Published in final edited form as:

Fam Process. 2011 June ; 50(2): 167–183. doi:10.1111/j.1545-5300.2011.01353.x.

Multilevel Models to Identify Contextual Effects on Individual Group Member Outcomes: A Family Example

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Abstract

This manuscript illustrates methods for utilizing measurements of individuals to identify group contextual effects on individual outcomes. Contextual effects can be identified by one of three methods: 1) divergence of the simple within- and between-group regression coefficients, 2) the presence of a cross-level interaction of the within- and between-group predictor variable, or 3) the effect of discrepancies within the group. These methods can be used to incorporate group context into an individual model and can be utilized for any individual process variable that might be affected by a group context. Example data include measures of hassles and coping adequacy of inner city, poor, African American new mothers and their family members.

Keywords

Multilevel; family; stress; coping; contextual effect

This manuscript illustrates a statistical approach to incorporate the family context into a model of an individual's process using data in which the individual reports on himself or herself rather than family context, specifically. These methods are commonly used in organizational psychology and other fields but have been less utilized in the family research field. The goal is to illustrate this method which may be useful for simultaneously investigating individual and family processes using data reported by the individual.

Individuals in a group, such as a family, are usually interdependent (Broderick, 1993; Hanson, 1995; Steinglass, 1987). That is, what influences one group member may also influence other group members, either directly (i.e., through direct interactions with other group members) or indirectly (i.e., by creating a group environment that influences individual members). This interdependence makes it likely that the beliefs, attitudes, cognitions and actions of individual group members are likely to influence other group members. Therefore, there may be gains from examining the individual's experiences within the framework of a group context.

Two important aspects of a group might provide information about the processes of the individual group members. First, the group's location on the distribution for the individual outcome variable may distinguish individuals from one particular group from individuals in another group. For example, an individual family member in a family characterized by high aggregate stress may have a very different stress reaction than a similar individual who is in a family characterized by low aggregate stress. This is consistent with the idea that family context may define risky families (Repetti, Taylor & Seeman, 2002) and resilient families

(Patterson, 2002), and also account for unobserved time-varying factors that affect all family members. Second, differences among group members on an outcome variable may affect all group members. For example, discrepancies in reporting of stress process variables have been linked to low family cohesiveness and closeness (Calysin et al., 1998); and larger differences in acculturation among Hispanic family members (Zayas, 1992; Santisteban, Muir-Malcom, Mitrani & Szapocznik, 2002) are associated with more intra-familial stress and problems in individual family members' functioning. There are numerous other possible individual characteristics where family may be important. Examples include affect (depression/anxiety), cognition, personality, and physical ability.

The now commonly used multilevel model is easily adapted for group data (Snijders & Bosker, 1999; Raudenbush & Bryk, 2002). Minimally, these models can be parameterized to account for the non-independence of the data from multiple individual group members. More conceptually informative multilevel models provide information on the group context. One way that this can be accomplished is by examining the different sources of variation across the different levels of nesting. In particular, examination of regression relationships as they are differentially identified by variation occurring within and between groups help to uncover these contextual effects (cf. Cronbach & Webb, 1975).

In this manuscript, we illustrate three methods for uncovering contextual effects among group members. These methods only require individual group members to report on themselves. In fact, all three methods are based on transformations of the data on individual members' reported variables. These models take the individual group member as the unit of analysis and use the data structure to uncover effects of the group context. Method 1 compares the within-group and between-group regression coefficients. This method factors each group member's predictor variable into two variables: the group mean level of that variable (which is common across all group members) and the individual's deviation from the group mean level of that variable. Thus, the effect of the predictor variable (X) is decomposed into the effect of between-group variation (the effect between group of the mean level of X) and the effect of within-group variation (the effect of the individual group member's deviation from the group mean of X). Method 2 adds a cross-level interaction to the first method. Thus, in addition to estimating the regression coefficient on the within-level variation and the regression coefficient on the between-level variation, this method creates an interaction term between these two sources of variance. Method 3 focuses on a different transformation. This method depends on a discrepancy score of X (Fisher et al., 1985). The discrepancy score for a particular group is the maximum of the pair-wise differences on X among its members. For each method, we describe the statistical methodology and provide results using data from the motivating example.

These methods are different from models of dyadic data which focus on the dyad or the family as the unit of analysis, through either aggregation of individual perspectives or direct measurement or observation of family-level characteristics. These methods are like the social relations model (Kenny, Kashy & Cook, 2006), because each family member is paired with multiple other family members in the current approach. Unlike the social relations model, the data are not reciprocal or relational. Each person within the family is only reporting on themselves and not reporting on any other family member.

Motivating Example

Data

The data utilized to illustrate these methods are described in detail in Feaster and Szapocznik (2002). Briefly, 168 families of inner city, poor, African American new mothers and their families were interviewed to examine the families' adaptation to the new infant. A

total of 144 of these families were re-interviewed one year later. Only data from the baseline assessment are included herein. There were 367 family members represented in this sample, or about 2.5 family members per family. Data collection was under the auspices of an institutional review board. All American Psychological Association ethical guidelines were followed.

Measures

Perceived Coping Adequacy—Perceived Coping Adequacy ($\alpha=.72$) was measured by the Perceived Stress Scale (Cohen, Kamarch, and Marmelstein 1983, Feaster & Szapocznik, 2002). and included items that reflect how well the woman or family member has successfully managed stress and dealt with problems, such as: In the last month, how often have you dealt successfully with irritating life hassles? and In the last month, how often have you felt that you were on top of things? This measure was administered to all adults in the family and any children 12 years or older.

Hassles—Hassles were measured by the Revised Hassles Scale for African American Women (Feaster & Szapocznik, 2002), an adaptation of the Hassles Scale developed by Delongis, Folkman, and Lazarus (1988). This instrument consists of 64 items that assess daily hassles occurring during the past thirty days. The count of hassles was used as the measure of hassles. This measure was also administered to all family members over the age of 12.

Methods for Uncovering Contextual Effects

Several statistical strategies have been developed for modeling multilevel data in which individuals are grouped or nested by higher order categories. Individuals within the same group may be more similar to each other than individuals from different groups. As a result of this similarity, observations of individuals within a group are not necessarily independent. This type of modeling is known by different names across disciplines, including: multilevel models (Snijders & Bosker, 1999), random effects or mixed models (Laird & Ware, 1982), and hierarchical linear models (Raudenbush & Bryk, 2002).

These models parameterize the structure of the dependence among group members by adding variance components, also called random effects, to describe and estimate how group members are correlated. In the current analyses, SAS Proc Mixed (Singer, 1998) was used to estimate the multilevel regression models however, many statistical packages are available including Mplus, Mlwin, Stata, and others. In these models both the fixed effects (the regression relationships of interest between dependent and independent variables) and random effects (the components of variance associated with the grouping factors) are estimated using either maximum likelihood (ML) or restricted maximum likelihood (REML). The REML estimator is normally preferred, particularly with small sample sizes, because the random effects are under-estimated using ML (Littell, Milliken, Stroup, Wolfinger & Schabenberger, 2006). Likelihood ratio tests of the fixed parameters are not appropriate when using REML.

Statistical power and sample size requirements for these type of models are discussed by Snijders and Bosker, (1999). The number of groups (families) rather than the number of people within a group is the most important factor and at least 50 groups is recommended (Maas & Hox, 2005). Small numbers of individuals per group should not be a problem (Snijders, 2005), but as is noted below, a sample of all 2-member groups would not allow all the methods described to be identified.

Method 1 and Method 2 involve decomposing the predictor variable (hassles) into its within-family and between-family components (Snijders & Bosker, 1999). Whereas the literature on family measurement focuses on different ways to aggregate individual data to get a measure of the family, this statistical approach can be considered a disaggregation of the individual level variance into two parts: (1) the portion associated with the group (family or between-groups component) and (2) the portion associated with the individual (individual or within-group component). Just as in analysis of variance, the decomposition of this variability into its within-family (individual) and between-family (group) components results in measures that are independent of each other and which therefore do not suffer from multicollinearity. This parameterization of the regression function (the fixed effects) allows a comparison of the regression on the within-family process and between-families processes.

For simplicity, the example models employ just one predictor variable and one outcome variable. However, these models can be extended to include more than one predictor variable. It would also be possible to allow the within-family regression estimate to vary across families using what is called a random-coefficient or, alternatively, a random slope specification. In the data used for the motivating example there is no evidence that these within-family regression estimates vary across families so instead the models specified below rely on what is called a random intercept specification (c.f. Raudenbush & Bryk, 2002).

Group Mean Centering—By formulating the model such that the independent variable is an individual's deviation from their family's mean we used group mean centering or centering within context (CWC). It is possible to test for the family contextual effect without CWC. In this case, the family mean would be added as a predictor at level 2 and the individual's hassles would be entered at level 1 without being deviated from the family mean level of hassles. The test of the family contextual effect is the significance of the coefficient on the family mean in this specification. See Snijders and Bosker (1999) for a comparison of these two methods. The specification that includes the family mean without CWC does not directly identify the within and between-family coefficients. The CWC specification directly identifies the within and between-family regression coefficients which facilitates graphing of the two distinct effects, and is warranted when examining contextual effects (Raudenbush, 1989b, Raudenbush & Bryk, 2002).

Method 1: Comparing the Within- and Between-Family Regression Coefficients

Multilevel models are frequently viewed as a cascading set of different equations at different levels. In the present example, individuals are nested within families; therefore, the model has two levels. At Level 1, there is a regression equation for the individual:

$$CA_{ij} = \pi_{0j} + \pi_{1j}(h_{ij} - \bar{h}_{.j}) + e_{ij} \quad (1.1)$$

where i indexes individuals and j indexes families. CA_{ij} is coping adequacy of individual i within family j and the sole predictor is group mean centered hassles, $(h_{ij} - \bar{h}_{.j})$. This expression represents the hassles of person i within family j minus the family mean of hassles for family j . Because the predictor is centered around the family's mean level of hassles, the parameter (or coefficient), π_{1j} , is called a within-family coefficient. The parameter, π_{0j} , is a family specific intercept term. Note that all the parameters at Level 1, the π s, are indexed by a variable number (0 or 1) and are subscripted with a j , indicating the particular family. The j subscript implies that the individual-level coefficients (level one) can vary across families. This variability is described using the Level 2 equations.

Level 2 explicitly describes how family-level variables affect the individual-level coefficients at Level 1. The intercept (from Level 1) is defined at Level 2 as:

$$\pi_{0j} = \beta_{00} + \beta_{01}(\bar{h}_{.j}) + r_{0j} \quad (1.2)$$

where $\bar{h}_{.j}$ is the mean of hassles for family j . Equation 1.2 then describes the Level 1 intercept as an overall intercept, β_{00} , the effect of family mean level of hassles on perceived adequacy of coping, β_{01} , and a family-specific error term, or random effect, r_{0j} . Because there is only variation in the family mean across families (at any point in time), the coefficient associated with the family mean hassles, β_{01} , is called a between-family coefficient. In this Level 2 equation for the Level 1 intercept, the inclusion of the random effect, r_{0j} , is sometimes called a random intercept specification. We have included a random intercept for family to estimate the amount of (residual) variance associated with families after accounting for the fixed effects in the model.

In Method 1 the Level 1 coefficient on the individual family member's deviation in hassles from the family mean is specified as the simple mean across families:

$$\pi_{1j} = \beta_{10} \quad (1.3)$$

Equations 1.1, 1.2 and 1.3 are estimated jointly. The full model specification (1.4) combines and regroups terms to clarify what is being estimated:

$$CA_{ij} = \beta_{00} + \beta_{01}(\bar{h}_{.j}) + \beta_{10}(h_{ij} - \bar{h}_{.j}) + (r_{0j} + e_{ij}) \quad (1.4)$$

In this model, an individual's coping adequacy is specified as the sum of an intercept term, the product of the coefficient on family's mean level of hassles and the family's mean level of hassles, $\beta_{01}(\bar{h}_{.j})$, the product of the coefficient on individual's deviation from the family mean level of hassles and the individual's deviation from the family mean, $\beta_{10}(h_{ij} - \bar{h}_{.j})$, and a random component which includes a family-specific component r_{0j} and an individual component, e_{ij} .

Testing Family Contextual Effects using Method 1

Using the model above, the first way to uncover a family contextual effect on individual stress processes is to test the equality of the within- and between-family coefficients, $H_0: \beta_{01} = \beta_{10}$, $H_A: \beta_{01} \neq \beta_{10}$. It is easiest to see why a difference in the magnitude of the within and between-family coefficient implies a family contextual effect by examining a plot of the within and between families regression lines. Figure 1A shows an example using the relationship between hassles and coping adequacy. The between regression line describes how the individual's coping adequacy changes when the family mean level of hassles changes and its slope is labeled " β_{01} ." The within regression line describes how the individual's coping adequacy changes when the individual's hassles change and its slope is labeled " β_{10} ." Note that there is only one between-family regression line, but there are (at least theoretically) an infinite number of within regression lines—one for each level of family mean of hassles. Only two of these within-family regression lines are shown in the diagram, one where family mean level of hassles is 20 and the other where family mean level of hassles is 25. Because the individual's level of hassles is centered at the family mean, when the individual's observed level of hassles equals the family mean, the family-centered value of the individual's level of hassles is zero causing the within and between regression functions to intersect. Consider an individual from a family with a mean of 20,

which also happens to be that individual's level of hassles. This person starts at point a in Figure 1A where family mean level of hassles is 20 and the individual's deviation from the family mean is zero. If other family member's hassles increase causing the family mean to increase to 25, this shifts the within regression line to intersect at point b (above the point where hassles = 25). This is not, however, where our original individual ends up. Because this person's hassles did not change, their deviation from the family mean has now become -5. They actually move along the new within-family regression line -5 hassles and end up at point c. There is an effect of the family context on the individual in this change because, whereas the hassles level of the individual remains unchanged, the individual's coping adequacy has decreased (due to the increase in the family mean level of hassles). Now, consider the case where the between-family regression coefficient is equal to the within-family regression coefficient as in Figure 1B. In this case, the within and between regression lines are identical (or are on top of each other). In Figure 1B, consider the same individual. They begin at the same point, a. When the family mean level of hassles increases to 25, they move up the between-family regression line to point b, however, they then move back down the within-family regression line to exactly the same point from which they started (a=c). In this case, there is no contextual effect of the family context.

Method 1 Empirical Example: Comparing Within and Between Coefficients—

Table 1 contains the descriptive statistics for the sample. Method 1 used the within and between-family hassles variables. The between-family variable which is the family mean level of hassles varied from 4.3 to 49.5 with a mean of 21.5 and S.D. of 8.5. The within-family variable which is centered around the family mean had mean zero (by definition) but varied from -21.5 to 24.4 with a standard deviation of 8.3. The estimates of Method 1 show that the between-families coefficient on hassles was significant and negatively related to individual's coping adequacy ($\hat{\beta}_{01} = -.197, t(149) = -4.93, p < .0001$), whereas the within families coefficient was not significant ($\hat{\beta}_{10} = -.035, t(239) = -0.96, p < .34$). There was a significant difference between the within and between families coefficient ($F(1, 332) = 8.92, p < .003$), which is evidence that there is an effect of family context on the relationship between individual's hassles and their perceived adequacy of coping. As shown in Figure 2, the between-family regression line is significantly negatively sloped. This implies that higher family mean level of hassles decreases the coping adequacy of all family members. In contrast, the within-family regression line is flat and not significantly different from zero. This implies that the individual family member's deviation from the family mean does not matter; the family mean on hassles is the important determinant of coping adequacy.

Interpretation of Method 1 Empirical Example—The results of Method 1 illustrate the importance of the family context on coping adequacy, and suggest that the individual's deviation from this context has little effect. This finding also implies that the family may play an important role in buffering the effect of stress experienced by an individual within the family, particularly as that individual's level of stress increases. Consider the individual in a family with moderate family mean hassles who is exposed to a large increase in stress and hassles. As noted above, all family members are affected through the family mean; however, the individual experiencing the increase does not bear the full impact of this increase, but rather only the increase to the family mean. Thus, each family member shoulders a portion of the burden. The family, in essence, acts as a shock absorber: the full impact of the increase is spread across the family.

Method 2: Including a Within- and Between-Family Cross-Level Interaction

The second method for identifying family contextual effects adds a cross-level interaction to the equations described in Method 1. This interaction is added by re-specifying the Level 2

equation for the individual's deviation from the family mean, Equations 1.3, above. In method 1, π_{1j} , the coefficient was estimated as simply an intercept term (i.e. the mean across families). In method 2 the family mean level of hassles, $\bar{h}_j$, is added as a predictor of the level-1 slope:

$$\pi_{1j} = \beta_{10} + \beta_{11}(\bar{h}_j) \quad (1.5)$$

This final specification results in a cross-level interaction, $\beta_{11}(\bar{h}_j)(h_{ij} - \bar{h}_j)$, when all equations are combined. This can be seen in the combined equation replacing 1.3 with 1.5:

$$CA_{ij} = \beta_{00} + \beta_{01}(\bar{h}_j) + \beta_{10}(h_{ij} - \bar{h}_j) + \beta_{11}(\bar{h}_j)(h_{ij} - \bar{h}_j) + (r_{0j} + e_{ij}) \quad (1.6)$$

Testing of Family Contextual Effects using Method 2—The second method to uncover a family contextual effect on the individual stress process is to test for a significant interaction of the within-family and between-family variables $H_0: \beta_{11} = 0$, $H_A: \beta_{11} \neq 0$. A significant interaction of the within and between-family variables implies that the effect of the individual's level of the predictor on the outcome varies by the level of the family mean of that predictor variable. This is precisely the definition of a contextual effect—what happens to one family member increases the family mean, which in turn affects the other family members by changing the slope of the within-family regression function through the interaction.

Method 2 Empirical Example: Interaction of the within and between variables

—The results of Method 2 showed there was a significant interaction effect

($\hat{\beta}_{11} = .018$, $t(236) = 3.43$, $p < .0008$). This implies that there is a significant effect of family context on the individual's relationship between hassle and coping adequacy and that this effect varies as level of family hassles changes (see Figure 3). At the lowest levels of family mean hassles, the within and between regression lines are nearly coincident. At this level, there is no contextual effect and the family mean does not affect the individual family members. As the family mean level of hassles increases, the within regression line begins to diverge with the between regression line and looks similar to the family of lines shown for the results of Method 1 (Figure 2). At the highest levels of family mean hassles, the within regression line appears to slope upward.

Interpretation of Method 2 Empirical Example—Method 2 gives a more nuanced view of the contextual effect of the family on coping adequacy. At low levels of family mean hassles, there is not a contextual effect of family's hassles on individual coping adequacy; however, as the family mean level of hassles increases, the contextual effect of the family becomes obvious and works as described above for Method 1. This pattern might have implications for designing an intervention. If an intervention were targeting the hassles-coping adequacy relationship, then when there are low levels of family hassles, it may be sensible to focus on the individual family member experiencing the most hassles. However, at higher levels of family mean hassles, the intervention will have little effect if focused on individuals. The intervention should be focused on the family context to have an effect.

At the very high end of family hassles, the family contextual effect has a different character. The context is so important that an individual family member having fewer hassles will report feeling as if they are coping less adequately than family members with hassles nearer the mean. One explanation may be that families with such high levels of hassles are

reinforcing and validating each of the individual member's experience of hassles. Within a family with extremely high hassles, it may difficult for an individual to forgo this validation. Whereas the contextual effect is different between families with moderate and high mean hassles, the need for a family-focused intervention is evident for both.

Method 3: The Discrepancy Score

Whereas Method 2 built on the specification of Method 1 by adding an interaction term, the discrepancy score approach introduced in Method 3 can be used independently from Methods 1 and 2. Recall that the discrepancy score is created by subtracting the minimum value of hassles across every family member from the maximum value of hassles across every family member. This constructed variable does not vary within the family. In this case, the multilevel model for testing the discrepancy score is quite simple. Level one is simple an intercept, π_{0j} , and a random error term for the individual nested within-family, e_{ij} :

$$CA_{ij} = \pi_{0j} + e_{ij} \quad (1.7)$$

At level 2 the intercept from level one is predicted by an overall intercept, β_{00} , the discrepancy score, β_{02} and a random effect for family, r_{0j} , to account for the statistical dependence.

$$\pi_{0j} = \beta_{00} + \beta_{02}(d_j) + r_{0j} \quad (1.8)$$

The final specification combines equations 1.7 and 1.8:

$$CA_{ij} = \beta_{00} + \beta_{02}(d_j) + (r_{0j} + e_{ij}) \quad (1.9)$$

Testing of Family Contextual Effects Using Method 3—This measure of discrepancy is the maximum pair-wise difference in hassles observed within the family, d_j . That is, the maximum pair-wise difference between all dyads in the family, and not the difference between the individual and the rest of the family. A significant coefficient estimate on the maximum discrepancy, $H_0: \beta_{02} = 0$ $H_A: \beta_{02} \neq 0$, indicates that the maximum discrepancy between any two members in the household affects all members of the household. This approach tests whether maximum differences within the family on hassles are a potential source of stress to the family, similar to how differences in acculturation can be for immigrant households, resulting in lower coping adequacy for individuals in the family.

Method 3 Empirical Example: Discrepancy Score—The maximum pair-wise discrepancy within the family on hassles varies from 0 to 43 with a mean of 13.9 and standard deviation of 10.7. The results for Method 3 show that the maximum family pair-wise discrepancy on hassles is negatively related to coping adequacy ($\hat{\beta}_{02} = -.096, t(134) = -2.93, p < .004$). Therefore, there is evidence that the greater the family discrepancy on hassles the greater the likelihood that the individual family members will report lower coping adequacy.

Interpretation of Method 3 Empirical Example—The discrepancy score on hassles also showed contextual effects of the family context on individual family member's coping adequacy, and this effect was evident across all family members, not just the individuals with the highest or the lowest levels of hassles. Thus, all family members are affected by this discrepancy, not just those contributing to the discrepancy. Therefore, the significant

effect of the discrepancy score is yet another indication of the importance of a family approach in stress research and interventions. If the discrepancy score is significant even controlling for family mean level of hassles, this would imply that even at low levels of family hassles (where there is not a contextual effect of the family mean, See Method 2 above), a family approach would be of benefit if any two family members diverge greatly in their level of hassles.

Combining Approaches

These three methods have been illustrated separately for clarity. However, either Methods 1 or 2 could be estimated jointly with Method 3 as long as the family data contains more than dyads. With family data that solely contains dyads it would be impossible to identify the within-family regression coefficient, the between-family regression coefficient and the maximum pair-wise difference. These methods can be combined by simply adding the discrepancy score variable as a predictor to the level two intercept, equation 1.2. When this is done with the illustrative dataset, there is both a contextual effect of family mean hassles because the within-family regression coefficient differs significantly from the between-family regression coefficient *and* there is a significant effect of the discrepancy composite. Likewise, when combining Methods 2 and 3, there is a significant cross-level interaction and there is a significant effect of the discrepancy composite. This implies that the discrepancy composite provides additional, independent information from either Methods 1 or 2. Thus, as noted above, even for families with low mean level of hassles, there is evidence of family contextual effects on individual stress processes when any two members have large differences in reported hassles.

Evaluating Different Models: Pseudo R^2

A final summary and comparison of the various approaches can be made by examining the pseudo- R^2 (Singer, 1998) of these models. Because these models are not estimated using least squares procedures, the standard measure of R^2 could not be applied. However, it is possible to construct a pseudo- R^2 which describes the percentage reduction in each variance component in the model relative to a model which just estimates the grand mean. This pseudo- R^2 measure should be interpreted with care because it does not have the same properties as the R^2 of ANOVA or regression. For example, an increase in R^2 is not algebraically guaranteed when including additional variables and an incremental pseudo- R^2 can be negative.

Comparing the Performance of the Models—Table 2 presents variance components and the pseudo R^2 values for each of the 5 models estimate (Method 1, 2, & 3, Methods 1 & 3 and Methods 2 & 3). The first column shows the variance components for a model in which just the grand mean is estimated. In this case, the variance component associated with families is 4.97 and the error variance is 33.52 resulting in an intraclass correlation of .13. The intraclass correlation can be interpreted as the percentage of the variance in coping adequacy that is associated with or explained by family membership. For Method 1, the variance component associated with families was 2.18 implying a pseudo R^2 equal to .561 for family variance or 56.1% of the family variance explained by the model. Method 1 did not explain any of the error variance (the pseudo R^2 is actually $-.001$) and the percentage of total variance explained is 7.1%. Because Method 1 explained such a high proportion of the family associated variance, the residual intraclass correlation falls from .13 in the grand mean model to .08 in this model.

Method 2 adds the cross-level interaction model in Method 1. For Method 2, the variance component associated with family is 2.73, resulting on a psuedo- R^2 of .451 on the family component of variance or 45.15% of family variance explained. This is a reduction relative

to the model without an interaction in Method 1. By contrast, Method 2 did have a larger pseudo- R^2 for both the error component, .045, and the total variance, .097. This indicates that whereas the interaction model was an improvement in explaining the overall variance in coping adequacy, it did explain less of the family variance. This illustrates one of the differences between the standard R^2 measure and the pseudo- R^2 . The addition of a variable may result in a reduction in the pseudo R^2 of one of the variance components.

The family variance component for Method 3 was 4.11 resulting in a pseudo R^2 for family of .173 and a residual inter-family correlation of .11. The pseudo R^2 for the error component was quite small, .005, and for the total variance it was .026. Thus, whereas the discrepancy composite was statistically significant, it did explain much smaller amounts of coping adequacy variance than did Methods 1 or 2.

The final 4 columns of Table 2 present the variance components and pseudo R^2 for the models which combined Method 3 with the first two methods. The model including Method 1 resulted in 65.8% of explained and 9.2% of family and total variance in coping adequacy explained, respectively. The model including Method 2 only explained 55.5% of family variability; however, it explained 11.8% of overall variance. Both models explain a majority of the family variance, but only the model including Method 2 accounted for a sizable amount of residual variance.

Discussion

This manuscript illustrates three methods of uncovering group contextual effects from individual-level data which can be of use in the study of families. In Method 1, the decomposition of effects to between-family coefficients (the effect of the family's mean level of a predictor) and the within-family coefficients (the effect of individual family member's deviation from the family mean level of a predictor) allow one measure of how individual differences from the family as a whole (as measured by the mean) affect the individual.

In Method 1 there are several effects to consider. First, if an individual has a change in the level of a predictor, this change will have a direct effect on that individual through the within-family coefficient. The individual's change in level will have an effect on the family's mean level of the predictor and affect other family members. In a large family, an individual's effect on the mean value is normally quite small unless the value is extreme. In small families, an increase in an individual's predictor will be related to an increase in their family mean level of the predictor as well as their individual deviation from the family mean. Thus, the individual's effect on the family mean level of a predictor may have a substantial contextual effect if the within- family coefficient (on individual deviation) is different than the between- family coefficient (on family mean value).

In Method 2, a family contextual effect is present when there is a significant within and between-family interaction on a predictor. This interaction implies that the magnitude of the within-family effect (the individual's deviation from the family mean) differs at every level of the family mean. Thus the family mean moderates the effect of the individual's level of the predictor.

In Method 3, the discrepancy score tests a special case of interdependence. Here, the maximum amount of difference within the family is used as an independent predictor of individual level of the outcome variable. Another potential candidate for this type of measure might be the standard deviation within the family on the predictor variable. One advantage of the discrepancy score or maximum pair-wise difference within the family is that it allows the inclusion of a dispersion measure even in two member groups, whereas the

standard deviation is not defined with two observations. The absolute value of the difference could also be used. A disadvantage of the discrepancy score is that there is a tendency for there to be a relationship between family size and the level of this discrepancy. This could be controlled by including family size as a predictor in the model.

Other forms of discrepancy could also be addressed by other categorizations of the distribution of the predictor within the family. In large families, it may be of interest to note whether there is polarization or clustering of family members at or near the minimum and maximum value, or whether there are two extreme individuals within the family with other family members clustered in the middle.

The three methods are complementary and assess slightly different aspects of family contextual effects. Method 3 directly assesses the impact of large discrepancies within the family. This method can be used in conjunction with either Method 1 or 2. Methods 1 and 2, in contrast, examine how where the family as a group falls within the distribution of how the individual outcome affects each individual family member. Whereas we have illustrated Methods 1 and 2 independently for clarity, the researcher should really approach these in a staged manner. Method 2 should be assessed first. If there is a significant within and between families interaction it does not make sense to assess whether the within and between families coefficient are equal (Method 1) because the within families effect is different at different family means. If, however, the within and between interaction is not significant, the interaction should be dropped and Method 1 should be tried. There still may be a family contextual effect if the within and between coefficients differ significantly.

The multilevel model with the three methods described herein can be augmented with other methods of group measurement. In particular, it is likely that this individually-focused method of assessment and identification of family contextual effects will be most useful in combination with other methods of family assessment (multiple self-reports of family members on the family as a whole or on their relationship with each other family member as in the social-relations model (Kenny, Kashy & Cook, 2006), rater interview of family interactions, rater observation of dyadic or family interactions) and from different levels of observation (individual, family, neighborhood, etc). Other established group constructs may have both a direct effect on the (individual level) outcome and may be potential moderators of the relationships uncovered using the three methods illustrated. For example, are discrepancies more problematic for enmeshed families? Thus, other group level measurement gleaned by other methods can be incorporated as a predictor, mediator or moderator variable in this analysis framework.

Limitations

A limitation of these approaches is that they do not directly address role-specific differences in the family. Each family member is treated equally, thus the methods do not model specific discrepancies between parent and child, or between siblings or adult partners. In theory, these kinds of analyses are possible, however they are unlikely in practice given the typically small number of members within a family and the different constellations presenting for assessment. A limitation of this presentation is that the examples used were kept simple to make the presentation clear. Our example interpretations are consistent with the results of these examples, but are not the only interpretation. For example, if families with high levels of hassles are clustered in neighborhoods that are more chaotic and that have lower available resources, the impact of family mean hassles may itself be caused by these additional variables omitted from the analysis.

Conclusion

Decomposition of the relationships between psychological measures of group members individual functioning into within and between-group regression coefficients can help to identify contextual effects of group on these supposed individual level processes. Unlike multivariate analysis of variance or standard structural equation modeling, it does not require families in the analysis to be of the same composition. Thus, it can be used to analyze families with different constellations of members in the same analysis. This approach can and should be used as a method in integrating theories of group functioning with theories of individual functioning and may be useful in the study of other group settings where members closely interact.

Acknowledgments

Data were collected with support of National Institute of Mental Health grants #MH51402 and #MH55796. In addition, Dr. Feaster and Ms. Brincks were supported by a grant from the National Institute on Drug Abuse (#DA 15004) and by a NIH Roadmap for Medical Research supplement through RFA RM 04- 013 (#DA 15004-03S1). We also appreciate the helpful comments of the Prevention Science Methodology Group (5R01MH40859). The views expressed herein are solely those of the authors and not necessarily those of the funding agencies.

References

- Broderick, CB. Understanding family process: Basics of family systems theory. Sage; Newbury Park, CA: 1993.
- Calsyn RJ, Winter J, Roades, L.A. Trusty ML, Pruett C, Lira C. Social support agreement between college students and their mothers. *Representative Research in Social Psychology*. 1998; 22:33–41.
- Chan D. Functional relations among constructs in the same content domain at different levels of analysis: A typology of composition models. *Journal of Applied Psychology*. 1998; 83(2):234–246.
- Cohen S, Kamarck T, Marmelstein R. A global measure of perceived stress. *Journal of Health and Social Behavior*. 1983; 24:385–396. [PubMed: 6668417]
- Cronbach LJ, Webb N. Between-class and within class effects in a reported aptitude X treatment interaction: Reanalysis of a study by G. L. Anderson. *Journal of Educational Psychology*. 1975; 67(6):717–724.
- Delongis A, Folkman S, Lazarus RS. The impact of daily stress on health and mood: Psychological and social resources as mediators. *Journal of Personality and Social Psychology*. 1988; 54:486–495. [PubMed: 3361420]
- Enders CK, Tofighi D. Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods*. 2007; 12:121–138. [PubMed: 17563168]
- Feaster DJ, Szapocznik J. Interdependence of stress processes among African American family members: Influence of HIV serostatus and a new infant. *Psychology and Health*. 2002; 17(3):339–363. [PubMed: 16609749]
- Fisher L, Kokes RF, Ransom DC, Phillips SL, Rudd P. Alternative strategies for creating “relational” family data. *Family Process*. 1985; 24:213–224. [PubMed: 4018242]
- Hanson, BG. General systems theory beginning with wholes. Taylor & Francis; Washington, DC: 1995.
- Kreft IGG, de Leeuw J, Aiken LS. The effect of different forms of centering in hierarchical linear models. *Multivariate Behavioral Research*. 1995; 30(1):1–21.
- Kenny, DA.; Kashy, DA.; Cook, WL. Dyadic Data Analysis. The Guilford Press; New York: 2006.
- Laird NM, Ware JH. Random-effects models for longitudinal data. *Biometrics*. 1982; 38:963–974. [PubMed: 7168798]
- Lazarus, RS.; Folkman, S. Stress, Appraisal and Coping. Springer; New York: 1984.
- Littell, RC.; Milliken, GA.; Stroup, WW.; Wolfinger, RD.; Schabenberger, O. SAS for Mixed Models. Second Edition. SAS Institute Inc; Cary, NC: 2006.
- Longford N. To center or not to center. *Multilevel Modelling Newsletter*. 1989; 1(3):7.

- Maas CJM, Hox JJ. Sufficient sample sizes for multilevel modeling. *Methodology*. 2005; 1(3):86–92.
- McCubbin HI, Joy CB, Cauble AE, Compeau JK, Patterson JM, Needle RH. Family stress and coping: A decade review. *Journal of Marriage and Family*. 1980; 42:855–871.
- Paccagnella O. Centering or not centering in multilevel models? The role of the group mean and the assessment of group effects. *Evaluation Review*. 2006; 30:66–85. [PubMed: 16394187]
- Patterson, JM.; McCubbin, HI. Chronic illness: Family stress and coping. In: Figley, CR.; McCubbin, HI., editors. *Stress and the Family: Volume II: Coping with Catastrophe*. Brunner/Mazel; New York: 1983. p. 21–37.
- Paschall MJ, Hubbard ML. Effects of neighborhood and family stressors on African American male adolescents: self-worth and propensity for violent behavior. *Journal of Consulting and Clinical Psychology*. 1998; 66(5):825–831. [PubMed: 9803701]
- Patterson JM. Integrating family resilience and family stress theory. *Journal of Marriage and Family*. 2002; 64:349–360.
- Pearlin LI, Leiberma MA, Mengahan EG, Mullan JT. The stress process. *Journal of Health and Social Behavior*. 1981; 30(3):241–256. [PubMed: 2674272]
- Plewis I. Comment on “Centering” predictors in multilevel analysis. *Multilevel Modelling Newsletter*. 1989; 1(3):6.
- Raudenbush S. “Centering” predictors in multilevel analysis: Choices and Consequences. *Multilevel Modelling Newsletter*. 1989a; 1(2):10–12.
- Raudenbush S. A response to Longford and Plewis. *Multilevel Modelling Newsletter*. 1989b; 1(3):8–10.
- Raudenbush, SW.; Bryk, AS. *Hierarchical Linear Models: Applications and Data Analysis Methods*. Second Edition. Sage; Thousand Oaks, CA: 2002.
- Repetti RL, Taylor SE, Seeman TE. Family social environments and the mental and physical health of offspring. *Psychological Bulletin*. 2002; 128:330–366. [PubMed: 11931522]
- Santisteban, DA.; Muir-Malcolm, JA.; Mitrani, VB.; Szapocznik, J. Integrating the study of ethnic culture and family psychology intervention science. In: Liddle, H.; Santisteban, D.; Levant, R.; Bray, J., editors. *Family psychology intervention science*. American Psychological Association Press; Washington, DC: 2002.
- Singer JD. Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics*. 1998; 24(4):323–355.
- Snijders, TAB. Power and sample size in multilevel modeling. In: Everitt, BS.; Howell, DC., editors. *Encyclopedia of Statistics in Behavioral Science*. Vol. Volume 3. Wiley; Chicester: 2005.
- Snijders, T.; Bosker, R. *Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling*. Sage Publications; London: 1999.
- Steinglass, P. A systems view of family interaction and psychopathology. In: Jacob, T., et al., editors. *Family interaction and psychopathology: Theories, methods and findings*. Plenum; New York, NY: 1987.
- Teachman J, Crowder K. Multilevel models in family research: Some conceptual and methodological issues. *Journal of Marriage and Family*. 2002; 64:280–294.
- Zayas LH. Childrearing, social stress, and child abuse: Clinical considerations with Hispanic families. *Journal of Social Distress and the Homeless*. 1992; 1:292–309.

Figure 1.
Decomposition of Change in Hassles to Within and Between Components

Figure 2.
Perceived Adequacy: No Interaction

Figure 3.
Perceived Adequacy: With Cross-level Interactions

Table 1

Descriptive Statistics for Model Variables

Variable	Mean	S.D.	Minimum	Maximum	n
Observed Variables:					
Perceived Adequacy	28.6	6.2	8.0	40.0	367
Hassles	21.5	11.7	0.0	54.0	367
Transformed Variables					
Within-family Hassles $(h_{ij} - \bar{h}_{.j})$	0.0	8.3	-21.5	24.4	367
Between-family Hassles $\bar{h}_{.j}$	21.5	8.5	4.3	49.5	144
Discrepancy Score $[Max(h_{ij}) - Min(h_{ij})]$	13.9	10.7	0.0	43.0	144

Table 2

Variance Components and Pseudo R^2

Variance Component	Grand Mean only	Method 1	Pseudo R^2	Method 2	Pseudo R^2	Method 3	Pseudo R^2	Methods 1 & 3	Pseudo R^2	Methods 2 & 3	Pseudo R^2
	(a)	(b)	(a-b)/a	(c)	(a-c)/a	(d)	(a-d)/a	(e)	(a-e)/a	(f)	(a-f)/a
Family	4.97	2.18	0.561	2.73	0.451	4.11	0.173	1.70	0.658	2.21	0.555
Error	33.52	33.57	-0.001	32.01	0.045	33.37	0.005	33.26	0.008	31.73	0.053
Sum	38.49	35.75	0.071	34.74	0.097	37.48	0.026	34.96	0.092	33.94	0.118
P_{family}	0.13	0.06		0.08		0.11		0.05		0.07	
# Parameters	3	5		6		4		6		7	
2*LL	2375.90	2352.9		2341.5		2367.5		2352.90		2341.50	