Kinds of Research Questions for MLM

(Tabachnick & Fidell, 2013)

Group Differences in Means

This question is answered as part of the first step in routine hierarchical analyses. Is there a significant difference in intercepts (means) for the various groups? For example, is there a significant difference in mean student achievement in the different classrooms? As in ANOVA, this is a question about variability: Is the variance between groups (between-subject variance in ANOVA) greater than would be expected by chance (within-subject variance in ANOVA)? Section 4.1.2 discusses analysis of first-level intercepts. These differences also are evaluated as precursors to MLM through calculation of intraclass correlations (Section 6.1).

Group Differences in Slopes

This question may also be answered as part of routine hierarchical analyses. Is there a significant difference in slopes for the various groups? For example, is there a significant difference in the slope for the relationship between student achievement and student motivation among the different classrooms? Group differences in slope between a predictor and the DV are called a failure of homogeneity of regression in ANCOVA, but in MLM such differences are expected and included in the model. These differences are assessed separately for all first-level predictors if there is more than one. Section 4.2.2 discusses second-level analysis of first-level predictors.

Cross-Level Interactions

Does a variable at one level interact with a variable at another level in its effect on the DV? For

example, does school-level poverty (a third-level variable) interact with student motivation (a first-level variable) to produce differences in student achievement? Or, does teacher level of enthusiasm (a second-level variable) interact with student motivation to produce differences in student achievement? Or, does school-level poverty interact with teacher enthusiasm to produce differences in student achievement? Addition of such cross-level interactions to the multilevel regression equation is discussed in Section 6.3. Cross-level interactions may be especially interesting in the context of experiments where the treated (as opposed to the control) group displays a different relationship between a predictor and the DV. Cohen et al. (2003) discuss an example in which the treatment moderates the relationship between weight loss (the DV) and motivation (a predictor)—treatment gives more highly motivated participants the means for effective dieting.

Meta-Analysis

MLM provides a useful strategy for meta-analyses in which the goal is to compare many studies from the literature that address the same outcome. For example, there may be hundreds of studies evaluating various aspects of student achievement. Original raw data usually are not available, but statistics for numerous studies are available in the form of effect sizes, *p* values, and often means and standard deviations. A common outcome measure is derived for the various studies, often a standardized effect size for the outcome measure (student achievement). When these problems are addressed through MLM, individual studies provide the lowest level of analysis. A simple analysis (Section 4.1) determines whether there are significant differences among studies in effect size. IVs (such as student motivation, teacher enthusiasm, or school poverty level) are then investigated to try to determine whether differences in the various studies are predicted by those IVs (cf. Hox, 2002, Chapter 6).

Relative Strength of Predictors at Various Levels

What is the relative size of the effect for individual-level variables versus group-level variables? Or, are interventions better aimed at the individual level or the group level? For example, if there is to be an intervention, should it be directed at the motivation of individual students or the enthusiasm levels of teachers? Analytic techniques are available through SEM to evaluate the relative strengths of individual versus group effects. Hox (2002), as well as Heck and Thomas (2000), demonstrates such multilevel factor and path analyses.

Individual and Group Structure

Is the factor structure of a model the same at the individual and group level? Do individual students and teachers have the same pattern of responses to a questionnaire? That is, do the same items regarding homework, extra curricular activities, and the like load on the same factors at the individual and group levels? These and similar questions can be answered through application of SEM techniques to analysis of covariance structures (variance–covariance matrices) aimed at data at the individual level and the group level. Section 5.3 discusses these models.

Effect Size

How much of the total variance in behavior is associated with predictors? How much better can we predict student motivation with the knowledge of their motivation, their teacher's enthusiasm, and the level of poverty of their schools? Section 6.6 discusses these issues, which are much less straightforward than are found with other techniques.

Path Analysis at Individual and Group Levels

What is the path model for prediction of the DV from level-1, level-2, and level-3 variables? For example, what is the path model for predicting student achievement from student-level variables (e.g., student motivation, study time, and gender), teacher/classroom-level variables (teacher enthusiasm and teacher emphasis on homework), and school-level variables (poverty level, type of school,

and school size)? Hox (2002) provides an example of this type of analysis in an educational setting. All of the power of path analysis and, indeed, latent factor analysis can be tapped by the application of SEM techniques to multilevel data.

Analysis of Longitudinal Data

What is the pattern of change over time on a measure? Do students show a linear trend of improvement over the school year or do improvements level off after a while? Do individuals differ in their trend of improvement (growth curves) over time? There are two MLM techniques that address this type of question without the restrictive assumptions of repeated-measures ANOVA: (1) direct application of MLM with occasions as the lowest level of analysis, and (2) latent growth modeling using the techniques of SEM. Section 5.1 demonstrates the first application and discusses the second. Section 7 provides a complete example of a three-level repeated-measures model through MLM techniques.

Multilevel Logistic Regression

What is the probability of a binary outcome when individuals are nested within several levels of a hierarchy? For example, what is the probability that a student will be retained when students are nested within classrooms and classrooms are nested within schools? Nonnormal, including binary,

outcomes are discussed in Section 5.4.

Multiple Response Analysis

What are the effects of variables at different levels on multiple DVs at the individual level? For example, what are the effects of predictors at the student level, the teacher/classroom level, and the school level on several different types of student achievements (achievement in reading, achievement in math, achievement in problem solving, and so on—the DVs)? In these analyses, the multivariate DVs are presented as the lowest level of analysis. Section 5.5 discusses the multivariate form of MLM.

Reference:

Tabachnick, B. G., & Fidell, L. S. (2013). *Using Multivariate Statistics*. Pearson Education. https://books.google.com/books?id=ucj1ygAACAAJ