GROWTH CURVE ANALYSES FOR COUPLES WITH DISTINGUISHABLE PARTNERS

Growth curve analyses for couples pose special analytic problems when the data are available from both partners and the partners can be distinguished from each other (such as husband and wife or male partner and female partner). In this case, the unit of analysis is the couple rather than the individual (see Raudenbush, Brennan, & Barnett, 1995). (By extension, the family could also be the unit of analysis with husband, wife, son, and daughter being distinguished from each other.) Couple-level growth curve analyses can be conducted either within a hierarchical linear modeling (HLM or multilevel) framework or within a structural equation modeling (SEM) framework (see Newsom, 2002). Because growth curve analyses require longitudinal data, most researchers will need to address issues of missing data or attrition. Fortunately, almost all HLM and SEM software programs are flexible in handling missing data using full information maximum likelihood procedures (Enders & Bandalos, 2001).

Researchers familiar with traditional regression methods know that two assumptions for using this analysis are (a) that the variance of errors (residuals) is constant and (b) that errors are not correlated (see Cohen, Cohen, West, & Aiken, 2003, pp. 119-120). In the couple-level growth curve context, this assumption would mean that the variances of all errors are the same for each assessment, that errors are not correlated within spouses over assessments, and that errors between spouses are not correlated at each assessment. In couple-level growth curve analyses, however, these assumptions may not met because, for each spouse, the variances for errors are likely to be different and errors are likely to be correlated across assessments. Further, between spouses, errors are likely to be correlated at each assessment (see Kurdek, 2003). All software programs include some default for the error covariance matrix, usually one in which error variances are equal and error covariances are 0. **Whatever model is being tested should include a description of the error covariance matrix associated with the model.**

Most growth curve analyses are done in two stages. In the first stage, the goal is to describe the features of the *baseline* growth curves for each spouse within one analysis. This usually involves estimating an intercept and a slope for each spouse. Because the meaning of the intercept depends on how the time variable is coded (see Biesanz, Deeb-Sossa, Papadakis, Bollen, & Curran, 2004; Duncan, Duncan, Strycker, Li, & Alpert, 1999), **reports of growth curve analyses should clearly describe how this coding was performed and what the intercept represents.**

The two most commonly used methods to code the time variable involve either power polynomials or orthogonal polynomials (see Cohen et al. 2003, Chapter 6). If data are available at four annual assessments for each spouse, using power polynomials, time would be coded so that 0 = A*ssessment 1*, 1 = A*ssessment 2*, 2 = *Assessment 3*, and 3 = *Assessment 4* for each spouse. In this instance, the intercept represents the value of the outcome variable at the first assessment (because 0 = first assessment, and in any regression analysis the intercept is the value of the outcome score when each predictor has a value of 0). In contrast, using orthogonal polynomials, time is coded so that -3 = *Assessment 1*, -1 = A*ssessment 2*, 1 = *Assessment 3*, and 3 = A*ssessment 4* for each spouse. In this instance, the intercept will reflect the average value of the outcome variable across all assessments (because 0 is the mean of the coded values). For either coding, the slope will represent the degree of linear change over time.

In more complex models, quadratic or curvilinear terms can be added with either the power polynomial or the orthogonal polynomial method to capture information about accelerated change. Because intercepts and linear change (and, when relevant, accelerated change) are typically regarded as random variables, **reports of growth curve analyses should indicate which parameters of the growth curve were treated as random variables**.

Two sets of statistics are associated with the baseline growth curve model, one for the fixed effects and the other for the random effects. The statistics associated with the fixed effects include whether the effects associated with the intercepts and slopes for each spouse differ from 0. Tests are usually significant for the intercepts because the coefficients associated with the intercepts are almost always larger than 0. The statistics associated with the random effects include reports of the variances associated with the intercepts and the slopes for each spouse, tests of whether these variances differ from 0, reports of the covariances (or correlations) among the intercepts and slopes, and tests of whether these covariances/correlations differ from 0. **Reports of analyses relevant to the baseline growth curve model should include coefficients for the intercepts and the slopes as well as the variances and covariances/correlations associated with the intercepts and the slopes. Tests of significance should be reported for both the slopes (usually, either *t* ratios or *z* values) and the variances and covariances/correlations associated with the intercepts and the slopes (usually, either χ^2 values or *z* values for covariances).**

Effect-sizes for the slopes may also be presented in which the test statistic for the slope (such as *t* or *Z*) is converted to an effect-size *r* (see Rosenthal, 1994). Reports of the fit of the overall model differ depending on whether the model was estimated within an HLM or an SEM framework. In the HLM framework, although the fit of the overall model can be represented by the deviance statistic, this statistic is not meaningful unless nested models are being compared and tested (e.g., whether the model fit improves when a quadratic term is added). If nested models are tested, the difference between the deviance statistics for the nested models is reported and tested as a χ^2 value. In the SEM framework, the fit of the overall model is reported as in any SEM model (e.g., χ^2 value, CFI, RMSEA, SRMR, etc.) and differences between nested models are reported and tested as differences between relevant χ^2 values.

In the second stage, interest shifts from the baseline model to identifying variables that account for variability in the individual parameters of the model (e.g., the intercepts and slopes for each spouse or partner). These variables can be either time invariant (e.g., level of social support at the start of the marriage) or time variant (e.g., rate of linear change in social support over the first four years of marriage). Ordinarily, the effects associated with these variables are treated as fixed rather than random effects. If the model has enough degrees of freedom, these effects could also be treated as random effects. **Reports of analyses relevant to the predictor model should include coefficients for each predictor as well as tests of significance for those coefficients (usually, either *t* ratios or *z* values).** Effect-size *r*s might also be provided.

In the example illustrated here, the baseline growth curve model addresses the nature of change in marital satisfaction for husbands and wives over the first four years of marriage. The predictor model addresses the extent to which levels of social support and distress for each spouse at the start of the marriage account for variability in both the intercept (starting level of satisfaction) and the slope (rate of linear change) in satisfaction for each spouse. Note that the predictor model simultaneously includes estimates of both intraspouse effects and cross-spouse effects (see below). Marital satisfaction was assessed annually over the first four years of marriage for husbands and wives with the Dyadic Satisfaction subscore from Spanier's Dyadic Adjustment Scale (scores ranging from 0 to 50). The number of couples providing data at Year 1, 2, 3, and 4 was 526, 396, 310, and 265, respectively. (It is important to note that reasons for attrition—such as separation or withdrawal from the project—could be included as covariates, but are not here.) Year of assessment was coded so that 0 = *Assessment 1*, 1 = *Assessment 2*, 2 = *Assessment 3,* and 3 = *Assessment 4* for each spouse. With regard to the error covariance structure, because preliminary analyses indicated that the model including correlated errors between spouses at each of the four assessments fit as well as the model in which correlated errors for one year lags for each spouse (i.e., Year 1 - Coefficient 2, Year 2 - Year 3, and Year 3 - Year 4) were added, only errors between spouses at each assessment were retained. As of the time of writing, modeling the error covariance matrix for couple-level growth curve analyses is flexibly handled in the multilevel modules of the LISREL and Mplus software programs (see Kurdek, 2003 for syntax for the multilevel module in LISREL).

Effects derived from the baseline growth model are shown in Table 1. It can be seen that the intercept (initial level) of marital satisfaction for each spouse was at the high end of the scale. The rate of linear change (slope) was negative for each spouse indicating that satisfaction declined over the first year of marriage. Effect-sizes for each slope were medium in size. Most researchers would want to know whether husbands and wives differ in both intercepts and slopes, and most software programs provide options to test such differences. As also shown in Table 1, the variances for the intercept and the slope were significant for each spouse, providing evidence that each is best regarded as a random effect and that the next step of accounting for variability in each effect is warranted. In this somewhat simple growth curve model, the information in Table 1 could be provided in the text of the manuscript.

The correlations among spouses' intercepts and slopes are presented in Table 2. Husbands' and wives' initial levels of marital satisfaction were moderately correlated as were the rates of linear change in marital satisfaction. For both husbands and wives, initial level of marital satisfaction was positively (and modestly) related to both their own rate of linear change as well as that of their spouse.

Effects derived from the predictor model are shown in Table 3. As is common in regression analyses (Cohen et al., 2003), predictors were mean-centered. As one reflection of the interdependent processes occurring in marriage, both intraspouse and cross-spouse links were assessed. Intraspouse links addressed whether *one's own* level of social support or distress at the beginning of the marriage predicted the initial level and rate of change in *one's own* marital satisfaction. Cross-spouse links addressed whether the level of social support or distress reported by *one's spouse* at the beginning of the marriage predicted the initial level and rate of change in *one's own* marital satisfaction. It can be seen that, for both predictors, intraspouse and cross-spouse effects occurred for only the initial level of marital satisfaction for each spouse. For husbands, high levels of social support were associated with high levels of marital satisfaction both for them and for their wives. For wives, high levels of social support were associated with high levels of marital satisfaction both for them and for their husbands. For husbands, high levels of distress were associated with low levels of marital satisfaction both for them and their wives. For wives, high levels of distress were associated with low levels of marital satisfaction both for them and their husbands. Intraspouse effects tended to be medium in size, whereas cross-spouse effects tended to be small in size. Again, most researchers would be interested in testing whether the differences between coefficients for husbands and wives were significant, and most software programs can do so.

References

Biesanz, J. C., Deeb-Sossa, N., Papadakis, A. A., Bollen, K. A., & Curran, P. J. (2004). The role of coding time in estimating and interpreting growth curve models. *Psychological Methods, 9,* 30-52.

Cohen, J., Cohen, P., West, S. G., & Aiken, L. A. (2003). *Applied multiple regression/ correlation analysis for the behavior sciences.* Mahwah, NJ: Erlbaum

Duncan, T. E., Duncan, S. C., Strycker, A. L., Li, F., & Alpert, A. (1999). *An introduction to latent variable growth curve modeling: Concepts, issues, and applications*. New Jersey, Mahwah: Lawrence Erlbaum Associates, Inc.

Enders, C. K., & Bandalos, D. L. (2001). Information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling, 8,* 430-457.

Kurdek, L. A. (2003). Methodological issues in growth-curve analyses with married couples. *Personal Relationships, 10,* 235-266.

Newsom, J. T. (2002). A multilevel structural equation model for dyadic data. *Structural Equation Modeling, 9,* 431-447.

Raudenbush. S. W., Brennan, R. T., & Barnett, R. C. (1995). A multivariate hierarchical model for studying psychological change within married couples. *Journal of Family Psychology, 9,* 161-174.

Rosenthal, R. (1994). Parametric measures of effect size. In H. Cooper & L. V. Hedges (Eds.), *The handbook of research synthesis* (pp. 231-244). New York: Russell Sage Foundation.

Table 1

Unstandardized Coefficients and Variances for Growth Curve Parameters for Husbands and Wives[a] *(*N *= 526 Couples at First Assessment)*

Parameter	Coefficient	Variance
Initial level		
Husbands	41.81**	14.97**
Wives	42.01**	11.44**
Rate of change		
Husbands	-0.94**	0.74*
Wives	-1.16**	1.51**

* *p* < .05, ***p* < .01.

[a] This information is provided in a table for didactic purposes only. Ordinarily, the information in this table could be reported efficiently in the text of the manuscript.

Table 2

Correlations Between Intercepts and Slopes for Husbands and Wives

	Husband intercept	Wife intercept	Husband slope
Wife intercept	.77**		
Husband slope	.11**	.15**	
Wife slope	.08**	.22**	.27**

**p < .01.

Table 3

*Unstandardized Coefficients for Intraspouse and Cross-Spouse Links Between Year 1 Levels of Social Support and Distress and Initial Level and Rate of Change in Marital Satisfaction for Husbands and Wives (*N *= 526 Couples at First Assessment)*

	Initial level of satisfaction		Rate of change in satisfaction	
Year 1	Husband	Wife	Husband	Wife
variable	Coefficient	Coefficient	Coefficient	Coefficient
Social support				
Intraspouse	0.34**	0.33**	-0.03	0.01
Cross-spouse	0.20**	0.18**	0.03	-0.04
Distress				
Intraspouse	-3.21**	-3.23**	-0.30	-0.06
Cross-spouse	-2.34**	-1.98**	0.00	0.13

**$p < .01$.