On the use of Social Relations and Actor–Partner Interdependence Models in developmental research

Todd D. Little and Noel A. Card
University of Kansas, Lawrence, USA

We offer comments on the eight works contained in the Special Issue, all of which use advanced methods for analysing interdependencies using variants of the Social Relations Model (SRM) or the Actor–Partner Interdependence Model (APIM). After critically discussing the SRM and APIM as used in these works, we describe similarities and differences between these two approaches. We also discuss the substantive contributions of this collection and then offer our suggestions for future development of the two models.

Developmental research is inherently a study of interpersonal interactions, yet researchers have too long been hampered by traditional analytic techniques that make assumptions about independence of cases. Fortunately, techniques that accurately model the interdependencies of group and dyadic contexts have been developed, including the Social Relations Model (SRM) and the Actor–Partner Interdependence Model (APIM). The collection of eight articles in this Special Issue offer a rich representation of the manner in which interdependencies can be conceptualised and analysed in developmental research.

In the following, we review and comment upon the analytic application of the SRM and APIM in the articles of this Special Issue. We then compare and contrast these two techniques. We will also comment on the substantive contribution of these articles, including how the conceptual focus on interdependencies have allowed these researchers to answer questions that could not be considered using traditional individual-oriented approaches. Finally, we will offer our suggestions for future substantive and analytic work.

As we begin our commentary, we note that there is no necessarily “right” way to analyse interdependent data; and the papers of this Special Issue present a range of analytic options, each with different advantages and foci. Although we address strengths and potential weaknesses, our aim is to highlight the exemplary nature and substantial advances represented by these works.

The Social Relations Model (SRM)

The SRM represents a powerful conceptual and analytic approach to examining interdependencies within groups. This approach has been applied for quite some time in research with

adults (for reviews see Kenny, 1994; Kenny, Albright, Malloy, & Kashy, 1994; Kenny, Mohr, & Levesque, 2001; Malloy & Kenny, 1986), but has not enjoyed widespread usage with children or adolescents. Perhaps the earliest application of the SRM in developmental psychology was Ross and Lollis’ (1989) analysis of observations of toddlers’ (20- and 30-month-olds) social behaviour in dyadic play settings. SRM analysis of play groups of unacquainted third-grade boys has shed light on the interpersonal nature of aggressive behaviour (Coie et al., 1999) and aggression-encouraging cognitions (Hubbard, Dodge, Cillessen, Coie, & Schwartz, 2001). Using the SRM in naturalistic settings is even less common, with only two prior studies to our knowledge that used this approach in classroom settings: Malloy and colleagues (Malloy, Sugarman, Montvilo, & Ben-Zeev, 1995; see also Malloy, Yaras, Montvilo, & Sugarman, 1996) performed SRM analysis of first- through sixth-graders’ interpersonal perceptions to determine the relative amount of actor and partner variances; and Scarpati, Malloy, and Fleming (1996) examined the perceptions of adolescents in special education classes of both their special education and mainstream peers. In the context of the family, however, Cook (1993, 1994, 2000, 2001; Cook & Kenny, 2004), Branje (Branje, Van Aken, & Van Lieshout, 2002; Branje, Van Aken, Van Lieshout, & Mathijssen, 2003), and others (e.g., Delsing, Oud, De Bruyn, & van Aken, 2003) have used the SRM, typically represented as structural equation models, in examining interpersonal perceptions and behaviours among different family members.

The four studies of this Special Issue that used the SRM build upon this small foundation, and, in our opinion, significantly advance the application of the SRM in developmental psychology. Specifically, the works advance prior applications through theory-driven partitioning of the sociomatrix, sophisticated modelling of social relations in families

Correspondence should be addressed to Todd Little or Noel Card at Schiefelbusch Institute for Life Span Studies, University of Kansas, 1000 Sunnyside Avenue, Lawrence, KS 66045-7555, USA; e-mail: yhat@ku.edu or ncard@ku.edu

Author contribution was equivalent. This work was supported in part by grants from the NIH to the University of Kansas through the

Mental Retardation and Developmental Disabilities Research Center, (5 P30 HD002528), the Center for Biobehavioral Neurosciences in Communication Disorders (5 P30 DC005803), and an NRSA fellowship to the second author (1 F32 MH072005). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the NIH.

as structural equation models, and applying a little-used ANOVA-based approach for analysing dyadic interactions between siblings and parents and children. We will discuss these four works in order of their emphasis on group to dyadic levels of analysis.

Card, Hodges, Little, and Hawley (2005) conducted traditional SRM analysis of interpersonal perceptions within children's naturally occurring classroom groups to elucidate the degree of actor and partner variances (and degrees of generalised and dyadic reciprocity) in sixth-graders' perceptions of various aspects of aggression and social status. This study is similar to prior work applying the SRM to children's interpersonal perceptions (e.g., Malloy et al., 1995). A unique aspect of this study, however, was the division of the round robin sociomatrix by gender, thereby allowing comparisons of both within- and between-sex perceptions. Although Card and colleagues examined only the influence of gender, the logic of their approach could be applied to other features that might be central to group identification, such as children's ethnicity. A second feature of their study is the application of the SRM model to peer nomination data, challenging typical usage that considers only partner effects.

Ross, Stein, Trabasso, Woody, and Ross (2005) present an interesting application of the social relations model to study the quality of relationships within four-person families. They assessed each individual's self-reported behaviour toward others and their reports of others' behaviours toward themselves. Ross et al. provide a good example of how to analyse the SRM through structural equation modelling procedures. Representing the SRM as a structural equation model is made possible by the fact that individual's within these families can be assigned to meaningful roles (i.e., father, mother, older child, or younger child). The meaningful roles provide multiple indicators such that sources of shared and unique variance can be partitioned according to the SRM model (e.g., actor and partner variance).

Branje, Van Lieshout, and Van Aken (2005) expand upon their previous univariate social relations models of interpersonal support (Branje et al., 2002) and personality judgments within families (Branje et al., 2003) to present a multivariate social relations model of both agreeableness and support within families. Like Ross and colleagues, each family consisted of four individuals having distinct roles, here fathers, mothers, older adolescents, and younger adolescents, and the SRM was again represented as a structural equation model. In contrast to Ross and colleagues, however, this paper models the SRM decomposition for two variables in a multivariate manner in which social relations analysis for two variables are modelled simultaneously, rather than as two separate univariate models. The advantage of this approach is demonstrated by Branje and colleagues' ability to explore unattenuated latent associations across constructs. This multivariate approach (whether performed within traditional SRM approaches or within structural equation representations) exponentially expands the range of covariances that can be explored from within-construct generalised and dyadic covariances to both within- and between-construct generalised and dyadic covariances, as well as between-construct covariances of actor, partner, and relationship effects.

We believe that modelling the SRM within structural equation models, as demonstrated by the two papers by Ross and colleagues and Branje and colleagues, represents an important advancement in the field. The study by Branje and

colleagues highlights the utility of modelling multiple variables of interest simultaneously. A useful aspect of SRM is its ability to meaningfully analyse multivariate data. With multivariate data unbiased estimates of actor, partner, and relationship effects are obtained for each construct, and the interrelations of these effects across constructs can be modelled. Simultaneous analysis of multivariate data within a single structural equation model allows for the estimation of disattenuated correlations between the self- and other-report actor, partner, and relationship constructs (as well as cross-construct generalised and dyadic reciprocity covariances). The advantage to such a modelling approach, as opposed to examining the manifest correlations among these constructs, is that it provides more accurate estimates of cross-construct covariances because they are corrected for measurement error.

A second advantage of modelling the SRM within structural equation models is the ability to include mean-level information in the model (i.e., Means and Covariance Structures, or MACS, analysis; see Little, 1997; Little & Slegers, in press). By including a constant in the model, one could make comparisons of the *latent* mean levels across roles (e.g., do mothers provide more support than fathers, both in general or toward specific children?) or constructs (e.g., is self-reported support greater than others' reports for each actor, partner, or relationship?). Again, the greater accuracy and power in comparing means, variances, and covariances among latent variables, as opposed to manifest variables, is a key advantage of modelling the SRM within MACS modelling framework.

Martin and Ross (2005) also examined four-person families, here consisting of fathers, mothers, older siblings (*M* ages = 4.4 years and 6.3 years at Times 1 and 2), and younger siblings (*M* ages = 2.4 years and 4.4 years at Times 1 and 2), observing families six times at each of two waves separated by approximately 2 years. The current report goes beyond previous reports from these data by examining the interdependency among siblings and between parents and children and by placing an emphasis on gender differences. The authors present data in which the four combinations of brother / sister with age-of-siblings is balanced (i.e., 10 each of brother-brother, brother-sister, sister-brother, and sister-sister as older-younger sibling pairs). Despite studying similar family structures (i.e., four-person families) as Ross and colleagues and Branje and colleagues did, Martin and Ross take a somewhat different analytic approach. Specifically, they used a form of Kraemer and Jacklin's (1979) method of analysing interdependent data described by Seay and Kay (1983), which is based more on an analysis of variance framework than the regression framework utilised by Ross and colleagues and Branje and colleagues. This method could also be analysed as a structural equation model. This observation should come as no surprise to readers familiar with parallelism between ANOVA and regression, although the complexity of the variance partitioning procedures shown in the Appendix of Martin and Ross makes this translation more subtle. Interested readers should consult Kenny (1996).

Although each of the four studies discussed in this section report using the SRM approach, it is important to distinguish between analysing group interdependency versus dyadic interdependency. The need for this distinction is not a negative quality, but rather, as discussed later, illustrates the flexibility and similarities of the SRM and APIM. Card and colleagues most strictly apply the random-effects *group-based* SRM,

though they then subdivide the sociometric data to perform fixed-effects comparisons of interpersonal perception between boys and girls. Ross and colleagues and Branje and colleagues examine four-person families in which each individual has a specific role in the family, and thus model *small groups* as composed of distinguishable dyadic combinations. Martin and Ross also examine interactions within families, but here the analytic focus is primarily *dyadic* (i.e., inter-sibling aggression, parents' responses to child's aggression).

The Actor–Partner Interdependence Model (APIM)

Relative to the SRM, the APIM is a new development in the analysis of interdependent data. In contrast to the SRM, the APIM explicitly examines the potential mutual influence within dyadic (rather than group) contexts. Four articles of this Special Issue utilise this approach. Cook and Kenny (2005) provide a clear and accessible overview of the APIM, in which characteristics of individuals in dyads are examined in terms of actor and partner effects. As Cook and Kenny explain, the APIM can be analysed within the framework of multiple regression, structural equation modelling, or multilevel modelling. Before discussing this and related approaches in more detail, we briefly summarise the analytic approach taken in these four articles using the APIM. In this summary, we will emphasise the difference between distinguishable and exchangeable case dyads: With distinguishable dyads there is some meaningful manner by which to distinguish the two individuals across dyads (e.g., relationships between parents and children, relationships between older and younger siblings, or mixed-sex romantic relationships); whereas with exchangeable case dyads there is no relevant characteristic by which the individuals in the dyads can be consistently distinguished (e.g., same-sex friendships).

Cook and Kenny provided an example of the APIM by analysing data on interpersonal comfort, interpreted as attachment security, among mother-adolescent dyads. These dyads can be considered distinguishable cases, and were analysed in a straightforward manner using structural equation modeling.

Cillessen, Jiang, Laszkowski, and West (2005) apply the APIM to the study of adolescent same-sex friendships, examining actor and partner effects of social behaviour (physical and relational forms of aggression and prosocial behaviour) on friendship qualities. Because these are same-sex friendships, and the dyads are not distinguished on any other characteristic, these dyads can be considered exchangeable. The authors present bivariate correlations between individual's characteristics and the characteristics of their friendships. In contrast to common misconceptions, such correlations are unbiased estimates of the association—only the standard errors and resultant inferential tests are biased by dependency (e.g., Cohen, Cohen, West, & Aiken, 2003). In other words, the association between individuals within dyads, averaged across dyads, is an unbiased estimate of the population association; but the sample estimates of the population variance (and hence standard errors and significance tests) are biased by dependency (either underestimated or overestimated, depending on the direction and magnitude of correlation and dependency).

Cillessen and colleagues also present the intra-class correlation of similarity within friendship dyads and path analysis (i.e., structural equation modelling with manifest variables) testing the APIM of the social behaviour of both individuals in the friendship predicting individuals' reports of the friendship quality. Because the dyads are exchangeable, Cillessen and colleagues appropriately modify the APIM by equating the means and variances of the exogenous variables and endogenous residuals and the actor and partner paths across dyad members.

Burk and Laursen (2005) also examine friendships using the APIM, specifically evaluating several questions related to friends' agreement of friendship qualities, the contributions of actor and partner perceptions of friendship qualities to conflict, and the contributions of actor and partner perceptions of friendship qualities to several individual indices of adjustment. As with Cillessen and colleagues, Burk and Laursen examine same-sex friendships, which are exchangeable case dyads. Burk and Laursen, however, adapt an analytic approach quite different from Cillessen and colleagues: They analyse dyad average (between-dyad variance) and difference (within-dyad variance) scores. The reason that this approach is useful in the analysis of exchangeable case dyads is that relations among means and differences of different variables are not affected by which individual is considered in which position (as long as the position is consistent within the dyad in computation of difference scores for different variables). This approach was recommended by Kenny (1996) as an extension to the strategy of Kraemer and Jacklin (1979), represented in the paper by Martin and Ross. Although the approach of Martin and Ross was appropriate for the evaluation of gender (a dichotomous variable), it would have been inappropriate for the analyses of Burk and Laursen because their predictors were continuous (see Kenny, 1996). We note that, although Burk and Laursen chose to perform a series of univariate analyses rather than a more complex multivariate analysis, Kenny's (1996) more generalised extension can also be applied to multivariate analyses.

Adams, Bukowski, and Bagwell (2005) examine how children's aggression (an actor effect) and their friends' aggression (a partner effect) predict aggression 6-months later. Thus, this study applies the APIM to the study of friends' influence on aggressiveness. Adams and colleagues analysed 149 dyads (with no overlapping individuals) comprised of reciprocated (66 dyads) and unreciprocated (83) friendships. Such a data set creates difficulties in the analyses because the reciprocated friends can be considered exchangeable case dyads whereas the unreciprocated friends should be considered distinguishable case dyads. To manage this analytic difficulty, Adams and colleagues randomly assigned reciprocated friends to either the first or second position and analysed these data as if they were distinguishable cases. This approach represents a reasonable approach to managing a difficult analytic situation, given that they wanted to examine reciprocated friends (exchangeable cases) and unreciprocated friends (distinguishable cases) within the same set of analyses. Asymptotically, we expect that such an approach probably would not bias estimates of actor and partner effects; however, such an approach certainly does lead to lower power than would be obtained if these data from reciprocated friendships had been analysed using exchangeable case procedures. Nevertheless, this approach highlights the important fact that unique research questions regarding interdependency are going to

lead to unique analytic problems, for many of which clear answers are not available. Through the creative application of extant approaches, however, the researcher can still address these questions in a reasonable manner.

Together these four papers provide examples of the complexity of dyadic data as well as sophisticated approaches to the analysis of dyadic data in either the distinguishable or exchangeable case. Cook and Kenny explain methods by which distinguishable case dyads can be analysed within the APIM framework using either regression analysis, structural equation modelling, or multilevel modelling. We view the regression approach as the least sophisticated because (1) separate (rather than simultaneous) analyses must be performed, and (2) there is no potential for modelling latent variables (i.e., correction for unreliability). However, this approach may be useful to those who want to reconceptualise previously published data (e.g., in meta-analytic work) within the framework of the APIM. We view the use of structural equation or multilevel modelling as preferable, and it is likely that similar results are obtained using either approach. Another advantage of the structural equation approach (either with manifest or latent variables) is that it provides a graphical presentation format that is very intuitive and easily accessible for readers.

The three papers in this Special Issue examining exchangeable case dyads (i.e., same-sex friendships) present three different approaches to the APIM, each with advantages and disadvantages. The simultaneous analysis of distinguishable and exchangeable dyads by Adams and colleagues presented difficult analytic choices; these authors ultimately chose to perform analyses appropriate to distinguishable case dyads and asymptotically unbiased (but low in power) with exchangeable cases. The approach of Burk and Laursen utilises a variance partitioning approach; although providing accurate results, extending this approach to latent variable modelling is complicated (see Kenny, 1996). Cillessen and colleagues' modification of the distinguishable case APIM by equating parameters across individuals in the dyad has the advantages of being easily comprehensible and easily modified to model latent interrelations.

We would also like to note an approach to analysing dyadic data not represented among these articles, which represents a reasonable alternative in both the distinguishable and exchangeable cases: the correlation procedures described by Gonzalez and Griffin (e.g., 1997). This approach involves analysing a data set in which data from each dyad are entered twice, once for each of the two positions of the dyad members. In the exchangeable case (Griffin & Gonzalez, 1995), similarities among dyad members and relations among variables of each member (i.e., actor and partner effects) are calculated using Pearson correlations within the doubly entered data arrangement (with the N^* used for the computation of standard errors adjusted depending on the degree of dependence, ranging from $N^* = \text{number of dyads for complete dependence}$ to $N^* = \text{number of individuals for complete independence}$). With distinguishable cases (Gonzalez & Griffin, 1999), similar analyses are performed, but a dichotomous variable representing the order of the distinguishable cases is covaried from the correlations. While we see no apparent reason why this approach would be more (or less) appropriate than those used in this Special Issue, it does represent yet another alternative for researchers analysing either exchangeable or distinguishable case dyadic data.

Similarities and differences between the SRM and the APIM

In some ways, the SRM and the APIM can be viewed as similar variants of one another. Before discussing similarities between the two models, however, we would like to emphasise the necessity of precision in terminology. Cook and Kenny point out in a footnote, and we wish to emphasise here, the distinction between the terms actor and partner effects in SRM and in the APIM. In the SRM, actor effects refer to the unbiased estimates of an individual's perception or behaviour toward others in general, and partner effects refer to the unbiased estimates of an individual's tendency to be perceived or behaved toward by others in general. Unfortunately, researchers using the SRM sometimes refer to actor and partner variances, or degrees of individual differences among individual's estimated actor and partner effects, as effects.

We wish to reiterate this distinction between effects and variances in the SRM; the former refers to individuals' estimates and the latter refers to the variability within a group (often averaged across multiple groups). In the APIM the terms actor and partner effects have an entirely different meaning. Here, these effects refer to regression paths (or comparable measures of association) between a characteristic of one individual in the dyad with either another characteristic of that same individual (an actor effect) or with a characteristic of the other individual in the dyad (a partner effect). To summarise, actor and partner effects in the SRM refer to estimated means of individuals, actor and partner variances in the SRM refer to the degree of individual differences among individuals, and actor and partner effects in the APIM refer to associations between variables either within an individual or across individuals in a dyadic relationship.

Keeping these terminological distinctions in mind, it is possible to envision the APIM of dyadic contexts demonstrated in this Special Issue being generalised to group-level analyses. Here, actor effects would be interpreted in the same manner—as relations among characteristics of one individual (between either different characteristics or across time). However, partner effects could be extended by interpreting them not as specific to one partner but rather as generalised across interaction partners (see Kashy & Kenny, 2000). In other words, whereas analysis in the dyadic context views partner effects as the relation of a *specific* partner's characteristics of the individuals, a group extension would view partner effects as the relation of the *average* of the other members of the group on a variable with the individual's dependent variable.

Dyadic data could also be considered a special case of the SRM in which there is insufficient information to determine the mean levels of dyadic behaviour for both the actor and partner. Such consideration is useful conceptually, if not analytically. The minimum number of individuals per group in the SRM is four, which can be reduced to three if reciprocity is not estimated (i.e., fixed at zero; see Kenny & La Voie, 1984). With dyadic data, one can not disentangle actor and partner mean tendencies (i.e., actor and partner effects in SRM terminology); for example, if child A aggresses against child B, it is impossible to determine if this is because child A is aggressive in general, child B is likely to be victimised in general, or if there is a unique aggressor-victim relationship between child A and child B.

If children interact with multiple partners, consistencies in their actor effects across partners (e.g., tendencies to aggress

against others) and partner effects across actors (e.g., tendencies to be victimised) can be identified (as can relationship effects with multiple indicators, and reciprocity correlations). Considering the structural equation model representations of the SRM, dyads within families would be under-identified (i.e., one could not estimate actor and partner variances for two family members based on two observed variables representing the directional behaviours between the two individuals); three-person families (with roles) could be identified (with assumptions of equal loadings between dyadic interaction variables and latent actor and partner constructs); and four- (or more) person families are identified as demonstrated in these two papers.¹ If we consider the APIM conceptually as a special case of the SRM, we must remember that correlations in the APIM are computed across groups (dyads), whereas actor-actor, partner-partner, and actor-partner cross-construct correlations in the SRM are computed within each group and then averaged across groups.

Substantive advances of these works

Although we have focused much of our attention in this Commentary on the analytic details of the works of this Special Issue, we would be remiss if we did not comment on the important substantive advances made by these works. Here, we comment on the contributions of these works in understanding the family and peer group environments.

Four of these works provide insight into the interpersonal dynamics of family relations, each focusing on a specific aspect of the family. Branje and colleagues and Ross and colleagues each examine exchanges among fathers, mothers, and children in four-person families. The example provided by Cook and Kenny focused on dyadic mother-adolescent interactions. The study of Martin and Ross focused both on dyadic sibling interactions as well as triadic parental involvement in these interactions. We will briefly discuss each of these in turn.

Branje and colleagues examined perceptions of agreeableness and the receipt of support among parents and adolescent children; their application of the SRM allowed them to detect associations both in general (e.g., fathers who are seen as agreeable are reported to provide more support) and within specific relationships (e.g., fathers who are seen as agreeable by older children are reported to provide more support to older children). Interestingly, the findings showed that being perceived as agreeable in general does not translate into the receipt of more support in general; instead, being perceived as agreeable by a specific family member translates into support only from that family member. Together, these findings suggest both generality and specificity in the interpersonal perceptions within families, but only specificity in the elicitation of support from other family members.

Ross and colleagues examined family members' appraisals of the quality of their relationships with one another. Their findings suggest differences in mean levels of quality between different roles (e.g., parent-child relationships are seen more positively than sibling relationships). The inclusion of both self and other report provides information on the degree of bias within intra-family relationship quality. These results indicated that some family members tended to exhibit biases across relationships (e.g., younger children exhibited positive self bias across relationships with all family members), whereas others varied in their biases across relationship partners (e.g., mothers exhibited positive self bias with their children and negative self bias with their husbands). These findings, as well as those of Branje and colleagues, highlight the importance of considering the specific dyadic relationships that are present within the larger family system.

Although Cook and Kenny presented data primarily to demonstrate analysis using the APIM, this work adds to prior contributions by Cook (2000, 2001) by demonstrating the mutual influence² between mothers' and adolescents' comfort with one another. The authors also examine how the child's age might moderate these effects. This example provides further demonstration of the interpersonal family processes demonstrated by Ross and colleagues and Branje and colleagues.

Martin and Ross examined various forms of aggression among siblings, with a focus on gender differences in acts of aggression and in parents' responses to sibling aggression. Relative to the study of aggression in the peer group, inter-sibling aggression has received little empirical attention. The results of this study reveal important differences in rates of aggression depending on the sex of both the aggressor and target. Although gender differences in parents' responses to aggression were rather inconsistent, this direction of research has potentially important implications for the socialisation of gender differences in aggression. If a larger sample were available (which might also clarify the noted inconsistencies), it would be interesting to test whether the gender differences in parents' responses fully or partially account for gender differences in behaviour (ideally in longitudinal studies).

The other four papers of this Special Issue focus on the peer context. Three of these examine friendships, whereas Card and colleagues look at interpersonal perception within the peer group. Specifically, this latter study examined interpersonal perception of various aspects of aggression and social status both in general and among boys and girls, testing two theoretically driven hypotheses about gender differences in interpersonal perception. The translation and testing of existing theories within the emergent interpersonal models such as the SRM and APIM represents an important direction for future work.

Cillessen and colleagues considered the impact of individual's social behaviour (aggression and prosocial) on the

¹ As a technical note, one should be aware that the actor and partner effects in the SRM in which individuals are exchangeable approximate the row and column means, respectively, of the sociomatrix only in very large groups; there is a correction in the calculation of actor and partner effects, which becomes increasingly substantial in smaller groups because individuals do not interact with a peer identical to themselves in terms of their partner or actor effects, respectively (see Appendix B of Kenny, 1994).

² We use the phrase "mutual influence" somewhat loosely here. According to the more precise definitions provided by Kenny (1996), the process modelled in the example of Cook and Kenny should specifically be termed partner effects. The term mutual influence would refer to a different model in which only intra-individual paths between the independent and dependent variables are modelled, and the only inter-individual influence is the modelling of reciprocal causal paths between the two individual's dependent variables (see Kenny, 1996).

quality of their friendships, and Burk and Laursen examined the contributions of friendship qualities on the qualities of conflict within the friendships, as well as on the individual's adjustment. An important advancement of both of these studies is the consideration of friends' agreement on relational qualities (i.e., friendship and conflict qualities) and the contributions of both friends' characteristics and perceptions to the quality of the friendship. Although results generally indicated greater actor effects than partner effects, there was some evidence that partner effects provided additional predictive power. An important detail of these studies was the reliance on multireporter assessments; studies relying only on self-reports would be expected to contaminate actor effects with shared rater variance, yet these authors use multiple reporters (e.g., peers, teachers) to avoid this confound in many of their analyses.

The study by Adams and colleagues is unique in examining both reciprocated and unreciprocated friends within the same set of analyses. This represents a significant substantive advancement in our understanding of the influence of friendships. Too often in studies of childhood friendships, individuals without reciprocated friends are excluded from analysis. Moreover, there is little prior work distinguishing the impact of unreciprocated and reciprocated friends. This study considers young people with and without reciprocated best friendships, and finds that the socialising influence on aggression is modestly greater within reciprocated than unreciprocated friendships.

We would like to note that although three of the papers examining the peer context focused on friendships, the APIM is in no way limited to these types of relationships. Further work applying this conceptual and analytic approach to the study of romantic relationships, antipathetic relationships, and aggressor-victim dyads all are potentially fruitful avenues for research. The application of the SRM as applied to family systems by Ross and colleagues and Branje and colleagues might also be used to study peer relations; there exist numerous role classifications within the peer relations literature (e.g., sociometric classifications) that could meaningfully be used as a framework to explore interpersonal perception, affect, and behaviours.

Future directions in analytic strategies

Although the papers of this Special Issue represent substantial advances in the analysis of interdependent data in developmental research, they also point to the need for further advancement in analytic techniques. We note three limitations that warrant discussion.

As seen among the works by Cook and Kenny, Adams and colleagues, Burk and Laursen, Cillessen and colleagues, and Martin and Ross, there exist multiple approaches to analysing dyadic data, all of which are perfectly valid. We also pointed out the correlational approaches advocated by Gonzalez and Griffin (1997, 1999; Griffen & Gonzalez, 1995) as another alternative. Given these multiple options, further work is needed in comparing these approaches. Opinions could be offered regarding the relative transparencies of the different approaches, adaptability to both distinguishable and exchangeable dyad situations, and ability to model latent constructs, and we have hinted at our preferences earlier. However, simulation work is needed regarding how well these approaches perform

given various sample sizes, degrees of dyadic interdependence, and distribution properties (e.g., violations of normality, noninterval measurement) before solid recommendations among these alternatives can be offered.

Another important future direction is the development of appropriate methods of handling missing data. A common approach is simply to drop individuals or families with missing data; however, this practice is well known to bias parameter estimates and decisions of inference. Another approach to missing data is to impute using algorithms developed under assumptions of interdependence. Although this approach is certainly preferable to deletion of cases (individuals, dyads, or families) with missing data, we believe that further advances in missing data estimation are needed. Specifically, if we know that interdependence is evident within our data, then this interdependence should be part of the imputation model. The development of techniques considering this interdependence in the imputing of missing data represents an important future direction.

Developmental research is inherently dependent on longitudinal results, yet methods of modelling longitudinal research in the SRM and APIM are lacking. Cook and Kenny noted that the APIM is adaptable to longitudinal designs, including analysis of longitudinal trajectories of individuals within dyads or time-series analysis of dyads over numerous time points. However, the methods of analysing these longitudinal patterns within the other dyadic analytic approaches are unclear. Moreover, modelling of longitudinal processes in the SRM is a topic that is virtually unexplored. We believe that appropriate techniques for modelling longitudinal processes within interdependent data represents one of the most critical future directions for applying the SRM and APIM in developmental research.

Conclusions

As mentioned, developmental research is inherently a study of interpersonal interactions, yet the field has generally relied on traditional analytic techniques that assume independence of cases. The papers presented in this Special Issue provide us with a variety of ways in which the interdependence of interpersonal interactions can be analysed accurately. More importantly, however, these papers offer us terrific examples of how the various analytic models also function as informative conceptual models. That is, the various modelable aspects of interpersonal interactions become grist for theorising about their basic nature, their developmental unfolding, and their mediating and moderating functions.

References

- Adams, R. E., Bukowski, W. M., & Bagwell, C. (2005). Stability of aggression during early adolescence as moderated by reciprocated friendship status and friend's aggression. *International Journal of Behavioral Development, 29*, 139–145.
- Branje, S. J. T., Van Aken, M. A. G., & Van Lieshout, C. F. M. (2002). Relational support in families with adolescents. *Journal of Family Psychology, 16*, 351–362.
- Branje, S. J. T., Van Aken, M. A. G., Van Lieshout, C. F. M., & Mathijssen, J. J. P. (2003). Personality judgments in adolescents' families: The perceiver, the target, their relationship, and the family. *Journal of Personality, 71*, 49–81.
- Branje, S. J. T., Van Lieshout, C. F. M., & Van Aken, M. A. G. (2005). Relations between Agreeableness and perceived support in family relation-

- ships: Why nice people are not always supportive. *International Journal of Behavioral Development*, 29, 120–128.
- Burk, W. J., & Laursen, B. (2005). Adolescent perceptions of friendship and their associations with individual adjustment. *International Journal of Behavioral Development*, 29, 156–164.
- Card, N. A., Hodges, E. V. E., Little, T. D., & Hawley, P. H. (2005). Gender effects in peer nominations for aggression and social status. *International Journal of Behavioral Development*, 29, 146–155.
- Cillessen, A. H. N., Jiang, X. West, T. V., & L., Laszkowski, D. K. (2005). Predictors of dyadic friendship quality in adolescence. *International Journal of Behavioral Development*, 29, 165–172.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression / correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum Associates Inc.
- Coie, J. D., Cillessen, A. H. N., Dodge, K. A., Hubbard, J. A., Schwartz, D., Lemerise, E. A., & Bateman, H. (1999). It takes two to fight: A test of relational factors and a method of assessing aggressive dyads. *Developmental Psychology*, 35, 1179–1188.
- Cook, W. L. (1993). Interdependence and the interpersonal sense of control: An analysis of family relationships. *Journal of Personality and Social Psychology*, 64, 587–601.
- Cook, W. L. (1994). A structural equation model of dyadic relationships within the family system. *Journal of Consulting and Clinical Psychology*, 62, 500–509.
- Cook, W. L. (2000). Understanding attachment security in family context. *Journal of Personality and Social Psychology*, 78, 285–294.
- Cook, W. L. (2001). Interpersonal influence in family systems: A social relations model analysis. *Child Development*, 72, 1179–1197.
- Cook, W. L., & Kenny, D. A. (2004). Application of the social relations model to family assessment. *Journal of Family Psychology*, 18, 361–371.
- Cook, W. L., & Kenny, D. A. (2005). The Actor-Partner Interdependence Model: A model of bidirectional effects in developmental studies. *International Journal of Behavioral Development*, 29, 101–109.
- Delsing, M. J. M. H., Oud, J. H. L., De Bruyn, E. E., & Van Aken, M. A. G. (2003). Current and recollected perceptions of family relationships: The Social Relations Model approach applied to members of three generations. *Journal of Family Psychology*, 17, 445–459.
- Gonzalez, R., & Griffin, D. (1997). On the statistics of interdependence: Treating dyadic data with respect. In S. Duck (Ed.), *Handbook of personal relationships* (2nd ed., pp. 271–302). New York: Wiley.
- Gonzalez, R., & Griffin, D. (1999). The correlational analysis of dyad-level data in the distinguishable case. *Personal Relationships*, 6, 449–469.
- Griffin, D., & Gonzalez, R. (1995). Correlational analysis of dyad-level data in the exchangeable case. *Psychological Bulletin*, 118, 430–439.
- Hubbard, J. A., Dodge, K. A., Cillessen, A. H. N., Coie, J. D., & Schwartz, D. (2001). The dyadic nature of social information processing in boys' reactive and proactive aggression. *Journal of Personality and Social Psychology*, 80, 268–280.
- Kashy, D. A., & Kenny, D. A. (2000). The analysis of data from dyads and groups. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 451–477). New York: Cambridge University Press.
- Kenny, D. A. (1994). *Interpersonal perception: A social relations analysis*. New York: Guilford.
- Kenny, D. A. (1996). Models of non-independence in dyadic research. *Journal of Social and Personal Relationships*, 13, 279–294.
- Kenny, D. A., Albright, L., Malloy, T. E., & Kashy, D. A. (1994). Consensus in interpersonal perceptions: Acquaintance and the big five. *Psychological Bulletin*, 116, 245–258.
- Kenny, D. A., & La Voie, L. (1984). The social relations model. In L. Berkowitz (Ed.), *Advances in experimental social psychology*, Vol. 18 (pp. 141–182). Orlando, FL: Academic Press.
- Kenny, D. A., Mohr, C. D., & Levesque, M. J. (2001). A social relations variance partitioning of dyadic behavior. *Psychological Bulletin*, 127, 128–141.
- Kraemer, H. C., & Jacklin, C. N. (1979). Statistical analysis of dyadic social behavior. *Psychological Bulletin*, 86, 217–224.
- Little, T. D. (1997). Mean and covariance structures (MACS) analyses of cross-cultural data: Practical and theoretical issues. *Multivariate Behavioral Research*, 32, 53–76.
- Little, T. D., & Slegers, D. (in press). Factor analysis: Multiple groups with means. In D. Rindskopf (Section Ed.), *Encyclopedia of statistic in behavioral sciences*. Chichester, UK: Wiley.
- Malloy, T. E., & Kenny, D. A. (1986). The social relations model: An integrative method for personality research. *Journal of Personality*, 54, 199–225.
- Malloy, T. E., Sugarman, D. B., Montvilo, R. K., & Ben-Zeev, T. (1995). Children's interpersonal perceptions: A social relations analysis of perceiver and target effects. *Journal of Personality and Social Psychology*, 68, 418–426.
- Malloy, T. E., Yarlas, A., Montvilo, R. K., & Sugarman, D. B. (1996). Agreement and accuracy in children's interpersonal perceptions: A social relations analysis. *Journal of Personality and Social Psychology*, 71, 692–702.
- Martin, J. L., & Ross, H. S. (2005). Sibling aggression: Sex differences and parents' reactions. *International Journal of Behavioral Development*, 29, 129–138.
- Ross, H. S., & Lollis, S. P. (1989). A social relations analysis of toddler peer relations. *Child Development*, 60, 1082–1091.
- Ross, H., Stein, N., Trabasso, T., Woody, E., & Ross, M. (2005). The quality of family relationships within and across generations: A social relations analysis. *International Journal of Behavioral Development*, 29, 110–119.
- Scarpatti, S., Malloy, T. E., & Fleming, R. (1996). Interpersonal perception of skill efficacy and behavioral control of adolescents with learning disabilities: A social relations approach. *Learning Disability Quarterly*, 19, 15–22.
- Seay, M. B., & Kay, E. J. (1983). Three-way analysis of dyadic social interactions. *Developmental Psychology*, 19, 868–872.