Ask Dom:

About NAs - done

About stepwise regression from sleep article

Need to change data and/or descriptions in methods to match the coding of the data set. For instance need to change coding for stress so it indicates 0 for no incidence of the stressor and 1 if it occurs. -done

Also, most measures used 1 for never so need to adjust the totals on the measures or re code so 1 is 0 etc.

Also, Sleep Hygiene has 1 for always and 5 for never.

Results:

The demographic characteristics of the subjects are presented in Table 1, including means and standard error. Report means of demographic variables on AE as I computed early on in my analyses?

*Demographic Variables of Participants*

Demographic variables for the participants are summarized in Table 1. Out of 203 participants there were 199 complete data sets used for analyses. Counter to methods outlined in the original questionnaire research, the Sleep Hygiene (SH) variable was collected with low scores indicating poorer hygiene practices in order to improve interpretability. Additionally, coding found on the stress factor (1=occurrence of the stressor and 2=NO occurrence of the stressor) was corrected post hoc so that the total stress amount reflected the total number of stressors (changed so that 0=NO occurrence of the stressor).

Using Bonferroni method to account for multiple tests, and subsequent alpha inflation, set p=.01 or lower would be equivalent to p=.05 with the five iterations of dependent variable (Y).

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| Table 1  *Demographic Characteristics of the Sample.* | |
| Variable | N |
| Participants | 203 |
| Gender |  |
| Female | 159 |
| Male | 44 |
| Age |  |
| 18-19 | 88 |
| 20-21 | 88 |
| 22-25 | 25 |
| 26-30 | 0 |
| 30+ | 2 |
| Ethnicity |  |
| Asian | 10 |
| Black | 40 |
| Hispanic | 23 |
| White (Non-Hispanic) | 121 |
| Biracial/Mixed | 9 |
| Class Standing |  |
| Freshman | 50 |
| Sophomore | 51 |
| Junior | 56 |
| Senior | 44 |
| N/A | 2 |
| *Note.* | |

Do table of demographic means as compared to AE factors. Table 2

|  |  |  |  |  |  |  |  |  |  |
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| Table 2  *Pearson product-moment correlations.* | | | | | | | | |  |
|  | AE | Skills | Emot | Part/int | Perf | Stress | SH | Exercise |
| Total Academic Engagement (AE) | -- |  |  |  |  | .055 | .254\*\* | .089 |
| Skills |  | -- |  |  |  | .242\*\* | .349\*\*\* | .072 |
| Emotional |  |  | -- |  |  | -.066 | .048 | .180! |
| Participation/interaction |  |  |  | -- |  | -.122 | .097 | .041 |
| Performance |  |  |  |  | -- | .112 | .212\* | -.113 |
| Stress | -.026 | -.205\* | .109 | .150! | -.109 | -- | -.306\*\*\* | .113 |
| Sleep Hygiene (SH) | .254\*\* | .349\*\*\* | .048 | .097 | .212\* | .327\*\*\* | -- | -.055 |
| Exercise | .089 | .072 | .180! | .041 | -.113 | -.054 | -.055 | -- |
| Mean | 45.92 | 17.30 | 9.99 | 10.54 | 8.19 | 43.04 | 41.33 | 46.86 |
| *SD* | 7.14 | 2.99 | 2.51 | 2.86 | 1.42 | 11.53 | 6.09 | 14.83 |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; ! should I report p<.05? – no do Bonferroni adjustment and only use .01 and below; red numbers are the correct ones after correcting the stress data | | | | | | | | |  |

*Correlations of Independent and Dependent Variables*

The correlations of all main effects with Academic Engagement (AE)/factors can be found in Table 2. For total AE, sleep hygiene is the only significantly correlated independent variable (p<.001). When looking at the individual factors of AE, results show a significant, negative relationship of stress with the skills engagement factor (p<.01), and a highly significant positive association between sleep hygiene and skills AE (p<.0001). Sleep hygiene was also positively correlated with the performance AE factor (p<.01). No significant correlations were found for either the emotional factor or the participation/interaction factor when compared against the independent variables.

The independent variables of stress and sleep hygiene showed a highly significant intercorrelation (p<.0001). No correlations were found between exercise and any of the included variables.

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|  | Table 3  *Mediation analyses for effect of sleep as mediator in relationship between stress and AE/factors.* | | | | | |
|  | | β1 | | p-value | β2 | p-value |
| Step 1: Model Y = β0 + β1 Stress + ε | |  | |  |  |  |
| Total Academic Engagement (Y) | | -.006 | | .887 |  |  |
| Skills (Y) | | -.053 | | .003\* |  |  |
| Emotional (Y) | | | .024 | .122 |  |  |
| Participation/interaction (Y) | | | .037 | .033 |  |  |
| Performance (Y) | | | -.013 | .123 |  |  |
| Step 2: Model Sleep = β0 + β1 Stress + ε | | | -.580 | .000009\*\*\* |  |  |
| Step 3: Model Y = β0 + β1 Stress + β2 Sleep + ε | | |  |  |  |  |
| Total Academic Engagement (Y) | | | .045 | .299 | .312 | .000157\*\* |
| Skills (Y) | | | **-.028** | .120 | .155 | .000009\*\*\* |
| Emotional (Y) | | | .030 | .064 | .038 | .210 |
| Participation/interaction (Y) | | | .049 | .007\* | .073 | .032 |
| Performance (Y) | | | **-.006** | .505 | .046 | .007\* |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; ! should I report p<.05? – no do Bonferroni adjustment and only use .01 and below | | | | |

*Mediation Analyses of Sleep Hygiene*

To determine if sleep hygiene has a mediating effect on the relationship between stress and AE, a mediational approach as outlined by Baron & Kenny (1986 – cite in references) was utilized. Using a linear model, the dependent variable (AE/factors) was first regressed on stress (independent variable) to determine if the effect was significant. A significant p-value (.003) was found on the estimate for skills engagement only (see Table 3). In a second step, sleep hygiene was regressed on stress and a significant, negative effect was found (β=-0.580, p-value = 0.000009).

In the third and final step, a linear model was utilized regressing AE on both stress and sleep hygiene. Sleep hygiene showed an independent effect on the outcome variable for total AE (β=0.312, p-value = 0.000157), skills engagement (β=-0.155, p-value = 0.000009), and performance engagement (β=-0.046, p-value = 0.007). The effect of stress on the dependent variable was reduced due to the addition of sleep hygiene for both the skills engagement factor (from β= -0.053 to β= -0.028) and performance engagement factor (from β= -0.013 to β= -0.006). Since an independent effect of stress on the dependent variable was only seen for the skills factor and not for the performance factor, it appears that a potential mediating effect of sleep hygiene is only occurring for the skills factor and not the other factors or total AE. The addition of sleep hygiene in the model resulted in what is referred to as the indirect effect via the mediator (βdifference for stress = -0.025).

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| Table 4  *Moderational analyses for effect of exercise as moderator in relationship between stress and AE/factors.* | | | | | | | |  |
|  | β1 | | p-value | β2 | p-value | β3 | p-value | |
| Model Y = β0 + β1 Stress + β2 Exercise + β3 Stress\*Exercise + ε | |  |  |  |  |  |  | |
| Total Academic Engagement (Y) | | .226 | .070 | .285 | .020 | -.006 | .042 | |
| Skills (Y) | | -.034 | .520 | .042 | .426 | -.0005 | .666 | |
| Emotional (Y) | | .094 | .037 | .105 | .018 | -.002 | .077 | |
| Participation/interaction (Y) | | .171 | .0008\*\* | .141 | .005\* | -.003 | .005\* | |
| Performance (Y) | | -.019 | .477 | -.020 | .448 | .0002 | .733 | |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; ! should I report p<.05? – no do Bonferroni adjustment and only use .01 and below | | | | | | |

*Moderation Analyses of Exercise*

To evaluate exercise as a moderator of the relationship between stress and AE/factors, a moderation model was employed. The individual and interaction estimates are outlined in Table 4. Significance for the influence of exercise and the interaction of stress and exercise was only seen in the model for participation/interaction engagement. In that model, participation/interaction was high when one or the other independent variables was high. The significant, albeit small, interaction effect between stress and exercise lowered performance in participation/interaction when both levels were high or low, instead of resulting in the expected additive effect of the two variables on participation/interaction. The interaction is showing a negative relationship on part/int, depressing part/int when both variables are either high or low together. No other influences of exercise were seen.

(When exercise or stress is high, so is participation/interaction; however, although you would expect an additive effect of the two to make participation/interaction even higher, the interaction of stress and exercise result in elevations in both resulting in lower part/int overall.)

When stress and exercise both go up participation goes down, but also when stress is low and exercise is low participation is also low. When stress is high (with exer low) it is showing high participation and when exercise is high (with stress low) it is showing high participation too.

Table 5

*Random Forest Variable Analyses with Variables Bolded for Importance*

|  |  | **Academic Eng** | | **Skills** | | **Emotional** | | **Participation** | | **Performance** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Importance Meas.** | **Mean** | **Stdev** | **Mean** | **Stdev** | **Mean** | **Stdev** | **Mean** | **Stdev** | **Mean** | **Stdev** |
| Age | % Increase MSE | 0.50 | 0.32 | 0.21 | 0.06 | 0.18 | 0.05 | 0.28 | 0.05 | 0.06 | 0.02 |
| Increase in RSS | 440.05 | 11.39 | 93.02 | 2.37 | 60.65 | 1.71 | 77.96 | 1.94 | 18.81 | 0.52 |
| Class | % Increase MSE | 2.71 | 0.41 | 0.50 | 0.07 | 0.35 | 0.05 | 0.46 | 0.07 | 0.09 | 0.02 |
| Increase in RSS | 760.20 | 14.79 | **142.97** | 2.82 | 93.96 | 2.02 | 117.82 | 2.57 | 30.56 | 0.71 |
| Ethnicity | % Increase MSE | 2.74 | 0.35 | 0.01 | 0.05 | 0.14 | 0.05 | 0.95 | 0.08 | 0.17 | 0.02 |
| Increase in RSS | **848.42** | 17.09 | 107.30 | 2.23 | **109.85** | 2.34 | **175.45** | 3.07 | **35.23** | 0.83 |
| Gender | % Increase MSE | 0.42 | 0.23 | 0.12 | 0.04 | 0.09 | 0.03 | 0.09 | 0.04 | 0.05 | 0.01 |
| Increase in RSS | 242.83 | 8.28 | 49.48 | 1.62 | 33.97 | 1.30 | 43.93 | 1.68 | 10.63 | 0.39 |
| Exercise | % Increase MSE | 1.90 | 0.45 | 0.26 | 0.07 | 0.60 | 0.07 | 0.88 | 0.08 | 0.19 | 0.02 |
| Increase in RSS | **1523.62** | 23.61 | **259.60** | 4.47 | **212.60** | 3.31 | **282.73** | 4.57 | **71.99** | 1.25 |
| Sleep | % Increase MSE | 7.54 | 0.52 | 1.80 | 0.09 | 0.53 | 0.06 | 0.75 | 0.07 | 0.28 | 0.02 |
| Increase in RSS | **1927.24** | 27.16 | **407.73** | 5.93 | **236.59** | 3.60 | **268.94** | 4.21 | **73.51** | 1.18 |
| Stress | % Increase MSE | 2.29 | 0.43 | 1.43 | 0.09 | 0.48 | 0.07 | 0.71 | 0.07 | 0.23 | 0.02 |
| Increase in RSS | **1810.64** | 27.19 | **415.79** | 6.53 | **237.85** | 3.50 | **333.96** | 4.66 | **76.26** | 1.28 |

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|  | Table 6  *Final predictive models for each dependent variable (AE/factors).* | | | | | |
|  | | β1 | | p-value | β2 | p-value |
| Total Academic Engagement (AE) | |  | |  |  |  |
| Model: AE = β0 + β1 Sleep Hygiene + ε | | 0.286 | | 0.0002 |  |  |
| Skills Engagement (Skills) | |  | |  |  |  |
| Model: Skills = β0 + β1 Stress + β2 Sleep + ε | | | -0.028 | 0.120 | 0.155 | 0.000009 |
| Emotional Engagement (Emot) | | |  |  |  |  |
| Model: Emot = β0 + β1 Stress + ε | | | -0.024 | 0.122 |  |  |
| Participation/interaction Engagement (Part) | | |  |  |  |  |
| Model: Part = β0 + β1 Stress + ε | | | -0.037 | 0.033 |  |  |
| Performance Engagement (Perf) | | |  |  |  |  |
| Model: Skills = β0 + β1 Stress + β2 Sleep + ε | | | -0.006 | 0.505 | 0.045 | 0.007 |
|  | | |  |  |  |  |
| *Note.* \*p<.01; \*\*p<.001; \*\*\*p<.0001; ! should I report p<.05? – no do Bonferroni adjustment and only use .01 and below | | | | |

*Confirmatory Factor Analysis for Academic Engagement measure SCEQ:*

A Confirmatory Factor Analysis (CFA) was completed to test the factor loadings as outlined in findings by Handelsman and colleagues (2005) in their development of the Student Course Engagement Questionnaire (SCEQ). They found evidence for the initial validation of the measure and a breakdown into four factors: skills engagement, emotional engagement, participation/interaction engagement, and performance engagement. Results of the CFA employed here show that the user model versus the baseline model have a Comparative Fit Index (CFI) = 0.826, a Tucker-Lewis Index (TLI) = 0.804, a Root Mean Square Error of Approximation = 0.090 (90% Confidence Interval 0.081-0.098), and a Standardized Root Mean Square Residual (SRMR) = 0.088, which demonstrate limited fit. The factor loadings from the original research and the current study are outlined in Table 7.

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| TABLE 7. |  |  |  | | |  | |  | | |  | |  | |  | | |
| Confirmatory Factor Analysis of Factor Structure of Student Course Engagement Questionnaire | | | | | | | | | | | | | | | | | |
|  | Factor 1  (Skills) | | | Factor 2  (Emotional) | | | | Factor 3  (Part/int) | | | | | Factor 4  (Performance) | | | | |
| Items | *Orig* | *New* | | *Ori* | | *New* | | *Orig* | *New* | | | | *Orig* | | *New* | | |
| Making sure to study on a regular basis | .64 | .63 | |  | |  | |  |  | | | |  | |  | | |
| Putting forth effort | .59 | .54 | |  | |  | |  |  | | | |  | |  | | |
| Doing all homework problems | .57 | .61 | |  | |  | |  |  | | | |  | |  | | |
| Staying up on the readings | .55 | .55 | |  | |  | |  |  | | | |  | |  | | |
| Looking over class notes between classes to  make sure I understand the material | .53 | .51 | |  | |  | |  |  | | | |  | |  | | |
| Being organized | .53 | .58 | |  | |  | |  |  | | | |  | |  | | |
| Taking good notes in class | .53 | .66 | |  | |  | |  |  | | | |  | |  | | |
| Listening carefully in class | .51 | .55 | |  | |  | |  |  | | | |  | |  | | |
| Coming to class every day | .47 | .53 | |  | |  | |  |  | | | |  | |  | | |
| Finding ways to make the course material  relevant to my life |  |  | | .86 | | .87 | |  |  | | | |  | |  | | |
| Applying course material to my life |  |  | | .86 | | .81 | |  |  | | | |  | |  | | |
| Finding ways to make the course interesting  to me |  |  | | .54 | | .73 | |  |  | | | |  | |  | | |
| Thinking about the course between class  meetings |  |  | | .46 | | .65 | |  |  | | | |  | |  | | |
| Really desiring to learn the material |  |  | | .43 | | .52 | |  |  | | | |  | |  | | |
| Raising my hand in class |  |  | |  | |  | | .82 | .97 | | | |  | |  | | |
| Asking questions when I don’t understand  the instructor |  |  | |  | |  | | .64 | 1.02 | | | |  | |  | | |
| Having fun in class |  |  | |  | |  | | .57 | .50 | | | |  | |  | | |
| Participating actively in small-group  discussions |  |  | |  | |  | | .55 | .77 | | | |  | |  | | |
| Going to the professor’s office hours to  review assignments or tests or to ask questions |  |  | |  | |  | | .50 | .60 | | | |  | |  | | |
| Helping fellow students |  |  | |  | |  | | .45 | .41 | | | |  | |  | | |
| Getting good grades |  |  | |  | |  | |  |  | | | | .77 | | .62 | | |
| Doing well on the tests |  |  | |  | |  | |  |  | | | | .68 | | .69 | | |
| Being confident that I can learn and do well  in the class |  |  | |  | |  | |  |  | | | | .64 | | .66 | | |
|  |  |  | |  | |  | |  |  | | | |  | |  | | |
| *Note. Orig = original study, New = new data set*  All factor loadings are significant, *p*< .01. (check this) | | | | | | | | | | | | | | | | | |
|  |  |  | |  |  | |  |  | |  | |  | |  | |  |  | |  |  |  |

*Predictive Model using Random Forest Analyses and Nested Model Comparisons*

In order to determine the variables that would explain the most variance in AE and the factors of AE, a Random Forest approach was utilized. Results of the Random Forest analysis can be found in Table 5, including variable importance measures for all potential predictor variables. Variable importance was measured by the average increase in residual sum of squares (RSS) across all regression trees when each variable was omitted. Generally, when looking at the RSS measure, the demographic variables showed the least importance, with ethnicity and class variably showing the most among demographic variables. The variables used in a final multiple regression model to predict AE were subsequently determined through a nested model, forward selection process with variables added in order of importance as determined through the random forest analysis. Nested model likelihood ratios were utilized to determine whether added variables improved the predictive ability of the model. If the addition of a variable resulted in a non-significant likelihood-ratio test, that variable and all subsequent variables were left out of the final model. For total AE the best fit model included only sleep hygiene (β=0.286, p-value=0.0002) since the addition of the variable deemed of secondary importance in the Random Forest analysis (stress) did not add to the explained variance when comparing the nested model through an ANOVA likelihood ratio (p-value=0.299).

Notably, the model for skills included both stress (β=-0.053, p-value=0.003) and sleep hygiene (likelihood-ratio p-value = 0.000009) before showing no added explanation of variance with the addition of exercise (likelihood-ratio p-value = 0.113). In the final model the estimate for stress changed from β=-0.053 to β=-0.028 and lost significance, while the estimate for sleep hygiene was significant at β=0.155, p-value = 0.000009. This effect is likely a result of the relationship between the independent variables of stress and sleep hygiene as outlined in the mediation analysis described above.

For the emotional and participation/interaction factors of AE there was only one variable fit to the final model, with stress (β=-0.024, p-value=0.122) for emotional engagement and also stress (β=-0.037, p-value=0.033) for participation/interaction engagement. Adding sleep hygiene in the emotional model and exercise in the participation/interaction model did not significantly improve fit (explanation of variance).

The performance factor of AE was similar in model specification as found in that of skills engagement. The inclusion of both stress (β=-0.013, p-value=0.123) in the initial model and sleep (β=0.045, p-value=0.007) in the combined model improved the explanation of variance (likelihood-ratio p-value = 0.007), but the model was not improved by the addition of exercise (likelihood-ratio p-value = 0.156). Notably, the stress variable was not significant in either the stand-alone model (β=-0.013, p-value=0.123) or the final, combined model (β=-0.006, p-value=0.505), while the estimate for sleep was significant when added. Table 6 includes all final predictive models with estimates for the variance explained by each included independent variable.

In order to determine the variables that would explain the most variance in AE, a Random Forest approach was utilized. Results of the Random Forest analysis can be found in Table 6, including variable importance measures for all potential predictor variables. Generally, the demographic variables showed minimal explanation of variance, with age showing the largest, yet still an insignificant beta weight. Consequently, the variables used in a final multiple regression model to predict AE are stress, sleep hygiene, and exercise. The variables included in the final model were stress, sleep hygiene, and exercise, and …..

Likelihood ratio testing of nested models, forward selection,