Summary of Activities and Accomplishments

Applications of Generalizability Theory for Objectively Scored Ordinal Measures

IMRF Project (Fall 2016, Spring 2017, Fall 2017, Spring 2018)

Purpose and Accomplishments

The overriding purpose of this project was to extend applications of generalizability theory (G-theory) to encompass scores that are ordinal rather than equal interval in nature. These applications are made possible via the use of structural equation modeling (SEM) techniques. Our initial step in implementing the project was to collect data from a wide variety of assessment measures using the university's QUALTRICS system. During the 2016-17 academic year, we obtained data from 282 participants who completed assessment measures on two occasions. We then used these data along with data collected during previous semesters to apply G-theory to ordinal measures in a variety of ways. A crucial step in making such applications possible was to develop SEM analogs to G-theory ANOVA models and then adapt the SEM procedures to allow for ordinal-level measurement. We accomplished this by constraining confirmatory factor analysis models in special ways to produce variance components needed to do G-theory analyses. When conventional covariance or correlation matrices are used in these analyses, variance components are obtained for equal-interval measures. When polychoric correlation matrices are substituted for conventional covariance or correlation matrices, variance components can be obtained for ordinal measures.

We used variance components from these and extended models primarily to quantify individual sources of measurement error for objectively and subjectively scored measures, derive comprehensive consistency indices for both norm- and criterion-referenced interpretations of scores, and estimate reliability for changes made to a measurement procedure. We also compared results when treating scores as ordinal versus equal interval in nature.

Key findings we obtained during the first year of the project were that measurement error was reduced, and reliability increased when properly treating data as ordinal in nature. We also found that number of scale points had powerful effects on differences in results using raw scores

with differences but not when referencing results to the continuous latent response variable metric.

During the second year of the project (fall 2017 and spring 2018), we collected data from an additional 275 respondents who again completed a wide variety of measures on two occasions. We also combined data collected from previous semesters for some analyses we reported in journal articles and conference papers. The primary new topics we addressed during the second year of the IMRF project were (a) to extend our G-theory based analyses to congeneric SEM models, and (b) to compare conventional, G-theory, and SEM techniques for disattenuating correlation coefficients for measurement error.

We are very pleased with what we accomplished during the project. Listed below are journal articles and professional conference papers relevant to the tasks we completed. Included in these materials are 100 pages of instructional material to enable readers to apply our new techniques to their own data using SPSS, SAS, R, and M*plus*.

Refereed Journal Articles

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2019). Using G-theory with continuous latent response variables. *Psychological Methods, 24(2),* 153-178. doi.org/10.1037/met0000177 (5-year impact factor = 10.32) [Epub in 2018]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2019). Instructional online supplement to Using G-theory with continuous latent response variables. *Psychological Methods, 1-35.* doi.org/10.1037/met0000177supp (5-year impact factor = 10.32) [Epub in 2018]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Applications of generalizability theory and their relations to classical test theory and structural equation modeling. *Psychological Methods, 23*(1), 1-26. doi.org/10.1037/met0000107 (5-year impact factor = 10.32) [Epub in 2017]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Practical applications of generalizability theory for designing, evaluating, and improving psychological assessments. *Journal of Personality Assessment, 100,* 53-67. doi:10.1080/00223891.2017.1296455 (5-year impact factor = 2.59) [Epub in 2017]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Instructional online supplement to Practical applications of generalizability theory for designing, evaluating, and improving psychological assessments. *Journal of Personality Assessment,* 1-17. doi:10.1080/00223891.2017.1296455supp (5-year impact factor = 2.59) [Epub in 2017]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Using G-theory to enhance evidence of reliability and validity for common uses of the Paulhus Deception Scales. *Assessment, 25*, 69-83. doi: 10.1177/1073191116641182 (5-year impact factor = 4.00) [Epub in 2016]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Using generalizability theory to disattenuate correlation coefficients for multiple sources of measurement error. *Multivariate Behavioral Research, 53(4),* 481-501. doi.org/10.1080/00273171.2018.1457938 (5-year impact factor = 6.07) [Epub in 2018]

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2018). Instructional Supplement to Using generalizability theory to disattenuate correlation coefficients for multiple sources of measurement error. *Multivariate Behavioral Research,* 1-22. doi.org/10.1080/00273171.2018.1457938supp (5-year impact factor = 6.07) [Epub in 2018]

Refereed Conference Presentations

Vispoel, W. P., Morris, C. A., Kilinc, M., Zhang, M. Xu, G., Schneider, S., Dilek, I. (2019, August). *Matching G-theory analyses to the numbers of response options available.* Paper to be presented at the Annual Meeting of the American Psychological Association, Chicago: IL.

Morris, C. A., & Vispoel, W. P., (2019, April). *Optimal methods for disattenuating correlation coefficients under realistic measurement conditions.* Paper presented at the Annual Meeting of the National Conference on Measurement in Education (NCME), Toronto, Canada

Vispoel, W. P., Morris, C., & Kilinc, M., (2018, April). *Disattenuating correlation coefficients for multiple sources of measurement error, scale coarseness, and congeneric relationships*. Paper presented at the annual meeting of the American Educational Research Association, New York City: NY.

Vispoel, W. P., Morris, C., & Kilinc, M., (2018, April). *Improving psychometric precision through CFA modeling of transient error and scale coarseness*. Paper presented at the annual meeting of the National Council on Measurement in Education, New York City: NY.

Morris, C. A., Vispoel, W. P., & Kilinc, M. (2018, April). *Scale-point effects on reliability and disattenuated correlation coefficients derived from CFA raw-score and continuous-latent-response-variable models*. Paper presented at the annual meeting of the American Educational Research Association, New York City: NY.

Vispoel, W. P., Morris, C. A., & Kilinc, M. (2017, August). *CFA frameworks for isolating and estimating multiple sources of measurement error.* Poster presented at the annual meeting of the American Psychological Association, Washington, DC.

Morris, C. A., Vispoel, W. P., & Kilinc, M. (2017, April). *A Latent State-Trait Theory approach to deriving reliability coefficients for congeneric measures.* Paper presented at the annual meeting of the National Council on Measurement in Education, San Antonio, TX.

Vispoel, W. P., Morris, C., & Kilinc, M. (2017, April). *Using G-theory with ordinal measures to enhance accuracy of reliability estimation.* Paper presented at the annual meeting of the National Council on Measurement in Education, San Antonio, TX.