**Multilevel Structural Equation Modeling Mediation & Moderation**

**1-1-1 Mediation w/MCCIs**

**Analysis Plan**

A multilevel structural equation model (MSEM) was run to test the following study hypotheses:

H1: Daily skill level will predict daily performance.

H2: Daily effort level will mediate the relationship between daily skill level and daily performance rating.

In order to test these hypotheses, we used a 1-1-1 mediation multilevel SEM (Preacher, Zyphur, Zhang, 2010) because the predictor, mediator, and outcome variables are all measured on the daily level.

All study variables were treated as continuous and normally distributed. While all variables were assessed on the within-level and have both within and between components, our hypotheses are focused on the within-level results. A path model is presented in Figure 1.

Analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998–2012). The model was run as a random effects model (i.e., intercepts and slopes were free to vary across participants). This approach models individual level variability in the intercepts and slopes.

Hypothesis 1 was tested by examining the random slope of the within-subjects effect of daily skill level predicting daily performance level.

Hypothesis 2 was tested using Monte Carlo Confidence Intervals of the within-subjects indirect effect from daily skill level to daily effort to daily performance level. The primary challenge in making appropriate determinations regarding the strength of an indirect effect is that the product of two regression slopes is not normally distributed. The violation of the normality assumption results in a loss of statistical power for many traditional approaches to testing mediation (e.g., the Sobel Test). In order, to circumvent this issue the best practices approach is to assess asymmetrical confidence intervals (ACIs) that best represent the true distribution of the product of coefficients. ACIs that do not contain zero are considered to be statistically significant. Resampling techniques including Monte Carlo confidence intervals (MCCIs) provide a robust test of the product of coefficients, are computationally efficient, and amenable to a variety of variable characteristics (e.g., hierarchical/nested data; Preacher & Selig, 2012).

**Results**

*Within-level effect of skill on performance.* The random slope of daily skill level predicting daily performance level was positive and statistically significant (Sskill-performance = .33, SE = .06, p < .001). This suggests that on a given day the higher a participant’s skill level the higher their performance. Specifically, a unit increase in skill level was associated with a .33 unit increase in performance.

*Effort as a within-subjects mediator of the skill-performance relationship.* There was a significant indirect effect from daily skill level to daily performance level via daily effort ratings (Indirect effect = .20; MCCI [.14, .26]. This suggests that skill is transmitted to performance based on daily level effort.

**Discussion**

The present study examined daily level effects of skill and effort on performance. Results revealed that on the daily level skill level predicted performance, and that this relationship was mediated by effort. Practical implications for this research are that regardless of a person’s skill level, it is the effort put forth that translates into higher levels of performance.

**2-1-2 Mediation with Bayesian Credible Intervals**

**Analysis Plan**

A multilevel structural equation model (MSEM) was run to test the following study hypotheses:

H1: Baseline skill level will predict follow-up performance ratings.

H2: Daily effort level will mediate the relationship between baseline skill level and follow-up performance ratings.

In order to test these hypotheses, we used a 2-1-2 mediation multilevel SEM (Preacher, Zyphur, Zhang, 2010) because the predictor and outcome variables were measured on the between level (i.e., at one time) and effort was measured on the daily level.

All study variables were treated as continuous and normally distributed. A path model is presented in Figure 1.

Analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998–2012). The model was run as a random effects model with Bayesian Estimation. This approach allows paths that include daily effort to have random intercepts, and allows for the creation of Bayesian Credible Intervals for assessing indirect effects.

Hypothesis 1 was tested by examining the slope of the between-subjects effect of baseline skill level predicting follow-up performance level.

Hypothesis 2 was tested using Bayesian Credible Intervals of the indirect effect from baseline skill level to daily effort to follow-up performance level. The primary challenge in making appropriate determinations regarding the strength of an indirect effect is that the product of two regression slopes is not normally distributed. The violation of the normality assumption results in a loss of statistical power for many traditional approaches to testing mediation (e.g., the Sobel Test). In order, to circumvent this issue the best practices approach is to assess asymmetrical confidence intervals (ACIs) that best represent the true distribution of the product of coefficients. ACIs that do not contain zero are considered to be statistically significant. Bayesian Credible Intervals provide a robust test of the product of coefficients, are computationally efficient, and amenable to a variety of variable characteristics (e.g., hierarchical/nested data; Gelman et al., 2004; Asparouhov & Muthen, 2003). Bayesian estimation typically involves the inclusion of model priors. By default, if no priors are added to the model, diffuse priors are used, which reduces the estimation to maximum likelihood. However, the repeated sampling procedure utilized in Bayesian estimation allows for ACIs to be derived from the sample data.

*Overall Model Fit.* Bayesian estimation utilizes posterior predictive p-values (PPP) as an index of overall model fit. The PPP value is defined as the proportion of chi-square values obtained in the simulated data that exceed that of the actual data. Values around .50 indicate a well fitting model.

**Results**

*Overall Model Fit.* The PPP value for the 2-1-2 multilevel mediation SEM was .52, which indicates it is a well fitting model.

*Between-level effect of skill on performance.* Baseline skill level did not predict follow-up performance (b = -.32, posterior SD = .29, Bayesian CI = [-1.18, .02]. This suggests that an individual’s initial skill level is not a strong predictor of follow-up performance.

*Effort as a within-subjects mediator of the skill-performance relationship.* There was a significant indirect from baseline skill level to follow-up performance level via daily effort ratings (Indirect effect = 1.15; Bayesian CI [.81, 2.02]. This suggests that skill is transmitted to performance based on daily level effort.

**Discussion**

The present study examined between subjects effects of skill and within-level effort on follow-up performance. Results revealed that the baseline skill level did not predict follow-up performance. However, this relationship was mediated by daily level effort. Practical implications for this research are that regardless of a person’s skill level at baseline, it is the effort put forth that translates into higher levels of performance at follow-up.

**2 X (1-1) Moderation with RCP method**

A multilevel structural equation model (MSEM) was run to test the following study hypotheses:

H1: Daily level pregaming will predict daily number of alcohol related consequences (ARC).

H2: Having a history of trauma will moderate the pregaming-ARC relationship, such that those with a history of trauma will have a steeper slope between pregaming and ARC.

In order to test these hypotheses, we used a 2 X (1-1) moderation multilevel SEM (Preacher, Zyphur, Zhang, 2010) because the predictor and outcome variables are measured on the daily level, and the moderator is measured once at baseline.

ARC was treated as continuous and normally distributed. Pregaming was coded 0 = non-pregaming day, 1 = pregaming day. Trauma history was coded 0 = trauma history, 1 = no trauma history. A path model is presented in Figure 1.

Analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998–2012). The model was run as a random effects model (i.e., intercepts and slopes were free to vary across participants). This approach models individual level variability in the intercepts and slopes.

Hypothesis 1 was tested by examining the random slope of the within-subjects effect of daily pregaming predicting daily ARC.

Hypothesis 2 was tested using the Random Coefficient Prediction (RCP) Method (Preacher, Zhang, Zyphur, 2016). The RCP method involves creating a random slope, which is predicted by the moderating variable. It is particularly useful for modeling cross-level interactions.

**Results**

*Within-level effect of pregaming on ARC.* The random slope of daily pregaming predicting daily ARC was positive and statistically significant (Spregaming-ARC = 2.436, SE = .15, p < .001). This suggests that on pregaming days participants reported 2.436 more ARC compared to non-pregaming days.

*Trauma as moderator of the pregaming-ARC relationship.* There was a significant effect of trauma history predicting the random slope of pregaming to ARC (b = -.522; SE = .23, p = .023). This suggests that those with a trauma history have a steeper slope of the pregaming – ARC relationship compared to those without a trauma history.

**Discussion**

The present study examined the relationship between pregaming and ARC, and the moderating effect of having a history of trauma. Results revealed that on the daily level pregaming predicted ARC. Further, this relationship was moderated by having a history of trauma. Practical implications for this research are that pregaming portends risk for ARC, and those with a trauma history are at particular risk for experiencing ARC on pregaming days.

**1 X (1-1) Moderation with LMS method**

A multilevel structural equation model (MSEM) was run to test the following study hypotheses:

H1: Daily level pregaming will predict daily number of alcohol related consequences (ARC).

H2: Daily levels of conscientiousness will moderate the pregaming-ARC relationship.

In order to test these hypotheses, we used a 1 X (1-1) moderation multilevel SEM (Preacher, Zyphur, Zhang, 2010) because all variables were measured on the daily level.

ARC and conscientiousness were treated as continuous and normally distributed. Pregaming was coded 0 = non-pregaming day, 1 = pregaming day. A path model is presented in Figure 1.

ARC and conscientiousness were manually disaggregated into within and between variances by creating cluster-mean centered variables and limiting their variance to the between-level only. This allows for modeling of association among traits of individuals who have higher or lower conscientiousness and more or less ARC relative to others in the study. In addition, the remaining variance was specified as within-level only, which allows for assessment of within-persons effects on the daily level. Single-indicator latent variables were created for pregaming, conscientiousness, and ARC specifying .1 residual variance, which is equivalent to an acceptable and moderate level of reliability in each variable. The within-level single indicator latent variables were used to create a latent interaction term between pregaming and conscientiousness. The pregaming, conscientiousness, and interaction latent variables were specified as predictors of the within-level ARC latent variable.

Analyses were conducted using Mplus 7.4 (Muthén & Muthén, 1998–2012). The model was run as a random effects model (i.e., intercepts and slopes were free to vary across participants). This approach models individual level variability in the intercepts and slopes.

Hypothesis 1 was tested by examining the fixed slope of the within-subjects effect of daily pregaming predicting daily ARC.

Hypothesis 2 was tested using the Latent Moderated Structural Equation (LMS) Method (Preacher, Zhang, Zyphur, 2016). The LMS method involves computing a product term involving at least one random between part of a level-1 variable as a latent predictor. LMS requires latent interactions among random coefficients by directly representing latent interactions as part of the structural model. LMS is appropriate for cross- and same-level interactions.

**Results**

*Within-level effects of pregaming and conscientiousness on ARC.* There were significant main effects of pregaming and conscientiousness predicting ARC on the within-level (pregaming-ARC: b = 1.27, SE = .08, p < .001; conscientiousness-ARC: b = -.15, SE = .03, p < .01), such that pregaming was associated with more ARC, and higher levels of conscientiousness were associated with less ARC. Further, the interaction of pregaming and conscientiousness was a significant predictor of ARC (pregamingXconscientiousness-ARC: b = -3.14, SE = .22, p < .001) indicating that conscientiousness buffers the effects of pregaming on ARC.

*Between level conscientiousness on ARC.* There was a significant between level effect of conscientiousness predicting ARC (b = -.06, SE = .02, p = .003), such that those with a trait for higher conscientiousness reported less ARC on average. This suggests that conscientiousness is a protective factor against ARC, regardless of pregaming.

**Discussion**

The present study examined the relationship between pregaming and ARC, and the moderating effect of conscientiousness. Results revealed that on the daily level pregaming portends risk for ARC. Further, this relationship was moderated by conscientiousness, such that conscientiousness protects against ARC. Moreover, on the between-level conscientiousness was negatively related to ARC, suggesting that having a trait for conscientiousness is a protective factor against ARC, controlling for pregaming. Practical implications for this research are that pregaming portends risk for ARC, and those with high levels of conscientiousness may be protected against the risk for experiencing ARC on pregaming days.