediator in the effect of physSelf on physHealth. Also, the direct effect (p=.000) and the indirect effect (the bootstrapped 95% CI excludes 0) are both statistically significant. Together, physSelf and exfreq explain R^2= 23.6% of the variance in physHealth. The results will be interpreted in more detail in section 6d).

Figure 4

The mediating role of frequency of exercise between physical self-perception (physSelf) and perceived physical health (physHealth).

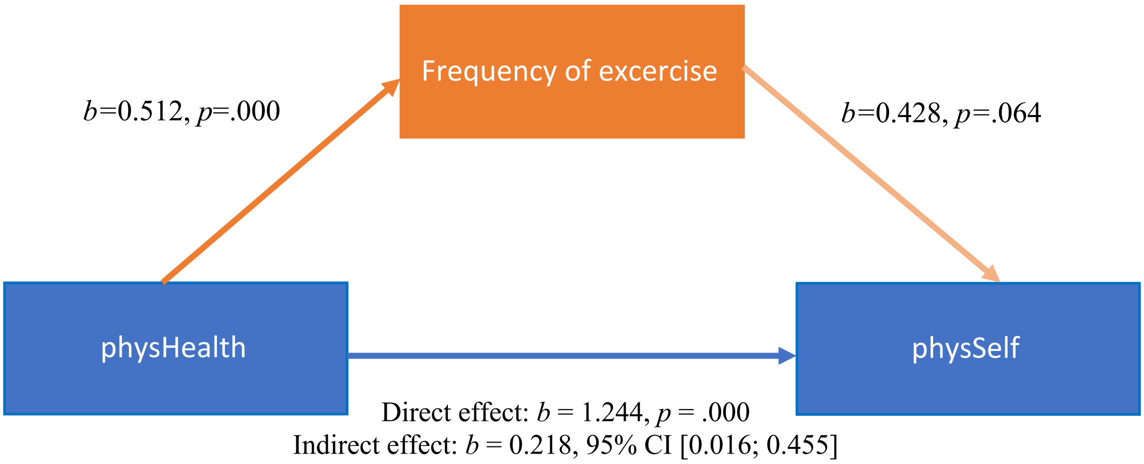


b) Pernilla might refer to a couple of potential problems associated with mediation analysis. For example, the effect of exercise frequency might have a confounding effect on physSelf and physHealth instead of being a mediator. This cannot be tested in the model from question 6a). Another issue might be reversed causality. This means that the physHealth variable might actually affect physSelf, perhaps mediated by frequency of exercise. This is what the following model will assess in more detail.

c) I used PROCESS in SPSS to evaluate the mediating effect of frequency of excercise in the effect of physHealth on physSelf. I used "model 4" to test for mediation. The results of the analysis are presented in figure 5 (for more details see tables 10 and 11 in the appendix). While the indirect effect of physHealth through frequency of exercise on physSelf is significant (the 95% confidence interval based on 5000 bootstrap samples does not include 0), the path from frequency of exercise on physSelf is not statistically significant (*p*=.064), even though the bootstrapped interval does not include 0 and therefore suggests statistical significance. Together, physHealth and frequency of excercise explain R^2= 16.3% of the variance in physSelf.

Figure 5

The mediating role of frequency of exercise between perceived physical health (physHealth) and physical self-perception (physSelf).



d) The mediation model from 6a) seems to be quite promising, as all the paths in the model are statistically significant. Also, both the direct and the indirect effect through exercise frequency are statistically significant. Together, these results suggest an effect of physSelf on physHealth, that is partially mediated through exercise frequency.
The model from 6c) on the other hand is less convincing. Even though both the direct and the indirect effect are statistically significant, the path from exercise frequency to physSelf is not statistically significant (if we were to ignore the bootstrapped confidence interval, that slightly excludes 0 and therefore suggests significance). This violates the assumptions of mediation presented by Baron & Kenny (1986), according to which each path must display statistical significance. Also, the explained variance in the outcome variable is stronger in the model from 6a) (R^2 = 23.6%) than in the model from 6c) (R^2 = 16.3%). Therefore, I would prefer the model from 6a), in which exercise frequency partially mediates the effect of physSelf on physHealth.

It is interesting to mention though, that physHealth seems to be a better predictor of frequency of exercise (β=.394, p =.000) than physSelf (β=.272, p =.004) is. Also, considering the bootstrapped confidence interval, the path from exercise frequency on physSelf in the model from 6c) is statistically significant. It is therefore hard to conclude which model is actually "better" than the other. Both are valid from a statistical perspective. To ultimately assess the direction of causality, an experimental design would be necessary.

Question 7

a) To address this question, I performed a logistic regression analysis in Jamovi. I used guilt as the outcome variable and entered interrogation pressure and confession detail as predictors. Concerning assumptions, multicollinearity is not an issue, with VIF values <1.1 (problematic if >10 (Fields, 2018)) and tolerance values >.9 (problematic if <.1 (Fields, 2018)).

The coefficients for each predictor are presented in table 3. Based on their z-values, both confession detail (z=4.97, p<.001) and interrogation pressure (z=-5.39, p<.001) are significant predictors of perceived guilt. These tests suggest that confession detail and interrogation pressure contribute significantly to the prediction of whether participants rated a person as guilty. Also, the likelihood ratio tests for both confession detail (X^2=27.0, df=1, p<.001) and for interrogation pressure (X^2=32.8, df=1, p<.001) are significant. This suggests that both predictors significantly improve the fit of the model. Increased detail of the confession increases the odds of individuals being perceived as guilty by 1.38 (increase of odds by 38%). In contrast, increased interrogation pressure lowers the odds of individuals being perceived as guilty by 0.67 (decrease of odds by 33%).

The model fit statistics are shown in table 5 (model 1). The overall model test (X^2=61.6, df=2, p<.001) indicates that the model is a significant fit for the data.

Table 3

The predictors in the logistic regression model for predicting perceived guilt. The b-value indicates the change in log odds of guilt if the predictor is increased by a value of 1.

Predictor	*b*	95% CI	SE	z	*p*	Odds ratio
Intercept	0.511	[-0.334; 1.357]	0.432	1.19	.236	1.67
Confession Detail	0.324	[0.196; 0.451]	0.065	4.97	<.001	1.38
Interrogation pressure	-0.399	[-0.544; -0.254]	0.074	-5.39	<.001	0.67

b) For the extended model, I added strength of prosecution and strength of defense as a second block in the logistic regression analysis from 7a). Again, collinearity poses no problems with VIF <1.3 and tolerance >.8 for all included covariates.

The predictors and their coefficients are presented in table 4. As we can see, interrogation pressure (z=2.28, *p*=.022), prosecution strength (z=7.00, *p*<.001) and defense strength (z=-6.22, *p*<.001) are significant predictors for perceived guilt. The likelihood ratio tests for interrogation pressure (X^2=5.47, *df*=1, *p*=.019), prosecution strength (X^2=118.96, *df*=1, *p*<.001) and defense strength (X^2=65.75, *df*=1, *p*<.001) suggest that all three predictors significantly improve the fit of the model.

However, in this extended model, detail of confession loses its statistical significance as a predictor of guilt in the z-test (z=1.46, *p*=.245) and its contribution to model fit in the likelihood ratio test (X^2=2.15, *df*=1, *p*=.143). Further analysis by stepwise inclusion and exclusion of predictors revealed that the inclusion of prosecution strength renders the predictive value of detail of confession non-significant. This could be due to shared variance between the two variables, but it is hard to clearly interpret this in the context of logistic regression.

The odds ratios suggest that increased prosecution strength (by 1) increases the odds of individuals being perceived as guilty by 6.53 (increase of odds by 553%). In contrast, increased interrogation pressure (change in odds = 0.73) and increased strength of prosecution (change in odds = 0.26) by 1 unit decrease the odds of individuals being perceived as guilty by 27% (interrogation pressure) and 74% (strength of prosecution).

Table 4

Predictors in the logistic regression model. Outcome variable: guilt. The b-value indicates the change in log odds.

Predictor	*b*	95% CI	SE	z	*p*	Odds ratio
Intercept	-2.862	[-5.806; 0.083]	1.502	-1.90	.057	0.057
Confession Detail	0.168	[-0.058; 0.394]	0.115	1.46	.145	1.183
Interrogation pressure	-0.315	[-0.584; -0.045]	0.138	-2.28	.022	0.730
Prosecution strength	1.877	[1.351; 2.402]	0.268	7.00	<.001	6.532
Defense strength	-1.353	[-1.780; -0.927]	0.218	-6.22	<.001	0.258

The model fit statistics from the first and second model are presented in table 5. The AIC and BIC values, indicating the tradeoff between model accuracy (fit to the data) and complexity, are far lower for the second model. This means that in terms of model fit the second model with all four predictors should to be preferred over the first model. The change of X^2 values from the overall tests of each model is also high and statistically significant (ΔX^2=280.5 – 62.6 = 217.9, *df*=2, *p*<.001), indicating a significantly improved fit of the second model. I also chose to calculate Nagelkerke's (pseudo) R^2 to get an idea of the explanatory power of each model. The pseudo R^2 of the second model (R^2_N=82%) is more than three times as high as the pseudo R2 of the first model (R^2_N=25.6%). All these statistics suggest that the second model, with strength of prosecution and strength of defense as additional predictors, should clearly be preferred to the first model.

Table 5
Model fit statistics for the models from questions 7a) and 7b) to predict guilt. The first model includes only confession detail and interrogation pressure as predictors, whereas the second model additionally includes prosecution strength and defense strength.

Step	Added predictors	Deviance	AIC	BIC	R^2_N	X^2	*df*	*p*
1	Confession detail Interrogation pressure	245	351	362	.256	62.6	2	<.001
2	Prosecution strength Defense strength	127	137	155	.820	280.5	4	<.001

Finally, I considered the exclusion of confession detail for a more parsimonious model. Model fit statistics of the resulting model are almost equal to the model including detail of confession (with BIC being slightly lower), as shown in table 12 in the appendix. The change of X^2 between the models is (ΔX^2= 280.8 – 278 = 2.8, *df* = 1, *p*=.094) not significant, so the model fit does not significantly decrease when confession detail is excluded. Therefore, I would suggest to exclude confession detail from the final model. Table 13 in the appendix shows the coefficients of each predictor in this model.

References

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology, 51(6), 1173–1182. https://doi.org/10.1037/0022-3514.51.6.1173

Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics. SAGE Publications Limited.

Appendix

Table 6

Results from the linear multiple regression analysis, with age, physical health, mental health and social anxiety predicting sense of coherence. Mental health is the only significant predictor with p <.05.

Predictor	*b*	95% CI	*β*	SE	*t*	*p*
Age	-0.005	[-0.024; 0.015]	-.030	.010	-0.457	.684
Physical health	0.107	[-0.027; 0.024]	.109	.068	1.58	.117
Mental health	0.438	[0.282; 0.594]	.377	.079	5.53	<.001
Social anxiety	-0.016	[-0.033; 0.002]	-.115	.009	-1.71	.088

Note. R2 = 22.3%, adjusted R2 = 20.7%

Table 7

The effect of sense of coherence on perceived mental health moderated by gender, age and social anxiety.

Moderator	Level / Magnitude	Effect of sense of coherence on perceived mental health	95% CI	SE	*p*
Gender					
	Male	0.506	[0.349; 0.663]	0.080	.0000
	Female	0.270	[0.117; 0.423]	0.077	.0006
Age					
	-1 SD (18.50)	0.360	[0.207; 0.512]	0.077	.0000
	Mean (23.14)	0.371	[0.260; 0.482]	0.056	.0000
	+1 SD (27.78)	0.383	[0.215; 0.551]	0.085	.0000
Social Anxiety					
	-1 SD (11.90)	0.194	[0.043; 0.36]	0.077	.0122
	Mean (16.99)	0.333	[0.224; 0.443]	0.055	.0000
	+1 SD (22.08)	0.472	[0.333; 0.612]	0.071	.0000

Table 8

The effect of each path in the mediation model of physSelf through exfreq on physHealth. The bootstrapped confidence intervals and standard errors are based on 5000 samples.

							Bootstrap	
Dependent variable	Independent variable	*b*	95% CI	SE	β	*p*	95% CI	SE
Exfreq	physSelf	0.092	[0.042; 0.142]	0.025	.272	.0004	[0.048; 0.145]	0.025
physHealth	physSelf	0.077	[0.041; 0.113]	0.018	.296	.0000	[0.041; 0.120]	0.020
	Exfreq	0.242	[0.134; 0.350]	0.055	.313	.0000	[0.134; 0.345]	0.054

Table 9

The total, direct and indirect effect of physSelf on physHealth through exfreq. For the indirect effect, the confidence interval and standard error are based on 5000 bootstrap samples. As we can see, the indirect path is significant, as the confidence interval does not include zero. However, the direct effect still remains significant, suggesting a partial mediation.

Effect	*b*	95% CI	SE	*p*
Total effect	0.099	[0.062; 0.136]	0.019	.0000
Direct effect	0.077	[0.041; 0.113]	0.018	.0000
Indirect effect	0.022	[0.009; 0.040]	0.008	

Table 10

The effect of each path in the mediation model for the effect of PhysHealth through exfreq on physSelf. The effect of exfreq on physSelf is not significant based on the conventional confidence interval and the corresponding p-value (>.05). However, the bootstrapped confidence interval for the same effect does not include zero, suggesting a significant effect based on 5000 bootstrap samples.

							Bootstrap	
Dependent variable	Independent variable	*b*	95% CI	SE	β	*p*	95% CI	SE
Exfreq	physHealth	0.510	[.328; .693]	0.093	.394	.0004	[0.294; 0.762]	0.117
physSelf	physHealth	1.244	[.657; 1.832]	0.298	.324	.0000	[0.700; 1.800]	0.277
	Exfreq	0.428	[-.026; .881]	0.230	.144	.0636	[0.033; 0.818]	0.199

Table 11

The total, direct and indirect effect of physHealth on physSelf through exfreq. For the indirect effect, the confidence interval and standard error are based on 5000 bootstrap samples.

Effect	*b*	95% CI	SE	*p*
Total effect	1.462	[0.918; 2.007]	0.276	.0000
Direct effect	1.244	[0.657; 1.832]	0.300	.0000
Indirect effect	0.218	[0.016; 0.455]	0.111	

Table 12

Comparison of model fit statistics for two steps of a logistic regression model predicting perception of guilt. The second step additionally includes confession detail.

Step	Added predictors	Deviance	AIC	BIC	R^2_N	X^2	*df*	*p*
1	Interrogation pressure Prosecution strength Defense strength	129	137	152	.816	278	3	<.001
2	Confession detail	127	137	155	.820	280.5	4	<.001

Table 13

Predictors of the logistic regression model without confession detail (corresponding to step 1 in table 12). The b-value indicates the change in log odds.

Predictor	*b*	CI 95%	SE	z	*p*	Odds ratio
Intercept	-2.358	[-5.216; 0.502]	1.459	-1.62	.106	0.095
Interrogation pressure	-0.582	[-0.582; -0.053]	0.135	-2.35	.019	0.728
Prosecution strength	1.918	[1.392; 2.444]	0.268	7.14	<.001	6.805
Defense strength	-1.351	[-1.770; -0.932]	0.214	-6.32	<.001	0.259